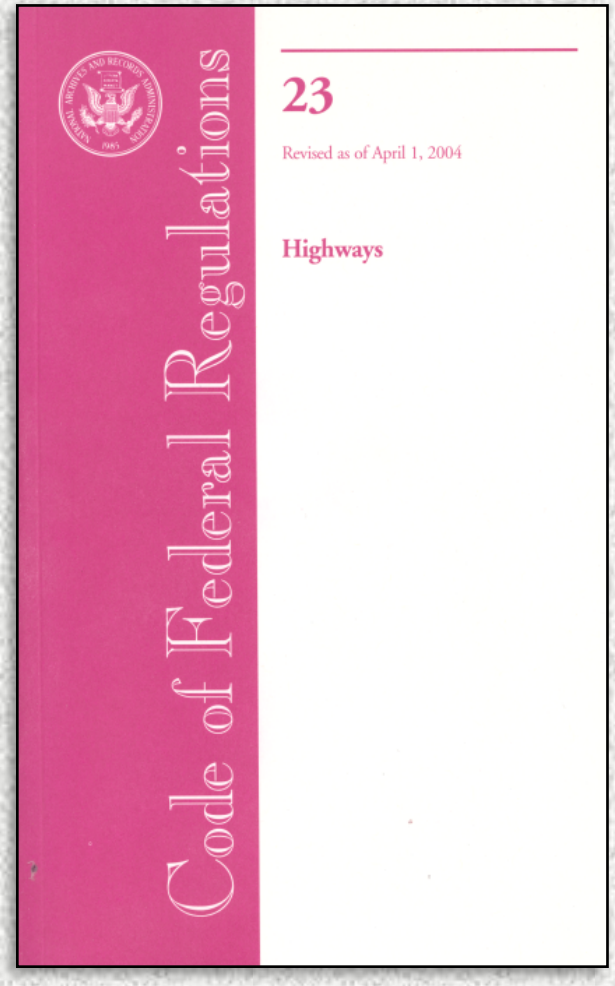
Risk-Based Quality Assurance Program

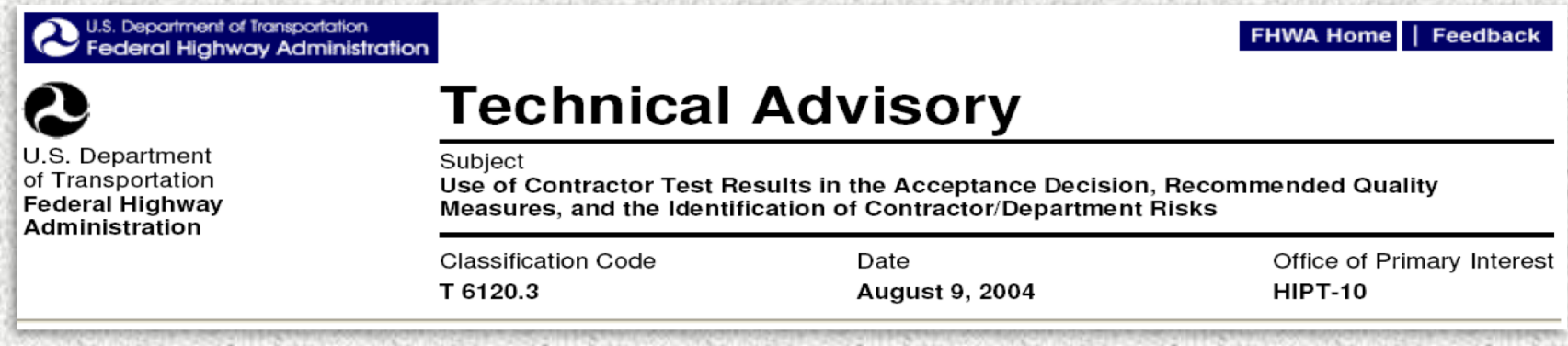
Weng On Tam, PE – Tam Consulting Services LLC

TCS

Federal Regulations



- **23 CFR Part 637 Subpart B**
  - Quality Assurance Procedures
- **Technical Advisory 6120.3**
  - Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, …



U.S. Department of Transportation
Federal Highway Administration

FHWA Home | Feedback

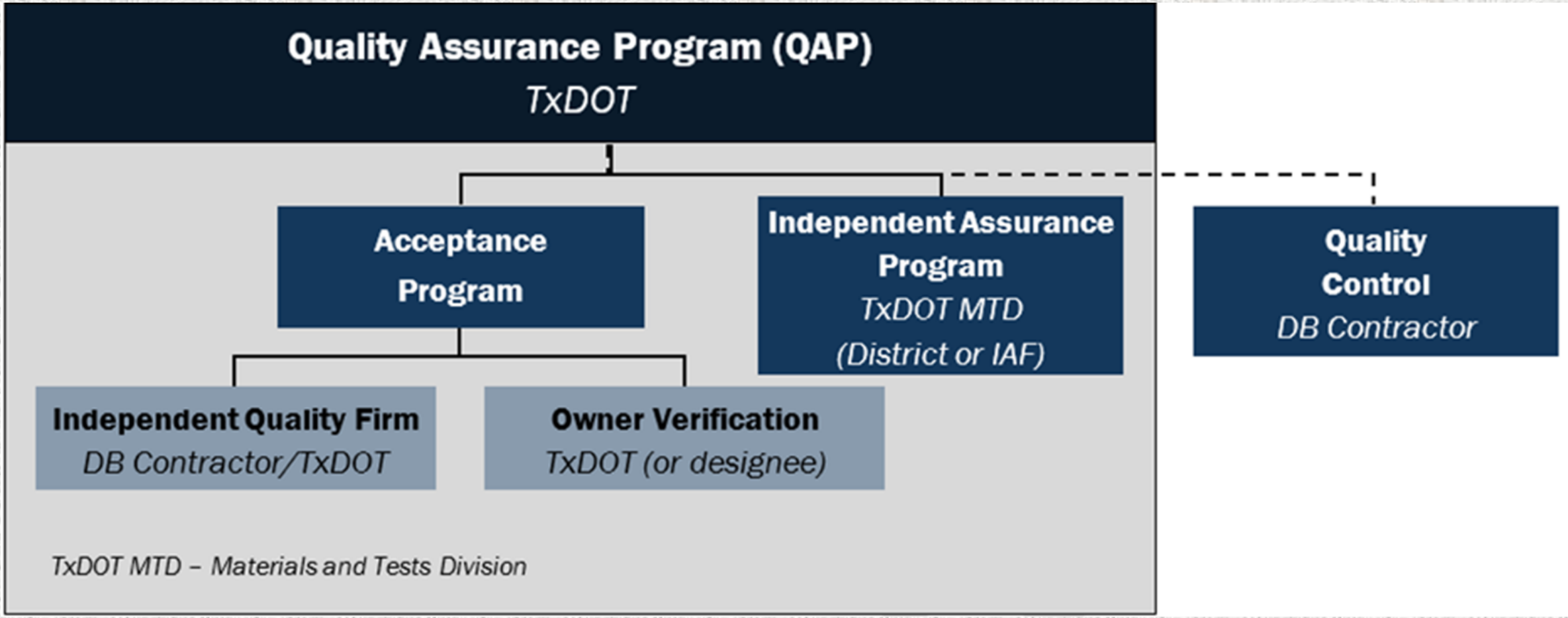
U.S. Department
of Transportation
Federal Highway
Administration

