Quality Management

Innovative Tools and Techniques



QMost

Quality Management Oversight Services for Transportation

Quality is never an accident; it is always the result of intelligent efforts

John Ruskin

19th Century British Philosopher

A brief bio…

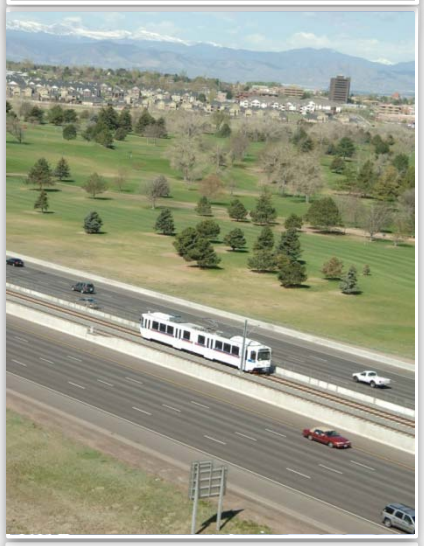
- Providing Engineering consulting services since 1953.
- A firm with a global presence but a North American focus.
- Seventeen major offices throughout North America, US Head Office in Virginia.
- 750 + staff include
  - engineers,
  - systems analysts,
  - management and technology consultants
- Services to the transportation industry include:
  - Program and Project Management
  - Quality Management Oversight
  - Engineering
  - Performance Management
  - Systems and Technology
  - Strategy, Finance and Economics

During the past ten years, Delcan has delivered Quality Management services on $50 billion of Capital Programs…



Various forms of Quality Management services…

Compliance Auditing Services



- Denver's Transportation Regional Expansion Project (TREX)

Quality Management Oversight



- Maryland's Intercounty Connector Project (ICC)

Independent Engineers



- New York City MTA
- $30 B Capital Program

Independent Quality Firm



- Utah's Pioneer Crossing Project

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Today's Presentation :

Discuss innovative quality management tools and techniques that

- better define quality expectations,
- help capture verification data,
- help look for items for improvement
- improve Final Acceptance efforts

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Defining Quality Management…

QUALITY = Conformance To Requirements

QUALITY Management

Is Not…

- QA/QC
- Looking for the bad
- Just focused on construction
- A Policing Effort

It is…

- Defining
- Planning
- Verifying
- Improving
- Value Added

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Progression in Project Delivery

Owner Self Perform

Design – Bid – Build

Construction Management General Contractor

Design Build

Public Private Partnership



Traditional **Innovative**

All delivery methods have their place.

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Developing A Quality Management Model

Based Upon…

- Systems Engineering
- Requirements Management
- Risk Profiling
- Training



Built Upon…

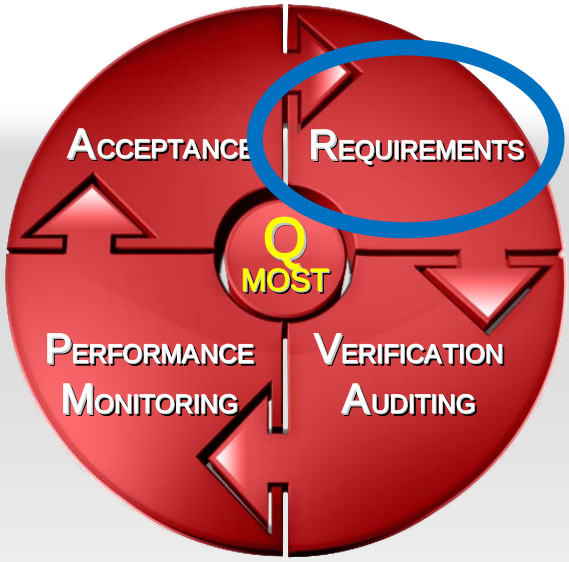
- Relational Database
- Good Data
- Statistical Analysis
- Off the shelf tools

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Quality Management Oversight Services for Transportation

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QMost Model



REQUIREMENTS…

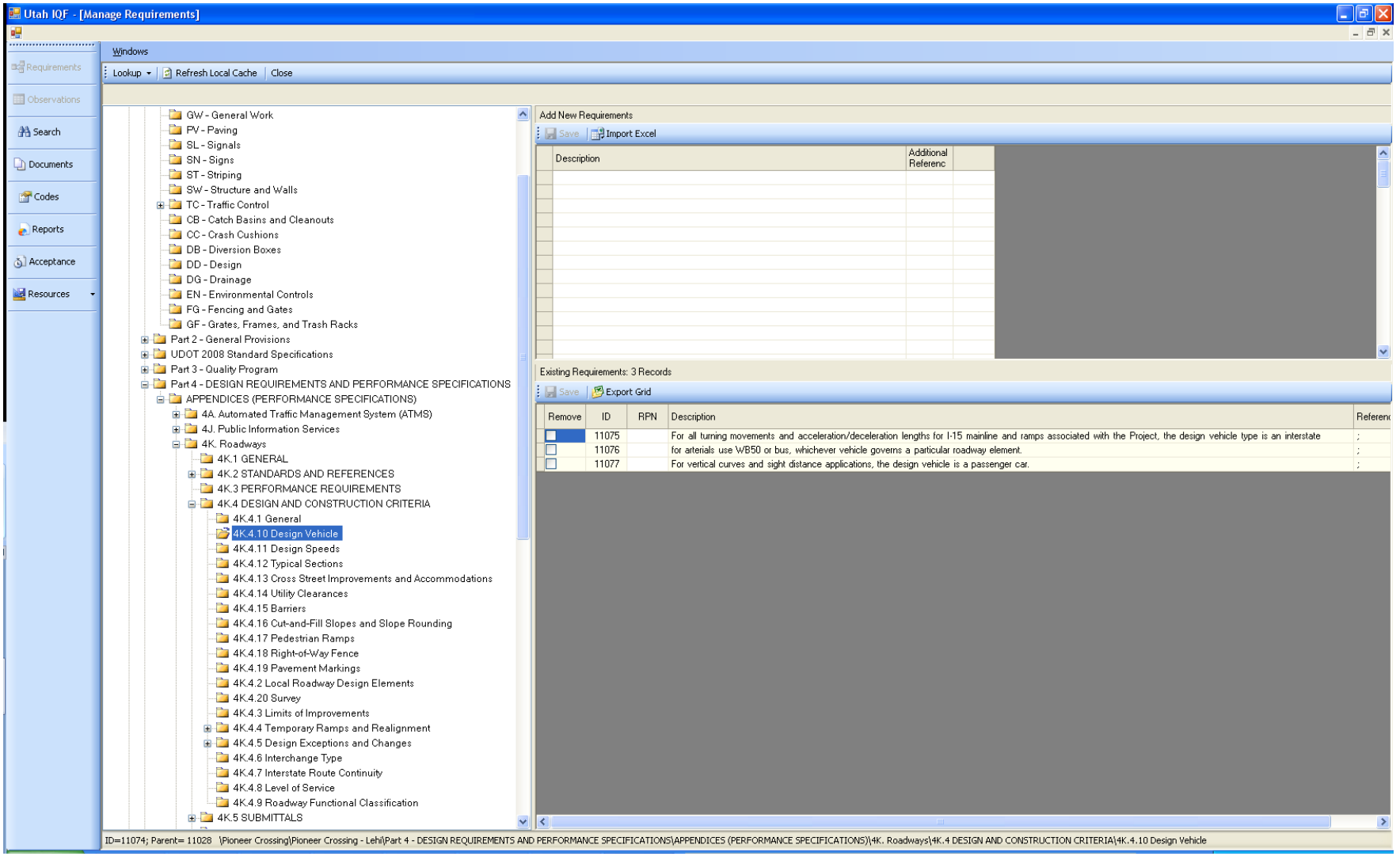
Primary root cause of disputes is misunderstood requirements.

