

ProVAL PCM Tests

Contents

Purpose	1
Issue No. 1.....	1
Issue No. 2.....	2
PCM Test Examples.....	2
ProVAL 3.61.....	3
PV36 for Uncorrected Profiles with different lengths	3
PV36 for Corrected profiles with the same length	6
ProVAL 4.0. Beta	10
PV40 for Uncorrected Profiles with different lengths	10
PV40 for Corrected profiles with the same length	13
Conclusions	16
Appendix A: ProVAL Software and Test Files.....	17

Purpose

This brief document is to explain the ProVAL Profiler Certification Module (PCM) issues that were passed on to the ProVAL team as follows:

1. The shape coefficient and roughness coefficients are reversed.
2. The IRI agreement is based on the comparison of the IRI over the two entire profiles, rather than the segments of each profile that was used (by virtue of overlap) to obtain the cross-correlation result.

An FHWA 2015 profiler round-up data set was used to illustrate the issues and solutions.

Issue No. 1

“The shape coefficient and roughness coefficients are reversed.”

The shape coefficient and roughness coefficients of cross-correlation were defined in AASHTO R56-2018’s Appendix A, as follows.

- X1.1.8. *Step 7:* Search the function of ρ_m for its maximum cross-correlation value ρ_{\max} .
- X1.1.9. *Step 8:* Calculate the adjustment factor for overall roughness as follows:

$$f = \frac{\min(\sigma_p, \sigma_q)}{\max(\sigma_p, \sigma_q)}$$

The ProVAL team implemented this method in PCM by interpreting:

- ρ_{\max} from step 7 as the “roughness coefficient” (termed “maximum correlation function” in AASHTO R56), and
- f from step 8 as the “scale factor” (termed “adjustment factor” in AASHTO R56).

Therefore, the ProVAL team will need the original author of the AASHTO R56 to clarify the above terminologies regarding Issue No. 1.

Issue No. 2

“The IRI agreement is based on the comparison of the IRI over the two entire profiles, rather than the segments of each profile that was used (by virtue of overlap) to obtain the cross-correlation result.”

ProVAL PCM and Automated Profile Synchronization Module (APSync) versions calculate the cross-correlation (CC) for each pair of profiles based on the overlapped sections. Therefore, the CC scores are always correct.

However, the initial PCM design assumes the certification profiles are of the same or a similar length. The IRI values from the basic and comparison profiles were used to compute the % differences. The recent issue occurred when different lengths of profiles were used, causing the IRI values from the different lengths of profiles be inconsistent with the CC based on the overlapped sections only.

Such an issue was discovered in a recent study, and corresponding changes were implemented in ProVAL 4.0 beta to handle such a situation.

PCM Test Examples

An FHWA 2015 profiler round-up data set was used to illustrate the issues and solutions.

The tests were conducted on a diamond ground section with relative smoothness by an ICC profiler with wide sensors running at 50 MPH.

The data set includes 10 ICC runs, uncorrected (“\raw profiles_Incorrect PPF”) and corrected (“\raw profiles_Corrected PPF”).

The former set has incorrect offset, lead-in, and lead-out that cause different lengths of profiles. The latter was corrected to obtain similar profile lengths. The corrections were documented in ICC-corrections.xlsx (under “\raw profiles_Corrected PPF”).

There was one reference profile, ref_LF.ERD, for the left wheel path.

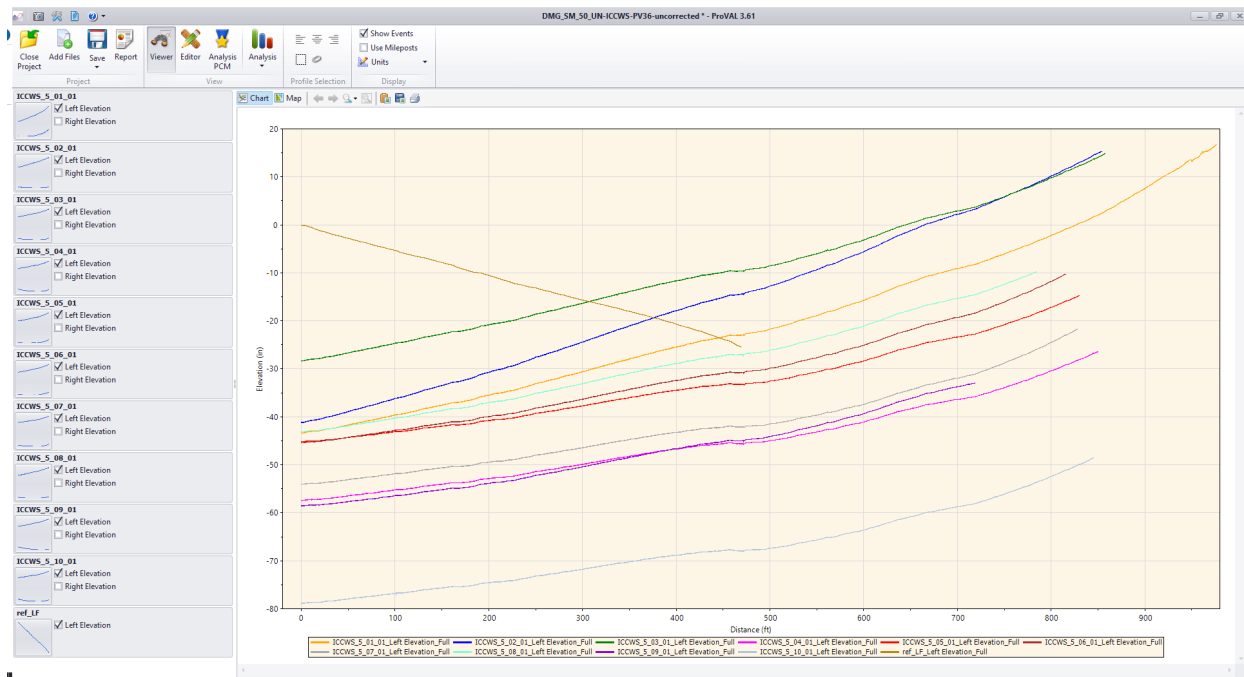
The followings are the ProVAL 3.61 and ProVAL 4.0 Beta analyses to illustrate Issue No. 2.

