



Data Integration Using GIS Systems and Improved Risk Modeling Boardwalk Pipeline Partners

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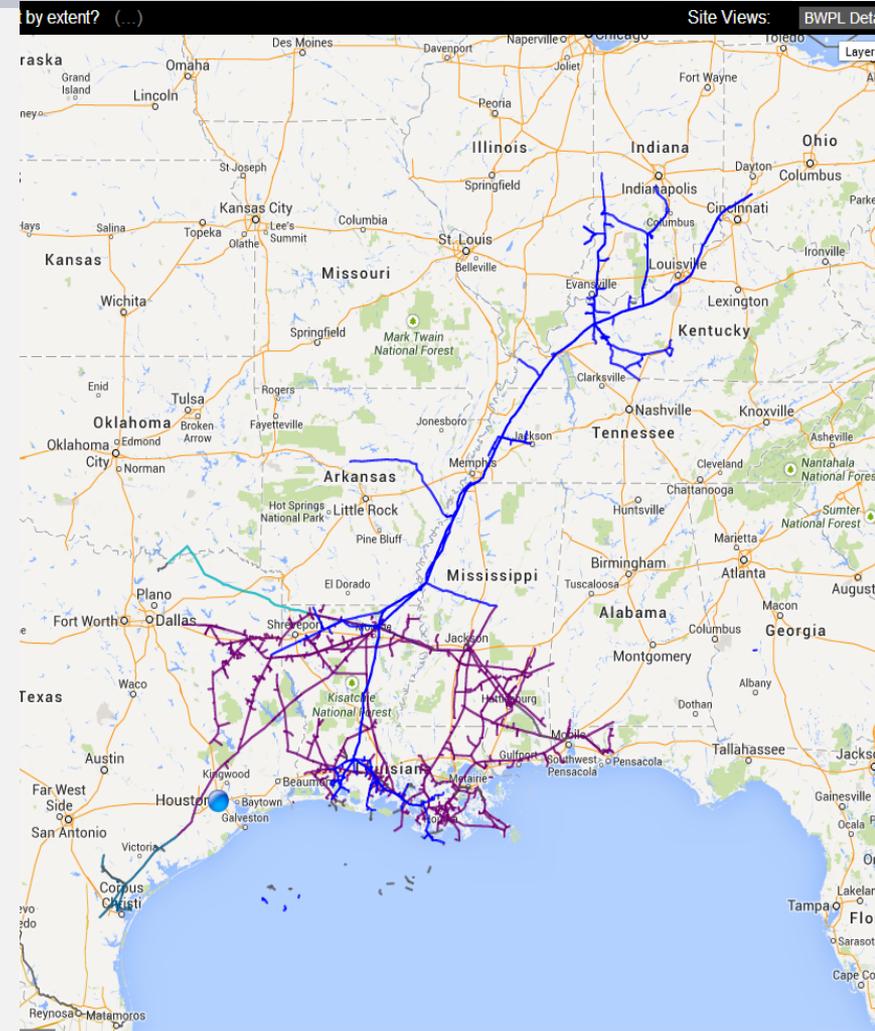
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About Boardwalk

- Boardwalk Pipeline Partners is a midstream company consisting of:
 - Gulf South Pipeline
 - Texas Gas Pipeline
 - Gulf Crossing Pipeline
 - Boardwalk Field Services (*gas processing*)
 - Boardwalk Storage Company
 - Boardwalk Louisiana Midstream (*Liquids transmission and storage*)
- 13 storage fields, 387 BCF working gas
- 9 liquids storage salt domes, 31 MMbbls
- 68 compressor stations
- 14,500 miles of gas transmission piping
- 580 miles of liquid piping





Know Your System !