Improvements include:

- **Consider for DESIGN and CONSTRUCTION**
- **Consistent use of terms (Shall, Will, May).**
- **Consider every Requirements has a cost.**
- **Minimize Requirements.**
- **Prioritize Requirements.**
- **Requirements database**

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Requirements Database Example



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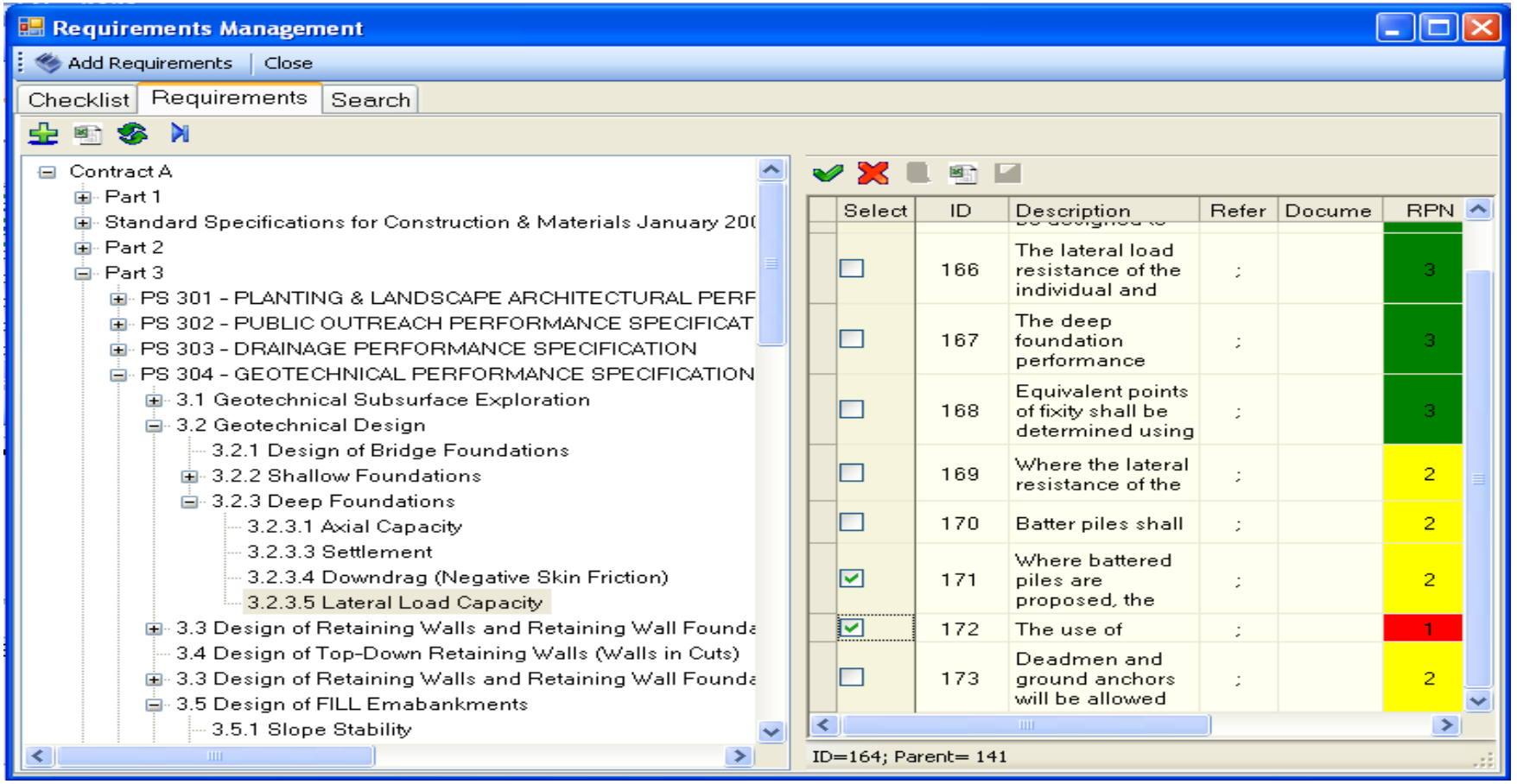
Example of Risk Profiling

3.7.11 Approach Slabs	Severity	Possibility	Detectability	RPN*
Approach slabs shall be designed to span in the longitudinal direction of the bridge. Approach slabs shall not be supported by wing walls.	8	5	5	200
Approach slabs shall be a minimum of 20 feet and a maximum of 30 feet in length for bridges with 90 degree skews. These lengths shall be increased for bridges with less skews than 90 degrees.	7	5	5	175
Approach slab width shall be equal to the curb-to-curb width.	8	5	6	240
Approach slab ends shall be oriented perpendicular to the traveled lanes of the bridge	6	6	4	96
Approach slabs on skewed bridges may be stepped at shoulders and edges of lanes to reduce length.	5	4	4	80
At the ends of the bridge, approach slabs shall be supported by the abutment backwall.	8	5	5	200
The cold joint between the approach slab and backwall shall be sealed with a joint sealant in conformance with Section 911.01.01 of the Administration's Standard Specification for Construction and Materials.	7	6	8	336

Tactical Risk Profiling

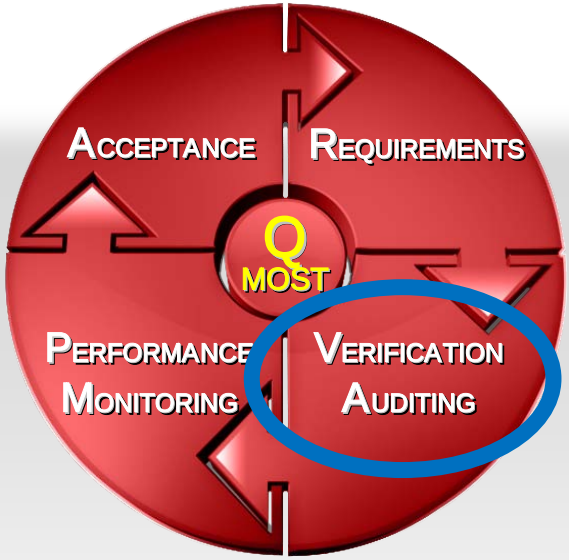
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Requirements Database Example



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VERIFICATION…

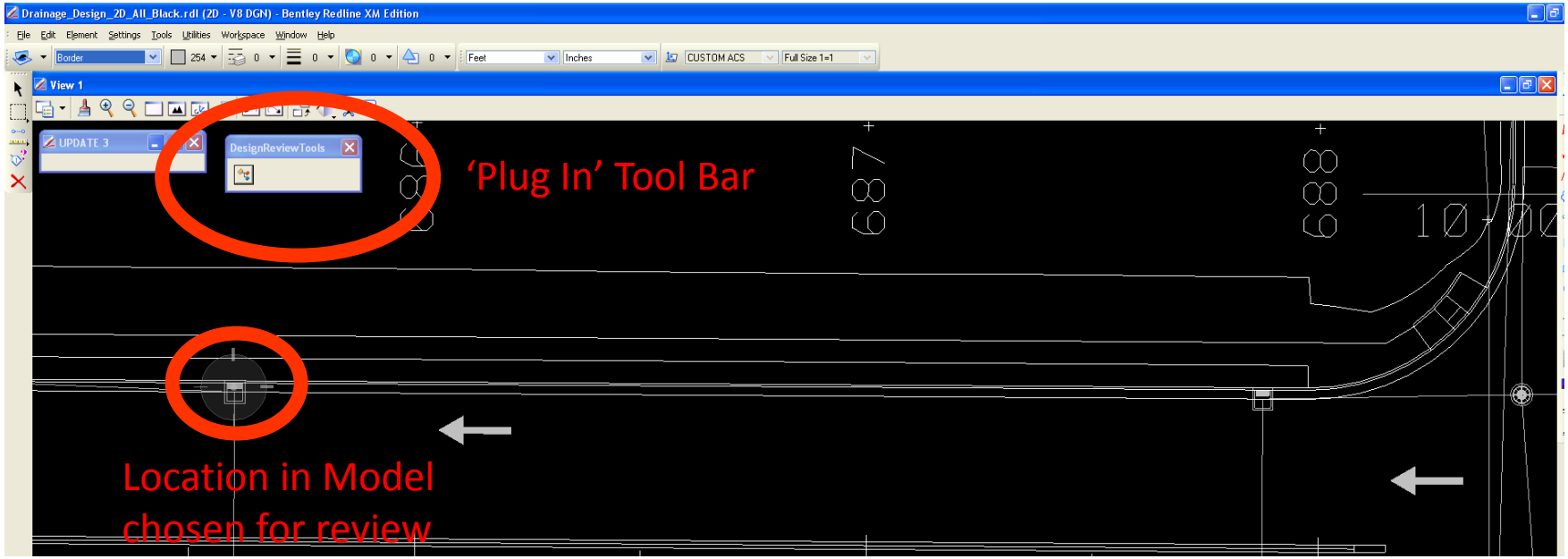
Sampling based upon RISK.

