Underground Void Inventory & Risk Assessment

July 31, 2013

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Dave Nicklaus – ODOT
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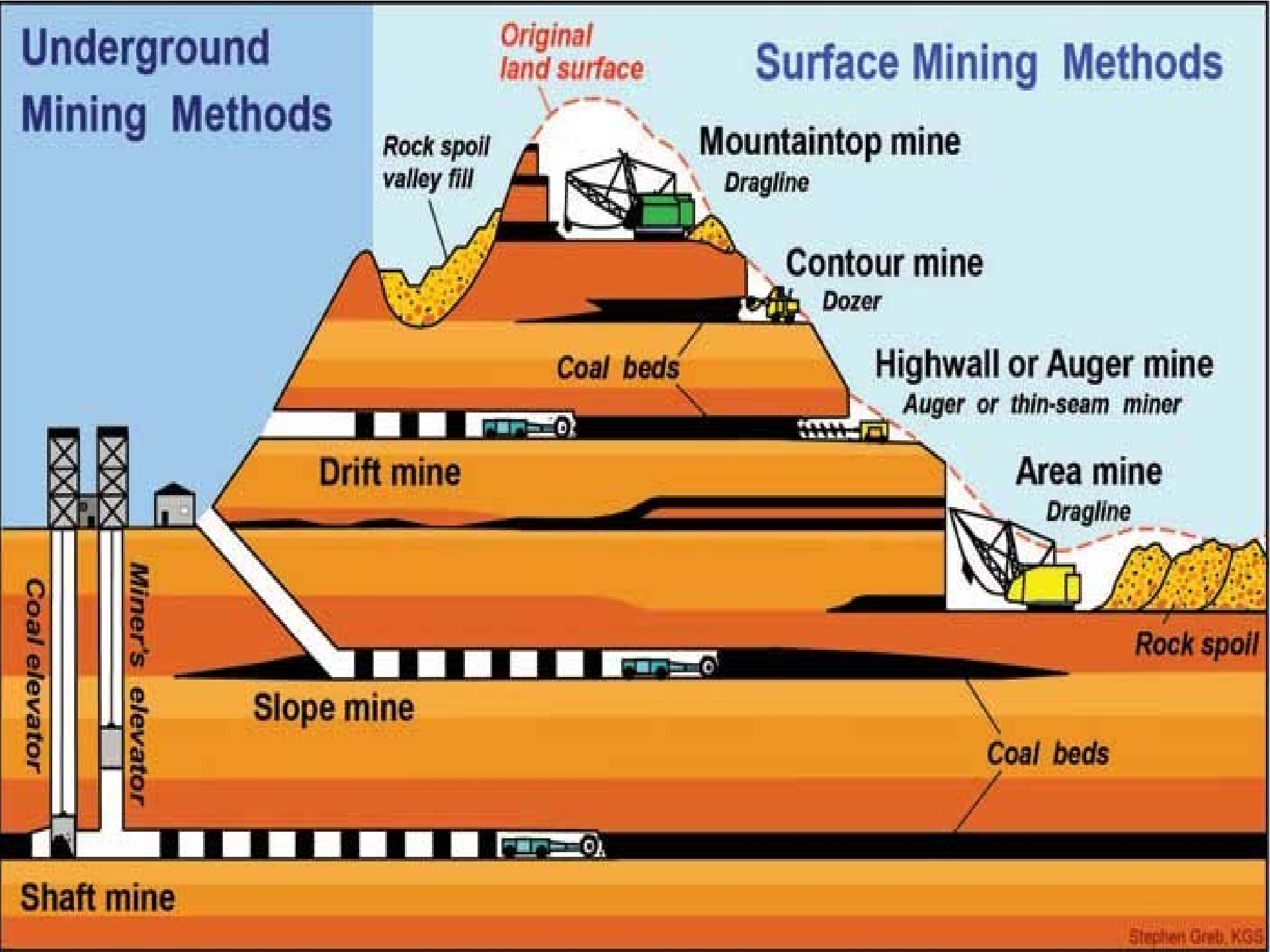
AUMIRA