ProVAL 3.61

PV36 for Uncorrected Profiles with different lengths

The incorrect profile of different lengths and the reference profile were imported to ProVAL 3.61 and the project was saved as “DMG_SM_50_UN-ICCWS-PV36-uncorrected.pvp”.

The ProVAL Viewer screens show the profiles in different lengths.



The PCM analysis uses the following settings:

Profiler Certification: Inputs

Maximum Offset (ft)

5.00

Minimum Repeatability (%)

92

Minimum Accuracy (%)

90

Basis Filter

[IRI \(with 250mm Filter\)](#)

Comparison Filter

[IRI \(with 250mm Filter\)](#)

File	Profiles	Basis	Run	Sample Interval (in)
<input checked="" type="checkbox"/> ICCWS_5_01_01	Left + Right	<input type="checkbox"/>	1	0.82
<input checked="" type="checkbox"/> ICCWS_5_02_01	Left + Right	<input type="checkbox"/>	2	0.82
<input checked="" type="checkbox"/> ICCWS_5_03_01	Left + Right	<input type="checkbox"/>	3	0.82
<input checked="" type="checkbox"/> ICCWS_5_04_01	Left + Right	<input type="checkbox"/>	4	0.82
<input checked="" type="checkbox"/> ICCWS_5_05_01	Left + Right	<input type="checkbox"/>	5	0.82
<input checked="" type="checkbox"/> ICCWS_5_06_01	Left + Right	<input type="checkbox"/>	6	0.82
<input checked="" type="checkbox"/> ICCWS_5_07_01	Left + Right	<input type="checkbox"/>	7	0.82
<input checked="" type="checkbox"/> ICCWS_5_08_01	Left + Right	<input type="checkbox"/>	8	0.82
<input checked="" type="checkbox"/> ICCWS_5_09_01	Left + Right	<input type="checkbox"/>	9	0.82
<input checked="" type="checkbox"/> ICCWS_5_10_01	Left + Right	<input type="checkbox"/>	10	0.82
<input checked="" type="checkbox"/> ref_LF	Left	<input checked="" type="checkbox"/>		0.79

The PCM summary results are as follows.

Profiler Certification: Summary Results

[illegible]

The accuracy test and left-wheel-path repeatability results were zoomed in:

Profiler Certification: Summary Results

[illegible]

The first set of the repeatability test and accuracy test were zoomed in. Note that the correlations are correct, but the IRI differences are not due to the latter using profiles of different lengths.

Profiler Certification: Detailed Results

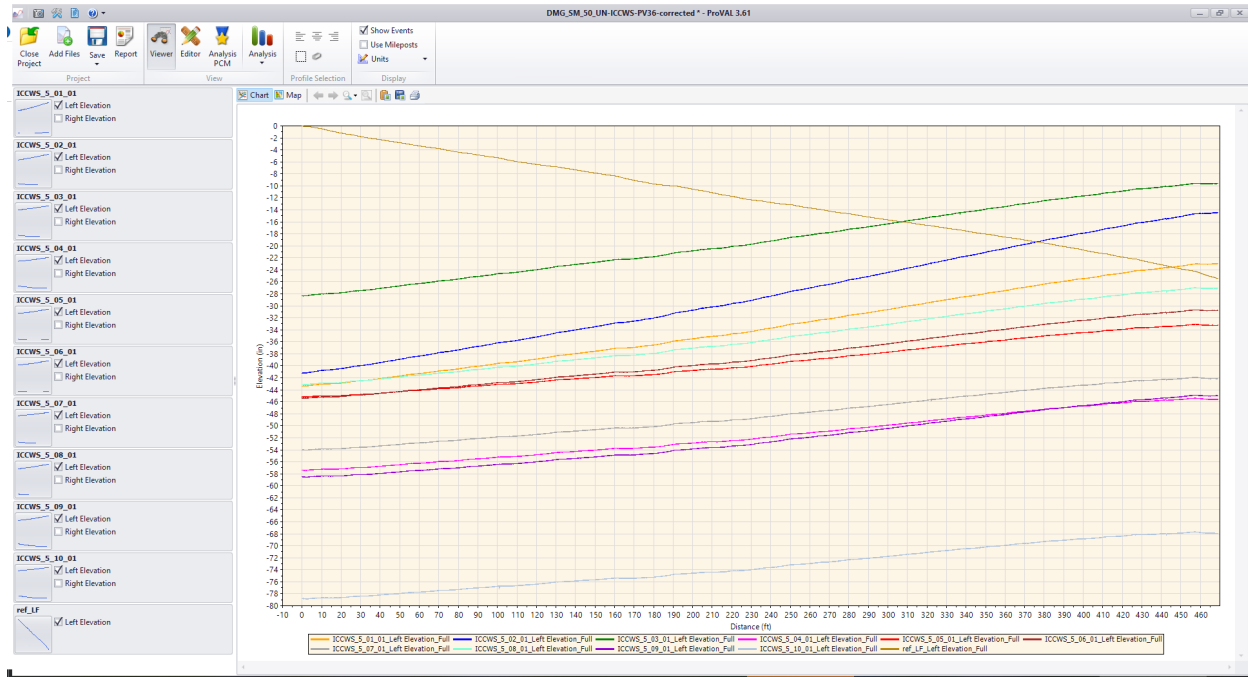
Repeatability - Left								
Basis	Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	ICCWS_5_02_01	98.26	0.995	98.77	0.1	87.02	74.35	-14.56
ICCWS_5_01_01	ICCWS_5_03_01	96.30	0.991	97.13	0.2	87.02	74.75	-14.11
ICCWS_5_01_01	ICCWS_5_04_01	93.44	0.988	94.63	0.4	87.02	75.46	-13.28
ICCWS_5_01_01	ICCWS_5_05_01	93.58	0.985	95.00	0.3	87.02	74.89	-13.95
ICCWS_5_01_01	ICCWS_5_06_01	93.48	0.983	95.09	0.4	87.02	73.79	-15.21
ICCWS_5_01_01	ICCWS_5_07_01	90.10	0.998	90.33	0.4	87.02	73.13	-15.96
ICCWS_5_01_01	ICCWS_5_08_01	95.64	0.976	98.00	0.3	87.02	73.55	-15.48
ICCWS_5_01_01	ICCWS_5_09_01	95.61	0.974	98.12	0.4	87.02	72.53	-16.65
ICCWS_5_01_01	ICCWS_5_10_01	93.26	0.994	93.83	0.5	87.02	74.49	-14.40