Technical Advisory

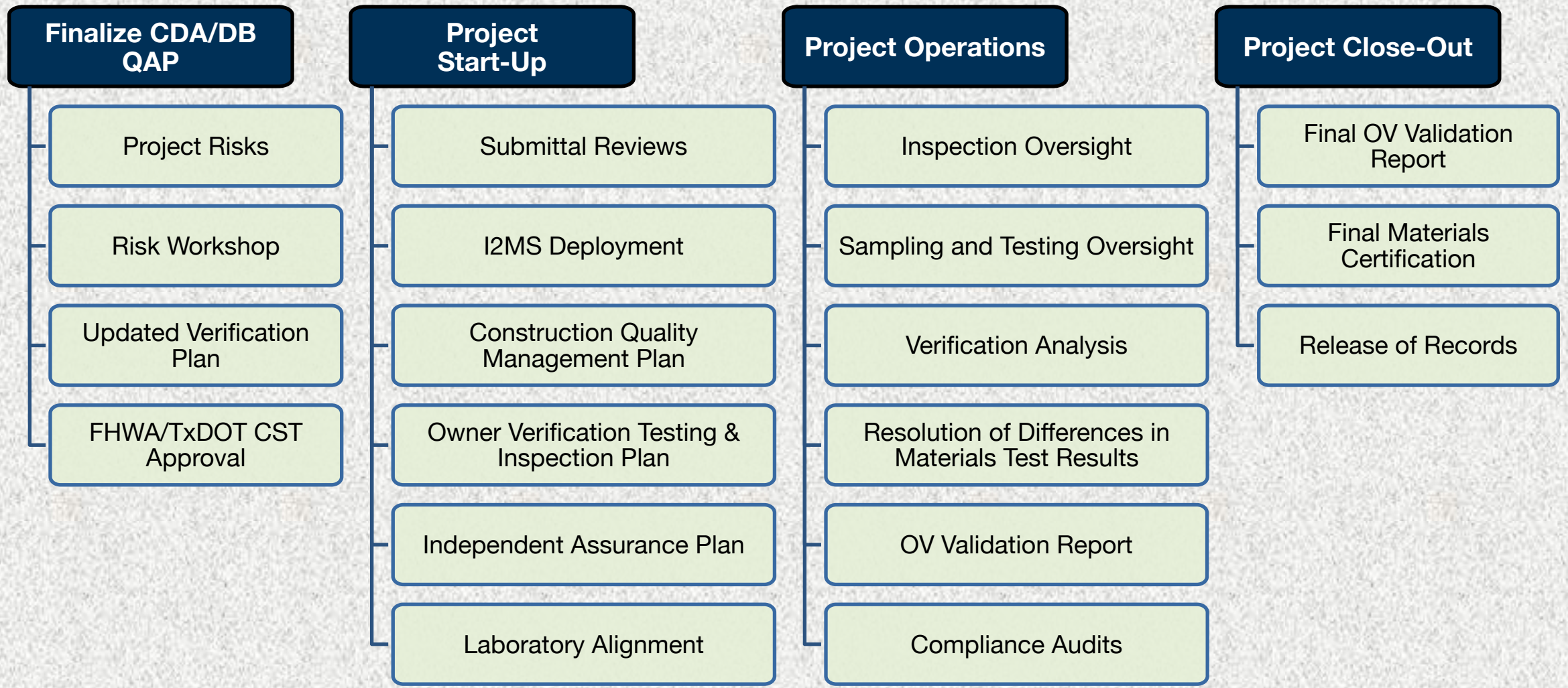
Subject
Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks

Classification Code	Date	Office of Primary Interest
T 6120.3	August 9, 2004	HIPT-10

Example Quality Assurance Program (TxDOT)



DB QAP Implementation Process (TxDOT)

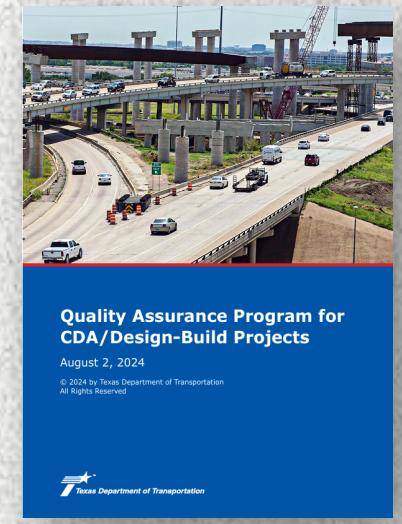


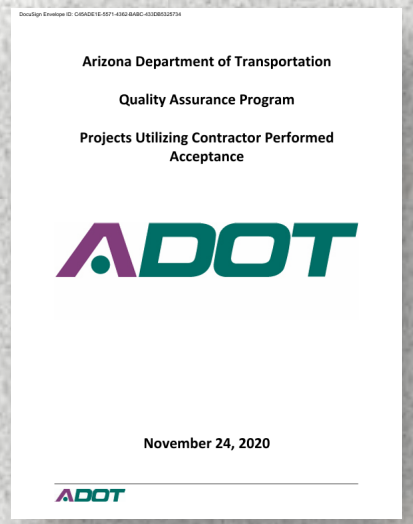
Project Risks & Risk Workshop

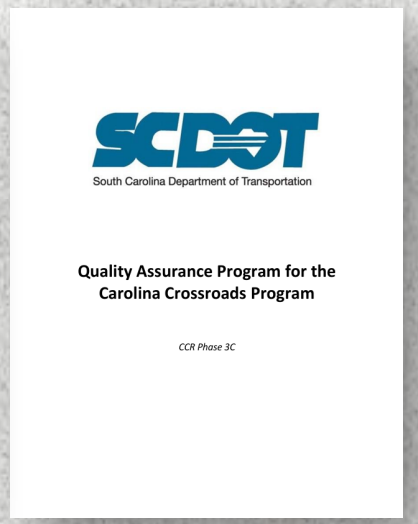
Finalize CDA/DB QAP

- Project Risks
- Risk Workshop
- Updated Verification Plan
- FHWA/TxDOT CST Approval

- **Evaluate Project Risks**
  - Identify Risks
- **Risk Workshop**
  - Customize Testing Oversight Levels
  - Concurrence From DOT & FHWA







Updated Verification Plan

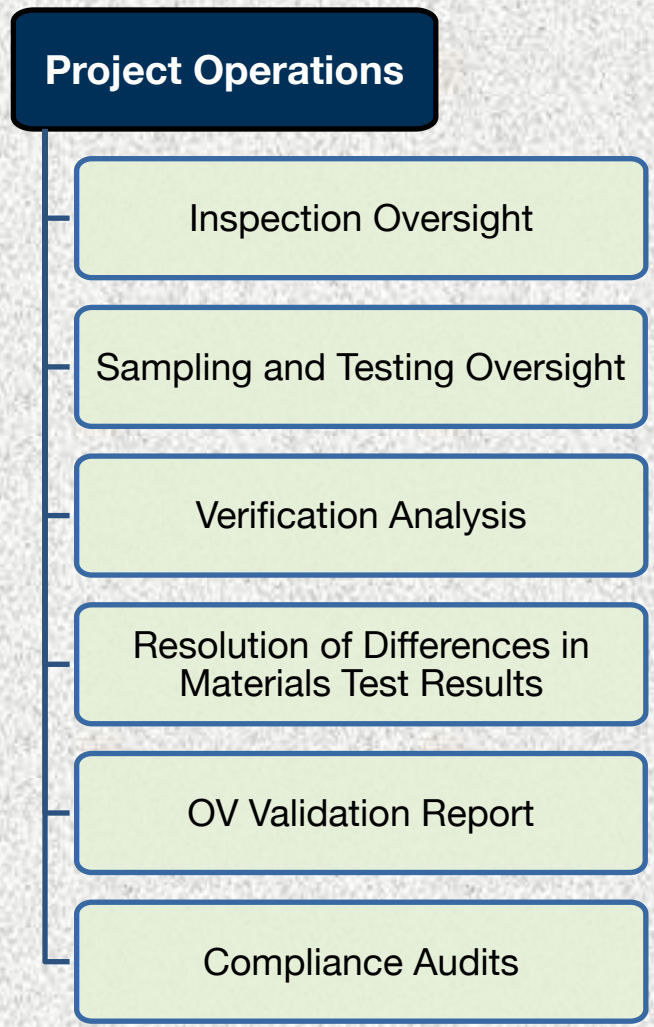
Finalize CDA/DB QAP

- Project Risks
- Risk Workshop
- Updated Verification Plan
- FHWA/TxDOT CST Approval