1890's

4600 Mapped Mines

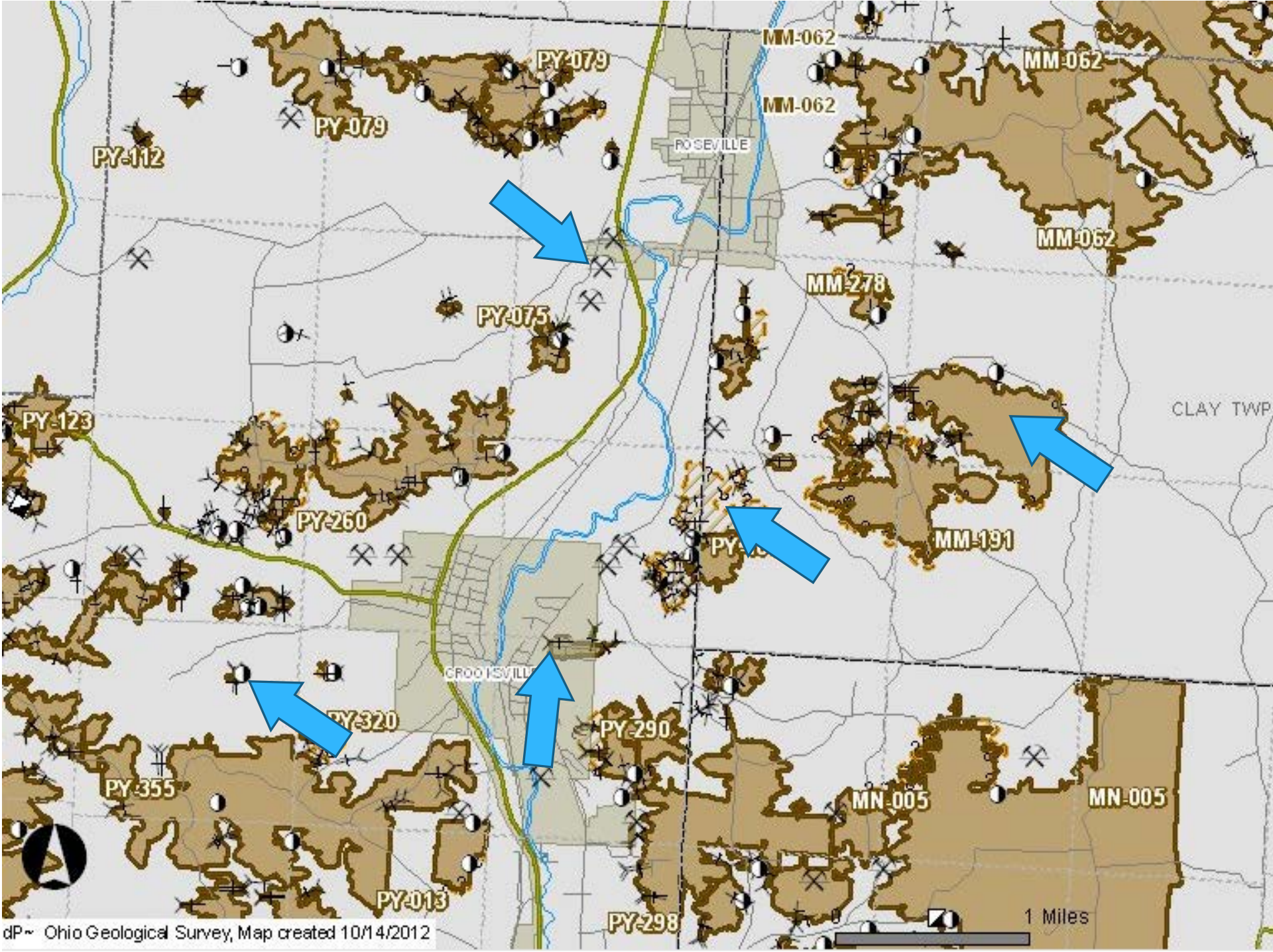

Underground Mining Methods
Surface Mining Methods
Original land surface
Rock spoil valley fill
Mountaintop mine
Dragline
Contour mine
Dozer
Coal beds
Highwall or Auger mine
Auger or thin-seam miner
Drift mine
Area mine
Dragline
Rock spoil
Coal elevator
Miner's elevator
Slope mine
Coal beds
Shaft mine
Stephen Greb, KGS

Thickness: 21-inches to 8-feet

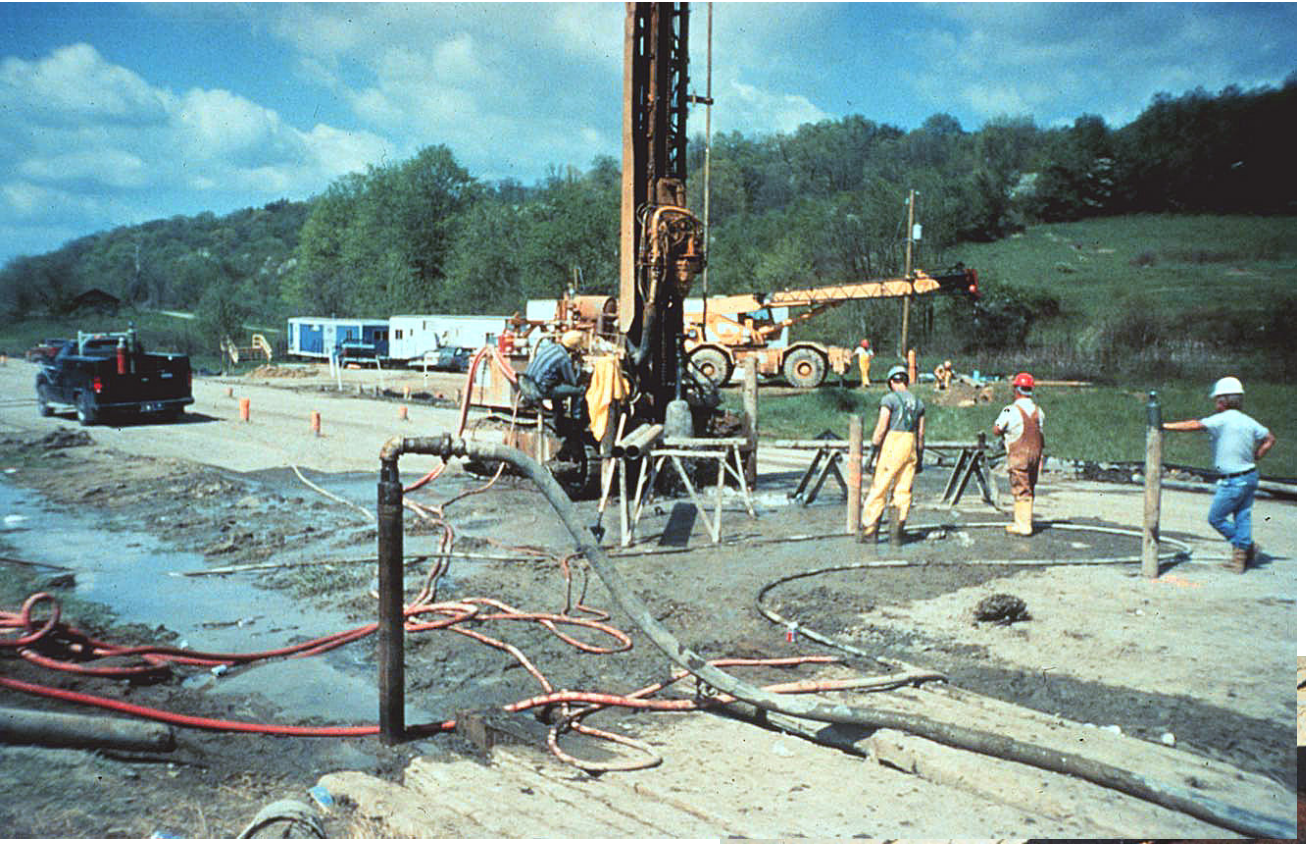

KGS

Longwall Mining

http://www.consolenergy.com/natural-gas-amp-coal/coal/mining-process.aspx


MM-062
MM-062
MM-062
MM-062
PY-079
PY-079
PY-112
POSEVILLE
MM-278
PY-075
CLAY TWP
PY-123
PY-260
MM-191
CROOKSVILLE
PY-320
PY-290
PY-355
MN-005
MN-005
PY-013
PY-298
1 Miles
dP~ Ohio Geological Survey, Map created 10/14/2012

- Subsidence of adjacent areas induced by mine remediation.



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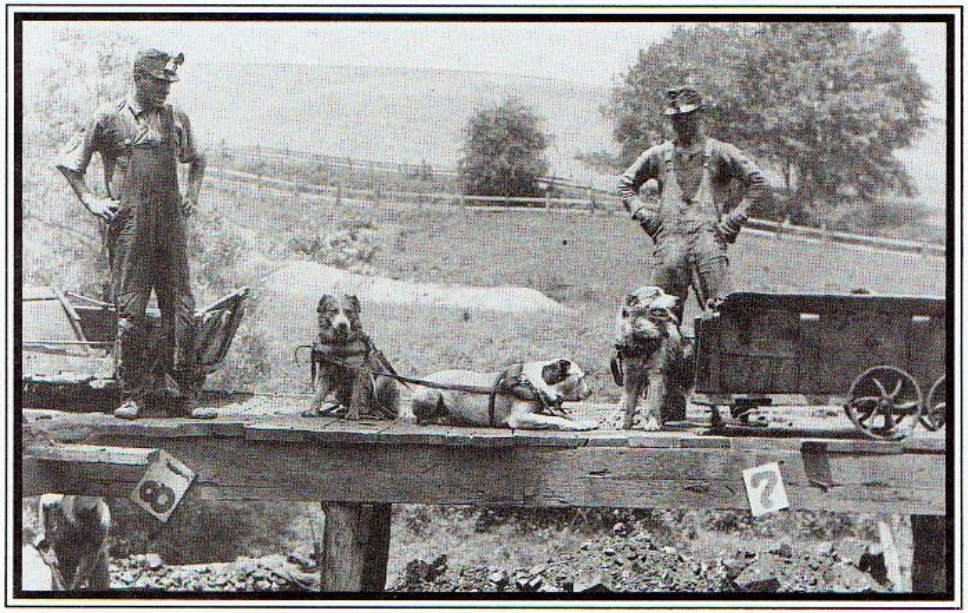
Underground Mine Subsidence