Accuracy - Left								
Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)	
ICCWS_5_01_01	89.47	0.997	89.73	0.1	64.95	87.02	33.98	
ICCWS_5_02_01	88.17	0.999	88.29	0.1	64.95	74.35	14.47	
ICCWS_5_03_01	88.15	0.992	88.89	0.1	64.95	74.75	15.08	
ICCWS_5_04_01	87.60	0.986	88.80	0.1	64.95	75.46	16.18	
ICCWS_5_05_01	86.53	0.981	88.17	0.1	64.95	74.89	15.29	
ICCWS_5_06_01	86.09	0.973	88.47	0.1	64.95	73.79	13.60	
ICCWS_5_07_01	86.84	0.981	88.55	0.1	64.95	73.13	12.59	
ICCWS_5_08_01	85.33	0.985	86.63	0.1	64.95	73.55	13.24	
ICCWS_5_09_01	86.05	0.979	87.94	0.2	64.95	72.53	11.67	
ICCWS_5_10_01	84.97	0.981	86.62	0.2	64.95	74.49	14.68	

PV36 for Corrected profiles with the same length

The corrected profiles of the same length and the reference profile were imported to ProVAL 3.61 and the project was saved as “DMG_SM_50_UN-ICCWS-PV36-corrected.pvp”.

The ProVAL Viewer screens show the profiles in the same length. The PCM analysis uses the same settings as the above test.



The PCM summary results are as follows.

Profiler Certification: Summary Results																																									
Statistics																																									
Statistic		Repeatability - Left					Repeatability - Right					Accuracy - Left																													
Comparison Count		45					45					10																													
% Passing		100.00					100.00					0.00																													
Mean		97.89					97.51					86.92																													
Minimum		95.98					95.21					84.97																													
Maximum		98.99					98.74					89.47																													
Standard Deviation		0.8					0.9					1.4																													
Grade		Passed					Passed					Failed																													
Accuracy		Repeatability - Left Correlations (%)										Repeatability - Left Offsets (ft)										Repeatability - Right Correlations (%)										Repeatability - Right Offsets (ft)									
Run	Left	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10
1	89.47	1	98.74	97.93	97.51	97.00	95.98	96.78	96.93	96.56	96.37	1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	1	97.41	95.56	97.57	96.25	97.88	97.87	96.62	97.14	97.24	1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2
2	88.17	2		98.29	97.91	97.37	96.34	97.34	97.62	97.10	97.15	2		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	2		95.21	98.69	96.76	98.04	98.01	97.11	97.05	97.33	2		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
3	88.15	3			98.47	98.10	96.95	98.01	98.19	97.78	97.57	3			0.1	0.0	0.0	0.0	0.1	0.1	0.1	3			96.04	97.23	96.32	96.34	97.84	96.56	96.89	3			0.1	0.1	0.1	0.1	0.1	0.2	0.2
4	87.60	4				98.73	97.68	98.49	98.65	98.29	98.16	4				0.0	0.0	0.0	0.0	0.1	0.0	4				97.05	98.45	98.46	97.62	97.68	98.04	4				0.0	0.0	0.0	0.0	0.1	0.1
5	86.53	5					98.17	98.99	98.62	98.85	98.82	5					0.1	0.0	0.1	0.2	0.1	5					97.35	97.02	98.31	97.54	97.64	5					0.0	0.0	0.0	0.2	0.1
6	86.09	6						98.14	97.56	98.46	97.86	6						0.0	0.0	0.1	0.1	6						98.74	97.90	98.53	98.67	6						0.0	0.0	0.1	0.1
7	86.84	7							98.46	98.72	98.69	7							0.1	0.1	0.1	7							97.86	98.54	98.34	7							0.0	0.1	0.1
8	85.33	8								98.32	98.52	8								0.1	0.0	8									98.15	98.46	8							0.1	0.1
9	86.05	9									98.69	9								0.0		9										98.74								0.0	
10	84.97	10										10										10																			

The accuracy test and left-wheel-path repeatability results were zoomed in and compared with the results from uncorrected profiles:

Profiler Certification: Summary Results												
Statistics												
Statistic		Repeatability - Left					Repeatability - Right					Accuracy - Left
Comparison Count		45					45					10
% Passing		100.00					100.00					0.00
Mean		97.89					97.51					86.92
Minimum		95.98					95.21					84.97
Maximum		98.99					98.74					89.47
Standard Deviation		0.8					0.9					1.4
Grade		Passed					Passed					Failed
Accuracy		Repeatability - Left Correlations (%)										
Run	Left	Run	2	3	4	5	6	7	8	9	10	
1	89.47	1	98.74	97.93	97.51	97.00	95.98	96.78	96.93	96.56	96.37	
2	88.17	2		98.29	97.91	97.37	96.34	97.34	97.62	97.10	97.15	
3	88.15	3			98.47	98.10	96.95	98.01	98.19	97.78	97.57	
4	87.60	4				98.73	97.68	98.49	98.65	98.29	98.16	
5	86.53	5					98.17	98.99	98.62	98.85	98.82	
6	86.09	6						98.14	97.56	98.46	97.86	
7	86.84	7							98.46	98.72	98.69	
8	85.33	8								98.32	98.52	
9	86.05	9									98.69	
10	84.97											