Improvements include:

- **Electronic DESIGN review**
- **Digital data collection**
- **RISK profiling to focus effort**

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Electronic Design Review

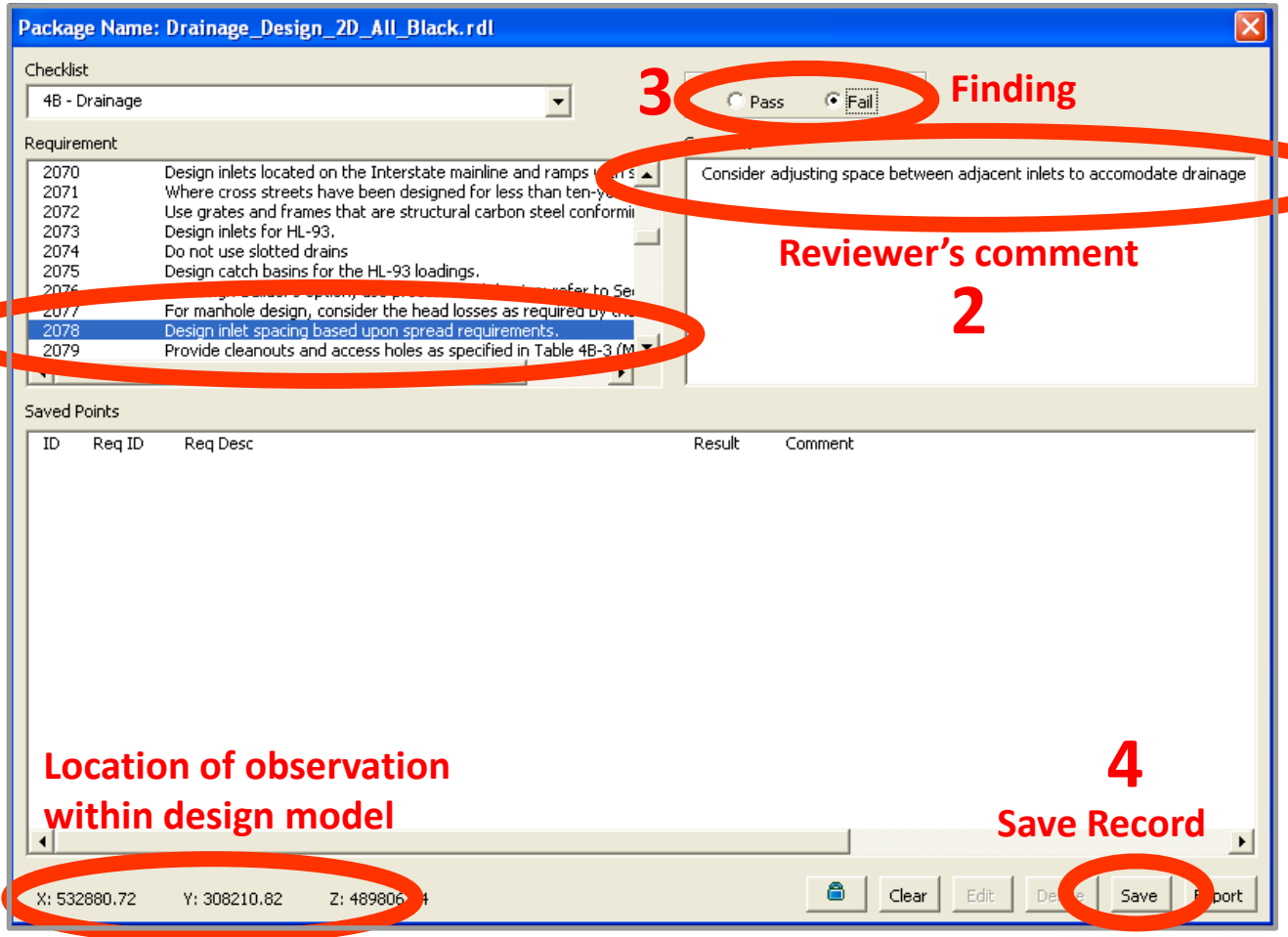


Reviewing the Design Model

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Electronic Design Review

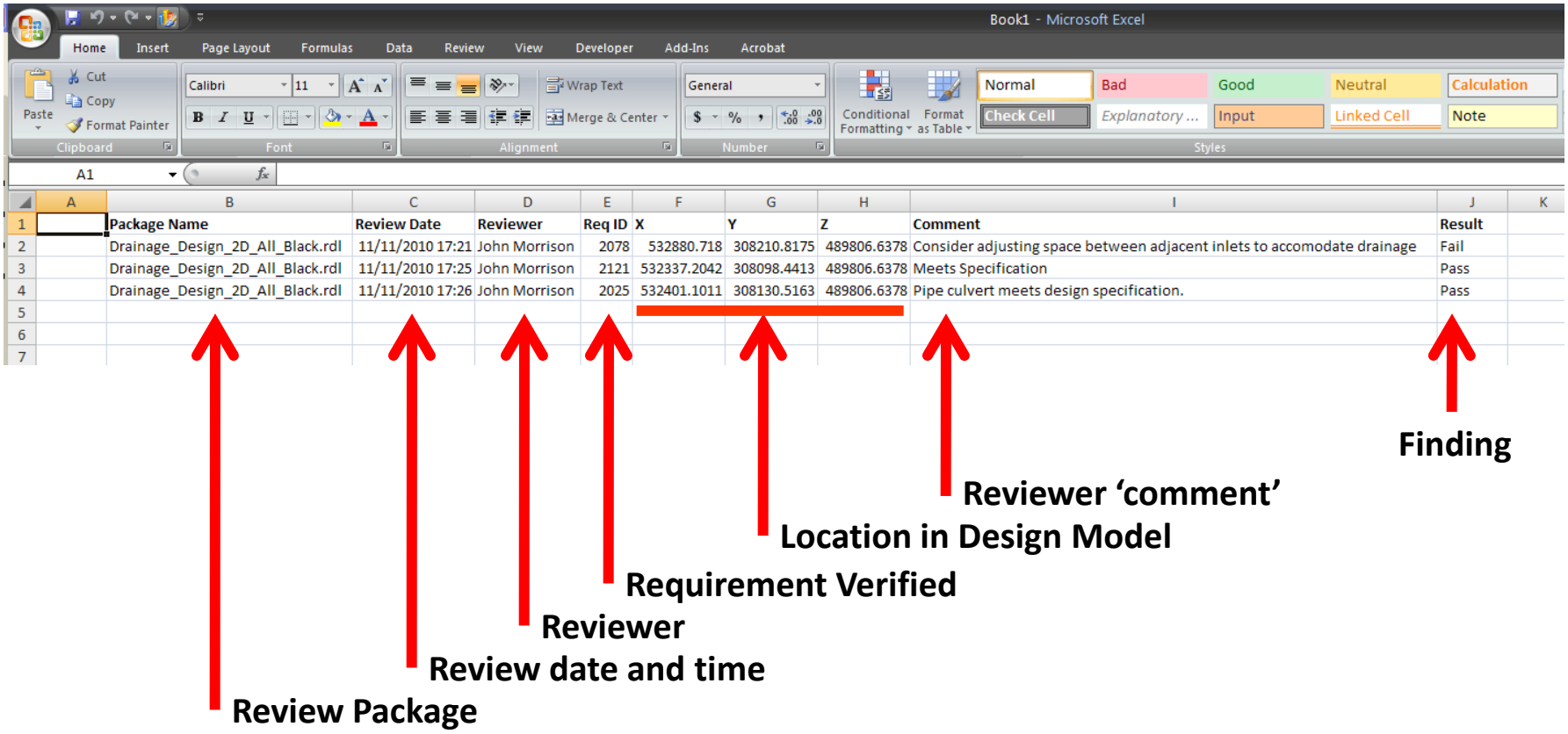
Verifying Design Input Requirements



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Electronic Design Review

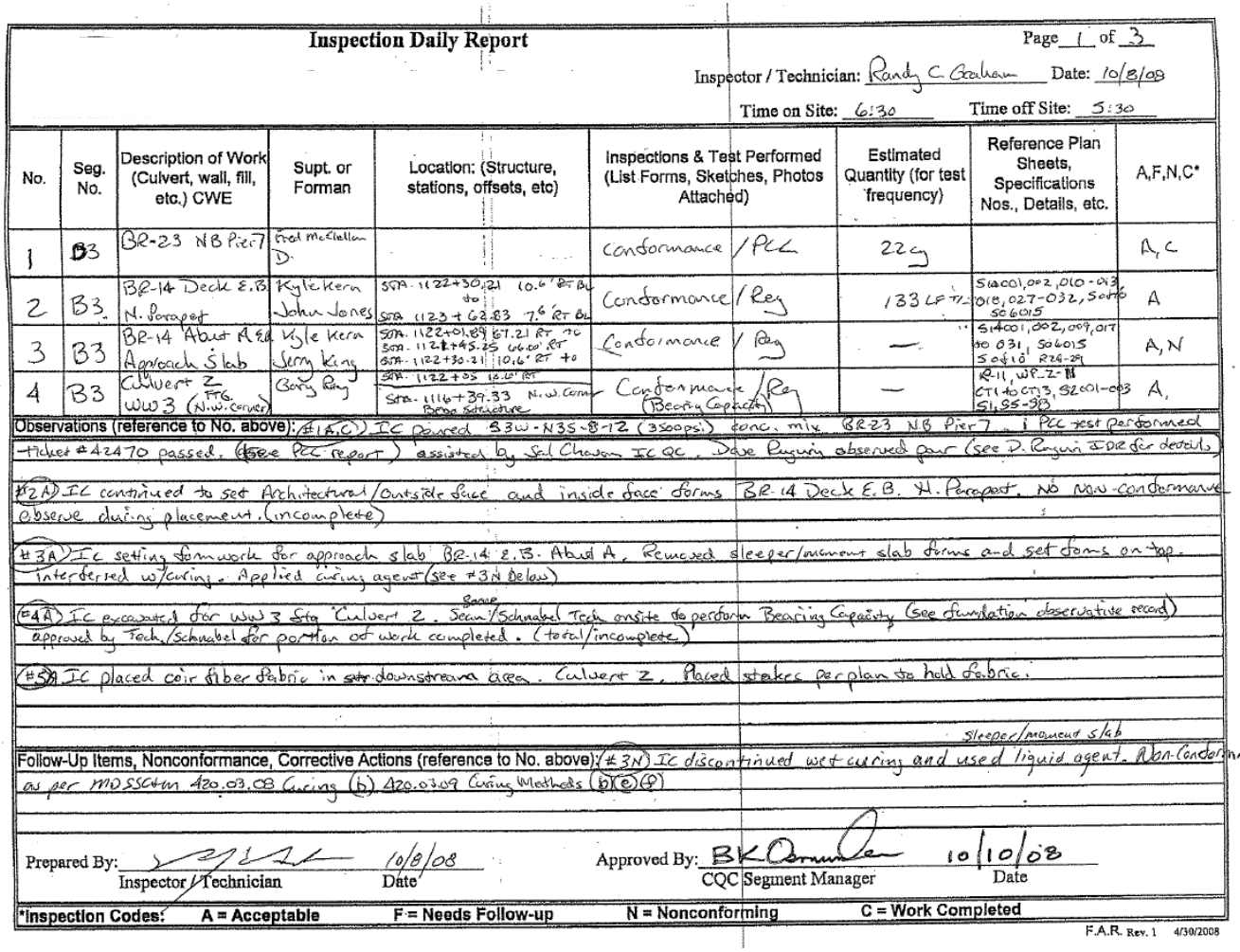
Direct export from database to Excel



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Field Verification Data Collection

Inspector Daily Reports



Inspection Daily Report

Page 1 of 3

Inspector / Technician: Randy C. Graham Date: 10/8/08

Time on Site: 6:30 Time off Site: 5:30

No.	Seg. No.	Description of Work (Culvert, wall, fill, etc.) CWE	Supt. or Forman	Location: (Structure, stations, offsets, etc)	Inspections & Test Performed (List Forms, Sketches, Photos Attached)	Estimated Quantity (for test frequency)	Reference Plan Sheets, Specifications Nos., Details, etc.	A,F,N,C*
1	B3	BR-23 NB Pier 7	Fred McClellan D.		Conformance / PCC	22cy		A, C
2	B3	BR-14 Deck E.B. N. Parapet	Kyle Kern John Jones	STA. 1122+30.21 10.6' RT BL to STA. 1123+62.83 7.6' RT BL	Conformance / Reg	133 LF +/-	S1a001, 002, 010-013, 018, 027-032, S06015	A
3	B3	BR-14 Abut A Rt Approach Slab	Kyle Kern Jerry King	STA. 1122+01.89 67.21 RT to STA. 1122+45.25 66.60' RT STA. 1122+30.21 10.6' RT to	Conformance / Reg	—	S14001, 002, 009, 017 to 031, S06015 S06016 RT4-29	A, N
4	B3	Culvert 2 WW3 (N.W. Corner) Stg.	Gary Ray	STA. 1122+35 16.0' RT STA. 1116+39.33 N.W. Corner Bridge Structure	Conformance (Bearing Capacity) / Reg	—	R-11, WP 2-11 CT1 to CT3, S2001-003 S1, S5-38	A,

Observations (reference to No. above): #1A,C) IC placed 33W-N35-872 (3500psi) conc. mix BR-23 NB Pier 7 ; PCC test performed ticket #42470 passed. (See PCC report) assisted by Sid Chavan IC QC. Dave Pugsley observed pour (see D. Pugsley IDR for details)

#2A) IC continued to set Architectural/outside face and inside face forms BR-14 Deck E.B. N. Parapet. No non-conformance observe during placement. (incomplete)

#3A) IC setting formwork for approach slab BR-14 E.B. Abut A. Removed sleeper/moment slab forms and set forms on top. Interfered w/curing. Applied curing agent (see #3N below)

#4A) IC excavated for WW3 Stg Culvert 2. Seam/Schnabel Tech onsite to perform Bearing Capacity (See foundation observation record) approved by Tech./Schnabel for portion of work completed. (total/incomplete)

#5A) IC placed coir fiber fabric in ~~str~~ downstream area. Culvert 2. Placed stakes per plan to hold fabric.