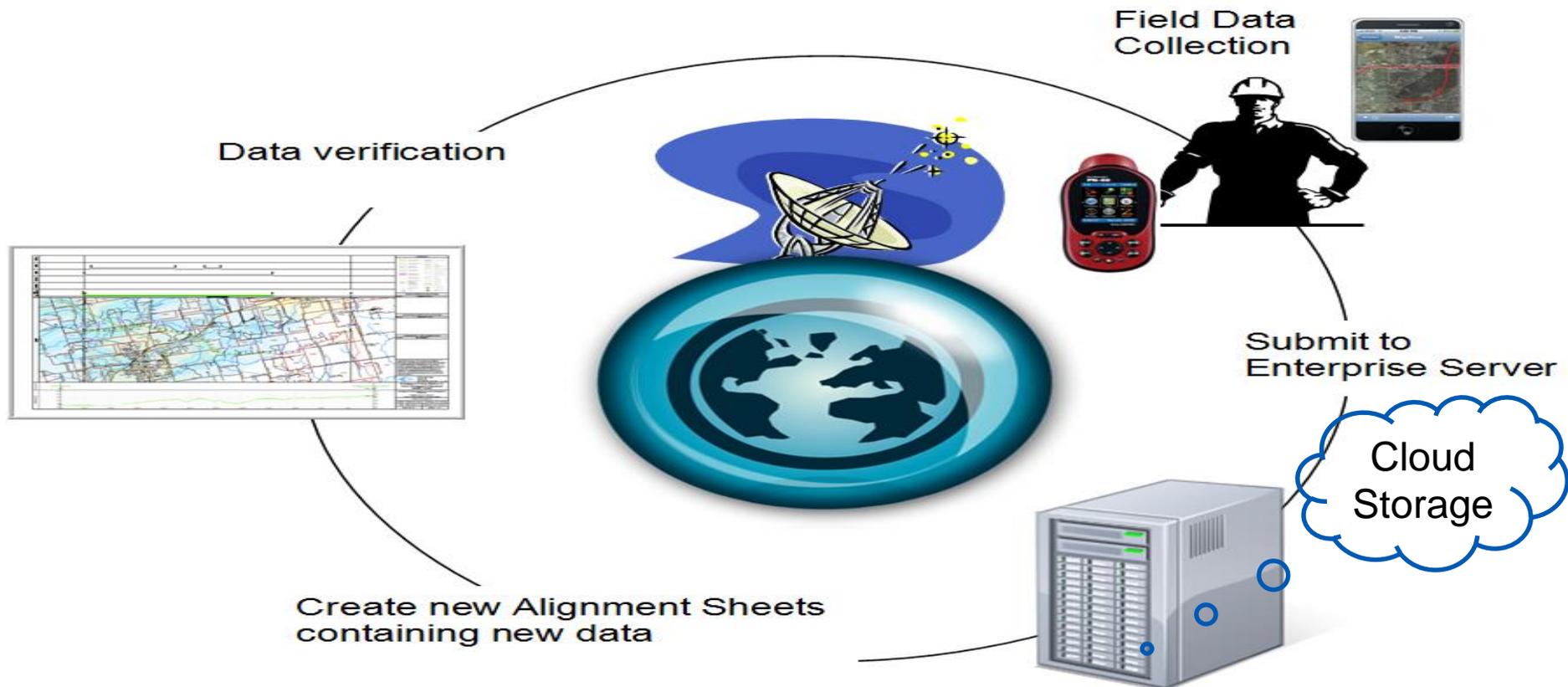
- Implement a Google-engine driven, cloud based GIS and Risk viewers to provide on-demand access to integrity data to ALL employees Anywhere, and on Any device (PC and mobile devices).
- Ability to view risk scores instantaneously.
- Ability to view updated alignment sheets and valve maps.
- Ability to view HCA boundaries, Class boundaries.
- Ability to view pipe material records, hydrotests, ILI anomalies, CIS data, etc.
- Develop and use Mobile Smart Forms to allow for accurate collection of data using iPhone or Ipad.
- KEYS – Simplicity, Efficiency, Accuracy



GIS System

Boardwalk GIS Implementation

Create an infrastructure that will modernize field data collection, simplify data validation efforts and data access, improve risk mitigation, and empower field Operations to know their systems, know the risks, and manage the integrity of their assets.



PODS ESRI Spatial Model

- 1) Migrated all subsidiaries to a uniform platform, PODS ESRI Spatial model.
- 2) Data verification, validation, and clean up – identify missing data elements
- 3) Allow the use of tools that are native to the ESRI environment
- 4) Integrated automated alignment sheets (Turboroute – Eagle/G2), HCA, MAOP, BAP, and Risk tools (Geonamic)
- Additional external data sources also synced with the new GIS:
 - Corrosion data (PCS/CPDM)
 - OneCall (IRTHnet) tickets for Third Party Damage data
 - In Line Inspection data
 - Pipeline maintenance and repair data
 - Close Interval Survey data

Implemented A Cloud Based Computing Data Solution

- Completely cloud based GIS
 - Amazon (EC2) Elastic Compute Cloud environment
 - Data-center, IT & Security teams supporting the BWP GIS infrastructure with Managed Service Level Agreements (SLA)
- Elasticity – Virtualized Hardware
 - If BWP needs more computer resources, BWP can add them rapidly
 - If fewer BWP computer resources are needed, BWP can reduce them rapidly
- All groups access GIS web viewer in the same way
 - Whether in Texas, Kentucky, Egypt or China ...
 - If you have Internet, you have access to Visual GIS (explicit permission for Boardwalk employees only)



