ision

TRiO

Research & Development Team 4.0

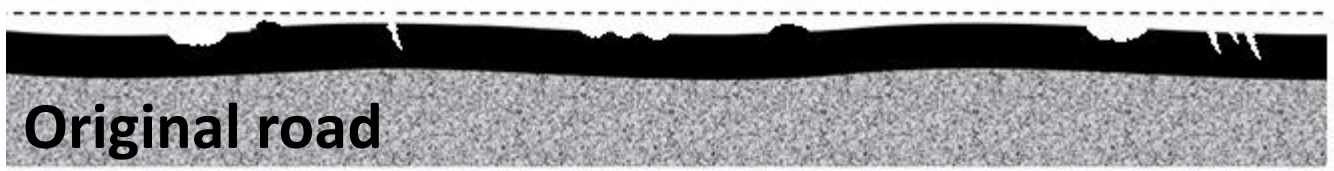
CZECH TECHNICAL
UNIVERSITY
IN PRAGUE

EXACT®

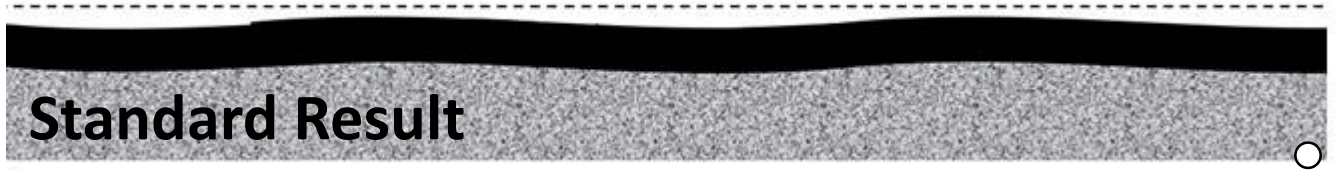
Automatizace výpočtu 3D modelu stavby pro realizaci zakázek oprav silnic

EXACT®
Passion for precision

Goals of EXACT Street



Standard process which copies the existing profile, leads to incorrect results.



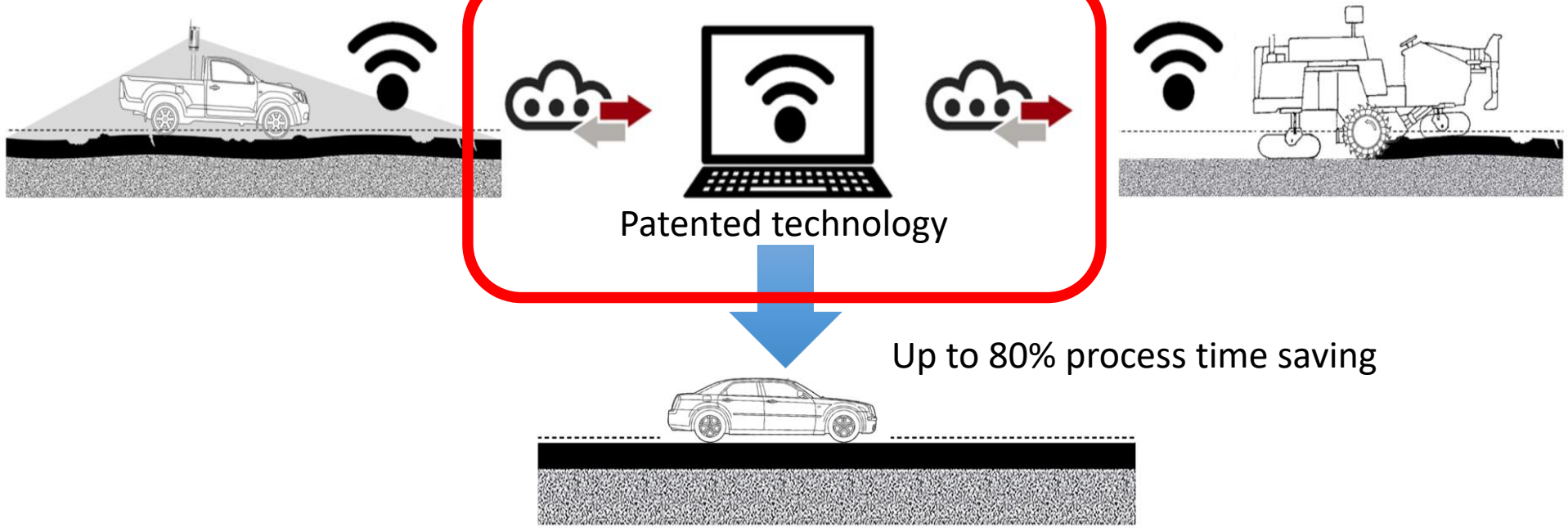
Re-profiling produces higher quality.

