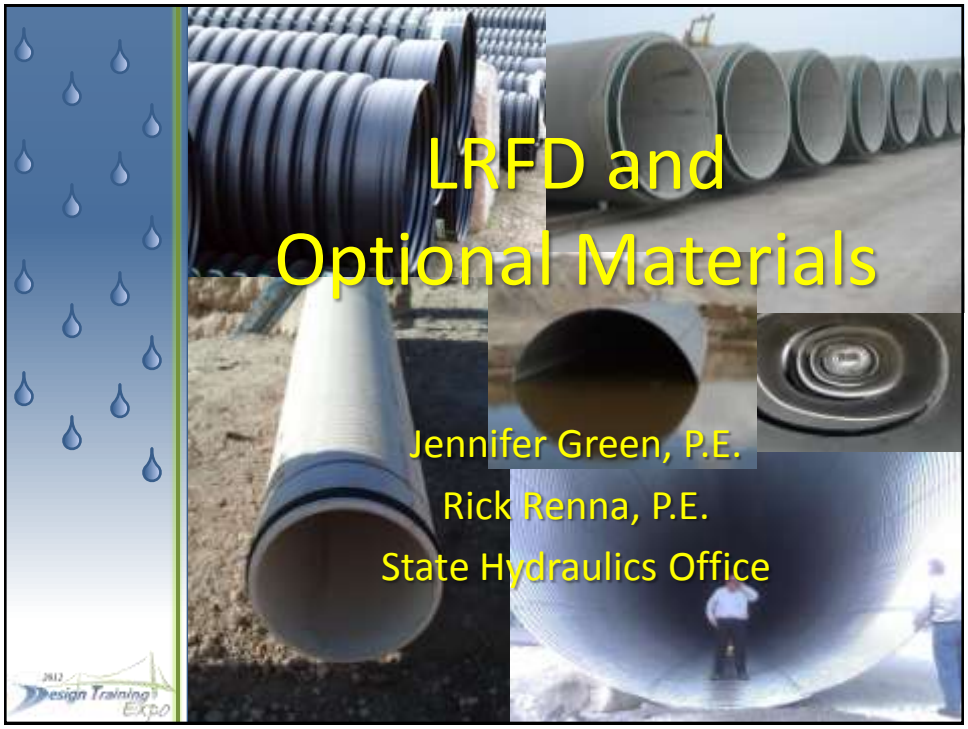


Load Resistance Factored Design

- Expected loads multiplied by *Load Factors*
  - Different values for different types of loads
  - "Probability of failure" of each limit state (failure mode)
- Strength reduced by *Strength Reduction Factors*
  - Accounts for variability in strength
- Factored loads ≤ factored strength

Why LRFD?

- FHWA requirement
- Consistent with other structural infrastructure
- No problems with Index 205

FDOT's LRFD Field Assumptions

- Pipe installed per FDOT specs
  - Deflection
  - Backfill compaction
  - Embankment load condition (wide trench)
  - Bedding approach
  - Backfill material
- Pipe above groundwater table (conservative)
- Soil = 120 pcf
- Standard LRFD code live loads

FDOT Field Assumptions?

What's Changing?

- Minimum cover
  - **NOT** increasing where past *significant* usage shows no record of problems
  - Decreasing for flexible pipes
- PVC maximum cover increasing significantly
- No more extra base / frangible base options
- Improved clarity & organization

Status of Index 205 Revision

- Pipe Industry review of computations ongoing
- New cover requirements being crafted
  - Will be discussed with Industry
- Layout of information in Index 205
  - Will be discussed with DDrEs
- Revised Index 205 in 2014 Design Standards

Standard Index 205

What do *YOU* want to change

Objectives

- How to document optional materials
- Optional Materials Tabulation Sheet
- Not:
  - Layout
  - Hydrology
  - Sizing
  - Flow Lines

Why Optional Materials?