Profiler Certification: Summary Results												
Statistics												
Statistic		Repeatability - Left					Repeatability - Right					Accuracy - Left
Comparison Count		45					45					10
% Passing		95.56					88.89					0.00
Mean		96.08					94.45					86.92
Minimum		89.45					74.89					84.97
Maximum		98.72					98.53					89.47
Standard Deviation		2.2					5.8					1.4
Grade		Passed					Passed					Failed
Accuracy		Repeatability - Left Correlations (%)										
Run	Left	Run	2	3	4	5	6	7	8	9	10	
1	89.47	1	98.26	96.30	93.44	93.58	93.48	90.10	95.64	95.61	93.26	
2	88.17	2		96.20	93.36	93.30	93.59	89.45	96.51	97.14	93.20	
3	88.15	3			97.30	95.69	96.34	94.41	97.19	96.74	97.00	
4	87.60	4				98.05	97.69	95.89	98.46	98.57	97.85	
5	86.53	5					97.11	94.99	97.07	96.97	96.45	
6	86.09	6						97.66	97.64	97.88	97.84	
7	86.84	7							96.71	97.74	97.87	
8	85.33	8								98.72	97.67	
9	86.05	9									97.75	
10	84.97											

Corrected profiles of the same length

Uncorrected profiles of different lengths

Profiler Certification: Detailed Results

Repeatability - Left								
Basis	Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	ICCWS_5_02_01	98.74	0.996	99.17	0.1	64.85	65.04	0.30
ICCWS_5_01_01	ICCWS_5_03_01	97.93	0.989	99.05	0.1	64.85	65.65	1.24
ICCWS_5_01_01	ICCWS_5_04_01	97.51	0.983	99.17	0.2	64.85	66.46	2.48
ICCWS_5_01_01	ICCWS_5_05_01	97.00	0.978	99.14	0.1	64.85	66.25	2.16
ICCWS_5_01_01	ICCWS_5_06_01	95.98	0.970	98.94	0.1	64.85	67.52	4.12
ICCWS_5_01_01	ICCWS_5_07_01	96.78	0.978	98.98	0.1	64.85	66.17	2.03
ICCWS_5_01_01	ICCWS_5_08_01	96.93	0.982	98.70	0.1	64.85	66.76	2.95
ICCWS_5_01_01	ICCWS_5_09_01	96.56	0.976	98.99	0.2	64.85	66.92	3.19
ICCWS_5_01_01	ICCWS_5_10_01	96.37	0.978	98.56	0.2	64.85	66.78	2.98
ICCWS_5_02_01	ICCWS_5_03_01	98.29	0.993	98.99	0.0	65.04	65.65	0.94
ICCWS_5_02_01	ICCWS_5_04_01	97.91	0.988	99.13	0.0	65.04	66.46	2.17
ICCWS_5_02_01	ICCWS_5_05_01	97.37	0.983	99.07	0.0	65.04	66.25	1.85
ICCWS_5_02_01	ICCWS_5_06_01	96.34	0.974	98.89	0.0	65.04	67.52	3.81
ICCWS_5_02_01	ICCWS_5_07_01	97.34	0.982	99.14	0.0	65.04	66.17	1.72
ICCWS_5_02_01	ICCWS_5_08_01	97.62	0.986	98.97	0.0	65.04	66.76	2.64
ICCWS_5_02_01	ICCWS_5_09_01	97.10	0.980	99.12	0.1	65.04	66.92	2.88
ICCWS_5_02_01	ICCWS_5_10_01	97.15	0.982	98.92	0.1	65.04	66.78	2.67
ICCWS_5_03_01	ICCWS_5_04_01	98.47	0.995	99.02	0.1	65.65	66.46	1.22
ICCWS_5_03_01	ICCWS_5_05_01	98.10	0.990	99.14	0.0	65.65	66.25	0.91
ICCWS_5_03_01	ICCWS_5_06_01	96.95	0.981	98.82	0.0	65.65	67.52	2.85
ICCWS_5_03_01	ICCWS_5_07_01	98.01	0.989	99.11	0.0	65.65	66.17	0.78
ICCWS_5_03_01	ICCWS_5_08_01	98.19	0.993	98.88	0.1	65.65	66.76	1.69
ICCWS_5_03_01	ICCWS_5_09_01	97.78	0.987	99.11	0.1	65.65	66.92	1.93
ICCWS_5_03_01	ICCWS_5_10_01	97.57	0.989	98.65	0.1	65.65	66.78	1.72
ICCWS_5_04_01	ICCWS_5_05_01	98.73	0.995	99.22	0.0	66.46	66.25	-0.31
ICCWS_5_04_01	ICCWS_5_06_01	97.68	0.987	99.01	0.0	66.46	67.52	1.60
ICCWS_5_04_01	ICCWS_5_07_01	98.49	0.994	99.05	0.0	66.46	66.17	-0.44
ICCWS_5_04_01	ICCWS_5_08_01	98.65	0.999	98.79	0.0	66.46	66.76	0.46
ICCWS_5_04_01	ICCWS_5_09_01	98.29	0.992	99.09	0.1	66.46	66.92	0.70
ICCWS_5_04_01	ICCWS_5_10_01	98.16	0.994	98.70	0.0	66.46	66.78	0.49
ICCWS_5_05_01	ICCWS_5_06_01	98.17	0.991	99.03	0.1	66.25	67.52	1.92
ICCWS_5_05_01	ICCWS_5_07_01	98.99	0.999	99.06	0.0	66.25	66.17	-0.13
ICCWS_5_05_01	ICCWS_5_08_01	98.62	0.996	98.98	0.1	66.25	66.76	0.78
ICCWS_5_05_01	ICCWS_5_09_01	98.85	0.997	99.17	0.2	66.25	66.92	1.01
ICCWS_5_05_01	ICCWS_5_10_01	98.82	0.999	98.88	0.1	66.25	66.78	0.80
ICCWS_5_06_01	ICCWS_5_07_01	98.14	0.992	98.91	0.0	67.52	66.17	-2.01
ICCWS_5_06_01	ICCWS_5_08_01	97.56	0.988	98.77	0.0	67.52	66.76	-1.12
ICCWS_5_06_01	ICCWS_5_09_01	98.46	0.995	99.01	0.1	67.52	66.92	-0.89
ICCWS_5_06_01	ICCWS_5_10_01	97.86	0.992	98.64	0.1	67.52	66.78	-1.09
ICCWS_5_07_01	ICCWS_5_08_01	98.46	0.996	98.89	0.1	66.17	66.76	0.91
ICCWS_5_07_01	ICCWS_5_09_01	98.72	0.998	98.96	0.1	66.17	66.92	1.14

The first set of the repeatability test and accuracy test were zoomed in. Note that Correlations are correct and consistent with the IRI differences since the profiles are of the same lengths or similar.