HCA and Class Tools

ROW Aerial Imagery Update

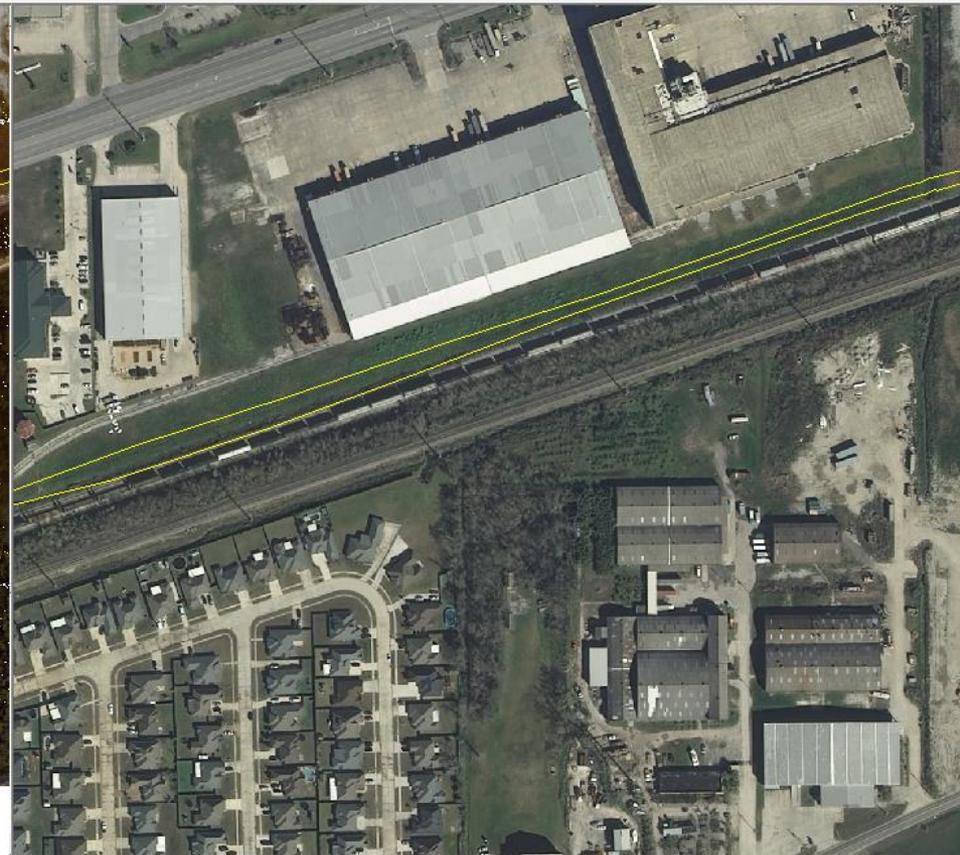
- Previous USDA Imagery VS New Photo Science Hi-Res Imagery
(2017 – a system-wide effort to re-validate all HCAs)