- Competition
- DOT policy since early 1990s
- Federal requirement in 2006

Optional Materials

N = 0.012:

- Steel Reinforced Concrete Pipe (SRCP)
- Non-reinforced Concrete Pipe (NRCP)
- Spiral Rib Steel Pipe (SRSP)
- Spiral Rib Aluminized Steel Pipe (SRASP)
- Spiral Rib Aluminum Pipe (SRAP)
- F 949 PVC Pipe (PVC)
- High Density Polyethylene Pipe (HDPE)
- Polypropylene Pipe (PPP)

Optional Materials

n ≥ 0.020:

- Corrugated Steel Pipe (CSP)
- Corrugated Aluminized Steel Pipe (CASP)
- Corrugated Aluminum Pipe (CAP)
- Structural Plate Metal Pipes
- Metal Box Culverts

Requirements

Topic #625-000-008
Plans Preparation Manual, Volume 2 - English

January 1, 2009

8.2 Optional Materials Tabulation

An optional materials tabulation shall be prepared and included in the plans (see ***Exhibits SDS-2a*** and ***SDS-3a***). The sheet format is available in the FDOT Engineering Systems Software.

As a minimum, the optional pipe material tabulation should include size, thickness or class, corrugation requirements, if necessary, and protective coating, if any. Additional information such as structure number, design service life (DSL), length, and flow line information may be included.

The general notes shown on the exhibits are also required.

Optional Materials HB

- FDOT Drainage Website http://www.dot.state.fl.us/rddesign/dr/Manualsandhandbooks.shtm
- Updated to include PPP
- 2010 CSLE is not included (updates pending)
- Examples
- Corrosion tables and charts

Optional Materials HB

TABLE 6.4

Estimated Service Life vs. pH and Resistivity for 16 ga. **ALUMINUM** Culvert Pipe

	Resistivity															
pH	≥200	400	600	800	1000	1200	1400	1600	1800	2000	2300	2700	3200	3800	4500	≥5000
4.5 & 9.0	36	39	40	41	41	42	42	42	43	43	43	43	44	44	44	45
4.6 & 8.9	38	41	42	43	43	44	44	45	45	45	45	46	46	47	47	48
4.7 & 8.8	40	43	44	45	46	46	47	47	47	48	48	48	49	49	50	51
4.8 & 8.7	42	45	46	48	48	49	49	50	50	50	51	51	52	52	53	54
4.9 & 8.6	44	48	49	50	51	52	52	53	53	54	54	55	55	56	56	57
5.0 & 8.5	46	50	52	53	54	55	56	56	57	57	58	58	59	59	60	61
5.1	49	53	56	57	58	59	60	60	61	61	62	62	63	64	65	66
5.2 & 8.4	52	57	59	61	62	63	64	65	65	66	67	67	68	69	70	71
5.3	55	61	64	66	67	68	69	70	71	71	72	73	74	75	76	77
5.4 & 8.3	59	66	69	71	73	74	75	76	77	78	79	80	81	82	83	84
5.5	63	71	75	78	80	81	83	84	85	86	87	88	90	91	92	93
5.6 & 8.2	68	78	82	85	88	90	91	93	94	95	97	98	100	102	104	105
5.7	74	85	91	95	98	100	102	104	106	107	109	111	113	116	118	119
5.8 & 8.1	81	95	102	107	110	114	116	119	121	122	125	128	131	134	137	138
5.9	89	107	115	122	127	131	134	138	140	143	146	150	154	158	163	165
≥6.0 & ≤8.0	100	122	133	142	149	154	159	164	168	171	176	182	188	194	200	204

Service Life (SL) = $T_p / (R_{pH} + R_r)$

Where:
SL = Years to first perforation
T_p = Thickness of pipe (inches)
R_{pH} = Corrosion rate for pH (inches/year)
R_r = Corrosion rate for resistivity (inches/year)

Culvert Service Life Estimator

Florida Department of Transportation
Corrosion Research Laboratory

Culvert Service Life Estimator

Date May 30, 2012

Design Life (Years)	50	pH	6.9
Manning's n Value	0.012	Resistivity	16661
Diameter (inches)	18.00	Chlorides	2000
'd' in Inches	36.00	Sulfates	42