Follow-Up Items, Nonconformance, Corrective Actions (reference to No. above): (#3N) IC discontinued wet curing and used liquid agent. Non-Conforming as per MDSSCtm 420.03.08 Curing (b) 420.03.09 Curing Methods (b)(c)(f) (sleeper/moment slab)

Prepared By: Inspector / Technician 10/8/08 Date

Approved By: BK CQC Segment Manager 10/10/08 Date

*Inspection Codes: A = Acceptable F = Needs Follow-up N = Nonconforming C = Work Completed

F.A.R. Rev. 1 4/30/2008

Inspector daily reports

- **Who can read it?**
- **Who signed it?**
- **Was the work good or bad?**
- **What data can be analyzed?**
- **What was the inspector actually looking at? Progress or performance?**

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Field Verification Data Collection

Field Test Results

RT 97 Median

NUCLEAR D/M COMPACTION REPORT

Gauge Model: ~~portaprobe~~ PCN Gauge Serial No.: _____ Contract No.: AT3765960 F.A.P. No.: AC-NH-ICC-1 (1)N Operator: S.A. Smith Date: 1-8-08

Standard Count: Moisture MS: _____ Density DS: _____ Average of four previous counts: Moisture MS: _____ Density DS: _____ Segment: D3

10 x 12 STA 28+00 — D 2'4" — ALL FACING NORTH

TEST SITE DATA	1. FIELD TEST NUMBER	9	10	11	12	13	14	15	16
	2. TYPE MATERIAL & C.Y. THIS FILL	CR-6	→	→	→	→	→	→	→
	3. SOURCE	Rockville	→	→	→	→	→	→	→
	4. STATION	229+50	228+50	227+50	226+50	225+50	224+50	223+50	221+50
	5. ITEM NUMBER	Temp Road	Median	→	→	→	→	→	→
	6. DISTANCE TO CENTER LINE OR BASE LINE	5' LT	8' LT	10' R	10' Rt	18' Rt	6' RT	CL	3'
	7. HEIGHT TO FINAL GRADE	F.G	→	→	→	→	→	→	→
IN PLACE MOISTURE & DENSITY	8. MEASURE COUNT, MC								
	9. Weight OF MOISTURE, M, P.C.F.	19.8	19.4	19.4	20.0	21.3	18.4	17.1	17.4
	10. MOISTURE CONTENT, % M *(Notes 1,2)*	15.8	15.04	14.6	15.6	16.2	14.6	13.5	13.4
	11. MOISTURE CORRECTION *(Note 2)* (9.9)	5.9	5.1	4.7	5.7	6.3	4.7	3.6	3.5
	12. MEASURE COUNT, DC	1003	1014	1101	1054	1050	1126	1148	1151
	13. WET Weight, WD, P.C.F.	139.2	148.7	152.8	148.6	152.8	144.5	143.9	147.4
	14. DRY Weight, DD, P.C.F.	131.4	141.5	145.9	140.6	143.7	138.0	138.9	142.4
COMPACTION	15. MAXIMUM DRY DENSITY FROM CHART *(Notes 3)* P.C.F.	142.1	142.1	142.1	142.1	142.1	142.1	142.1	142.1
	16. OPTIUM MOISTURE FROM CHART, % *(Note 3)*	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
	17. COMPACTION REQUIRED, % *(Note 4)*	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
	18. COMPACTION OBTAINED, %	92.5	99.6	100+	98.9	100+	97.1	97.7	100
		F	P 1	P	P	P	P	P	P

Ver. 1 12/07 map

Field Test Record

- **Are the numbers correct?**
- **Are the calculations correct?**
- **Are the selected passing criteria correct?**
- **Who is going to analyze the data?**

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Field Verification Data Collection



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Field Verification Data Collection