Finalize Levels of Analysis

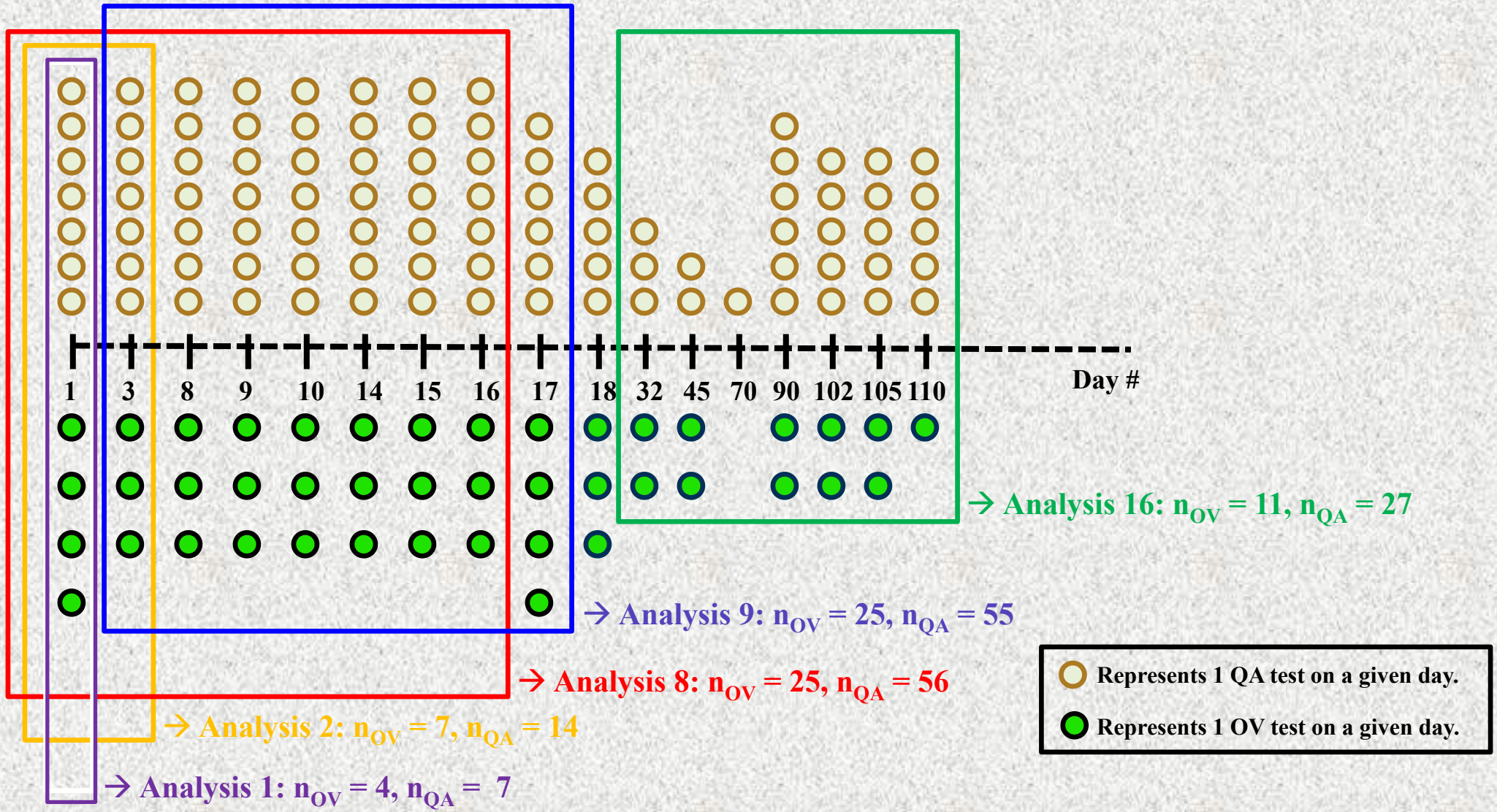
Levels for Analysis		Level 1	Level 2	Level 3
EMBANKMENTS, SUBGRADES, BACKFILL, AND BASE COURSES				
MATERIAL OR PRODUCT		TEST FOR	TEST NO.	TxDOT RECOMMENDED
EMBANKMENT (CUTS & FILLS)		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-114-E	3
		In-Place Density	Tex-115-E	1
RETAINING WALL (NON-SELECT BACKFILL)		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-114-E	3
		In-Place Density	Tex-115-E	1
RETAINING WALL (SELECT BACKFILL)		Gradation	Tex-110-E	2
		Resistivity	Tex-129-E	2
		pH	Tex-128-E	2
		Soundness	Tex-411-A	3
		In-Place Density	Tex-115-E	1
UNTREATED BASE COURSES		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-113-E	3
		Wet Ball Mill	Tex-116-E	2
		Triaxial	Tex-117-E	2
		In-Place Density	Tex-115-E	1
		Moisture Content	Tex-103-E	2
		Thickness	Tex-140-E	1
TREATED SUBGRADE AND BASE COURSES	New Base Material	Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-113-E	3
		Wet Ball Mill	Tex-116-E	2
		Triaxial	Tex-117-E	2
		In-Place Density	Tex-115-E	1
		Moisture Content	Tex-103-E	2
		Thickness	Tex-140-E	1
	Complete Mixture	Pulverizatin Gradation	Tex-101-E, Part III	2
		Moisture Content	Tex-103-E	2
		In-Place Density	Tex-115-E	1
		Thickness	Tex-140-E	1

Level 1: F- and t- Tests



- **Level 1**
  - High Residual Risk
  - Primary Indicator of Performance
  - OV Minimum Frequency Approximately 10%
- **Continuous Analysis**
  - F- and t- Tests (Variances and Means)
  - Max. No. of Days = 90
  - Max. No. of OV Results = 25
  - Exception for Unanalyzed Results
    - No Test Left Behind