Type of Culvert	Service Life	Enviroment	Structural	Computed Cover
(NRCP) Non-Reinforced Concrete, Cl. 'S'	360	Pass	Pass	33.50
(SRAP) Aluminum - Spiral Rib, 16 GA.	252	Pass	Pass	35.94
(SRASP) Aluminized Steel - Spiral Rib, 16 GA.	116	Pass	Pass	35.94
(PVC) Polyvinyl Chloride, ASTM F-949	100	Pass	Pass	35.75
(HDPE) High Density Polyethylene, Cl. II	100	Pass	Pass	35.85
(RCP) Steel-Reinforced Concrete, Cl. 'S'	75	Pass	Pass	33.50
(SRSP) Galvanized Steel - Spiral Rib, 14 GA.	50	Pass	Pass	35.92
(HDPE) High Density Polyethylene, Cl. I	50	Pass	Pass	35.85

2010 CSLE

- Culvert Service Life Estimator
  - http://www.dot.state.fl.us/rddesign/dr/Manualsandhandbooks.shtm

Design Aids			
CSLE 2010.zip	Culvert Service Life Estimator	31mb	6/7/11
sdtab2006.pdf	Storm Drain Tabulation Form	22kb	7/1/08
IDF Curves.pdf	Drainage Manual Appendix B: IDF Curves Precipitation Data and Rainfall Distributions	756kb	4/02/03
gibanniet.pdf	Guideline for Flow Under Temporary Barrier Walls	12kb	12/04/98
Geopak-Guide	GEOPAK Drainage Course Guide/Users Manual (Link to PDF File)	Link	
Hydraulic Calculator	Hydraulic Calculator for Pipe Flow *Note** If you are not a registered customer, please register prior to purchase to create a Maps and Publications User Account. However, you can browse items without registering*	Link	
ScourProgram.xls	Complex Pier Procedure Program	Link	

2010 CSLE

- Updates
  - New LRFD pipe cover requirements
  - Removal of restrictions on HDPE Class II (still not allowed in Florida Keys)
  - Addition of 50yr acceptance for Polypropylene Pipe (PPP)

2010 CSLE

- Tutorial Available
  - http://www.dot.state.fl.us/rddesign/dr/upcoming-events.shtm

OMTS

Optional Materials Tabulation Sheet

What OMTS Should Be

- Short
- Clear
- Succinct
- Project specific
  - Station limits with exceptions
  - Structure #
- Demonstrate options considered
  - Documentation requirements in DM Ch. 6
- Cross Drain and Side Drain pipes

What OMTS is NOT

- Generic
- Exhaustive
- More than two pages

When would you not prepare an Optional Materials Sheet?

- Existing CD or SD extensions only
  - Same material required
  - Exception for MES with plastic pipe types
- PPM changes underway

OMTS Examples

STRUCTURE	SIZE (inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
S-7, 10, 15, 18, 19, 20, 24, 25, 26, 27, 31, 32, 35, 36, 38, 39, 40, 42, 43A, 44, 44A, 46, 47, 53, 54, 55, 59, 61, 62	14 X 23	SRCP (CLASS I)	X		
S-1, 48, 49, 50, 51	18	HDPE (CLASS II)			
		NRCP			
		SRCP (CLASS I)	X		
		PVCP (ASTM F-949)			
S-17, 21A, 37, 52, 58, 60, 63	19 X 30	SRCP (CLASS I)	X		
S-2, 3, 5, 6, 12, 16, 21, 23, 28, 28A, 30, 34, 41, 43, 45, 48A, 56	24	HDPE (CLASS II)			
		NRCP			
		SRCP (CLASS I)	X		
		PVCP (ASTM F-949)			
S-33, 57	42	HDPE (CLASS II)			
		SRCP (CLASS I)	X		

- Structure by Structure

OMTS Examples

ELLIPTICAL PIPE INSTALLATIONS (All Sizes)