Passion for precision

Solution: Methodical Robotization for Road Resurfacing

Complex **digitization**, **virtualization** and **optimization** of the production **process**.

OUR CORE ADDED VALUE



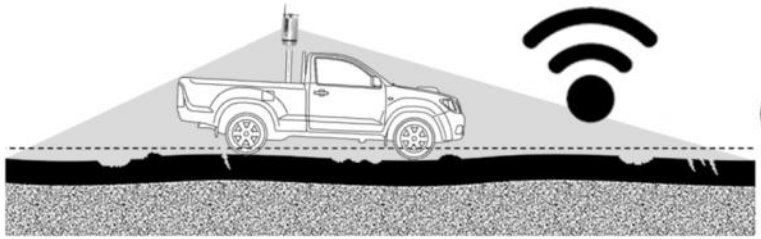
"EXACT Street survey and advanced grade information allowed the milling machine operators to control the equipment's grade system to create a much more accurate milling operation to greatly improve longitudinal ride (smoothness, cross slope, super elevation and only remove the minimum amount of asphalt milling material that is required in the correct locations."

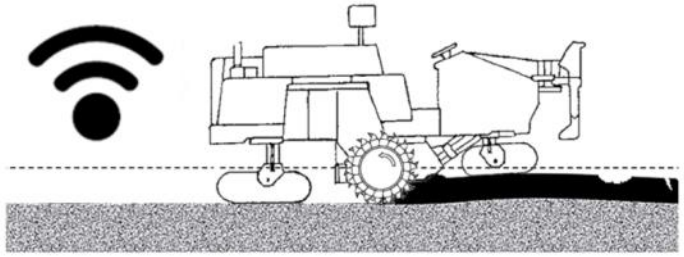
Ted A.E. Arscott, President, ROTO-MILL INC., ON, CANADA