PHMSA Bulletin -
HCAs - 2016-2988C

USDA Imagery

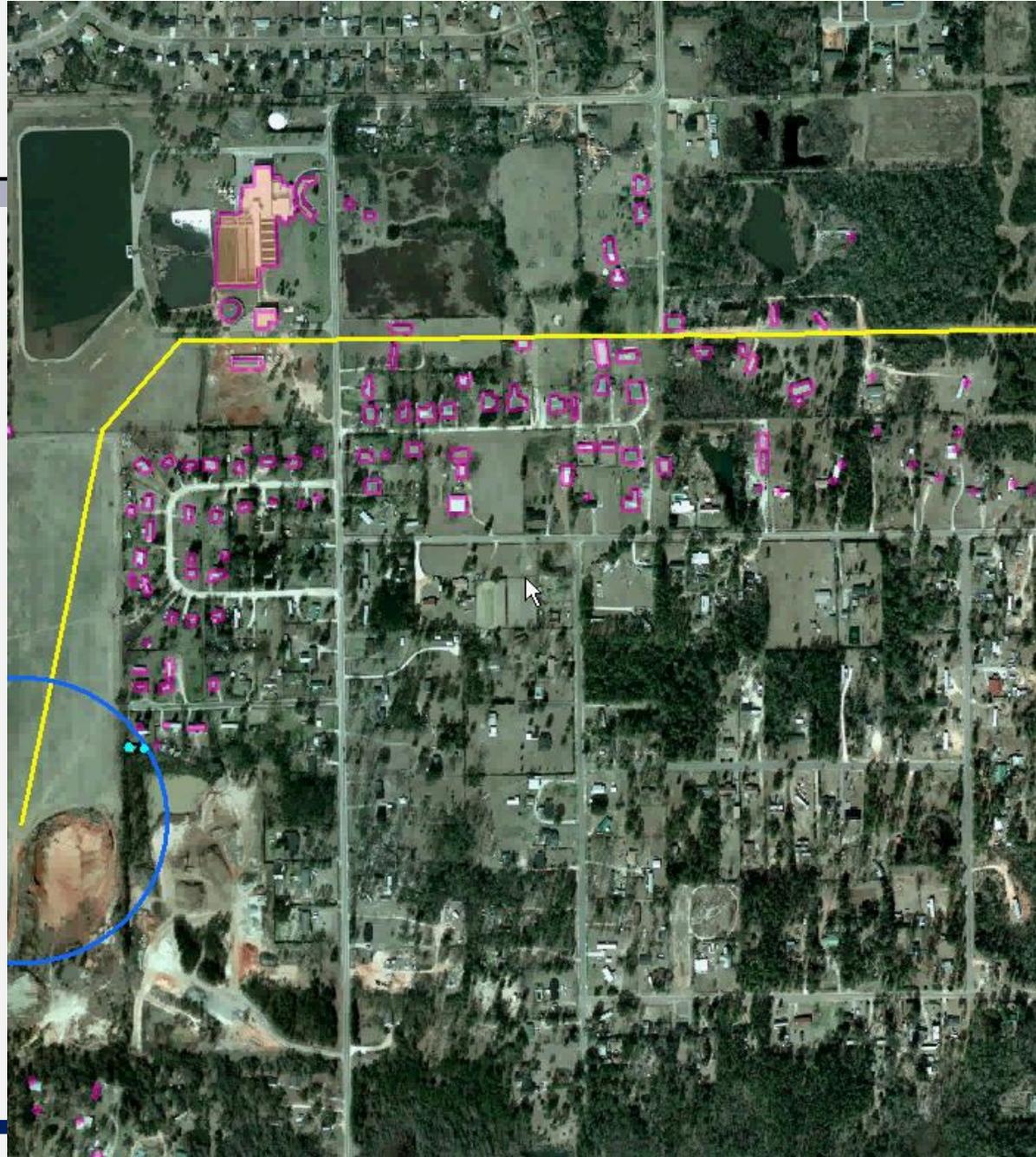
Hi-Res Imagery



**Automated
HCA
Calculator**



**Automated
CLASS
Calculator**





BAP Tool

Baseline Assessment Plan (BAP) Application

- Manages all integrity assessments for HCAs
- Fully integrated with the new Risk model
- Will review Risk and Threat scores, comparing changes from previous years
- Integrated with the Integrity Management Plans “rules” for proper assessment selections based on threats.

HCA review based on Risk and Threats

Review/Override HCA Threats Filter

General
 Company: ALL
 Pipeline: ALL
 HCA Name: 2003 - SLE 12-1TT - 315

Status
 Decreased
 Increased
 New
 Unchanged Apply

HCA List
 Boardwalk Field Services, LLC.
 Boardwalk Louisiana Midstream, LLC.
 Gulf Crossing Pipeline Company, LLC.
 Gulf South Pipeline Company, LP.
 Petal Gas Storage, LLC.
 Texas Gas Transmission, LLC.
 SLE 12-1TT-01 MP 34+2983 - MP 37+4133

2013 HCA
 Name: 2003 - SLE 12-1TT - 315 ID: 1380233
 Company: Texas Gas Transmission, LLC.
 Pipeline: SLE 12-1TT-01 MP 34+2983 - MP 37+4133
 Length(ft): 3482.0 From: 34+2983 To: 35+1086
 Status: **Unchanged** Determination Date: 12/05/2003

Threat	Score	Existence	Override	Identified Date
Construction	1.95	No		
Equipment	0.34	Yes		04/12/2013
External Corrosion	1.29	Yes		04/12/2013
Incorrect Operations	0.79	Yes		04/12/2013
Internal Corrosion	1.18	Yes		04/12/2013
Manufacturing - Hard Spot	0.00	No		
Manufacturing - Pipe Wall	0.00	No		
Manufacturing - Unstable Seam	0.83	No		
SCC - High pH	0.03	No		
SCC - Near Neutral	0.07	Yes		04/12/2013
Third Party	1.95	Yes		04/12/2013
Weather and Outside Force	1.00	No		

Threat Override Comments

Threat Override Date:

Save Cancel

2012 HCA
 Name: 2003 - SLE 12-1TT - 315 ID: 1379089
 Company: Texas Gas Transmission, LLC.
 Pipeline: SLE 12-1TT-01 MP 34+2983 - MP 37+4133
 Length(ft): 3482.0 From: 34+2983 To: 35+1086
 Determination Date: 12/05/2003

Threat	Score	Existence	Override	Identified Date
Construction	1.95	No		
Equipment	0.34	Yes		04/12/2013
External Corrosion	1.47	Yes		04/12/2013
Incorrect Operations	0.79	Yes		04/12/2013
Internal Corrosion	1.18	Yes		04/12/2013
Manufacturing - Hard Spot	0.00	No		
Manufacturing - Pipe Wall	0.00	No		
Manufacturing - Unstable Seam	0.83	No		
SCC - High pH	0.03	No		
SCC - Near Neutral	0.07	Yes		04/12/2013
Third Party	1.92	Yes		04/12/2013
Weather and Outside Force	1.00	No		

Active Mandatory Assessment Segments Covering the HCA

Segment Name	Assessment Method	Execution Compliance Date	Planned Completion Year	Planned Completion Date	Last Assessment Date	Reassessment Interval	Covered
JMP 2018 SLE 12-1TT ILL-N HCA 315 ILL (HPL/Deformation Combo-Nitrogen Run)		12/31/2017	2017		12/31/2011		2003 - SLE 12-

Assessment Segment Range

Company	Pipeline	Route	From Region and District	To Region and District	From MP+Footage	To MP+Footage
Texas Gas Transmis	SLE 12-1TT-01 MP 34+2983 - MP 37+4133	SLE 12-1TT	TGT NORTH PETERSBUJ	TGT NORTH PETERSBUJ	34 + 2983	35 + 1086

Review/Update Assessment Segments Export Assessment Segments

HCA, MCA, USA

- It is not *only* about HCAs or MCAs, or USAs.
- Recent ruptures and failures in non-HCAs have been extremely costly to operating companies (examples)
 - Recent corrosion failure at girth weld
 - Recent corrosion failure in a casing
 - Recent hard spot failure
- It is about Safety: protecting the people, the environment, and greatly reducing risk for the company



MAOP Automatic Calculation and MAOP Validation Tool

Maximum Allowable Operating Pressure (MAOP) Application

- The tool has several screens to show the individual SMAOP calculations.
- Each section of the PHMSA code that has a bearing on a SMAOP calculation is represented.
- Every code section calculation is displayed, along with the limiting SMAOP basis.
- Graphics help the user understand the calculation paths.