Inspections



Material tests



Location accuracy

Better tools, better training…

RESULT: Better data, increased efficiency

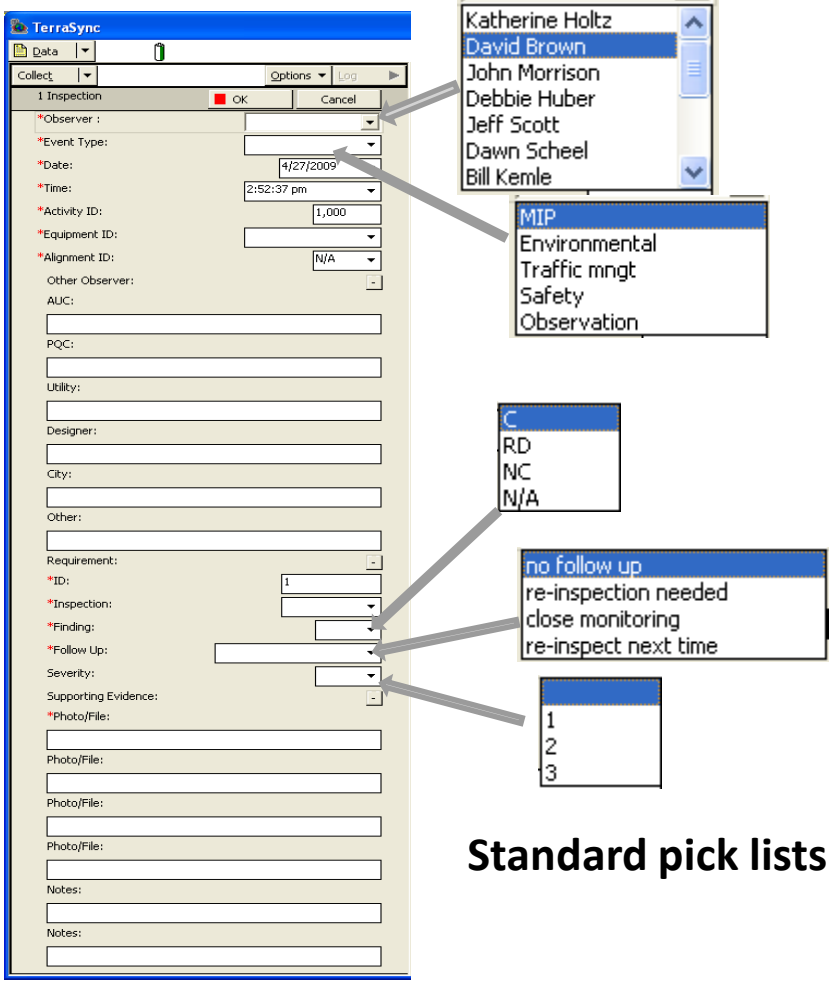
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Field Verification Data Collection

Moving data from the field…



Field Data

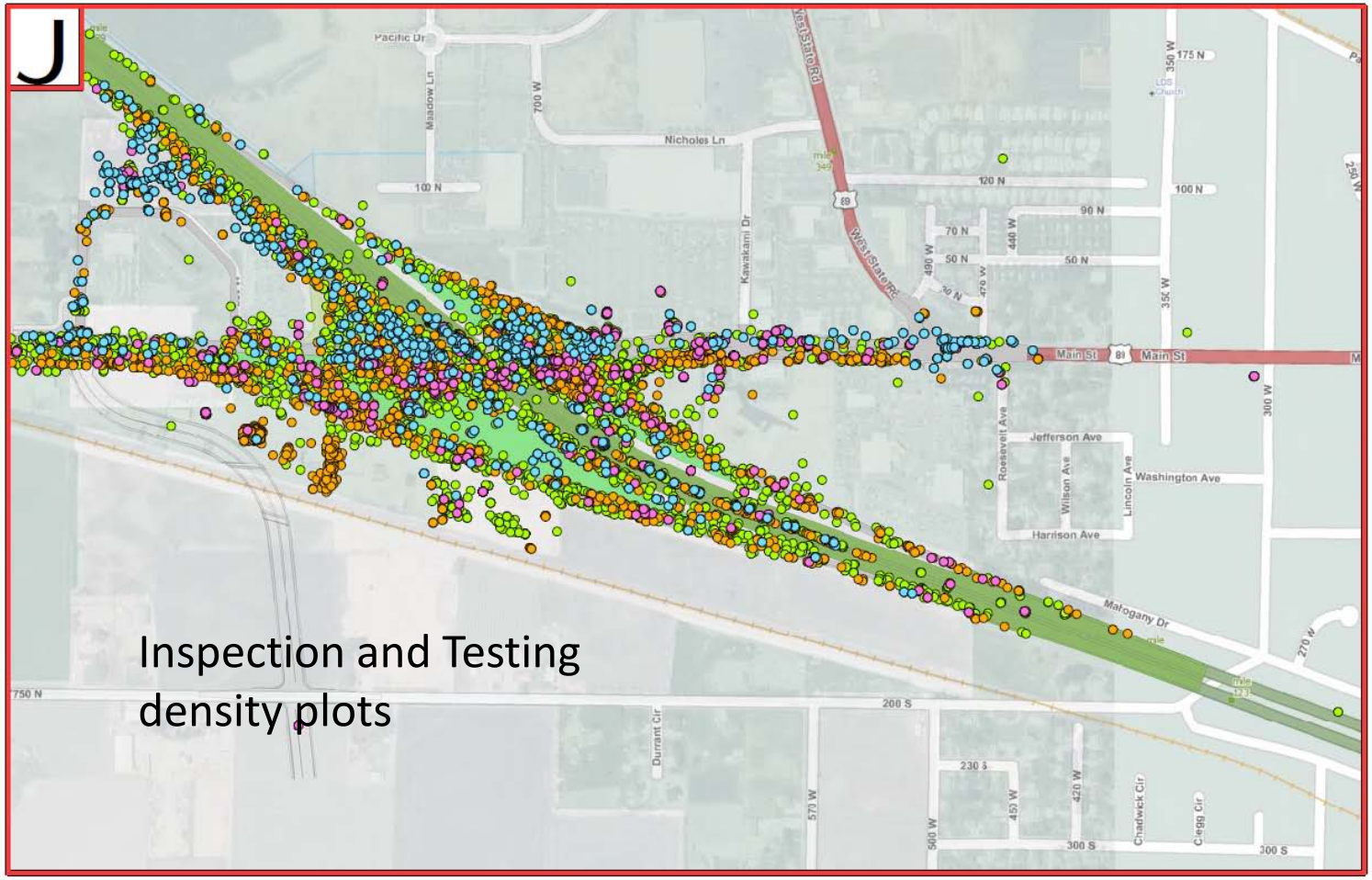


Customized user interface

Standard pick lists

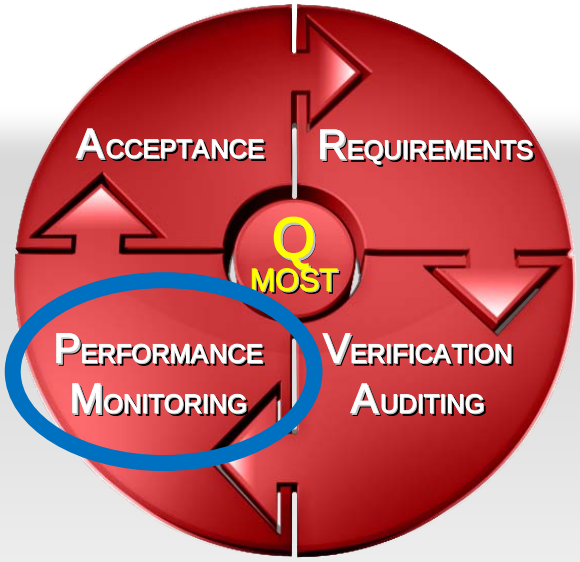
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Field Verification Data Collection