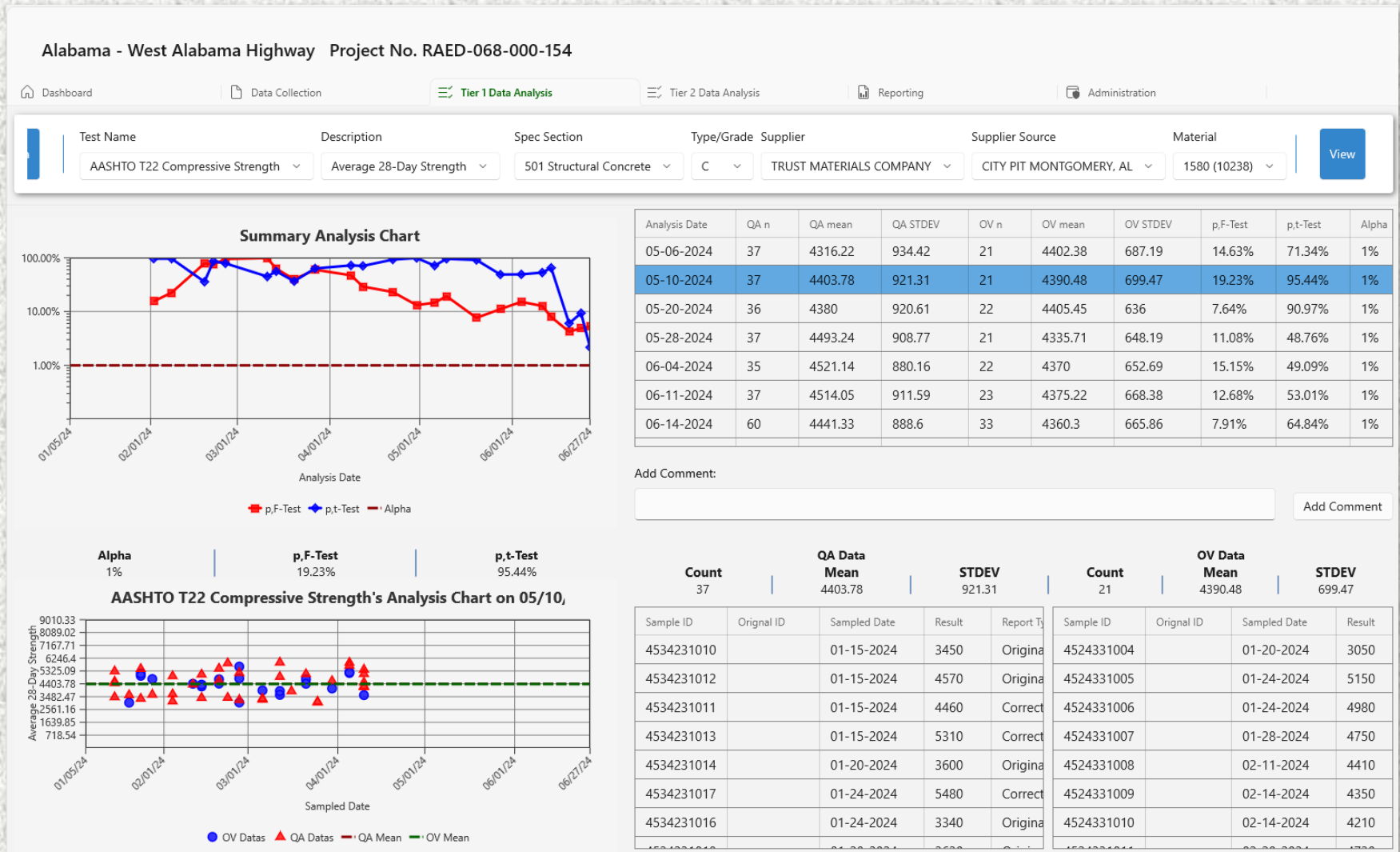
Level 1 Theory Example



Level 1: Example Dashboard (TCS DARPA)

Project Operations

- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Analysis Date	QA n	QA mean	QA STDEV	OV n	OV mean	OV STDEV	p,F-Test	p,t-Test	Alpha
05-06-2024	37	4316.22	934.42	21	4402.38	687.19	14.63%	71.34%	1%
05-10-2024	37	4403.78	921.31	21	4390.48	699.47	19.23%	95.44%	1%
05-20-2024	36	4380	920.61	22	4405.45	636	7.64%	90.97%	1%
05-28-2024	37	4493.24	908.77	21	4335.71	648.19	11.08%	48.76%	1%
06-04-2024	35	4521.14	880.16	22	4370	652.69	15.15%	49.09%	1%
06-11-2024	37	4514.05	911.59	23	4375.22	668.38	12.68%	53.01%	1%
06-14-2024	60	4441.33	888.6	33	4360.3	665.86	7.91%	64.84%	1%

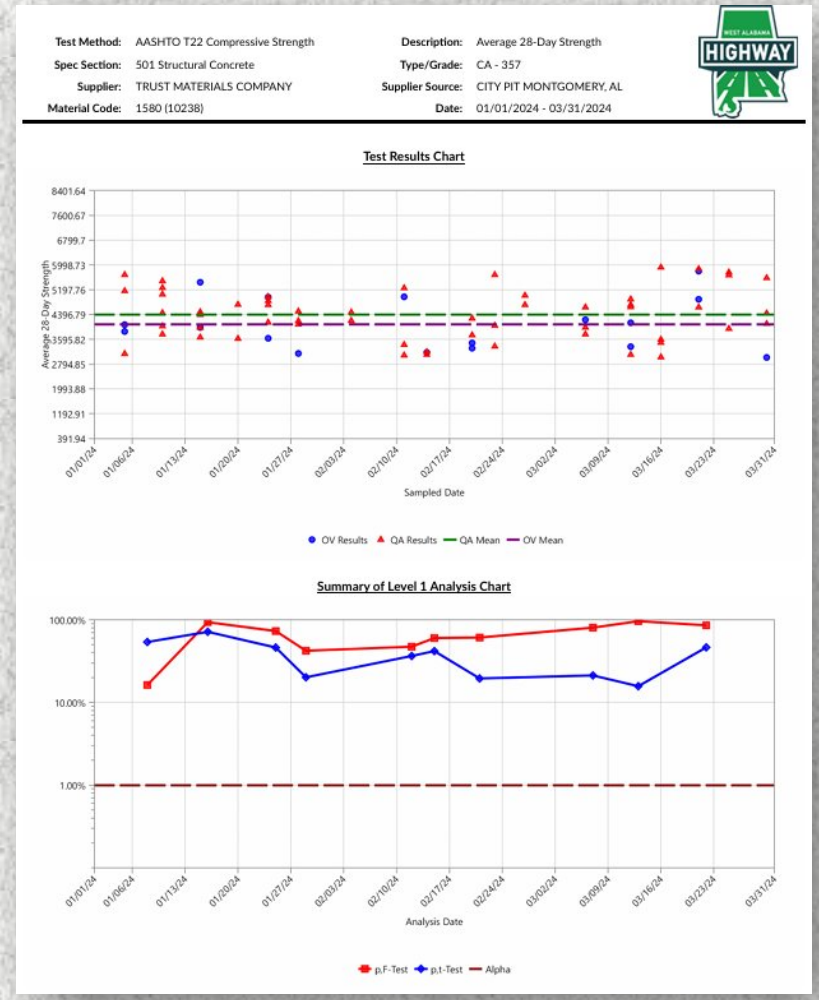
Sample ID	Orignal ID	Sampled Date	Result	Report Ty
4534231010		01-15-2024	3450	Origina
4534231012		01-15-2024	4570	Origina
4534231011		01-15-2024	4460	Correct
4534231013		01-15-2024	5310	Correct
4534231014		01-20-2024	3600	Origina
4534231017		01-24-2024	5480	Correct
4534231016		01-24-2024	3340	Origina

Sample ID	Orignal ID	Sampled Date	Result
4524331004		01-20-2024	3050
4524331005		01-24-2024	5150
4524331006		01-24-2024	4980
4524331007		01-28-2024	4750
4524331008		02-11-2024	4410
4524331009		02-14-2024	4350
4524331010		02-14-2024	4210

Level 1: Example Report (TCS DARPA)