Installation	Maximum Height Of Fill (Ft.)	Pipe Class	Bedding Class
Horizontal	1-6*	HE II*	C
	7-10	HE III	C
	11-16	HE IV	C
	17+	Special Design	Modified
Vertical	1-6*	VE II*	C
	7-10	VE III	C
	11-16	VE IV	C
	17+	Special Design	Modified

OMTS Examples

STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
SIDE DRAIN	14 x 23	ELLIPTICAL SRCP (CLASS HE-III)	X		DUE TO COVER HEIGHT
	18	SRCP (CLASS III)	X		DUE TO COVER HEIGHT

- Documentation ☺
- Concrete class ☺

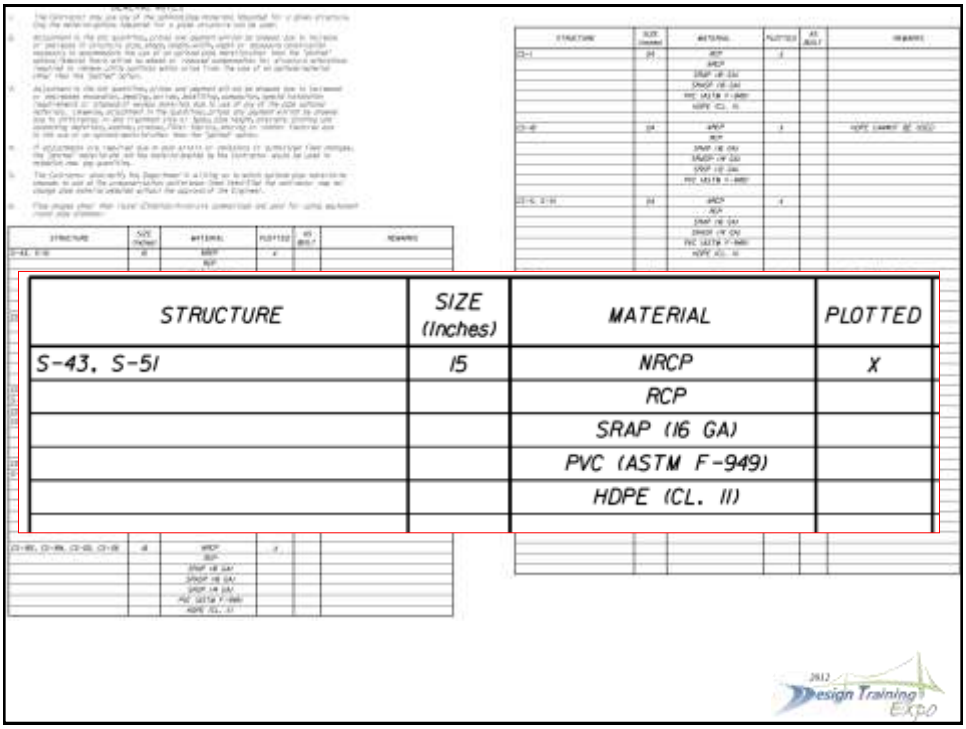
OMTS Examples

MATERIAL & THICKNESS	S/CD PIPE (LF) SHAPE-OTHER 60"	S/CD PIPE (LF) SHAPE-ROUND 36"	REMARKS
			INDEX 250 MODIFIED - PIPE SPACING TO MATCH EXISTING PIPES
			INDEX 250 MODIFIED - PIPE SPACING TO MATCH EXISTING PIPES
CMP - ARCH	2 - 8' EXTENSIONS, 16' TOTAL		COLLAR EXISTING PIPES TO PIPE EXTENSION, INDEX 280
CMP - ARCH	2 - 4' EXTENSIONS, 8' TOTAL		COLLAR EXISTING PIPES TO PIPE EXTENSION, INDEX 280
RCP CLASS IV		64'	DUE TO COVER REQUIREMENTS
RCP CLASS IV		54'	DUE TO COVER REQUIREMENTS

- Great example of “non-traditional” use of summary of drainage structures and optional materials tabulation combined in one table
- See remarks column for reasoning for pipe material restrictions.