Data and Graphics to Illustrate the Basis of Each MAOP Calculation

The screenshot displays the Geosomatic MAOP Calculator - TG software interface. It consists of several main components:

- Data Table (Left):** A table listing pipeline sections with columns: Line ID, Line Name, Description, Begin Milepost, Begin Plus/Offset, End Milepost, and End. The table shows multiple sections, with one section highlighted in red.
- Parameters Pane (Center):** A list of parameters used in the calculation, including:
 - # Computer Calculated SMAOP - TG: 900
 - MAOP Determination Method: 192.619(a)(1)
 - # 192.619(a)(1) - Design Pressure (Determine MAOP Based Pipe Strength): 900
 - 192.107 - SMYS: 60000
 - 192.105(a) & 192.109 - Wall Thickness: 0.25
 - Pipe Diameter: 20
 - # 192.113 - Seam Factor: 1
 - Loss Seam: ELEC RESIST
 - 192.115 - Temperature Derating Factor: 1
 - # 192.105 - Design Factor: 0.6
 - 192.5 - Class Location: 2
 - 192.111(d)(1) - Compressor/Regulator/Measuring Station?: N
 - 192.111(d)(2) - Riser or Deck Pipe in Nav. Waterway?: N
 - # 192.111(b)(1)(2) - Public Road or Railroad Crossing?: N
 - # 192.13 and DOT P-77-013 Interpretation Dated 5/11/97 - Was road/railroad?: N
 - Road/Rail/Road Install Date: 1/1/1989
 - # 192.111(b)(3) - Is pipe on bridge?: N
 - RoadType: 192.111(b)(4) - Fabricated Assembly?: N
 - # 192.111(b)(2) - Is Road/Rail/Road closed?: 1/1/1989
 - Pipe Installation Date: N
 - # 192.611 and DOT Interpretation P-77-024 - Has class increased?: 2
 - 192.5 - Class Location: 2
 - Previous Class: 2
 - 192.505(c) - Test Hours: 8
 - # 192.619(a)(1): ignore
 - # 192.619(a)(1)(i): ignore
 - # 192.619(a)(1)(ii): ignore
 - # 192.619(a)(2) - Test MAOP: 1200
 - Pipe Installation Date: 1/1/1989
 - Test Pressure Qualified?: Y
 - Test Date: 11/5/1989
 - 192.505(c) - Test Hours: 8
 - 192.619(a)(2)(i) - Test Pressure: 1500
 - # 192.619(a)(2)(ii) - Test Factor: 1.25
 - # 192.611 - Change in Class Location: N
 - 192.5 - Class Location: 2
 - Previous Class: 2
 - 192.505(b) - Compressor Regulator or Measuring Station Qualification?: N
 - # 192.619(a)(2)(iii) Subnote 1 - Riser or Deck on Platform in Navigable Water: N
 - # 192.14 - Convert from other service or 192.505(a) Building within 300 ft?: N
 - # 192.505(a) - Building within 300 ft?: N
 - # Pipe Status: N
- Flowchart (Right):** A decision tree diagram showing the logic of the calculation. It starts with a decision diamond '(TestPreAvailable) = Y?'. If 'Yes', it leads to a box '1200'. If 'No', it leads to another diamond '(TestLength) >= 4'. From there, it branches based on 'Yes' or 'No' answers to various conditions, eventually leading to a final MAOP value of 900.
- Summary Table (Bottom Right):** A small table summarizing the logic steps:

Step	Logic	Value
1	(TestPreAvailable) = Y	True
2	(TestLength) >= 4	True
3	192.619(a)(2) - Test MAOP = ((TestPressure) / (TestFactor)) * ((NominalWallThicknessCL) / (NominalDiameterCL)) * 0.25, 192.619(a)(4)(i), 0	
- Bottom Panel:** Shows the calculated MAOP (900), current MAOP (1080), and buttons for 'What If?' and 'Calculate'.