Project Operations

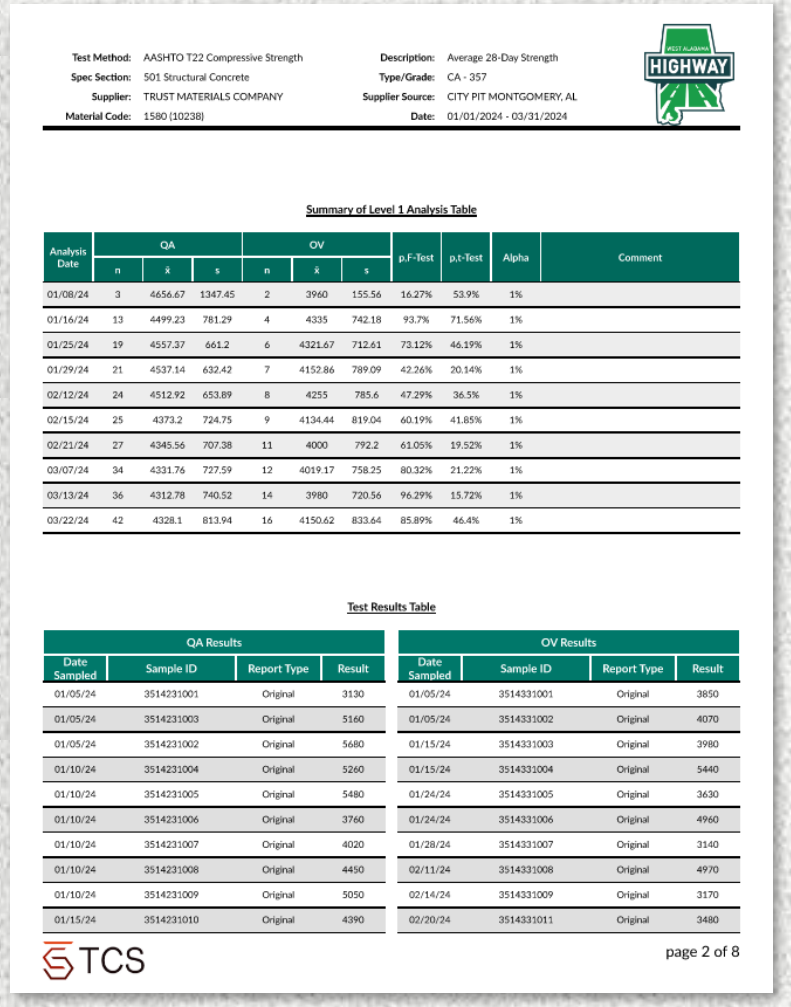
- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Test Method:	AASHTO T22 Compressive Strength	**Description:**	Average 28-Day Strength
Spec Section:	501 Structural Concrete	**Type/Grade:**	CA - 357
Supplier:	TRUST MATERIALS COMPANY	**Supplier Source:**	CITY PIT MONTGOMERY, AL
Material Code:	1580 (10238)	**Date:**	01/01/2024 - 03/31/2024

Test Results Chart

Summary of Level 1 Analysis Chart



Test Method:	AASHTO T22 Compressive Strength	**Description:**	Average 28-Day Strength
Spec Section:	501 Structural Concrete	**Type/Grade:**	CA - 357
Supplier:	TRUST MATERIALS COMPANY	**Supplier Source:**	CITY PIT MONTGOMERY, AL
Material Code:	1580 (10238)	**Date:**	01/01/2024 - 03/31/2024

Summary of Level 1 Analysis Table

Analysis Date	QA			OV			p,F-Test	p,t-Test	Alpha	Comment
	n	$\bar{x}$	s	n	$\bar{x}$	s				
01/08/24	3	4656.67	1347.45	2	3960	155.56	16.27%	53.9%	1%	
01/16/24	13	4499.23	781.29	4	4335	742.18	93.7%	71.56%	1%	
01/25/24	19	4557.37	661.2	6	4321.67	712.61	73.12%	46.19%	1%	
01/29/24	21	4537.14	632.42	7	4152.86	789.09	42.26%	20.14%	1%	
02/12/24	24	4512.92	653.89	8	4255	785.6	47.29%	36.5%	1%	
02/15/24	25	4373.2	724.75	9	4134.44	819.04	60.19%	41.85%	1%	
02/21/24	27	4345.56	707.38	11	4000	792.2	61.05%	19.52%	1%	
03/07/24	34	4331.76	727.59	12	4019.17	758.25	80.32%	21.22%	1%	
03/13/24	36	4312.78	740.52	14	3980	720.56	96.29%	15.72%	1%	
03/22/24	42	4328.1	813.94	16	4150.62	833.64	85.89%	46.4%	1%	

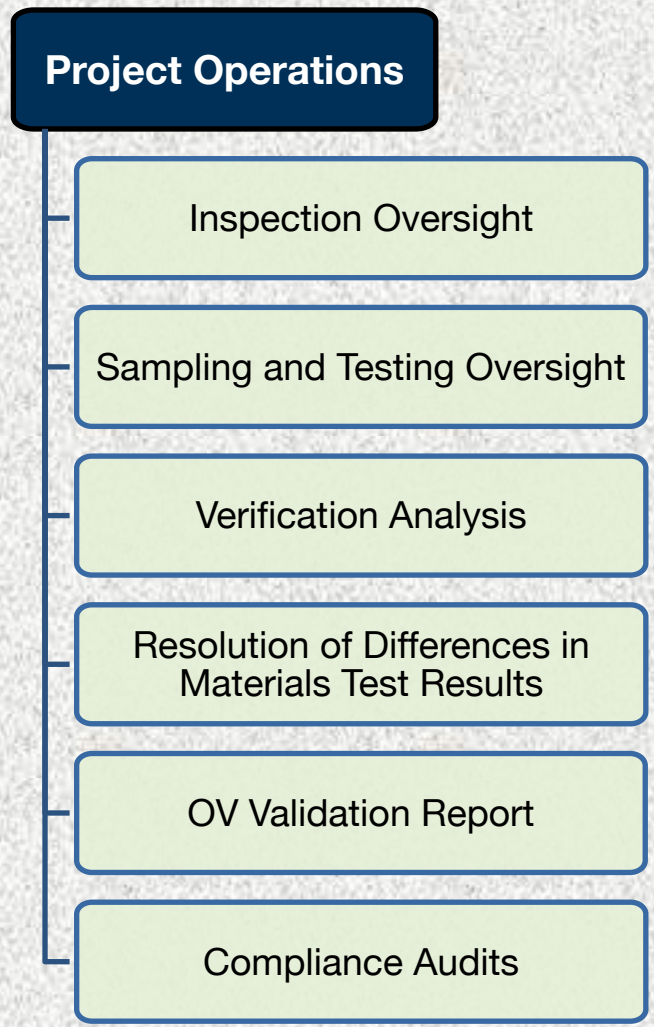
Test Results Table

QA Results				OV Results			
Date Sampled	Sample ID	Report Type	Result	Date Sampled	Sample ID	Report Type	Result
01/05/24	3514231001	Original	3130	01/05/24	3514331001	Original	3850
01/05/24	3514231003	Original	5160	01/05/24	3514331002	Original	4070
01/05/24	3514231002	Original	5680	01/15/24	3514331003	Original	3980
01/10/24	3514231004	Original	5260	01/15/24	3514331004	Original	5440
01/10/24	3514231005	Original	5480	01/24/24	3514331005	Original	3630
01/10/24	3514231006	Original	3760	01/24/24	3514331006	Original	4960
01/10/24	3514231007	Original	4020	01/28/24	3514331007	Original	3140
01/10/24	3514231008	Original	4450	02/11/24	3514331008	Original	4970
01/10/24	3514231009	Original	5050	02/14/24	3514331009	Original	3170
01/15/24	3514231010	Original	4390	02/20/24	3514331011	Original	3480