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QMost Model



PERFORMANCE MONITORING…

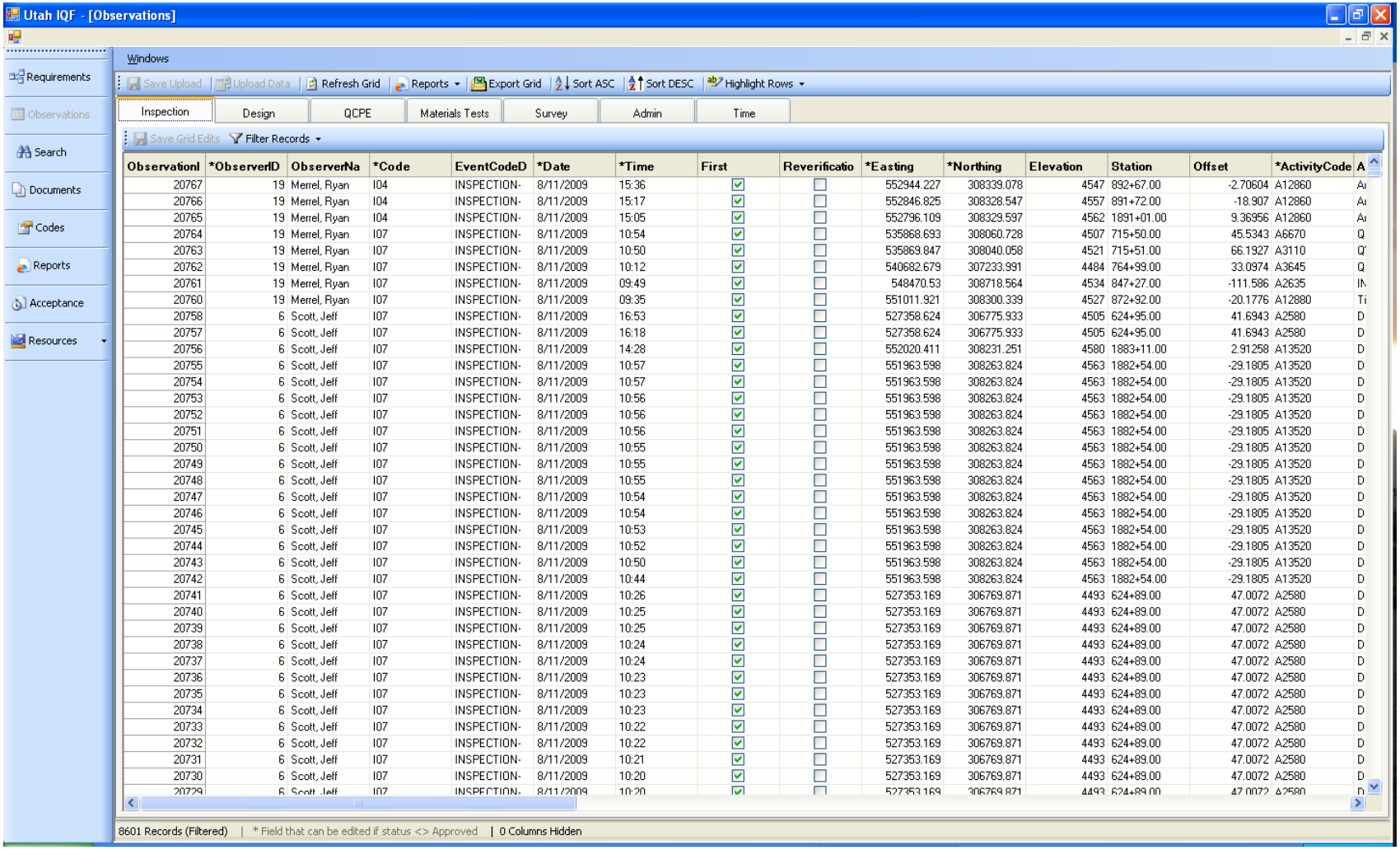
Analysis of data.

Improvements include:

- **Unleash the power of the database**
- **Visualize the data**
- **DATA – INFORMATION – KNOWLEDGE**
- **Builds confidence in Performance**

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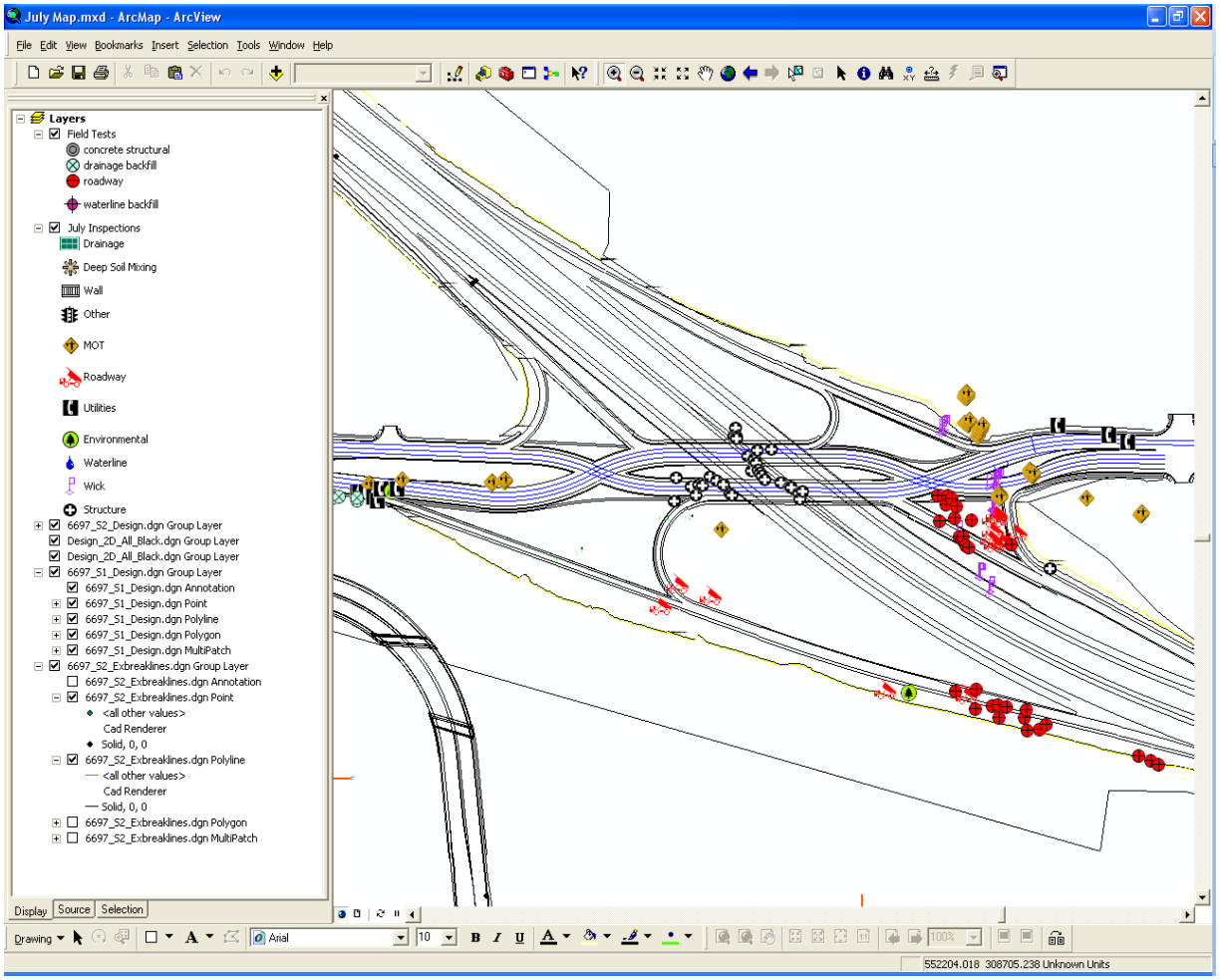
Web-enabled database system…



ObservationI	*ObserverID	ObserverNa	*Code	EventCodeD	*Date	*Time	First	Reverificatio	*Easting	*Northing	Elevation	Station	Offset	*ActivityCode	A
20767	19	Merrel, Ryan	I04	INSPECTION-	8/11/2009	15:36	☑	☐	552944.227	308339.078	4547	892+67.00	-2.70604	A12860	Ai
20766	19	Merrel, Ryan	I04	INSPECTION-	8/11/2009	15:17	☑	☐	552846.825	308328.547	4557	891+72.00	-18.907	A12860	Ai
20765	19	Merrel, Ryan	I04	INSPECTION-	8/11/2009	15:05	☑	☐	552796.109	308329.597	4562	1891+01.00	9.36956	A12860	Ai
20764	19	Merrel, Ryan	I07	INSPECTION-	8/11/2009	10:54	☑	☐	535868.693	308060.728	4507	715+50.00	45.5343	A6670	Q
20763	19	Merrel, Ryan	I07	INSPECTION-	8/11/2009	10:50	☑	☐	535869.847	308040.058	4521	715+51.00	66.1927	A3110	Q
20762	19	Merrel, Ryan	I07	INSPECTION-	8/11/2009	10:12	☑	☐	540682.679	307233.991	4484	764+99.00	33.0974	A3645	Q
20761	19	Merrel, Ryan	I07	INSPECTION-	8/11/2009	09:49	☑	☐	548470.53	308718.564	4534	847+27.00	-111.586	A2635	IN
20760	19	Merrel, Ryan	I07	INSPECTION-	8/11/2009	09:35	☑	☐	551011.921	308300.339	4527	872+92.00	-20.1776	A12880	Ti
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20736	6	Scott, Jeff	I07	INSPECTION-	8/11/2009	10:23	☑	☐	527353.169	306769.871	4493	624+89.00	47.0072	A2580	D
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20729	6	Scott, Jeff	I07	INSPECTION-	8/11/2009	10:20	☑	☐	527353.169	306769.871	4493	624+89.00	47.0072	A2580	D