Maximum Allowable Operating Pressure (MAOP) Application

- The tool allows the user to understand not only the individual SMAOP calculations, but which SMAOP calculation may result in an overall lowering of a MAOP.
- 2-step approvals and publishing screens are built into the tool for safety and security

Reviewing the Results (each record in red has a calculated SMAOP lower than the current MAOP):

Type	Approved?	Approved By (GIS-Operator)	Approved By (GIS-Approval)	Established By?	Comments	RouteID	Line Name	RecordType	BeginMeasure	EndMeasure	BeginMilepost	BeginPipefootage	EndMilepost	EndPipefootage	Calculated SMAOP	Current SMAOP
Segment Maximum Allowable Operating Pressure		corley_j				800	BEI 20-TT	PIPELINE	0	76	0	80	0	156	99	99
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	76	1356	0	156	0	1436	1473	1473
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	1326	1326	0	1406	0	1406	1473	1473
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	1356	14121	0	1436	2	3500	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	8609	8609	1	3352	1	3352	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	14121	14662	2	3590	2	4131	900	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	14662	14725	2	4131	2	4194	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	14687	14687	2	4156	2	4156	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	14725	15434	2	4194	2	4903	900	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	15434	15500	2	4903	2	4969	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	15464	15464	2	4933	2	4933	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	15500	16805	2	4969	3	1002	900	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	16805	17058	3	1002	3	1255	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	16951	16951	3	1148	3	1148	1200	1200
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	17058	17809	3	1255	3	2006	900	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	17809	17857	3	2006	3	2054	900	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	17857	19912	3	2054	3	4000	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	19912	19975	3	4000	3	4063	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	19933	19933	3	4021	3	4021	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	19975	21030	3	4063	4	744	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	21030	21070	4	744	4	784	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	21070	26446	4	784	4	5260	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	26446	26452	4	5260	5	0	1364	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	26452	26496	5	0	5	43	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	26499	26499	5	7	5	7	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	26496	30660	5	43	5	4208	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	30660	30723	5	4208	5	4271	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	30691	30691	5	4239	5	4239	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	30723	32507	5	4271	6	756	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	32507	32570	6	756	6	819	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	32539	32539	6	788	6	788	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	32570	39578	6	819	7	2584	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	39578	39641	7	2584	7	2647	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	39603	39603	7	2609	7	2609	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	39641	44810	7	2647	8	2318	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	44810	44873	8	2318	8	2381	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	ROAD CROSSING	44841	44841	8	2349	8	2349	1364	1364
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	44873	46222	8	2381	8	3930	1080	1080
Segment Maximum Allowable Operating Pressure		AUTO	corley_j			800	BEI 20-TT	PIPELINE	46222	46302	8	3930	8	4010	1364	1364



Automatic Alignment Sheet Generation



GIS Viewer

IntegraLink

Benefits of GIS Viewer

- Simple and easy access from anywhere.
- No more calls on “Where is the HCA? What class is it? What is the MAOP here? What type of pipe and coating? How old is this line? Do we have a valid hydrotest? Any line crossings? ...
- Mobile “smartforms” to collect data (recoats, dig inspections, replacements, re-routes) and uploaded electronically to GIS QA server.
- Operational personnel are identifying errors in the records, alignment sheets, valve maps, etc. *That is Perfect! Now you have hundreds of eyes in the field to help validate your data.*