TCS

page 2 of 8

Level 2: Independent Verification

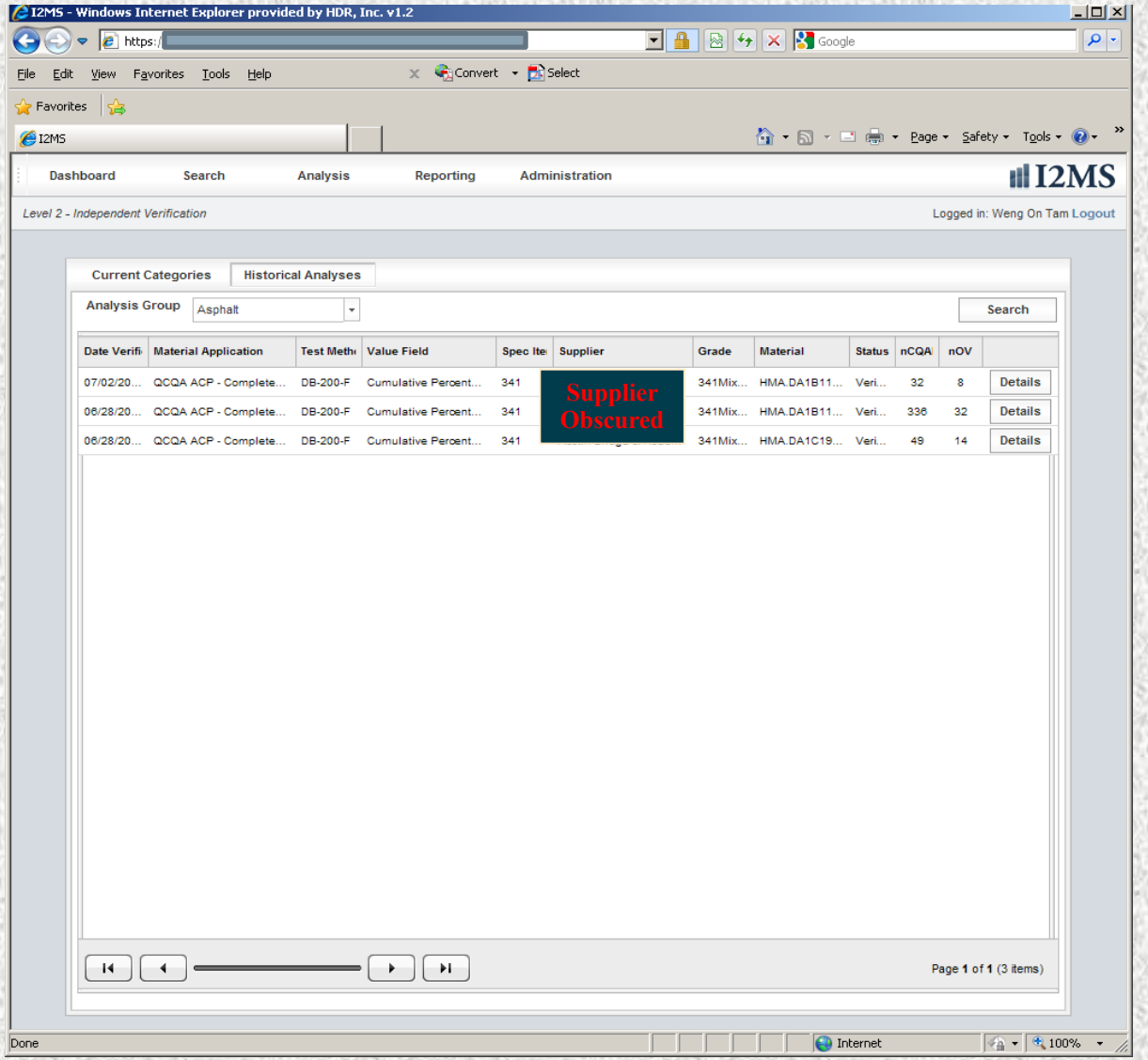


- **Level 2**
  - Medium Residual Risk
  - Secondary Indicator of Performance
  - OV Min. Frequency Approximately 1 to 3 per Quarter
- **Engineering Judgment**
  - Ongoing Review
  - Quarterly Reporting

Level 2: Example Dashboard (TxDOT I2MS)

Project Operations

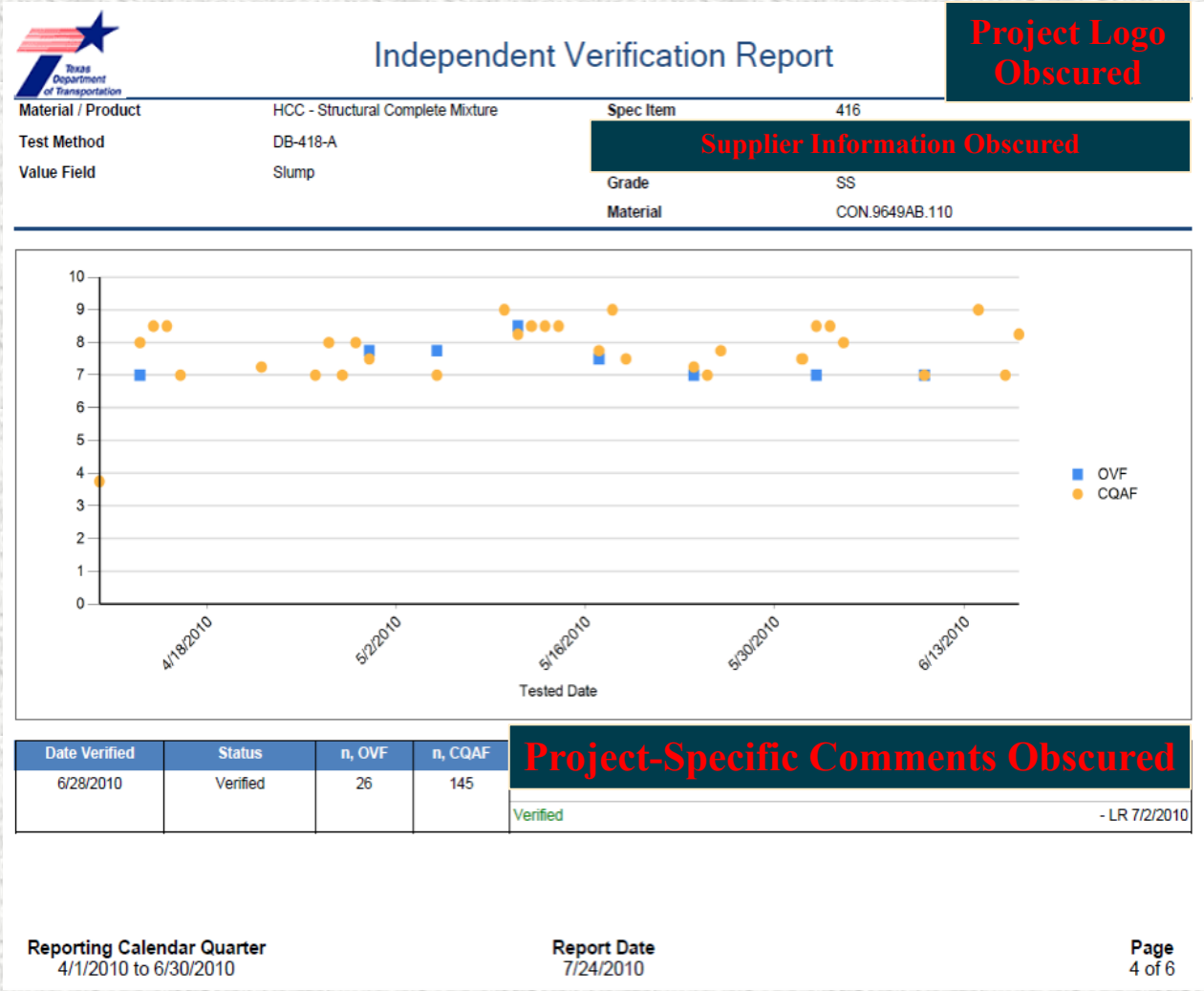
- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Level 2: Report Example (TxDOT I2MS)

Project Operations

- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Independent Verification Report

Project Logo Obscured

Material / Product	HCC - Structural Complete Mixture	Spec Item	416
Test Method	DB-418-A	Supplier Information Obscured	
Value Field	Slump	Grade	SS
		Material	CON.9649AB.110