Passion for precision

Exact Street Technology

3 stages





1. Data acquisition
   Laser scanning
   Surveying

2a. Post-processing I.
Reality model

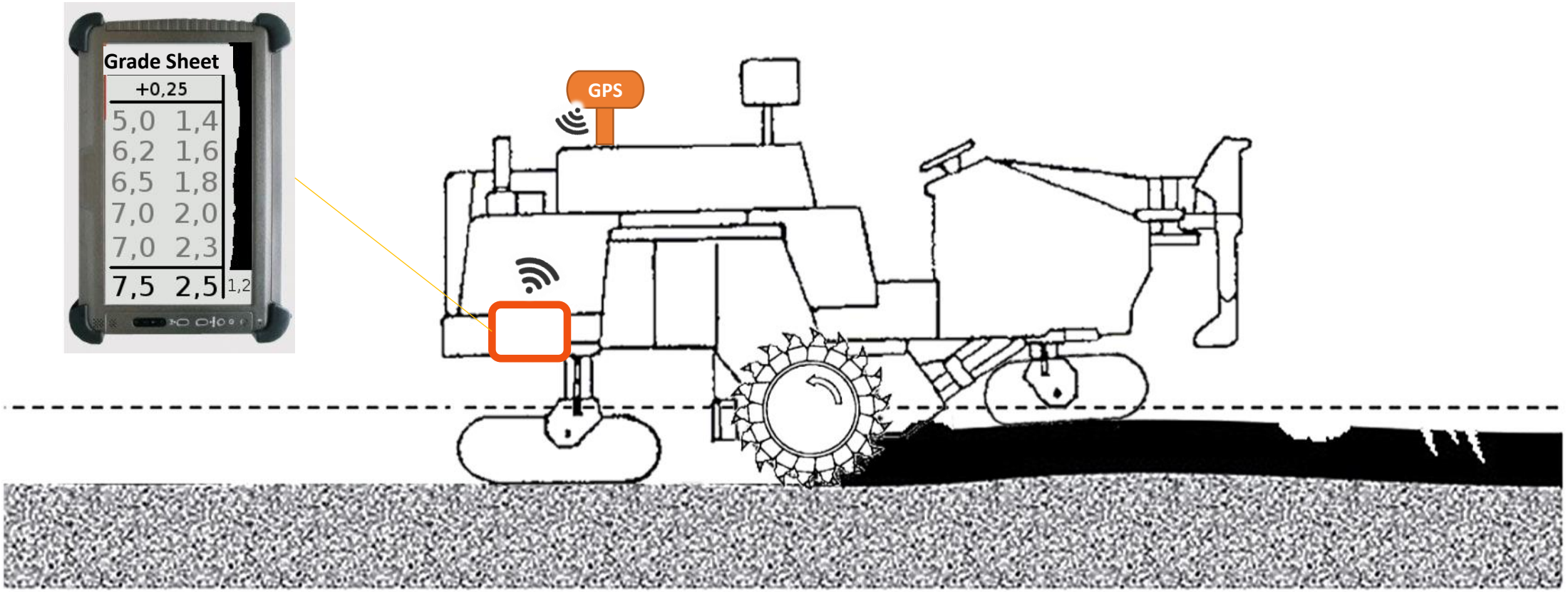
2b. Post-processing II.
Construction model

3. Navigation Tech.

Passion for precision

Differential Milling Control

Road itself as navigation tool



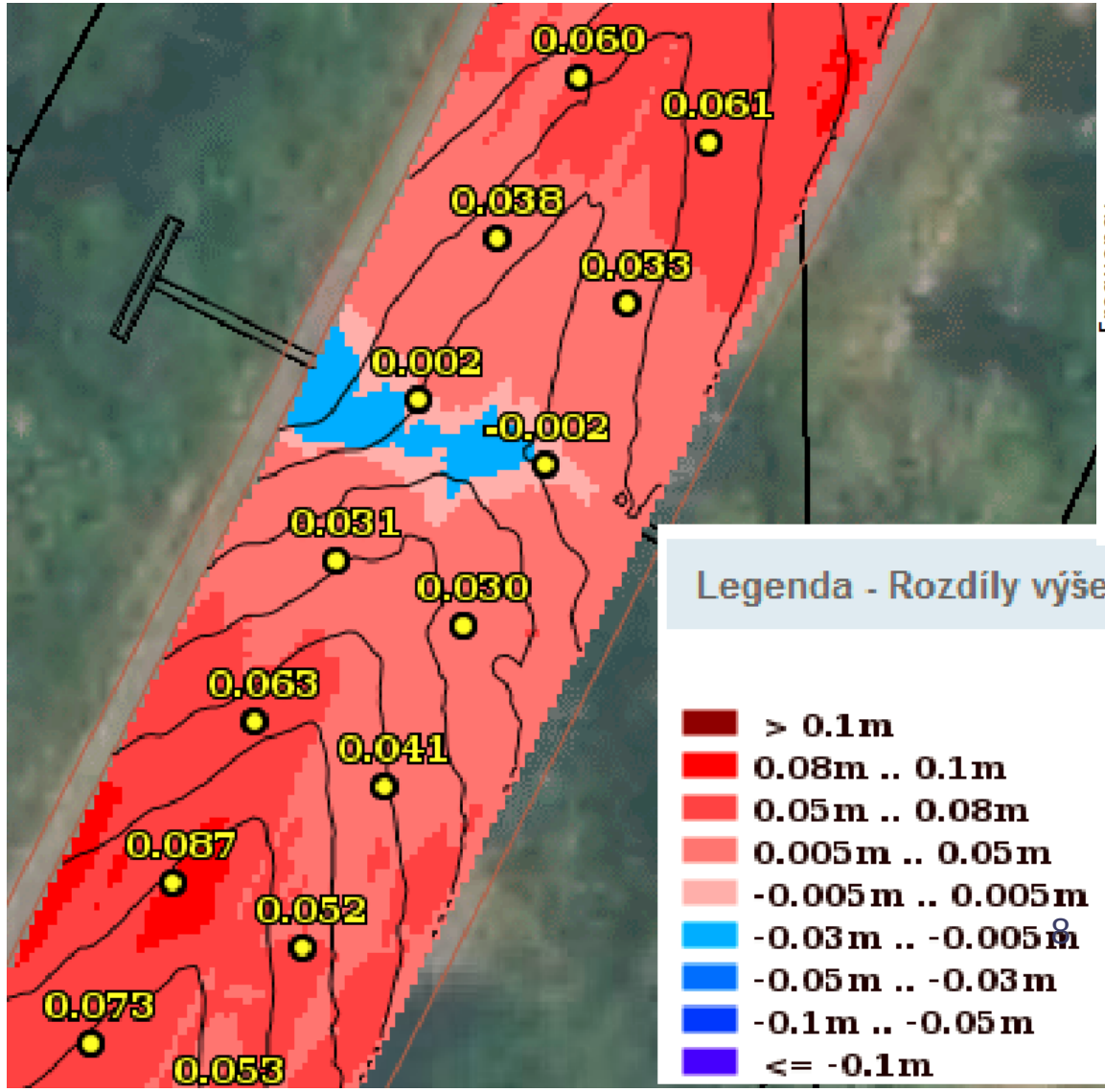
EXACT Street survey and advanced grade information allowed the milling machine operators to control the equipment's grade system to create a much more accurate milling operation to greatly improve longitudinal ride (smoothness, cross slope, super elevation and only remove the minimum amount of asphalt milling material that is required in the correct locations.