VLLA446 Original



VLLA446 Updated



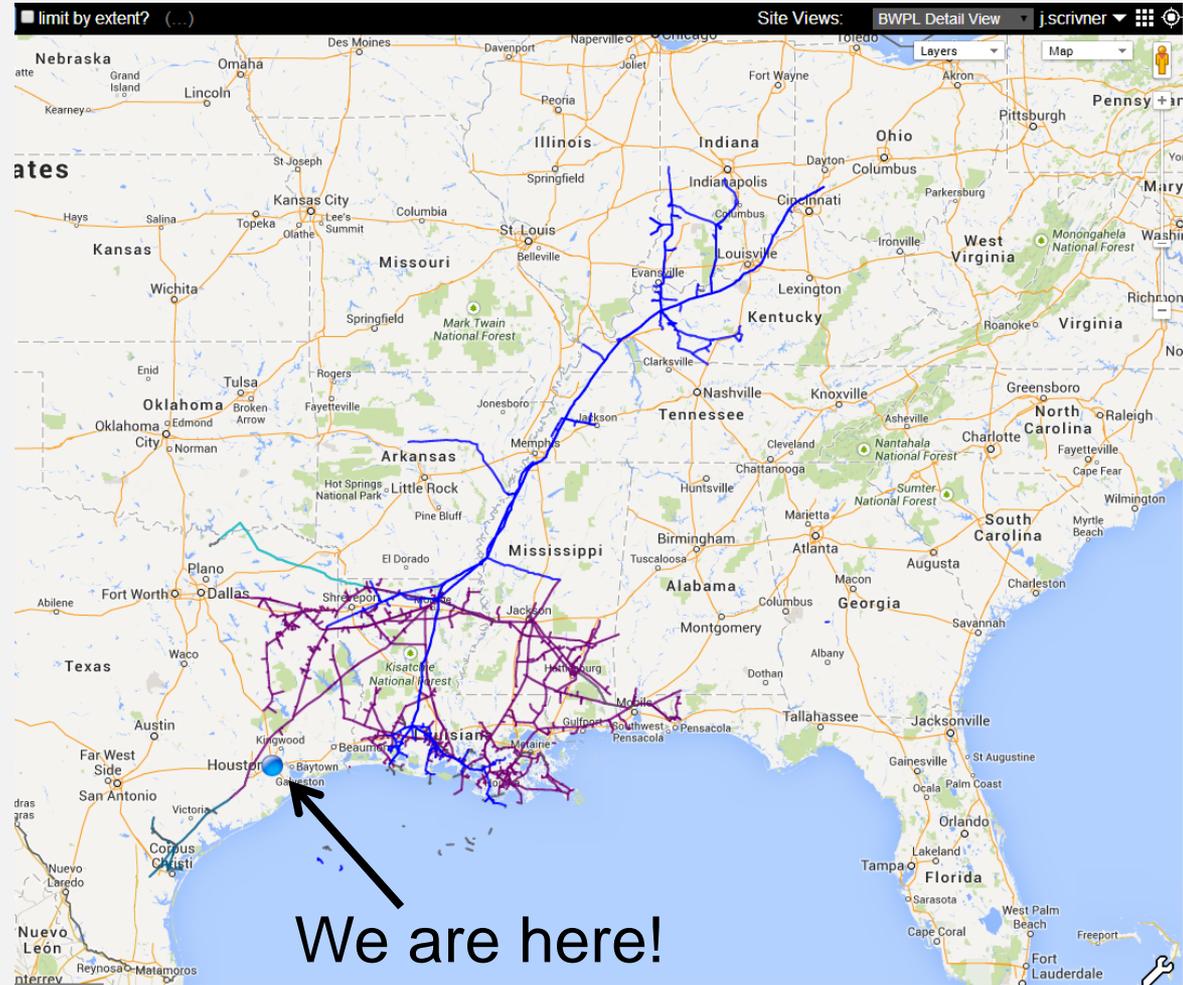
Original Delhi
Map



Updated Delhi
Map

Internet based GIS data viewer (or Integra Link)

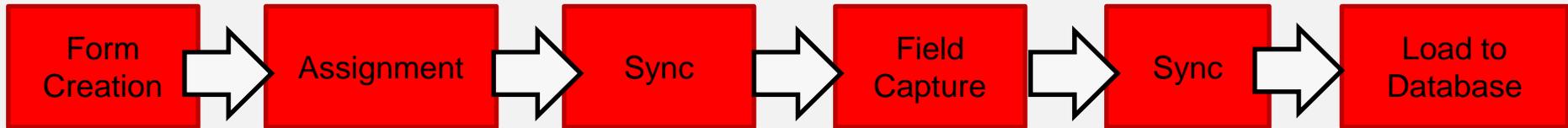
- BWP GIS Viewer



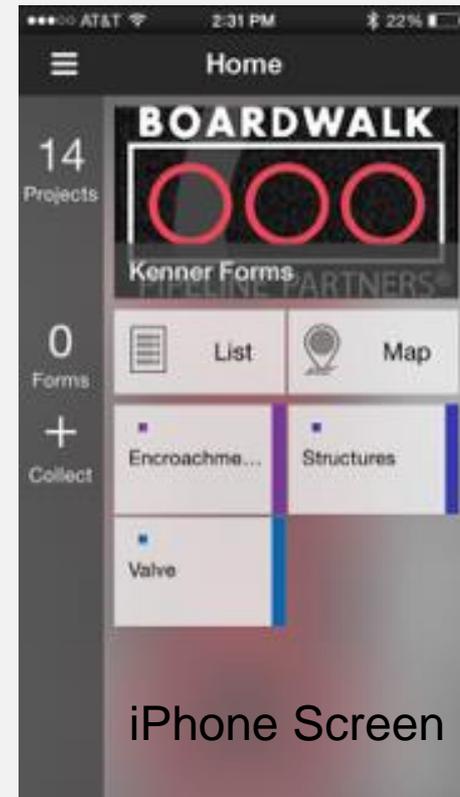
GIS Viewer – Main Features

- Separate Views to customize data access (Commercial, Integrity, Detail views by Company...)
- Ability to add KMZ file to views
- Alignment sheets (with geospatial data)
- Layers – OPP, valves, CP, HCA, class, ILI data, CIS data, 811 one calls, etc.
- Pictometry ortho 6” hi-res imagery
- Liquid HCAs
- Unlimited search capabilities (ex. Index 129 HCA)
- Report generation (in progress)
- Future enhancements planned.

Electronic Mobile Smart Form



Trimble R1 Sub-meter GPS Unit



iPhone Screen

Mobile Smart Forms / As-Builts (New construction)

- TerraFlex is the software platform for mobile forms
- Forms are created/programmed in-house
- Available on all devices (iPhone, iPad)
- Bluetooth synced to R1 sub-meter GPS devices (no post processing needed)
- Automatic upload to QC server
- 3 forms currently in use. 12 scheduled for creation in 2017

- AS-BUILT – New Construction
 - PODS blank database provided to Survey company
 - Data returned to BWP GIS
 - Data verified against MTRs etc.
 - Uploaded to GIS
 - Process time reduced from 9-12 months to 1-2 months.