Date Verified	Status	n, OVF	n, CQAF
6/28/2010	Verified	26	145

Project-Specific Comments Obscured

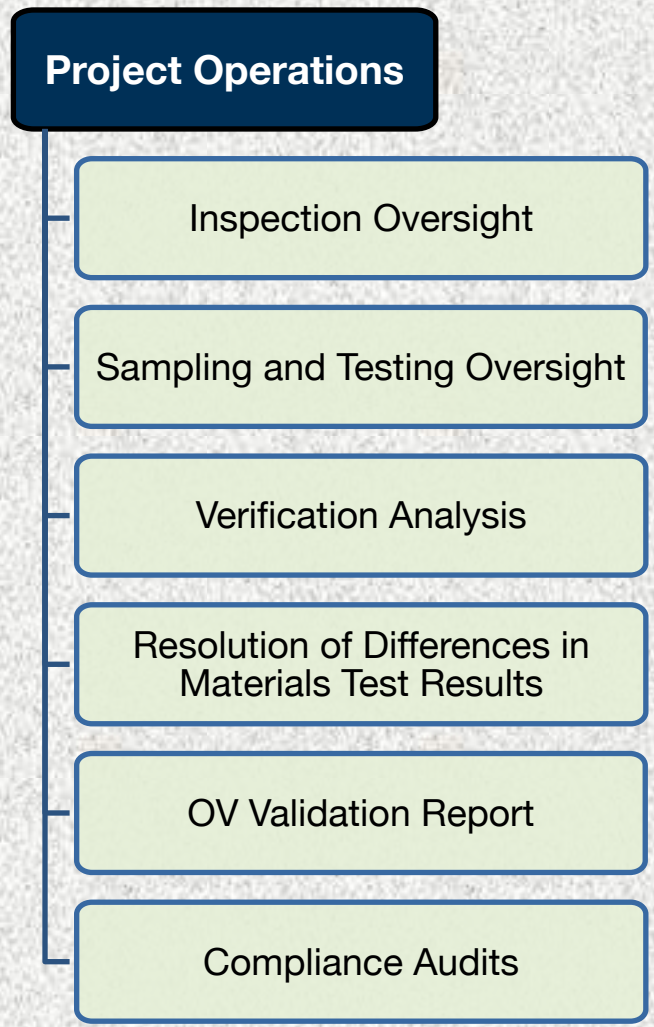
Verified - LR 7/2/2010

Reporting Calendar Quarter
4/1/2010 to 6/30/2010

Report Date
7/24/2010

Page
4 of 6

Level 3: Observation Verification

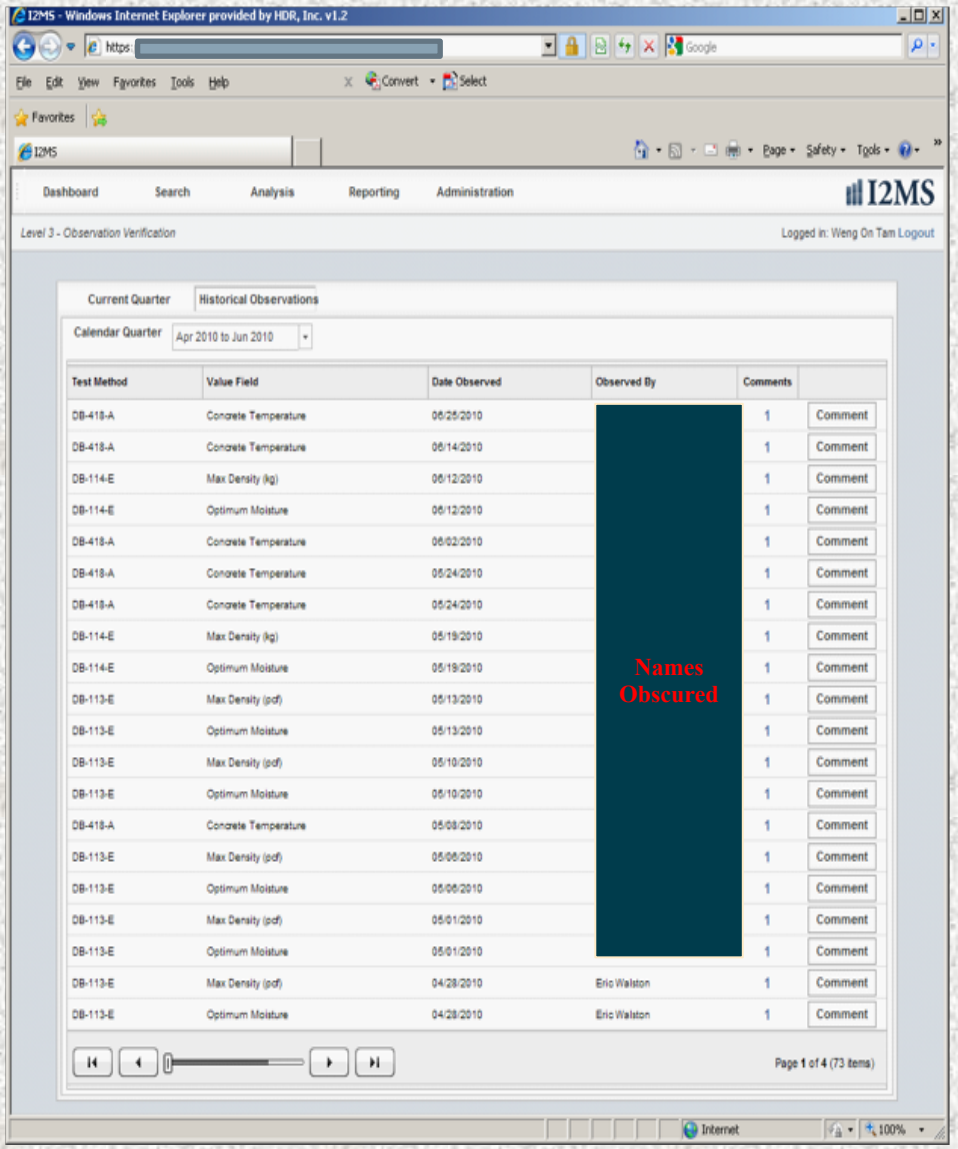


- **Level 3**
  - Low Residual Risk
  - No Testing Performed
  - Once Per Test Method and Periodically As Needed
- **Compliance with Test Performance**

Level 3: Dashboard Example (TxDOT I2MS)

Project Operations

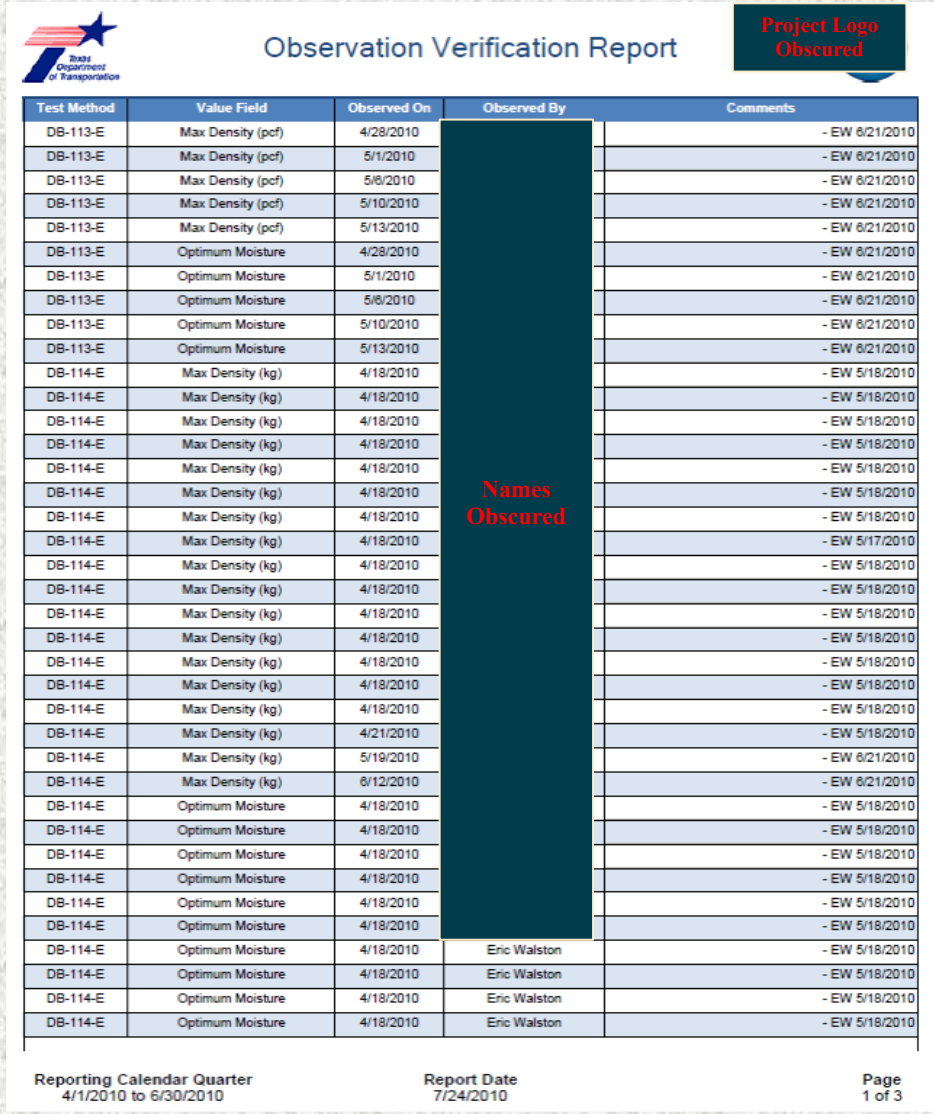
- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Level 3: Report Example (TxDOT I2MS)