Profiler Certification: Detailed Results

Repeatability - Left								
Basis	Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	ICCWS_5_02_01	98.74	0.996	99.17	0.1	64.85	65.04	0.30
ICCWS_5_01_01	ICCWS_5_03_01	97.93	0.989	99.05	0.1	64.85	65.65	1.24
ICCWS_5_01_01	ICCWS_5_04_01	97.51	0.983	99.17	0.2	64.85	66.46	2.48
ICCWS_5_01_01	ICCWS_5_05_01	97.00	0.978	99.14	0.1	64.85	66.25	2.16
ICCWS_5_01_01	ICCWS_5_06_01	95.98	0.970	98.94	0.1	64.85	67.52	4.12
ICCWS_5_01_01	ICCWS_5_07_01	96.78	0.978	98.98	0.1	64.85	66.17	2.03
ICCWS_5_01_01	ICCWS_5_08_01	96.93	0.982	98.70	0.1	64.85	66.76	2.95
ICCWS_5_01_01	ICCWS_5_09_01	96.56	0.976	98.99	0.2	64.85	66.92	3.19
ICCWS_5_01_01	ICCWS_5_10_01	96.37	0.978	98.56	0.2	64.85	66.78	2.98

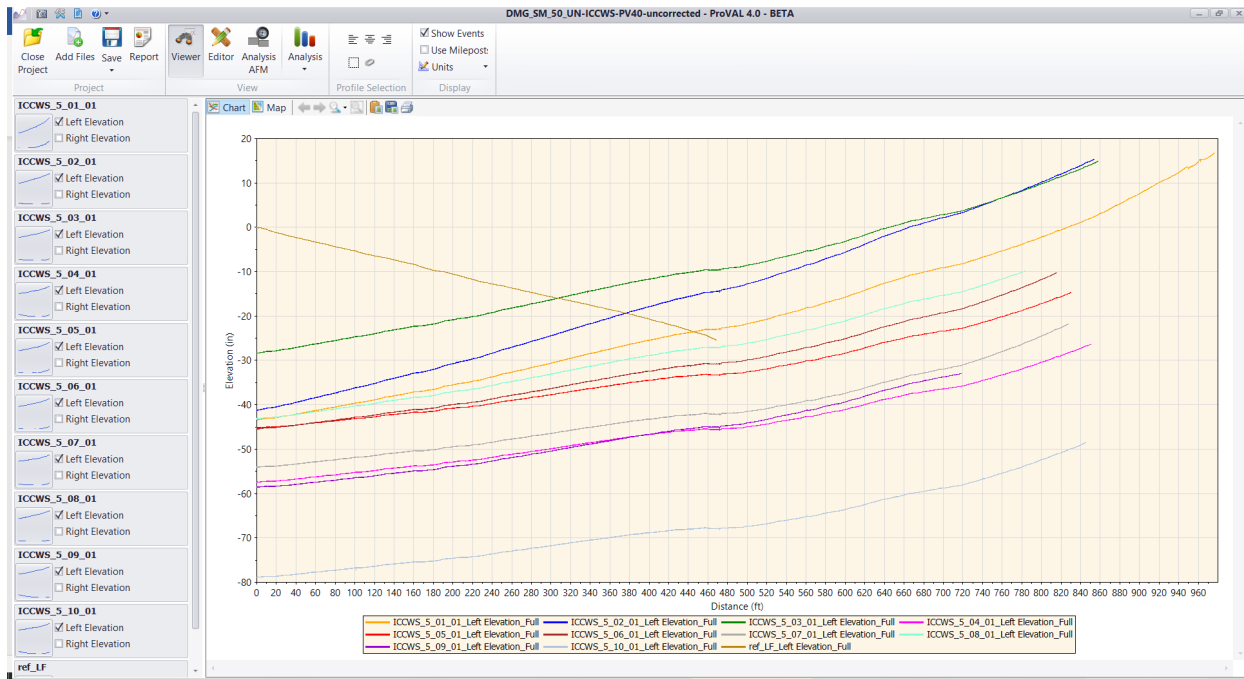
Accuracy - Left								
Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)	
ICCWS_5_01_01	89.47	0.997	89.73	0.1	64.95	64.85	-0.16	
ICCWS_5_02_01	88.17	0.999	88.29	0.1	64.95	65.04	0.14	
ICCWS_5_03_01	88.15	0.992	88.89	0.1	64.95	65.65	1.08	
ICCWS_5_04_01	87.60	0.986	88.80	0.1	64.95	66.46	2.31	
ICCWS_5_05_01	86.53	0.981	88.17	0.1	64.95	66.25	1.99	
ICCWS_5_06_01	86.09	0.973	88.47	0.1	64.95	67.52	3.95	
ICCWS_5_07_01	86.84	0.981	88.55	0.1	64.95	66.17	1.86	
ICCWS_5_08_01	85.33	0.985	86.63	0.1	64.95	66.76	2.79	
ICCWS_5_09_01	86.05	0.979	87.94	0.2	64.95	66.92	3.02	
ICCWS_5_10_01	84.97	0.981	86.62	0.2	64.95	66.78	2.81	

ProVAL 4.0. Beta

PV40 for Uncorrected Profiles with different lengths

The incorrect profile of different lengths and the reference profile were imported to ProVAL 4.0 beta and the project was saved as “DMG_SM_50_UN-ICCWS-PV40-uncorrected.pvp”.

The ProVAL Viewer screens show the profiles in different lengths.



The PCM analysis uses the following settings: Note that the options for decimation, sample interval adjustment, padding, and upsampling were turned off for the comparison against ProVAL 3.61 results.