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GIS data points from Construction…



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Data reported in any summary format…

Monthly summary of IQF Field Observations

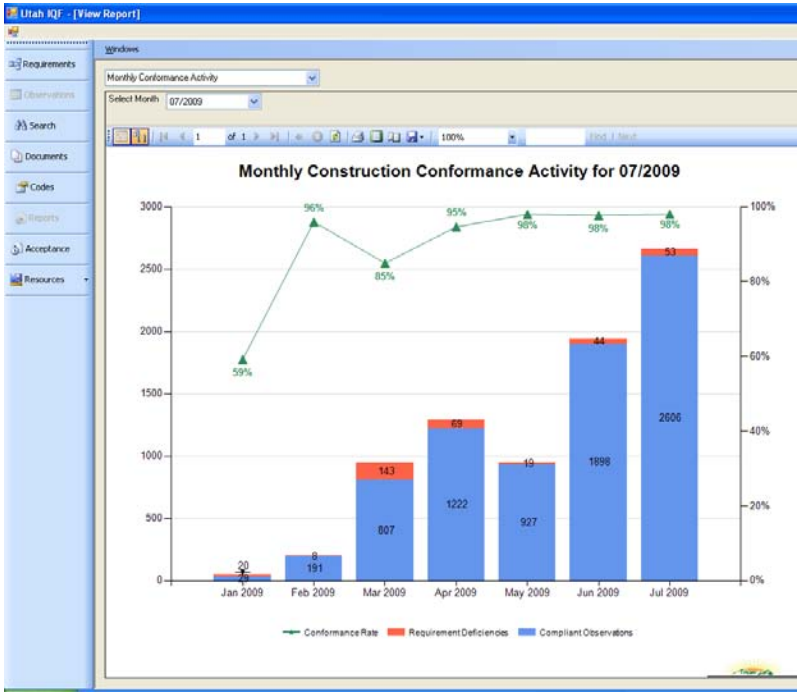
			Location						Activity		Observer		Requirement			
Time	First	Reverification	Easting	Northing	Elevation	Alignment	Station	Offset	ID	Name	Inspector	Others present	IQF Requirement ID	Requirement	Finding	NC / Lev
09:53	Yes		548219.432	308397.412	4514	6697_S2_Pioneer Crossing West of DDI	843+96.00	115.424	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	Scott, Jeff		200758	Advance the mandrel with constant load or constant rate of advancement.	C	
08:21	Yes		542386.577	307219.174	4518	6697_S2_Pioneer Crossing West of DDI	782+02.00	-21.3204	A3570	Place Borrow & Granular 500 W TO 300 E (771+50 - 807+50)	Salisbury, Garry			General Observation		
08:30	Yes		549994.685	308303.867	4527	6697_S2_Pioneer Crossing West of DDI	862+76.00	49.1048	A12880	Timpanogos TSSD 24" Sewer Relocate/Betterment (42")	Salisbury, Garry			General Observation		
08:52	Yes		539048.908	307774.431	4521	6697_S2_Pioneer Crossing West of DDI	747+71.00	5.38279	A3480	Place Borrow & Granular 1100 W TO 500 W (742+50 - 771+50)	Salisbury, Garry		202279	Acceptance sampling and testing of material is in accordance with UDOT Minimum Sampling and Testing Requirements		
08:55	Yes		539048.871	307771.577	4521	6697_S2_Pioneer Crossing West of DDI	747+71.00	8.23647	A3480	Place Borrow & Granular 1100 W TO 500 W (742+50 - 771+50)	Salisbury, Garry		200445	Compact borrow and backfill material in 6-inch layers to a 96 percent density		
09:13	Yes		548310.562	308438.115	4534	6697_S2_Pioneer Crossing West of DDI	844+96.00	107.961	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	DeAlba, Bob		202029	Are the PV drains being installed using a mandrel or sleeve that inserts the PV drain (pushed or vibrated) into the soil?	C	
09:16	Yes		548309.917	308437.773	4535	6697_S2_Pioneer Crossing West of DDI	844+95.00	108.063	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	DeAlba, Bob		202033	Are the final PV drain locations within 6 inches from plan location?	C	
09:16	Yes		548310.025	308438.723	4538	6697_S2_Pioneer Crossing West of DDI	844+95.00	107.206	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	DeAlba, Bob		202039	Is a 4 to 8 inch length of PV drain material protruding above the sand surface at each PV location?	C	
09:16	Yes		548310.131	308438.126	4538	6697_S2_Pioneer Crossing West of DDI	844+95.00	107.804	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	DeAlba, Bob		202030	Is a vibrator available should the constant load method for installation not work?	C	
09:16	Yes		548309.116	308437.267	4542	6697_S2_Pioneer Crossing West of DDI	844+94.00	108.266	A1860	INSTALL WICK DRAIN SOUTH ABUTMENT- UPRR BRIDGE	DeAlba, Bob		202037	Was the equipment plumb prior to the installation of each drain?	C	
09:17	Yes		548200.229	308564.905	4516	6697_S2_Pioneer Crossing West of DDI	844+35.00	-48.6838	A12780	UPRR Bridge Deep Soil Mix North	DeAlba, Bob		202886	As penetration occurs, bentonite, cement, lime or other stabilizing slurry is injected into the soil thru the HSAs (hollow stem auger)	C	
09:24	Yes		534658.104	308102.968	4511	6697_S2_Pioneer Crossing West of DDI	703+41.00	38.3331	A14230	E/L/B 60" WATERLINE Crew 3- 114+00 to 128+00 (1700 W)	Simpson, Fred		202291	Removal and Exclusion of Water: The D/B CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 1-feet below the bottom of excavations. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed. See Section 02140 -"Control of Water" for additional requirements	C	
09:26	Yes		542291.271	307182.695	4513	6697_S2_Pioneer Crossing West of DDI	781+11.00	23.4429	A3570	Place Borrow & Granular 500 W TO 300 E (771+50 - 807+50)	Salisbury, Garry			General Observation		
09:27	Yes		548081.398	308476.79	4599	6697_S2_Pioneer Crossing West of DDI	842+93.00	-5.97765	A6080	DRIVE PILE- S. ABUTMENT - UPRR BRIDGE	Scott, Jeff		206311	F-787-14 Driven Pile Details - Pioneer Crossing over UPRR/UTA - General Notes	C	
09:28	Yes		534659.557	308096.166	4506	6697_S2_Pioneer Crossing West of DDI	703+43.00	45.0067	A14230	E/L/B 60" WATERLINE Crew 3- 114+00 to 128+00 (1700 W)	Simpson, Fred		202294	Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete or CLSM has attained sufficient strength to withstand the loads imposed. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the	C	