Risk Model



Risk Algorithm and Risk Dashboard

- **D.R.I.P Model**

- Drivers (data that provide information on specific failure component)
 - Resistors (data that indicates resistance to failure)
 - Indicators (data that indicates if a failure may or may not exist)
 - Preventers (data that indicate action taken to prevent failure)
-
- Provide an easy viewer for risk scores
 - Provide ability to identify what risk is driving the score
 - Provide what-if scenarios on how to reduce the risk score
 - Accessible to all employees
 - Used to standardize risk score across all assets, and aid in budgeting and maintenance activities

Mitigation Manager for Viewing Risk Results - [Risk Dashboard Web Access](#)



Mitigation Manager

Help

RiskScore
Mitigation
Admin

User: BOARDWALK\SCRIVNER_J(MM_Admin)

Drilldown: Company->Region->Area->Line->HCA->Segment

< Company(TGT)->Region(TGT NORTH)->Area >

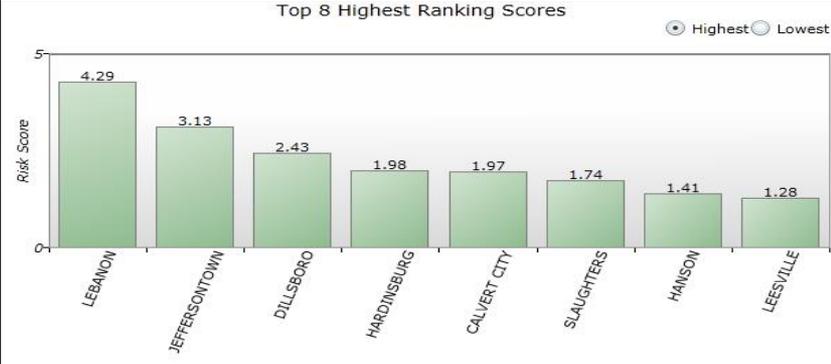
Filter Filter

Area	Wavg Score	High Score	Low Score
LEBANON	4.29	21.25	0.26
JEFFERSONTOWN	3.13	21.37	0.08
DILLSBORO	2.43	12.76	0.07
HARDINSBURG	1.98	10.96	0.09
CALVERT CITY	1.97	16.06	0.14
SLAUGHTERS	1.74	15.87	0.06
HANSON	1.41	10.40	0.11
LEESVILLE	1.28	13.78	0.08
WILFRED	1.09	9.27	0.06
WEST GREENVILLE	0.90	9.21	0.06
PETERSBURG	0.86	11.50	0.06
MIDLAND	0.80	10.13	0.07
DIXIE	0.65	6.03	0.06
BOWLING GREEN	0.52	7.98	0.07

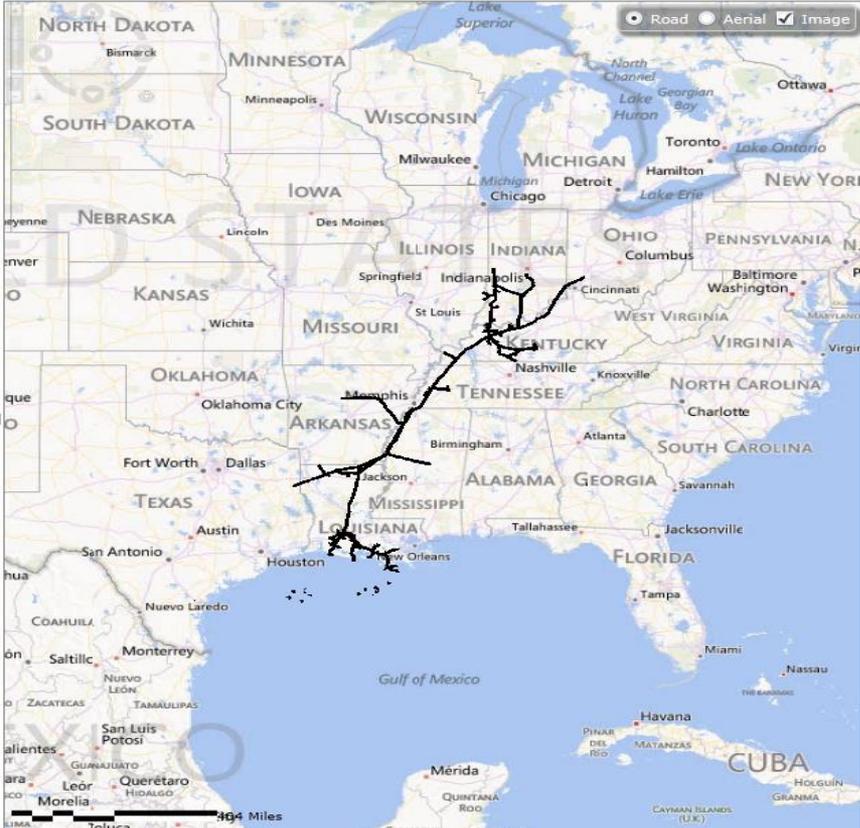
Page 1 of 2 Total Records: 16

Chart Type: Ranking

Top 8 Highest Ranking Scores



Area	Risk Score
LEBANON	4.29
JEFFERSONTOWN	3.13
DILLSBORO	2.43
HARDINSBURG	1.98
CALVERT CITY	1.97
SLAUGHTERS	1.74
HANSON	1.41
LEESVILLE	1.28



Questions – Open Discussion