AUMIRA

MANUAL FOR

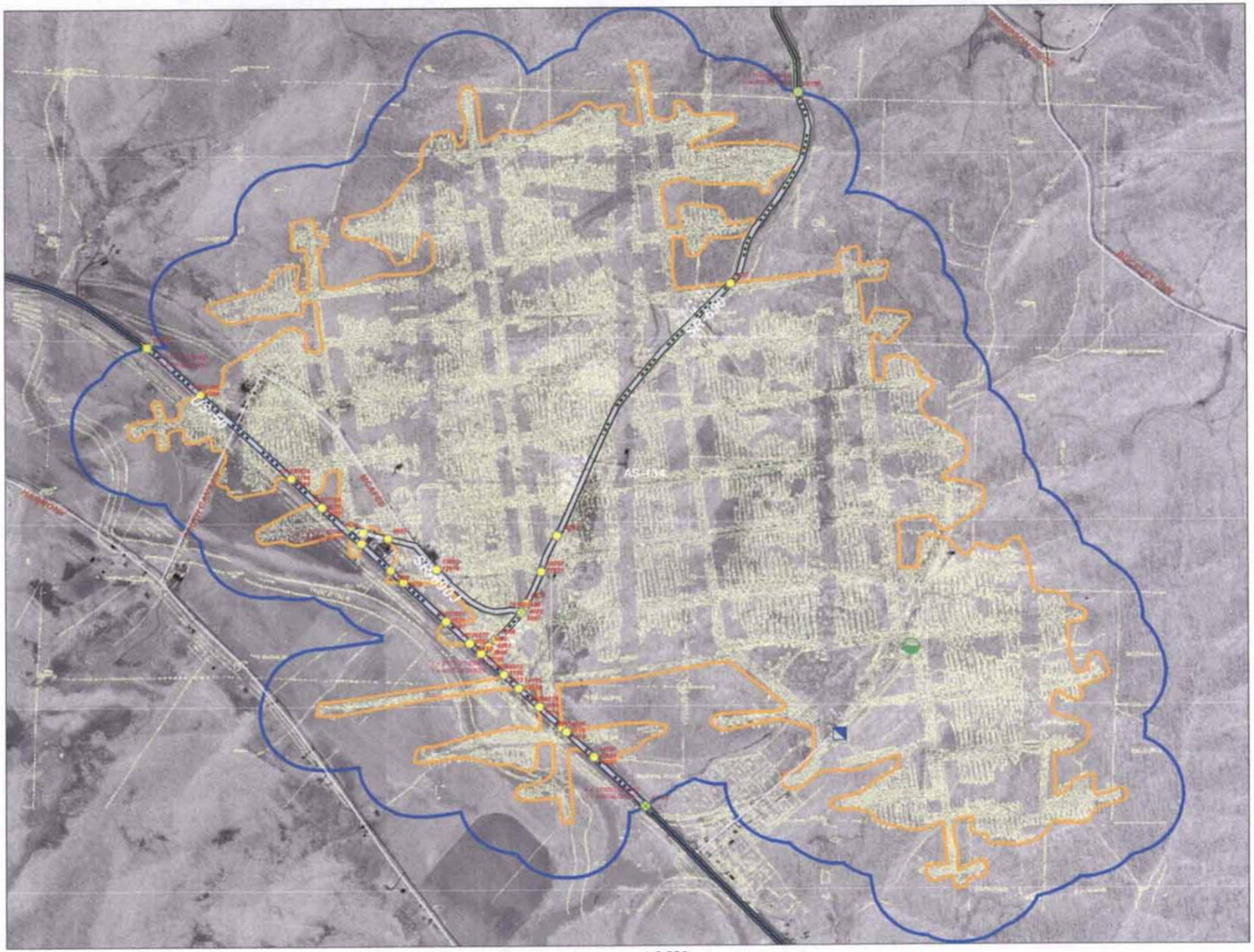
ABANDONED UNDERGROUND MINE INVENTORY AND RISK ASSESSMENT



STATE OF OHIO DEPARTMENT OF TRANSPORTATION

MAY 15, 1998

The State of Ohio is an
Equal Opportunity Employer



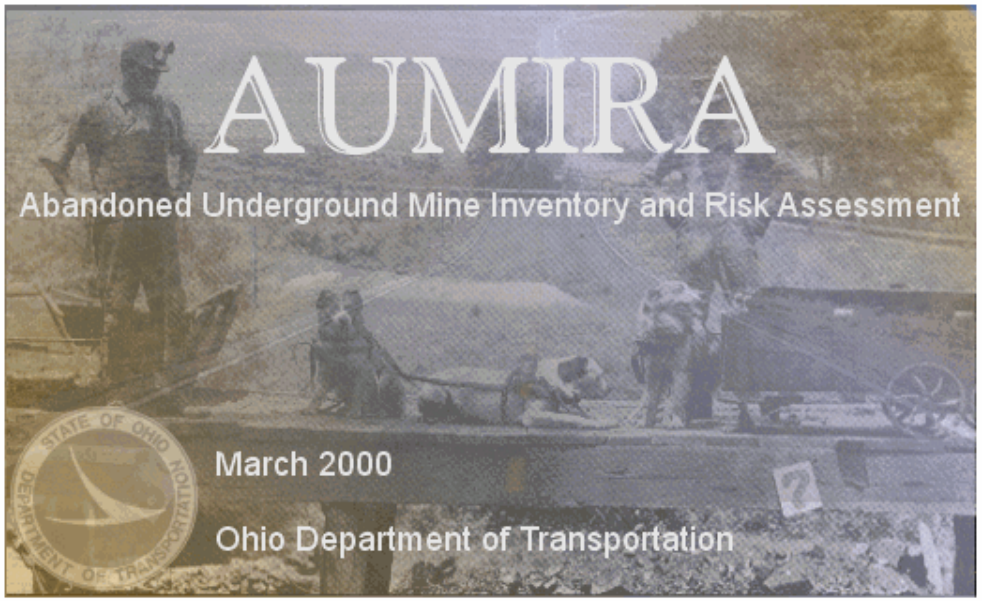
ODOT AUMIRA FIELD MAP for MINE: AS –134 ATHENS COUNTY, OHIO

AUMIRA Scoring Matrix

* Initial Site Evaluation
* Detailed Surface Deformation Site
* Detailed Mine Opening Site
* Detailed High Rating Site

AUMIRA - Abandoned Underground Mine Inventory and Risk Assessment

File Site Tools Help



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Mine Opening Evaluation

Evaluator: guest Date of Evaluation: 6/23/2005

New Evaluation

☐ - Have site investigations and/or interviews conclusively proven that the identified mine(s) at this site is (are) not an apparent threat to the safety of the roadway?