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Trending Data over time…



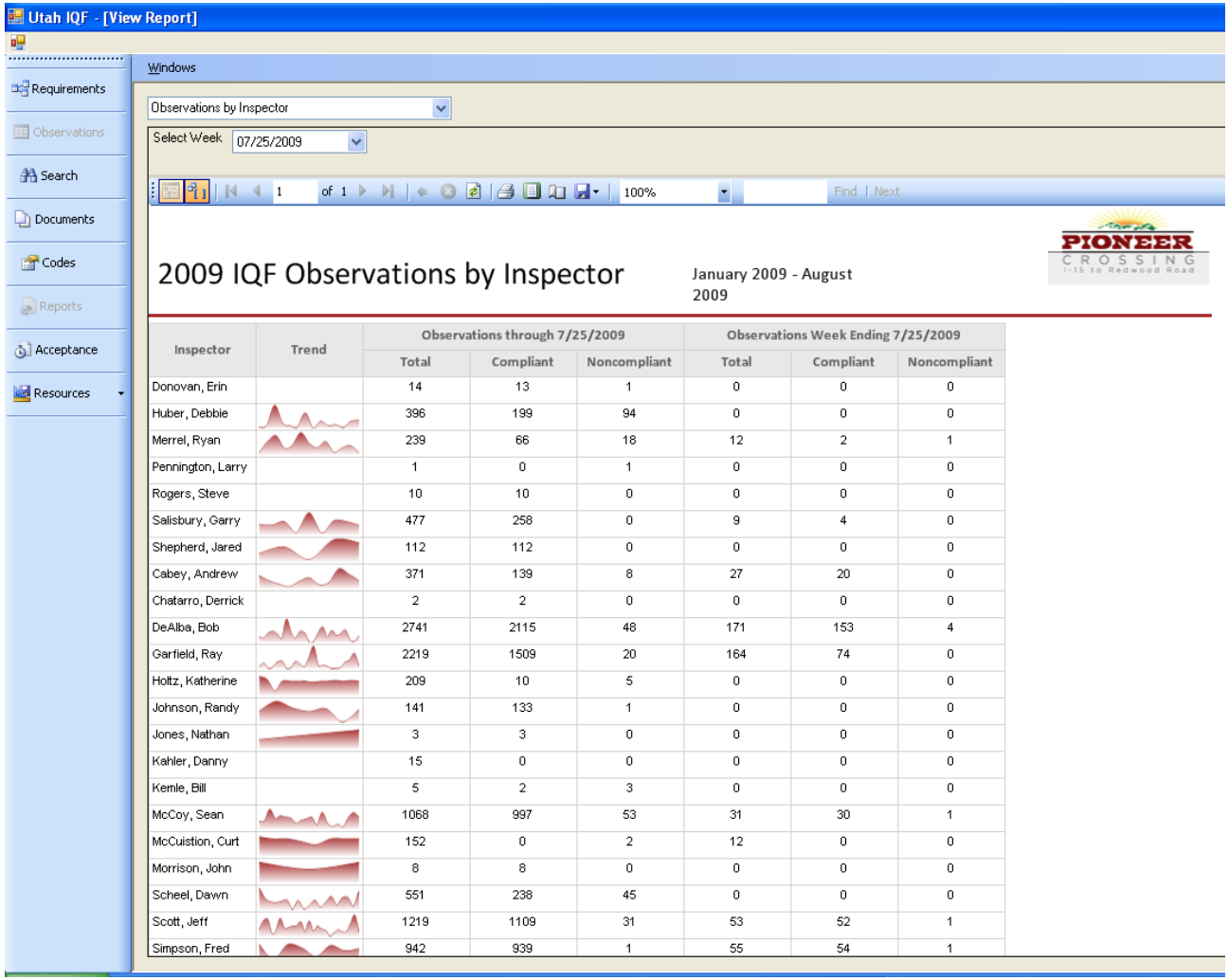
Summarized Weekly



Summarized Monthly

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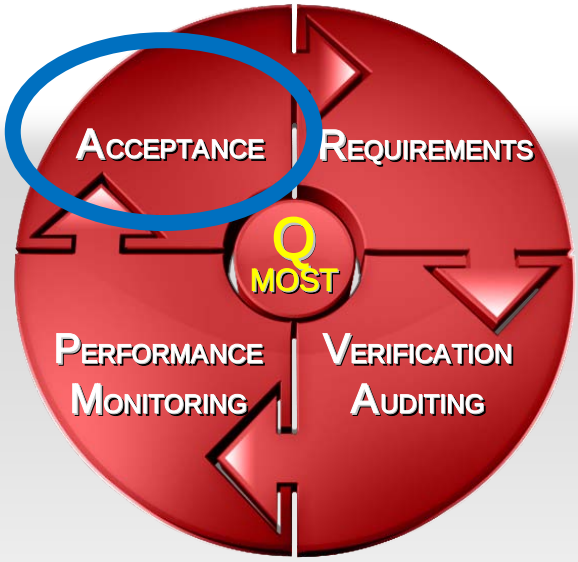
Tracking Inspector Efforts…



Inspector	Trend	Observations through 7/25/2009			Observations Week Ending 7/25/2009		
		Total	Compliant	Noncompliant	Total	Compliant	Noncompliant
Donovan, Erin		14	13	1	0	0	0
Huber, Debbie		396	199	94	0	0	0
Merrel, Ryan		239	66	18	12	2	1
Pennington, Larry		1	0	1	0	0	0
Rogers, Steve		10	10	0	0	0	0
Salisbury, Garry		477	258	0	9	4	0
Shepherd, Jared		112	112	0	0	0	0
Cabey, Andrew		371	139	8	27	20	0
Chatarro, Derrick		2	2	0	0	0	0
DeAlba, Bob		2741	2115	48	171	153	4
Garfield, Ray		2219	1509	20	164	74	0
Holtz, Katherine		209	10	5	0	0	0
Johnson, Randy		141	133	1	0	0	0
Jones, Nathan		3	3	0	0	0	0
Kahler, Danny		15	0	0	0	0	0
Kemle, Bill		5	2	3	0	0	0
McCoy, Sean		1068	997	53	31	30	1
McCuistion, Curt		152	0	2	12	0	0
Morrison, John		8	8	0	0	0	0
Scheel, Dawn		551	238	45	0	0	0
Scott, Jeff		1219	1109	31	53	52	1
Simpson, Fred		942	939	1	55	54	1

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FINAL ACCEPTANCE…

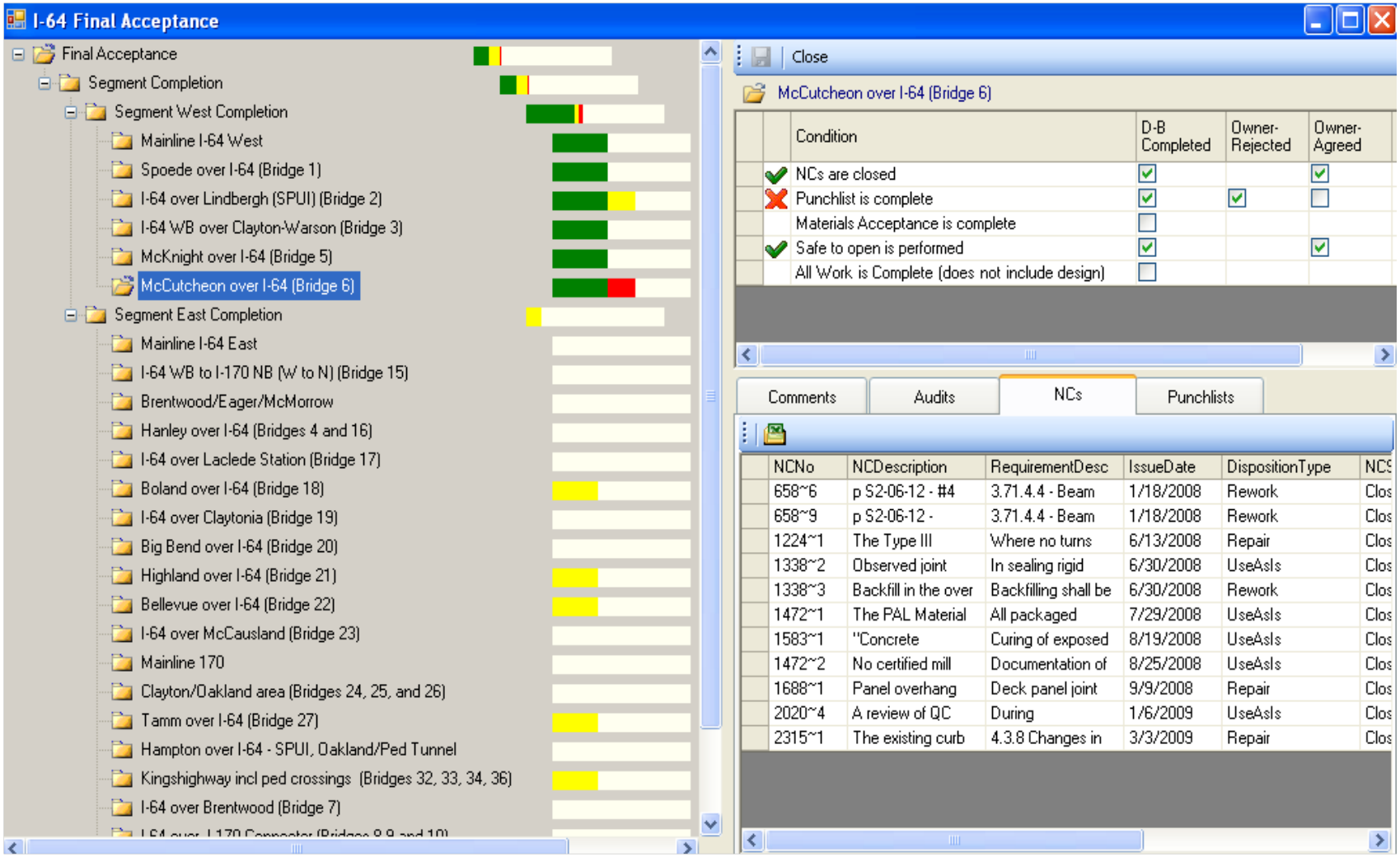
Start closing out project from day one.

Improvements include:

- **Final Acceptance Dashboard**
- **Understand CONDITIONS for acceptance**
- **Simplify final closeout task**

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Final Acceptance Dashboard…



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