Profiler Certification: Inputs					
Minimum Repeatability (%)	92	File	Sample Interval (in)	Profiles	Basis Run
Minimum Accuracy (%)	90	<input checked="" type="checkbox"/> ICCWS_5_01_01	0.82	Left + Right	<input type="checkbox"/> 1
Maximum offset (ft)	5.00	<input checked="" type="checkbox"/> ICCWS_5_02_01	0.82	Left + Right	<input type="checkbox"/> 2
<input type="checkbox"/> Use decimation	10	<input checked="" type="checkbox"/> ICCWS_5_03_01	0.82	Left + Right	<input type="checkbox"/> 3
<input type="checkbox"/> Use interval adjustment (%)	1.00	<input checked="" type="checkbox"/> ICCWS_5_04_01	0.82	Left + Right	<input type="checkbox"/> 4
<input type="checkbox"/> Use padding		<input checked="" type="checkbox"/> ICCWS_5_05_01	0.82	Left + Right	<input type="checkbox"/> 5
<input type="checkbox"/> Use upsampling		<input checked="" type="checkbox"/> ICCWS_5_06_01	0.82	Left + Right	<input type="checkbox"/> 6
Basis Filter		<input checked="" type="checkbox"/> ICCWS_5_07_01	0.82	Left + Right	<input type="checkbox"/> 7
IRI (with 250mm Filter)		<input checked="" type="checkbox"/> ICCWS_5_08_01	0.82	Left + Right	<input type="checkbox"/> 8
Comparison Filter		<input checked="" type="checkbox"/> ICCWS_5_09_01	0.82	Left + Right	<input type="checkbox"/> 9
IRI (with 250mm Filter)		<input checked="" type="checkbox"/> ICCWS_5_10_01	0.82	Left + Right	<input type="checkbox"/> 10
		<input checked="" type="checkbox"/> ref_LF	0.79	Left	<input checked="" type="checkbox"/> 11

The PCM summary results are as follows.

[illegible]

The accuracy test and left-wheel-path repeatability results were zoomed in:

[illegible]

The first set of the repeatability test and the accuracy tests were zoomed in. Note that the Correlations are correct, and the IRI differences are correct (in the orange box) based on the overlapped sections, although the profiles are of different lengths.

Profiler Certification: Detailed Results

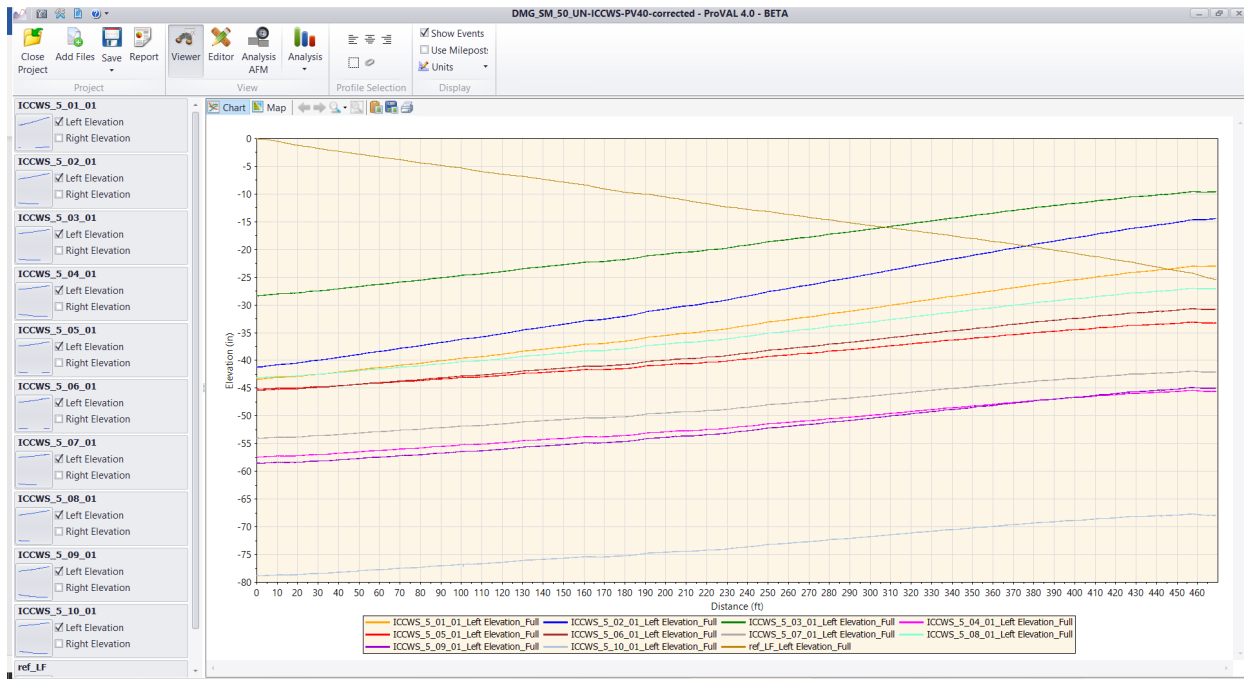
Repeatability - Left								
Basis	Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	ICCWS_5_02_01	98.26	0.995	98.77	0.1	74.30	74.35	0.07
ICCWS_5_01_01	ICCWS_5_03_01	96.30	0.991	97.13	0.2	74.23	74.75	0.70
ICCWS_5_01_01	ICCWS_5_04_01	93.44	0.988	94.63	0.4	74.27	75.46	1.61
ICCWS_5_01_01	ICCWS_5_05_01	93.58	0.985	95.00	0.3	72.98	74.89	2.62
ICCWS_5_01_01	ICCWS_5_06_01	93.48	0.983	95.09	0.3	71.87	73.79	2.66
ICCWS_5_01_01	ICCWS_5_07_01	90.10	0.998	90.33	0.4	73.05	73.13	0.11
ICCWS_5_01_01	ICCWS_5_08_01	95.64	0.976	98.00	0.3	71.95	73.55	2.23
ICCWS_5_01_01	ICCWS_5_09_01	95.61	0.974	98.12	0.3	71.20	72.53	1.87
ICCWS_5_01_01	ICCWS_5_10_01	93.26	0.994	93.83	0.5	73.56	74.49	1.27