1	Method of Mine Closure:	No Info 0	Timber 0	Random 0	Concrete 0	Controlled 0				0
2	Type of Cribbing:	No Info 0	Timbers 0	Brick 0	Concrete 0					0
3	Average Daily Traffic (ADT):	> 30K	20K to 30K	10K to 20K	5K to 10K	< 5K				0
4	Mine Opening Location:	Not Known 0	> edges < 0	< 50' 0	50' - 100' 0	Sight 0				0
5	Classification of Roadway:	IR 0	NHS 0	Arterial 0	Collector 0					0
6	Minimum Overburden:	0'	< 25'	25' to 50'	50' to 100'	> 100'				0
7	Recent Dewatering:	< 1 yr.	1 to 3 yrs.	4 to 6 yrs.	7 to 9 yrs.	> 9 yrs.				0
8	Average Daily Truck Traffic (ADTT):	> 6K	4K to 6K	2K to 4K	1K to 2K	< 1K				0
9	Type of Pavement:	Other	Reinforced							0
10	Structures in Roadway:	Yes	No							0
11	Traffic Speed:	> 35 mph	0 to 35 mph							0
12	Type of Mine Opening:	Shaft 0	Slope 0	Drift 0						0
13	Plan Area of Mine Opening:	> 750 0	500 - 750 0	250 - 500 0	Unknown 0	150 - 250 0	< 150 0			0
14	Age of Mining:	< 1900	1900 - 1930	1931 - 1945	1946 - 1968	> 1968				0
15	Availability of reasonable Detour Routes:	None	Yes							0

Comments:

Overall Site Evaluation Rating: 0

Inventory of Underground Mines underlying Ohio's Highway System

* Total Number of Mine Sites = 1840
  * Surface Deformation = 156
  * Mine Openings = 628
  * High Rated Sites = 432
* Lane Miles underlain by mines = 550
* Average cost per lane mile = $4.8M
  (based on drilling and grouting costs)

AUMIRA Matrix Scores

* Which score do I use?
  * Initial Site Evaluation
  * Detailed Surface Deformation Site
  * Detailed Mine Opening Site
  * Detailed High Rating Site

* But, what if I have sites with surface deformation and mine openings?

AUMIRA

ISSUES

* Four data entry forms
* Duplication of data entry
* Same data fields scored differently depending on the data form being used
* No comprehensive scoring matrix
* Lack of statistical reference for weighting factors and scores

The Fix!

* 2007 to 2012
* Review of AUMIRA & its Database
* Developed a new version of AUMIRA called **UVIRA**

UVIRA

* An underground void created by man-made extraction. These include abandoned underground mines, active underground mines, inactive underground mines, public transportation tunnels, commercial transportation tunnels, highwall augering areas, and highwall mining areas.

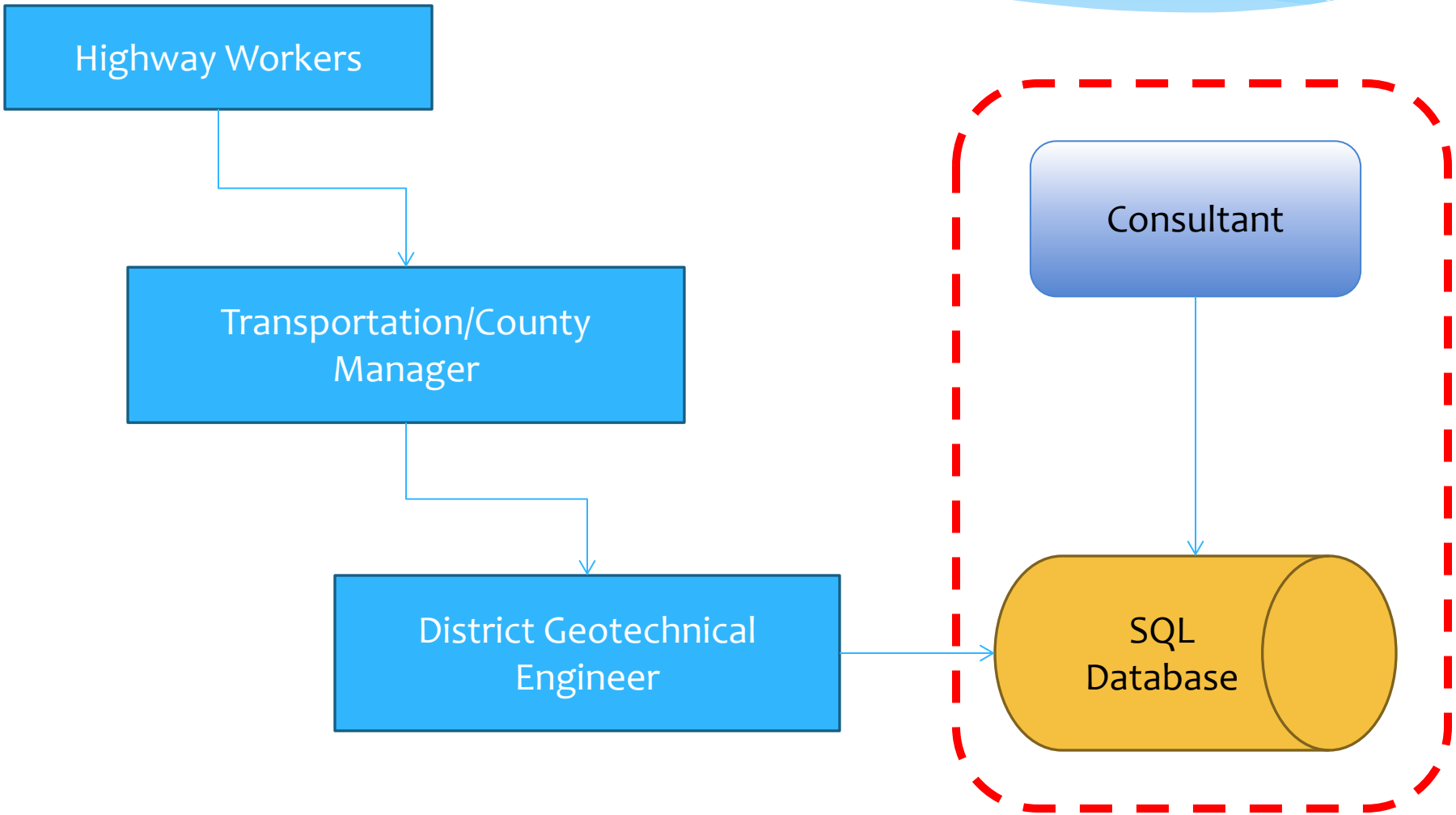
* UVIRA does not address man-made excavations related to drainages and utilities.