Project Operations

- Inspection Oversight
- Sampling and Testing Oversight
- Verification Analysis
- Resolution of Differences in Materials Test Results
- OV Validation Report
- Compliance Audits



Observation Verification Report

Project Logo Obscured

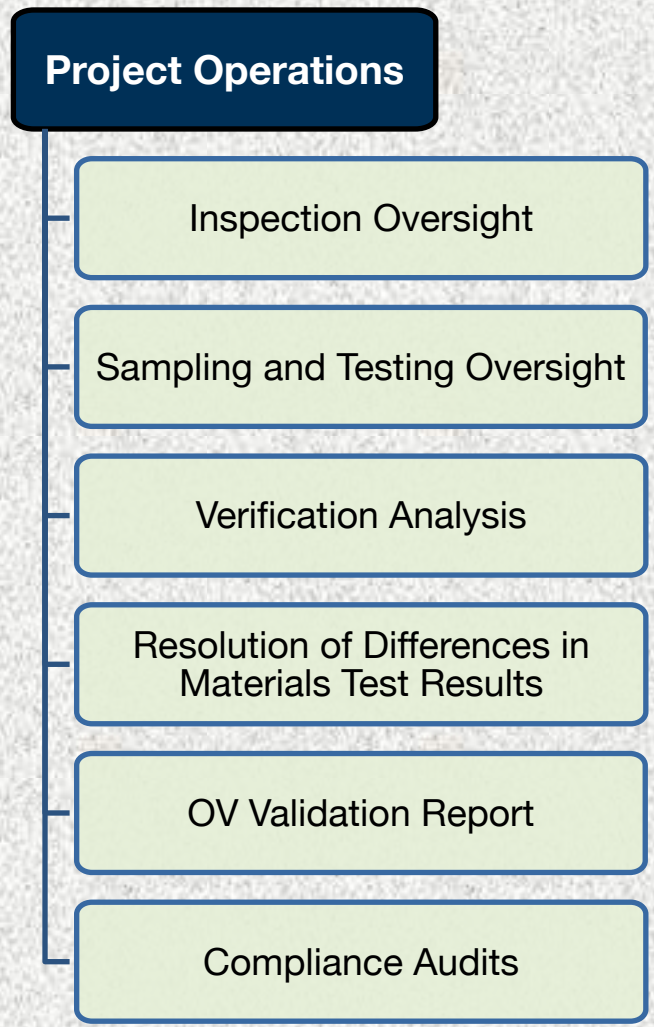
Test Method	Value Field	Observed On	Observed By	Comments
DB-113-E	Max Density (pcf)	4/28/2010	Names Obscured	- EW 6/21/2010
DB-113-E	Max Density (pcf)	5/1/2010		- EW 6/21/2010
DB-113-E	Max Density (pcf)	5/6/2010		- EW 6/21/2010
DB-113-E	Max Density (pcf)	5/10/2010		- EW 6/21/2010
DB-113-E	Max Density (pcf)	5/13/2010		- EW 6/21/2010
DB-113-E	Optimum Moisture	4/28/2010		- EW 6/21/2010
DB-113-E	Optimum Moisture	5/1/2010		- EW 6/21/2010
DB-113-E	Optimum Moisture	5/6/2010		- EW 6/21/2010
DB-113-E	Optimum Moisture	5/10/2010		- EW 6/21/2010
DB-113-E	Optimum Moisture	5/13/2010		- EW 6/21/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/17/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/18/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	4/21/2010		- EW 5/18/2010
DB-114-E	Max Density (kg)	5/19/2010		- EW 6/21/2010
DB-114-E	Max Density (kg)	6/12/2010		- EW 6/21/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010		- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010	Eric Walston	- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010	Eric Walston	- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010	Eric Walston	- EW 5/18/2010
DB-114-E	Optimum Moisture	4/18/2010	Eric Walston	- EW 5/18/2010

Reporting Calendar Quarter
4/1/2010 to 6/30/2010

Report Date
7/24/2010

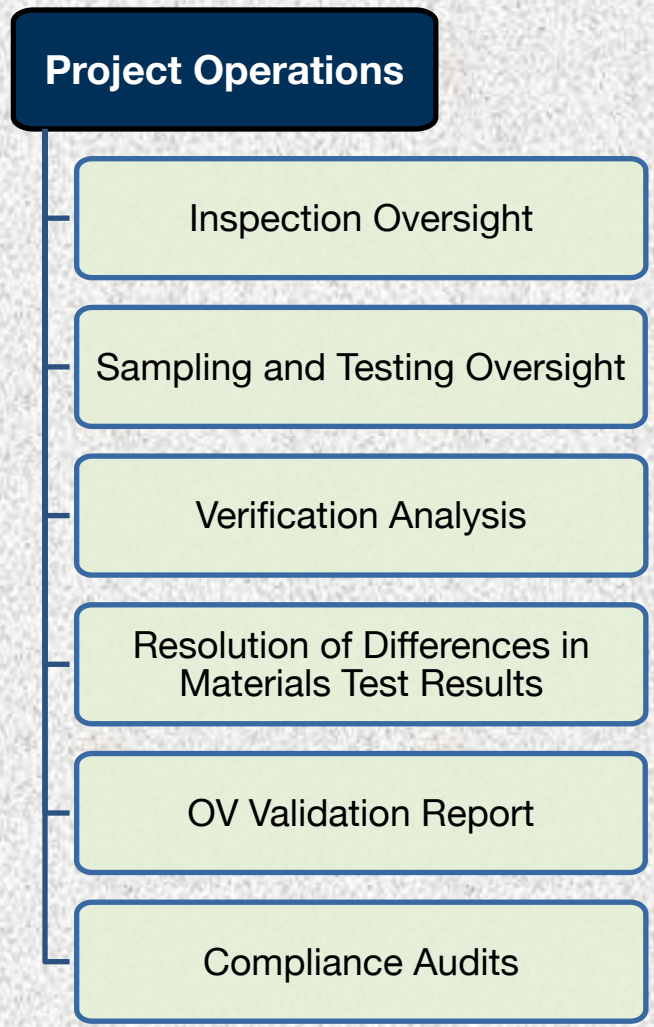
Page
1 of 3

Non-Validation Investigation



- **Investigate When**
  - Level 1: Non-Validation of F- or t- Test
  - Level 2: Verification Not Achieved
- **Investigation Approach**
  - Review CVL Compliance
  - Review OV and QA Sampling and Testing Performance
  - Increase OV Sampling and Testing
  - Perform Split Sample Testing

Inspection Oversight



- **Risk-Based Inspection Oversight**
  - "Management Exercise"
  - Oversight ≠ 100% Coverage
  - Oversight = "Continuous Audit"
  - Focus on Higher Risk Items of Work
  - Levels of Verification Oversight

Questions?

Weng On Tam, PE
Tam Consulting Services LLC
WengOnTam@tcsengineering.com