Accuracy - Left							
Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	89.47	0.997	89.73	0.1	64.95	64.88	-0.12
ICCWS_5_02_01	88.17	0.999	88.29	0.1	64.95	65.07	0.18
ICCWS_5_03_01	88.15	0.992	88.89	0.1	64.95	65.67	1.11
ICCWS_5_04_01	87.60	0.986	88.80	0.1	64.95	66.48	2.35
ICCWS_5_05_01	86.53	0.981	88.17	0.1	64.95	66.30	2.07
ICCWS_5_06_01	86.09	0.973	88.47	0.1	64.95	67.54	3.98
ICCWS_5_07_01	86.84	0.981	88.55	0.1	64.95	66.19	1.91
ICCWS_5_08_01	85.33	0.985	86.63	0.1	64.95	66.79	2.83
ICCWS_5_09_01	86.05	0.979	87.94	0.2	64.95	66.95	3.07
ICCWS_5_10_01	84.97	0.981	86.62	0.2	64.95	66.81	2.85

PV40 for Corrected profiles with the same length

The corrected profiles of the same length and the reference profile were imported to ProVAL 4.0 Beta, and the project was saved as “DMG_SM_50_UN-ICCWS-PV40-corrected.pvp”.

The ProVAL Viewer screens show the profiles in the same length. The PCM analysis uses the same settings as the above test.



The PCM summary results are as follows.

Profiler Certification: Summary Results																																										
Statistics																																										
Statistic		Repeatability - Left					Repeatability - Right					Accuracy - Left																														
Comparison Count		45					45					10																														
% Passing		100.00					100.00					0.00																														
Mean		97.89					97.51					86.92																														
Minimum		95.98					95.21					84.97																														
Maximum		98.99					98.74					89.47																														
Standard Deviation		0.8					0.9					1.4																														
Grade		Passed					Passed					Failed																														
Accuracy		Repeatability - Left Correlations (%)										Repeatability - Left Offsets (ft)										Repeatability - Right Correlations (%)										Repeatability - Right Offsets (ft)										
Run	Left	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	
1	89.47	1	98.74	97.93	97.51	97.00	95.98	96.78	96.93	96.56	96.37	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	97.41	95.56	97.57	96.25	97.88	97.87	96.62	97.14	97.24	1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
2	88.17	2		98.29	97.91	97.37	96.34	97.34	97.62	97.10	97.15	2		0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	0.1	2		95.21	98.69	96.76	98.04	98.01	97.11	97.05	97.33	2		-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
3	88.15	3			98.47	98.10	96.95	98.01	98.19	97.78	97.57	3			0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	3			96.04	97.23	96.32	96.34	97.84	96.56	96.89	3			0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	87.60	4				98.73	97.68	98.49	98.65	98.29	98.16	4				-0.1	-0.1	-0.1	0.0	0.1	0.0	0.0	4				97.04	98.45	98.46	97.62	97.68	98.04	4				0.0	0.0	0.0	0.0	0.1	0.1
5	86.53	5					98.17	98.99	98.62	98.85	98.82	5					0.1	0.0	0.1	0.1	0.1	0.1	5					97.35	97.02	98.30	97.53	97.63	5					0.0	0.0	0.0	0.1	0.1
6	86.09	6						98.14	97.56	98.46	97.86	6						0.0	0.0	0.1	0.1	0.1	6						98.74	97.90	98.53	98.67	6						0.0	0.0	0.1	0.1
7	86.84	7							98.46	98.72	98.69	7							0.1	0.1	0.1	0.1	7							97.86	98.54	98.34	7							0.0	0.1	0.1
8	85.33	8								98.32	98.52	8									0.1	0.0	8								98.15	98.46	8							0.1	0.1	
9	86.05	9									98.69	9									0.0	0.0	9									98.74	9								0.0	
10	84.97	10										10											10																			

The accuracy test and left-wheel-path repeatability results were zoomed in and compared with the results from uncorrected profiles:

Profiler Certification: Summary Results												Profiler Certification: Summary Results																							
Statistics												Statistics																							
Statistic		Repeatability - Left				Repeatability - Right				Accuracy - Left				Statistic		Repeatability - Left				Repeatability - Right				Accuracy - Left											
Comparison Count		45				45				10				Comparison Count		45				45				10											
% Passing		100.00				100.00				0.00				% Passing		95.56				88.89				0.00											
Mean		97.89				97.51				86.92				Mean		96.08				94.45				86.92											
Minimum		95.98				95.21				84.97				Minimum		89.45				74.89				84.97											
Maximum		98.99				98.74				89.47				Maximum		98.72				98.53				89.47											
Standard Deviation		0.8				0.9				1.4				Standard Deviation		2.2				5.8				1.4											
Grade		Passed				Passed				Failed				Grade		Passed				Passed				Failed											
Accuracy		Repeatability - Left Correlations (%)										Accuracy		Repeatability - Left Correlations (%)																					
Run	Left	Run	2	3	4	5	6	7	8	9	10	Run	Left	Run	2	3	4	5	6	7	8	9	10	Run	Left	Run	2	3	4	5	6	7	8	9	10
1	89.47	1	98.74	97.93	97.51	97.00	95.98	96.78	96.93	96.56	96.37	1	89.47	1	98.26	96.30	93.44	93.58	93.48	90.10	95.64	95.61	93.26	1	89.47	1	98.26	96.30	93.44	93.58	93.48	90.10	95.64	95.61	93.26
2	88.17	2		98.29	97.91	97.37	96.34	97.34	97.62	97.10	97.15	2	88.17	2		96.20	93.36	93.30	93.59	89.45	96.51	97.14	93.20	2	88.17	2		96.20	93.36	93.30	93.59	89.45	96.51	97.14	93.20
3	88.15	3			98.47	98.10	96.95	98.01	98.19	97.78	97.57	3	88.15	3			97.30	95.69	96.34	94.41	97.19	96.74	97.00	3	88.15	3			97.30	95.69	96.34	94.41	97.19	96.74	97.00
4	87.60	4				98.73	97.68	98.49	98.65	98.29	98.16	4	87.60	4				98.05	97.69	95.89	98.46	98.57	97.85	4	87.60	4				98.05	97.69	95.89	98.46	98.57	97.85
5	86.53	5					98.17	98.99	98.62	98.85	98.82	5	86.53	5					97.11	94.99	97.07	96.97	96.45	5	86.53	5					97.11	94.99	97.07	96.97	96.45
6	86.09	6						98.14	97.56	98.46	97.86	6	86.09	6						97.66	97.64	97.88	97.84	6	86.09	6						97.66	97.64	97.88	97.84
7	86.84	7							98.46	98.72	98.69	7	86.84	7							96.71	97.74	97.87	7	86.84	7							96.71	97.74	97.87
8	85.33	8								98.32	98.52	8	85.33	8								98.72	97.67	8	85.33	8							98.72	97.67	
9	86.05	9									98.69	9	86.05	9								97.75	9	86.05	9								97.75		
10	84.97											10	84.97											10	84.97										