CAUTION

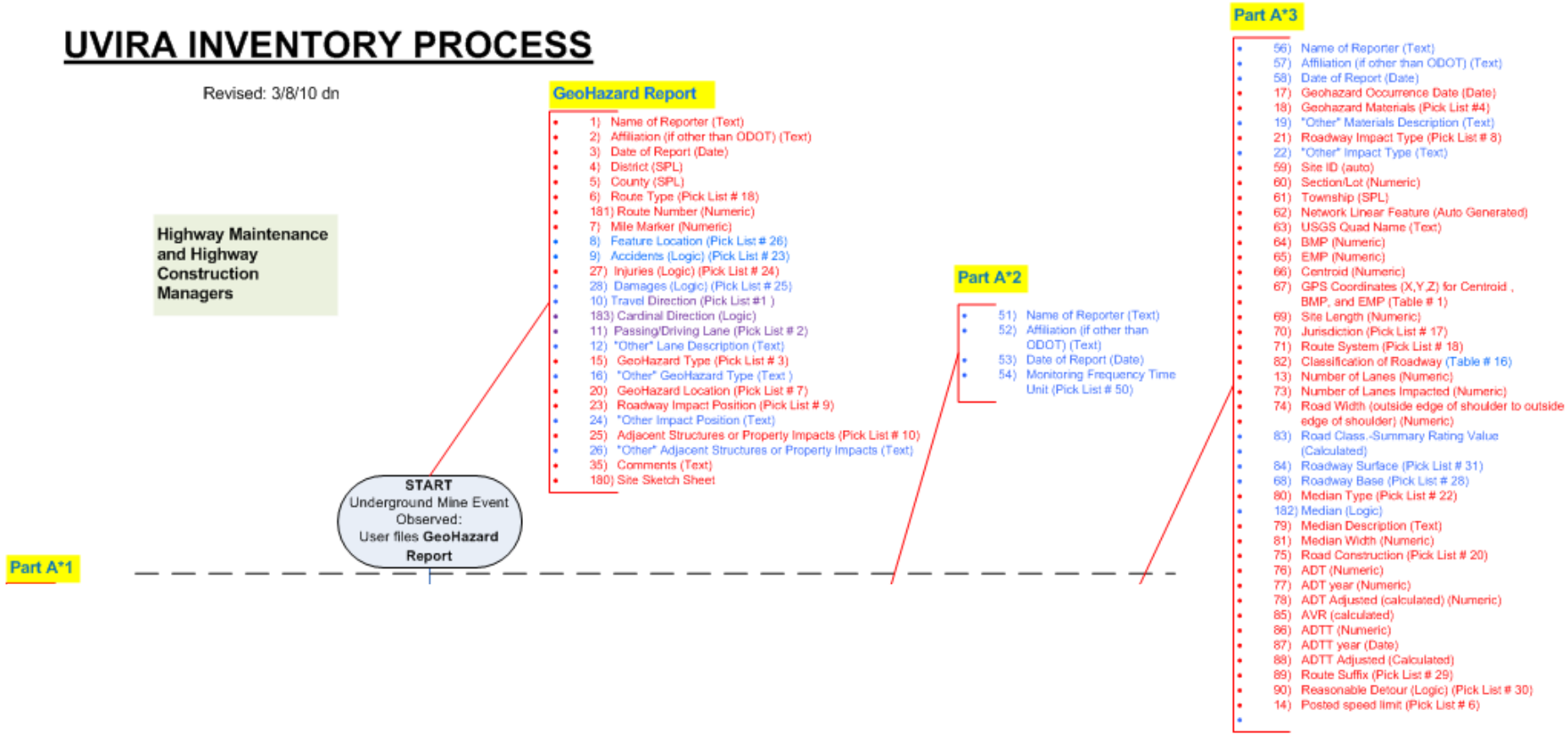
UVIRA

BENEFITS

* Comprehensive inventory system risk assessment employing a single scoring matrix.
* Single data form using multiple parts
* Facilitates auto-population of data fields
* Addresses multiple seam mining
* Records attributes of individual features
* Includes other anthropogenic disturbances
* Allows states to inventory, plan remediation and allocate funds for mine remediation


Highway Workers
Transportation/County Manager
District Geotechnical Engineer
Consultant
SQL Database

Work Flow Model



Duplication of Data Entry

Initial Site Evaluation

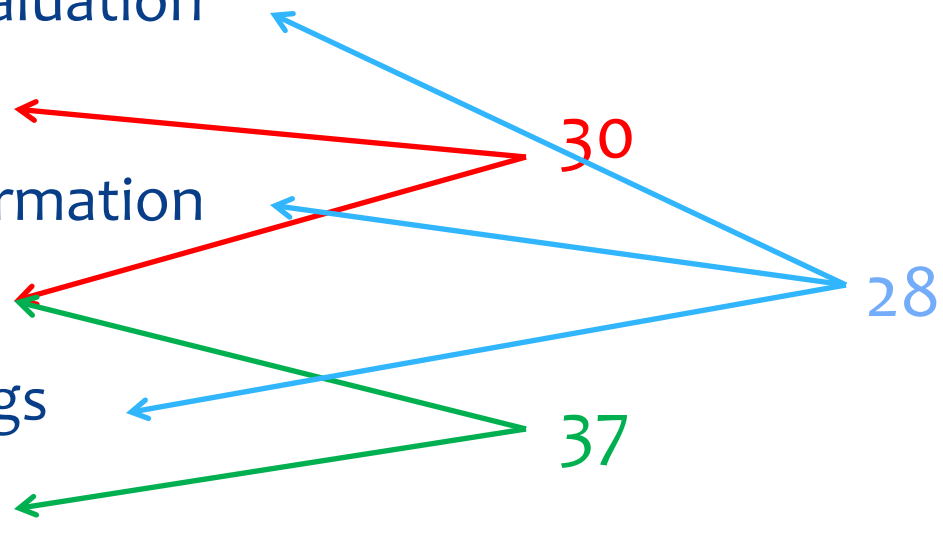
* 42 fields

Surface Deformation

* 40 fields

Mine Openings

* 47 fields



UVIRA Scoring Matrix

* Maintain scoring attributes used by AUMIRA
* Combine the scoring matrixes of AUMIRA
  * Eliminate redundancy
  * Utilize existing data bases for data entry and maintenance