OMTS Examples

EXCEPTION: S-204, S-312, S-316, S-303D	15"
SRCP CLASS II ONLY	
S-205	14" X 23"
EXCEPTION: S-201, S-204A, S-208A, S-301, S-314	18"
S-317, S-320, S-322, S-323, S-324, S-328	
S-330, S-333, S-334A, S-335, S-336, S-338	
S-402, S-406, S-408, S-411, S-413, S-415, S-417	
S-501A, S-502, S-504, S-506A, S-506B, S-508	
S-510, S-513 SRCP CLASS II ONLY	
EXCEPTION: S-304, S-332	18" FD
SRCP CLASS II ONLY	



STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED
S-43, S-51	15	NRCP	X
		RCP	
		SRAP (16 GA)	
		PVC (ASTM F-949)	
		HDPE (CL. II)	

OMTS Examples

STRUCTURE	SIZE (inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
ALL	15	RCP CLASS II	X		
ALL	18	RCP CLASS II	X		
ALL	24				
ALL	30				
ALL	36				
ALL	14 X 23				
ALL	19 X 30				

- RCP ONLY!!!! V
- Elliptical abbreviation?
- Side Drains shall be extended with “like” materials

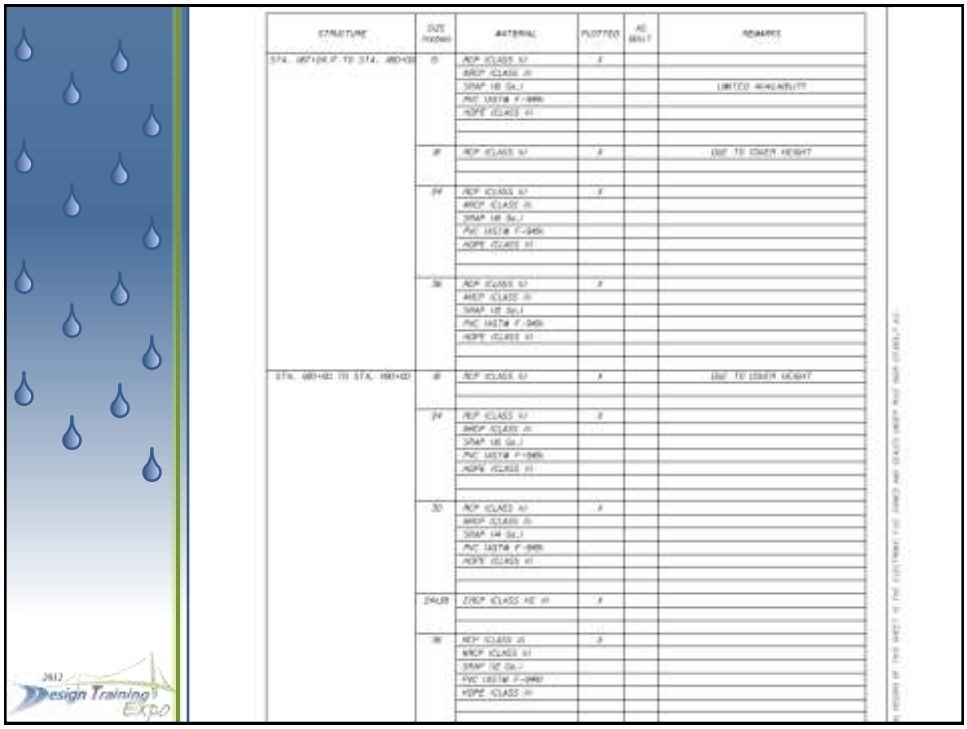
OMTS Examples

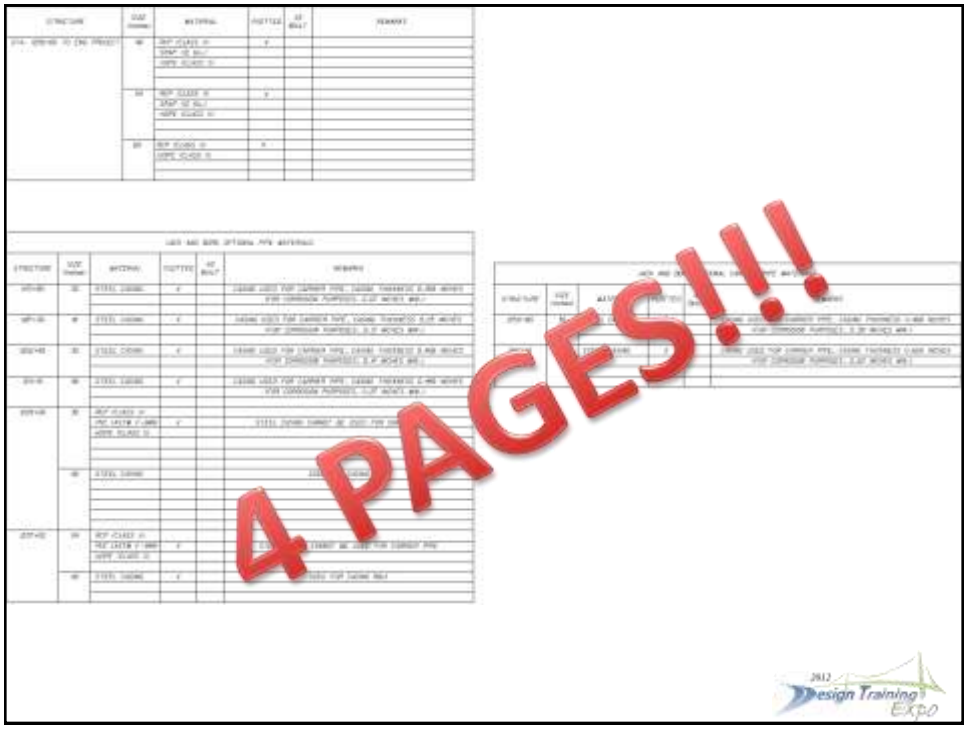
S-6	15	RCP	
		NRCP	
		SRAP (16 GA.)	
		SRASP (16 GA.)	
		PVC (ASTM F-949)	X
		HDPE (CLASS II)	
S-8	15	RCP	
		NRCP	
		SRAP (16 GA.)	
		SRASP (16 GA.)	
		PVC (ASTM F-949)	
		HDPE (CLASS II)	
S-16	18	RCP	
		NRCP	
		SRAP (16 GA.)	
		SRASP (16 GA.)	
		PVC (ASTM F-949)	
		HDPE (CLASS II)	