The first set of the repeatability test and the accuracy test were zoomed in. Note that correlations are correct and consistent with the IRI differences for the profiles that are of the same lengths or similar.

Profiler Certification: Detailed Results

Repeatability - Left								
Basis	Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	ICCWS_5_02_01	98.74	0.996	99.17	0.1	64.85	65.04	0.30
ICCWS_5_01_01	ICCWS_5_03_01	97.93	0.989	99.05	0.1	64.85	65.65	1.24
ICCWS_5_01_01	ICCWS_5_04_01	97.51	0.983	99.17	0.1	64.85	66.46	2.48
ICCWS_5_01_01	ICCWS_5_05_01	97.00	0.978	99.14	0.1	64.85	66.28	2.20
ICCWS_5_01_01	ICCWS_5_06_01	95.98	0.970	98.94	0.1	64.85	67.52	4.12
ICCWS_5_01_01	ICCWS_5_07_01	96.78	0.978	98.98	0.1	64.85	66.17	2.03
ICCWS_5_01_01	ICCWS_5_08_01	96.93	0.982	98.70	0.1	64.85	66.76	2.95
ICCWS_5_01_01	ICCWS_5_09_01	96.56	0.976	98.99	0.1	64.85	66.92	3.19
ICCWS_5_01_01	ICCWS_5_10_01	96.37	0.978	98.56	0.1	64.85	66.78	2.98

Accuracy - Left							
Comparison	Correlation (%)	Shape Coefficient	Roughness Coefficient	Offset (ft)	Basis IRI (in/mi)	Comparison IRI (in/mi)	IRI Difference (%)
ICCWS_5_01_01	89.47	0.997	89.73	0.1	64.95	64.88	-0.12
ICCWS_5_02_01	88.17	0.999	88.29	0.1	64.95	65.07	0.18
ICCWS_5_03_01	88.15	0.992	88.89	0.1	64.95	65.67	1.11
ICCWS_5_04_01	87.60	0.986	88.80	0.1	64.95	66.48	2.35
ICCWS_5_05_01	86.53	0.981	88.17	0.1	64.95	66.30	2.07
ICCWS_5_06_01	86.09	0.973	88.47	0.1	64.95	67.54	3.98
ICCWS_5_07_01	86.84	0.981	88.55	0.1	64.95	66.19	1.91
ICCWS_5_08_01	85.33	0.985	86.63	0.1	64.95	66.79	2.83
ICCWS_5_09_01	86.05	0.979	87.94	0.2	64.95	66.95	3.07
ICCWS_5_10_01	84.97	0.981	86.62	0.2	64.95	66.81	2.85

Conclusions

Based on the above test results, the following conclusions can be drawn:

- Issue 1: *“The shape coefficient and roughness coefficients are reversed”*
 - The ProVAL team implemented it based on interpreting the terms in AASHTO R56, and they will need the original author of the AASHTO R56 to clarify the terminologies.
- Issue 2: *“The IRI agreement is based on the comparison of the IRI over the two entire profiles, rather than the segments of each profile that was used (by virtue of overlap) to obtain the cross-correlation result.”*
 - ProVAL 3.61 PCM’s cross-correlation values are correct based on the overlapped sections of a profile pair. Therefore, anyone who uses the CC values for PCM’s Summary Results that follow AASHTO R56 should have no issues.
 - Researchers or some agencies who also use the IRI differences in PCM’s Detailed Results (not required in AASHTO R56-2018) should not have issues if they use profiles of the same length. However, if the profiles are of different lengths, the IRI % differences in PCM’s Detailed Results may not be consistent with the CC values since the IRI values were based on the entire profile lengths.
 - ProVAL 4.0 Beta has changed the computation of IRIs in PCM’s Detailed Results based on the overlapped sections, so they will be consistent with the CC results. Therefore, ProVAL 4.0 Beta PCM can handle profiles of different lengths. It is still recommended to use profiles of similar lengths for such analysis, as it shows that the different lengths may be due to incorrect offset, lead-in, or lead-out illustrated in this document.

Appendix A: ProVAL Software and Test Files

The ProVAL 3.61 software can be downloaded from:

(<https://www.roadprofile.com/download/ProVAL-3.61.50.msi>)

The ProVAL 4.0 Beta can be downloaded from **FOR SDDOT and APPROVED PARTIES** only: (after download, the file's extension needs to be unzipped to a ".msi" file) (~ 38 MB)

https://www.intelligentconstruction.com/wp-content/uploads/2023/08/ProVAL-4.0.38.0-x64-BETA.msi_.zip

The sample files, ProVAL 3.61 projects, ProVAL 4.0 Beta projects, and document files can be downloaded from:

<https://www.intelligentconstruction.com/wp-content/uploads/2023/08/PCM-FHWA-2015.zip>

NOTICES:

- ***PV36* project files can only be opened with ProVAL 3.61**
- ***PV40* project files can only be opened with ProVAL 4.0 Beta. These project files may not be opened by later ProVAL 4.0 versions, so the profile data files will need to be re-imported again.**