Summary of Rank Score Calculation

Evaluation Parameter	Part	Section	Field Name	Value	Calculation			
Classification	A	Site Location Information	Classification of highway	Arterial	1	5	7	10
					Collector	Arterial	NHS other than Interstate	Interstate (IR)
Adjusted ADT	B	Traffic Information	ADT	5000	Use Equation			
			ADT Year					
			Road Type					
Adjusted ADTT	B	Traffic Information	ADTT	1000	Use Equation			
			ADTT Year					
Speed	B	Traffic Information	Posted Speed Limits	55 MPH	1		10	
					<= 35 MPH		> 35 MPH	
Detour	B	Traffic Information	Reasonable Detour	NO	1		10	
					YES		NO	
Accident History	B	Accident Information	Total number of accident	0	*3*	*9*	*27*	*81*
			Total property loss	$0	No Accident	Vehicle or property damage Injury Fatality	Injury	Fatality
			Total vehicle damage	$0				
			Total number of injuries	0				
			Total number of fatalties	0				
Hydrogeologic Conditions	C	Hydrological Information	Current condition	Flooded	1	6	8	10
					Dry	Partial	Flooded	Dewatered
Dewatering	C	Hydrological Information	Most Recent Dewatering Year	2000	RV = year of inventory - Most Recent Dewatering Year Use Equation			