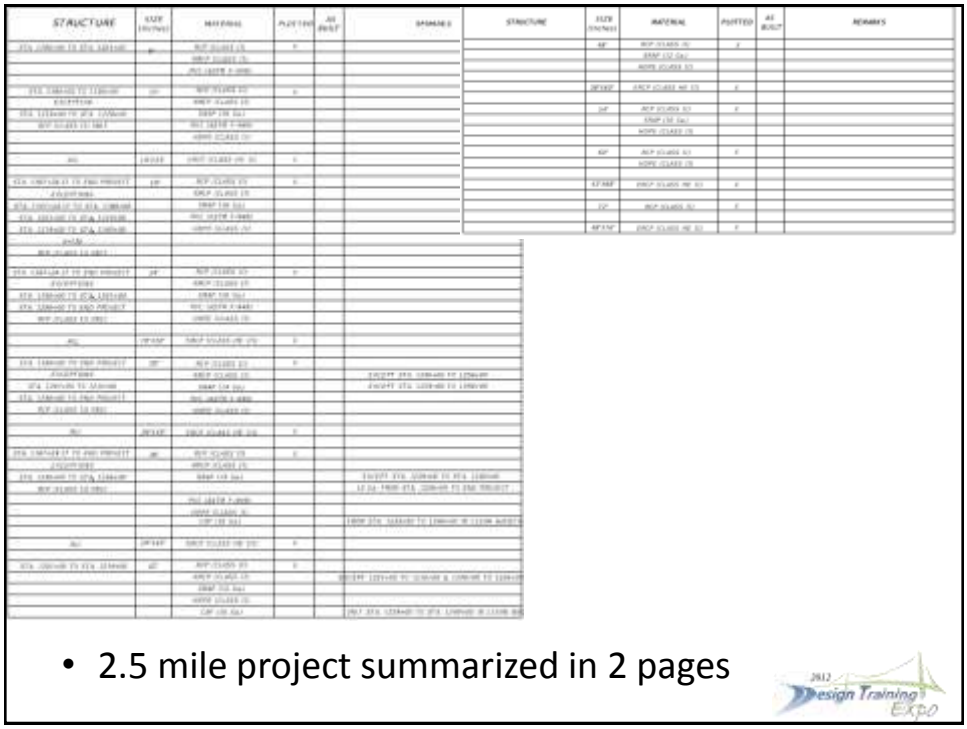
OMTS Examples

STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
SD-1	12"X18"	SRCP (CLASS I)	X		
S-5, S-6, S-8, S-9, S-10, S-11, S-12	14"X23"	SRCP (CLASS I)	X		
SD-3, S-7	18"	HDPE (CLASS II)			
		NRCP			
		SRCP (CLASS I)	X		
		PVCP (ASTM F-949)			
S-2, S-3, S-4	19"X30"	SRCP (CLASS I)	X		

- Elliptical Class I?
- SD-3 with MES – end metal or concrete
- No metal option shown – 25 yr DSL







- 2.5 mile project summarized in 2 pages

OMTS Examples

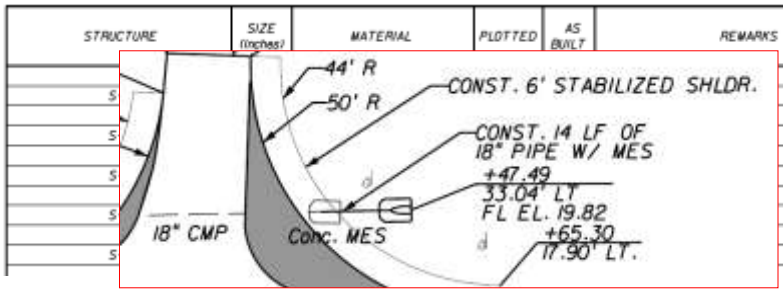
STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
S-3, S-4, S-8	24	RCP	X		
		ARCP			
		SRAP 16 GA.)			
		SRASP (14 GA.)			
		PVC (ASTM F-949)			
		HDPE (CLASS IV)			

JACK AND BORE OPTIONAL MATERIALS

STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
S-5	18	STEEL CASING	X		CASING USED FOR CARRIER PIPE
S-6, S-7	24	STEEL CASING	X		CASING USED FOR CARRIER PIPE

- RCP Class?
- Minimum gage thickness for corrosion?

OMTS Examples



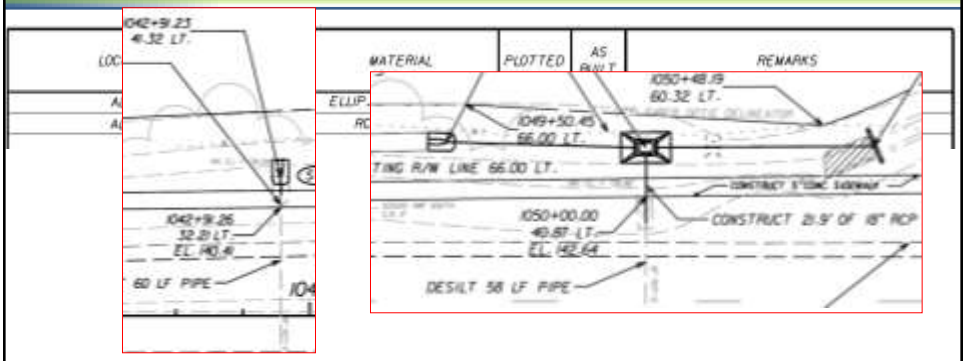
- RCP ONLY! Concrete Class?
- Document “why”
- Don’t forget optional materials for side drains!