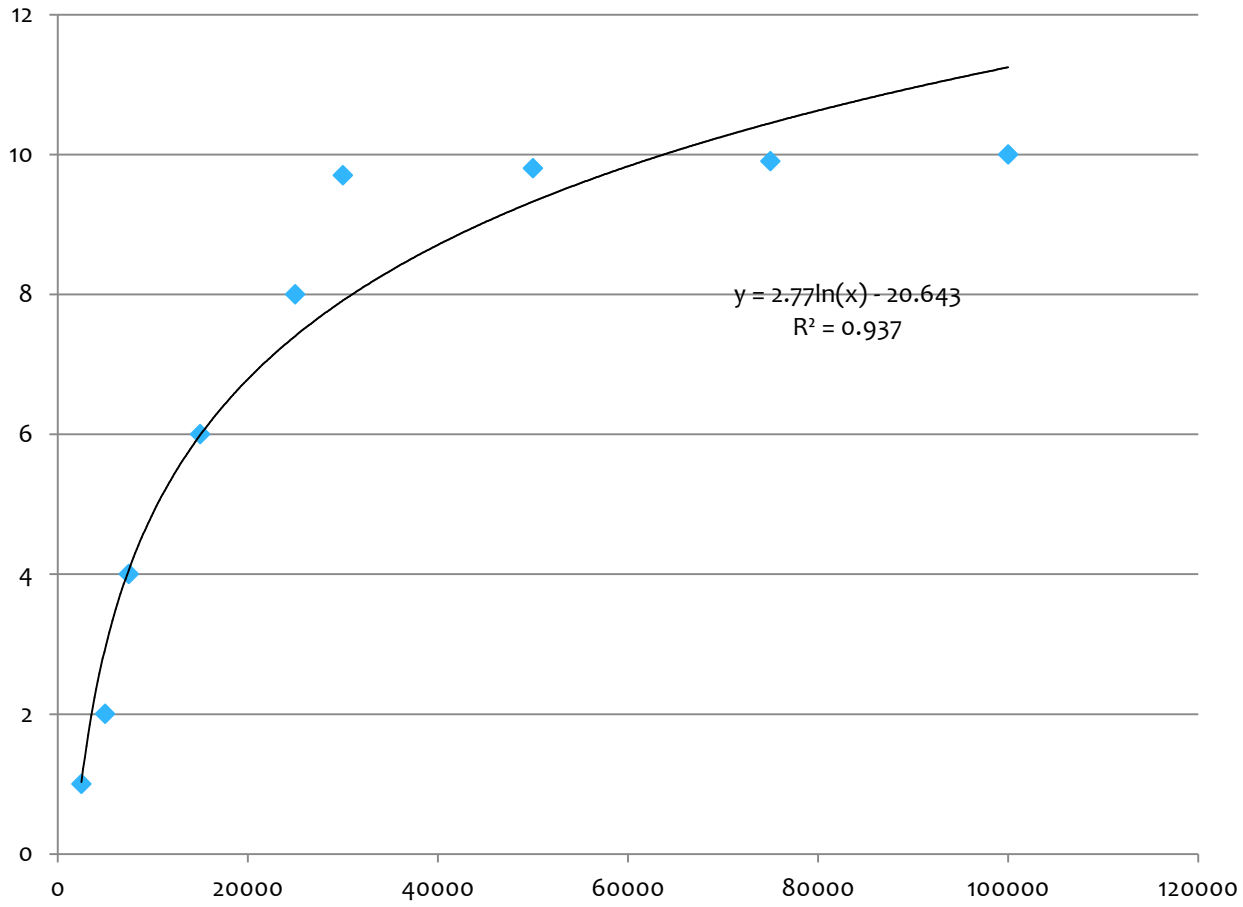
Summary of Rank Score Calculation

Inventory Site Risk Score Worksheet

Inventory Site: *UV001695*

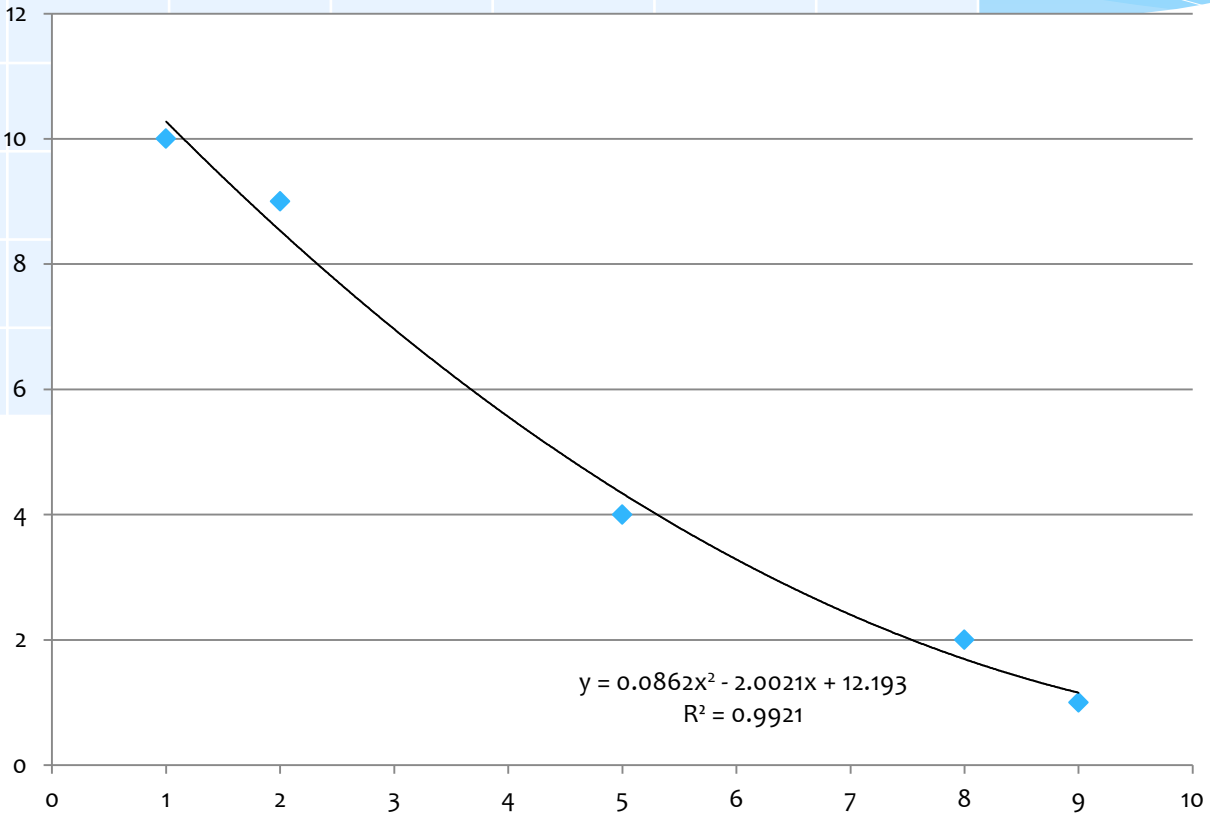
Evaluation Parameter	Raw Value(RV)	Equation	Max	Min	Weighting Factor	Result	Score
Classification	Arterial	N/A ———— Matrix Table Only, see below	10	1	10	5	50
Adjusted ADT		(-7E-17)*(RV)^4 + (6E-12)*(RV³) - (2E-07)*(RV²) + 0.0024*RV - 6.3571	10	2	11	0	0
Adjusted ADTT		(-4E-14)*(RV)^4 + (8E-10)*(RV³) - (5E-06)*(RV²) + 0.0122*RV - 6.3571	10	2	7	0	0
Speed	55 mph	N/A ———— Matrix Table Only, see below	10	1	5	10	50
Detour	NO	N/A ———— Matrix Table Only, see below	10	1	4	10	40
Accident History	No accident	N/A ———— Matrix Table Only, see below	81	3	1	3	3
Hydrogeologic Conditions	Flood	N/A ———— Matrix Table Only, see below	10	1	8	8	64
Dewatering	13(years of Dewatering)	0.0862*(RV²) - 2.0021*RV + 12.193			13	0.733	10
Deformation	1	N/A ———— Matrix Table Only, see below			30	1	30
Pavement		N/A ———— Matrix Table Only, see below	10	1	6	10	60
Void Location		N/A ———— Matrix Table Only, see below	10	1	3	0	0
Age	113	-0.0006*(RV²) + 0.1535*RV	10		6	9.684	58
Extract	Rate of extraction >50%	N/A ———— Matrix Table Only, seebelow	10	1	6	7	42
Special Mine Feature	None	N/A ———— Matrix Table Only, see below	10	5	2	0	0
Problems Due To Mining	NO	N/A ———— Matrix Table Only, see below	10	1	2	1	2
Sturctures In Roadway	NO	N/A ———— Matrix Table Only, see below		1	4	1	4
Special Mine Feature	None	N/A ———— Matrix Table Only, see below	10	5	2	0	0
Problems Due To Mining	NO	N/A ———— Matrix Table Only, see below	10	1	2	1	2
Sturctures In Roadway	NO	N/A ———— Matrix Table Only, see below		1	4	1	4
Void Closure		N/A ———— Matrix Table Only, seebelow	10	2	3	0	0
Void Feature		N/A ———— Matrix Table Only, seebelow	10	1	5	0	0
Void Support		N/A ———— Matrix Table Only, seebelow	10	4	3	0	0
Void Opening Stability		N/A ———— Matrix Table Only, see below	10	1	10	0	0
Void Area		N/A ———— Matrix Table Only, seebelow	10	2	3	5	15
UNC / CON		2.1446*((RV)^0.7102)	10		8	0	0
Overburden Thickness	ft	-0.1129*RV + 12.72			6	0	0
Void Thickness	ft	0.6359*((RV)^1.1721)			6	0	0
Overburden / Void (Thickness)		-1.5*RV + 17.333			6	0	0
Site Score							428

Value	Score	WF=11	= ADT		Value	Score
30000	10				100000	10
25000	8				75000	9.9
15000	6				50000	9.8
7500	4					
5000	2					
	Maxi. Score = 10					
	Mini. Score = 2					



Dewatering

Value	Score	WF = 13	= year of inventory - year that last dewatering event occurred
1	10		
2	9		
5	4		
8	2		
9	1		



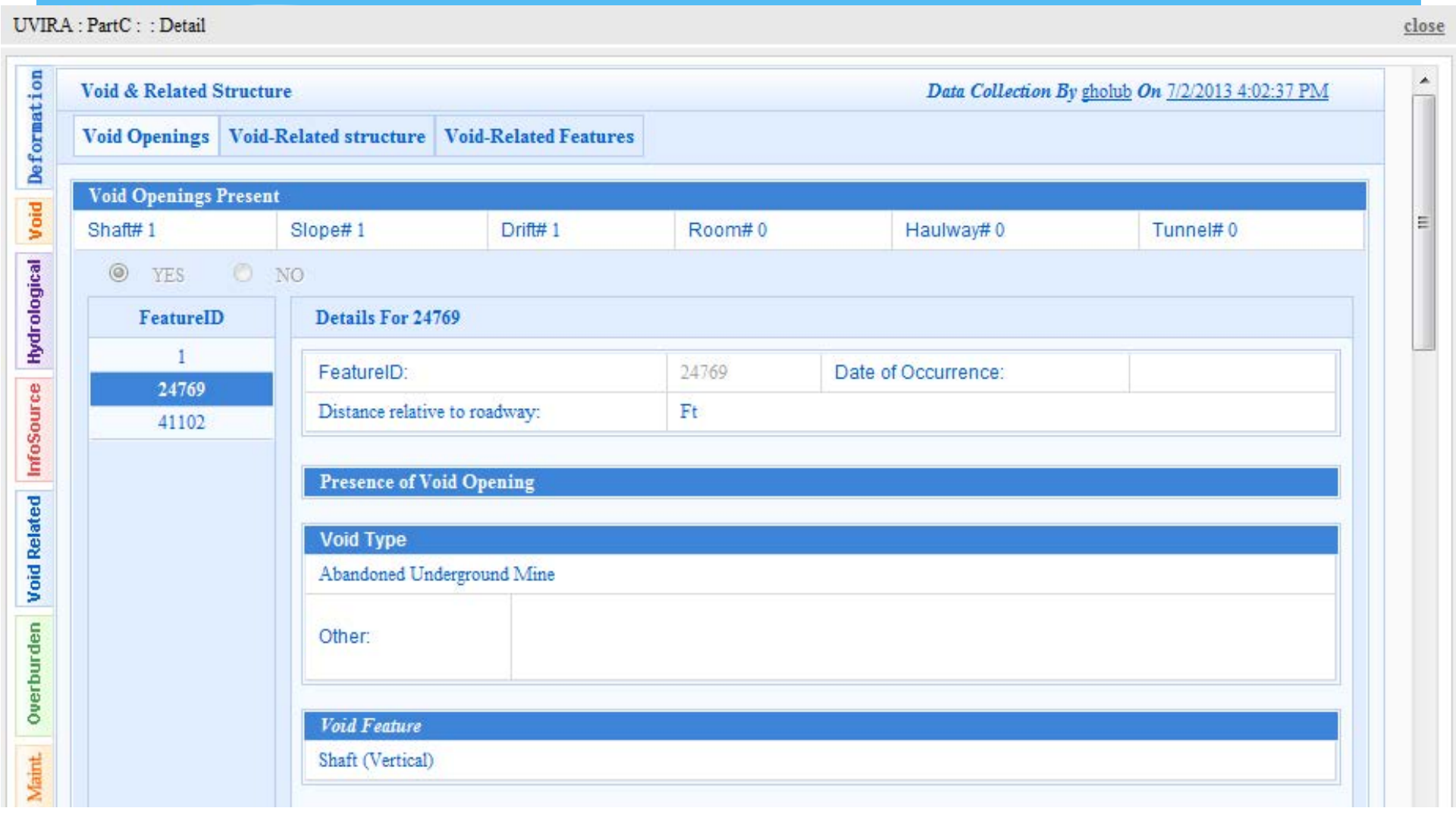
Additional Data Fields

* 80 new fields
  * Consistency with the other Geohazard Inventory Systems at OhioDOT
  * Provides data required by the Remediation Cost Database Application (RCDA)
  * Future search and reporting requirements
* Examples:
  * GPS locations, AVR, Adjusted ADT, BMP/EMP/Centroid, Impact to adjacent structures, Associated sites, and Void Type

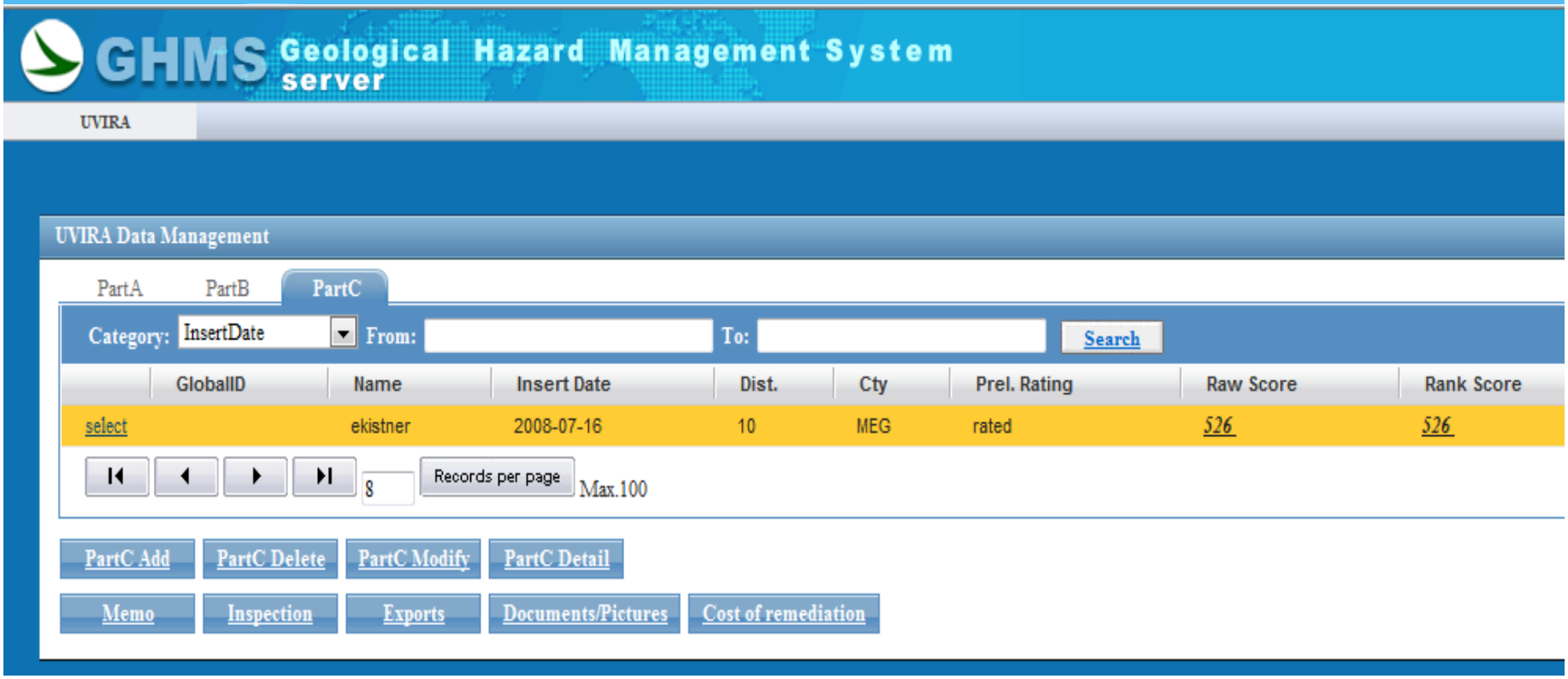
Data Transformation

Questions	Question #	Data Type	Weighting Factor	Selections	Line Score	Weighted Line Score	New Value
Evidence of Surface Deformation	1	Logic	--				
				Y			
				N			
Presence of Mine Opening	2	Logic	--				
				Y			
				N			
ADT	4	Numeric	9				
				> 30K	10	90	30000
				20K to 30K	8	72	25000
				10K to 20K	6	54	15000
				5K to 10K	4	36	7500
				< 5K	2	18	5000
Minimum Overburden Thickness	6	Calc	4				
				< 25'	10	40	25
				25' to 50'	8	32	38
				50' to 100'	5	20	75
				> 100'	1	4	100
Ratio of Minimum Overburden Thickness to Maximum Mined Interval Thickness	8	Calc	6				
				< 5	10	60	5
				5 to 11	5	30	8
				> 11	1	6	11

Field Application for Tablet



Server Application



Primary Goals

* Maintain the bases for AUMIRA scoring
* Eliminate duplication of data
* Develop a comprehensive scoring matrix
* Utilize existing data and automate the process
* Expand the applicability of the Inventory and Risk Assessment process to similar void conditions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AREA