OMTS Examples

STRUCTURE	SIZE (Inches)	MATERIAL	PLOTTED	AS BUILT	REMARKS
S-2	14"X23"	ECP ONLY	X		
S-4	12"X18"	ECP ONLY	X		

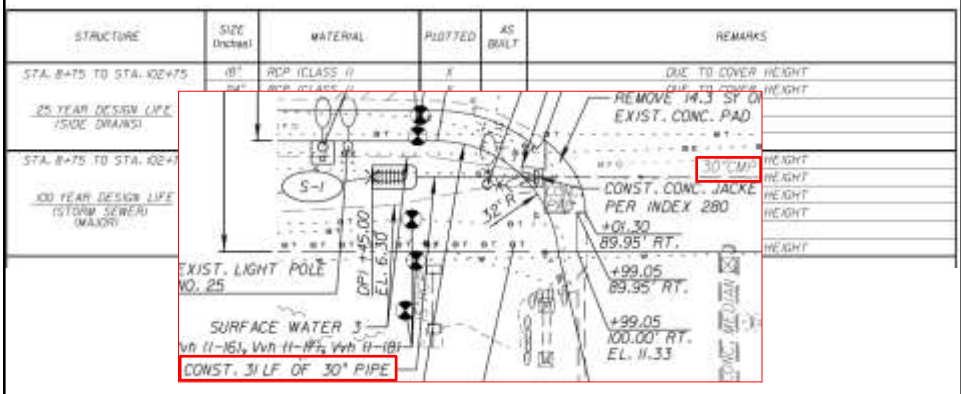
- Abbreviation for elliptical concrete?
- Concrete class?

OMTS Examples



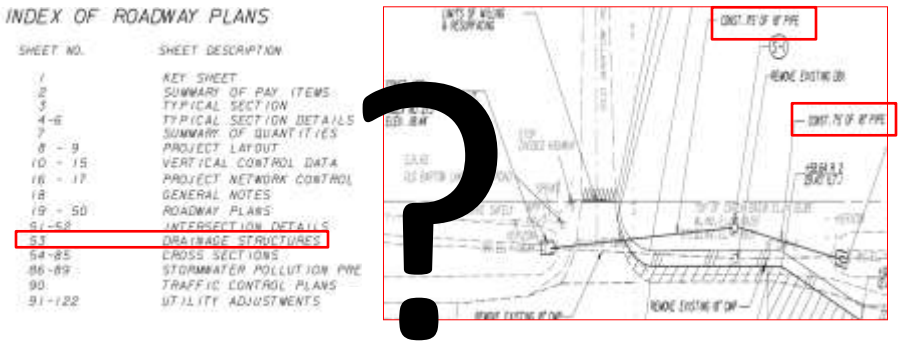
- Good – Extension of CD with same material
- Bad – Forcing new const. to be RCP also

OMTS Examples



- Extending pipe with dissimilar pipe material

OMTS Examples



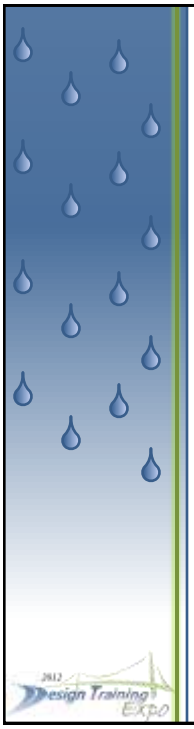
- Drainage Structure sheets with no OMTS!

Summary

- 8 months of Tallahassee Lettings for a District
- 21 projects with OMTS
- 76% inappropriately documented materials on the OMTS (if one was provided)

Summary

- OMTS
  - Succinct
  - Complete
- Document “WHY”
- State as well as a Federal Requirement
  - applies to ALL LAP projects with Federal $



Questions?

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