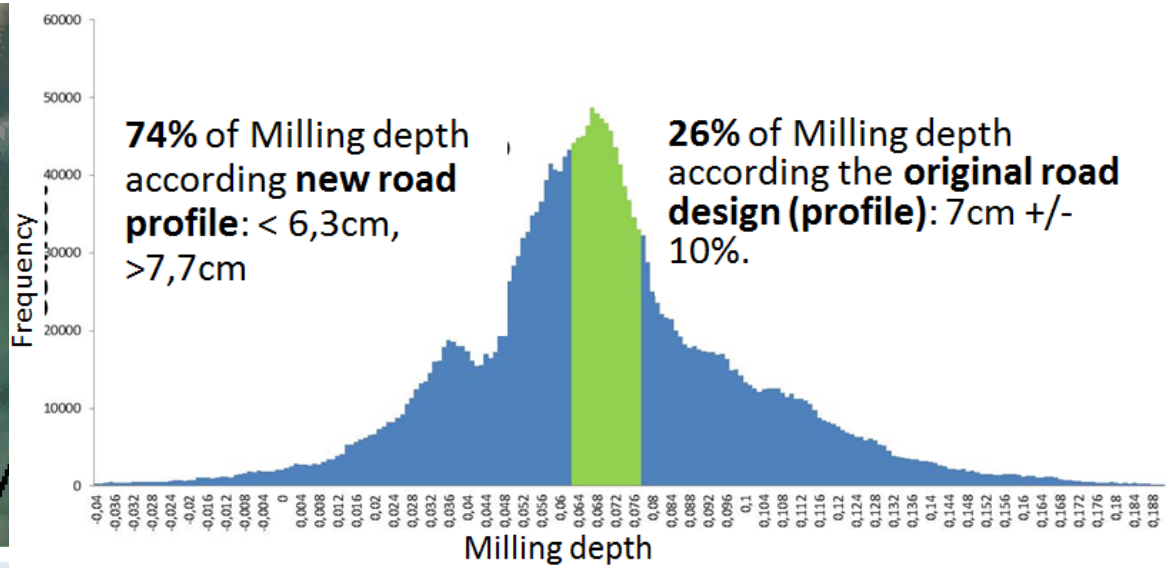
Passion for precision

Differential Milling Control

Road itself as navigation tool

Construction model: re-profiling



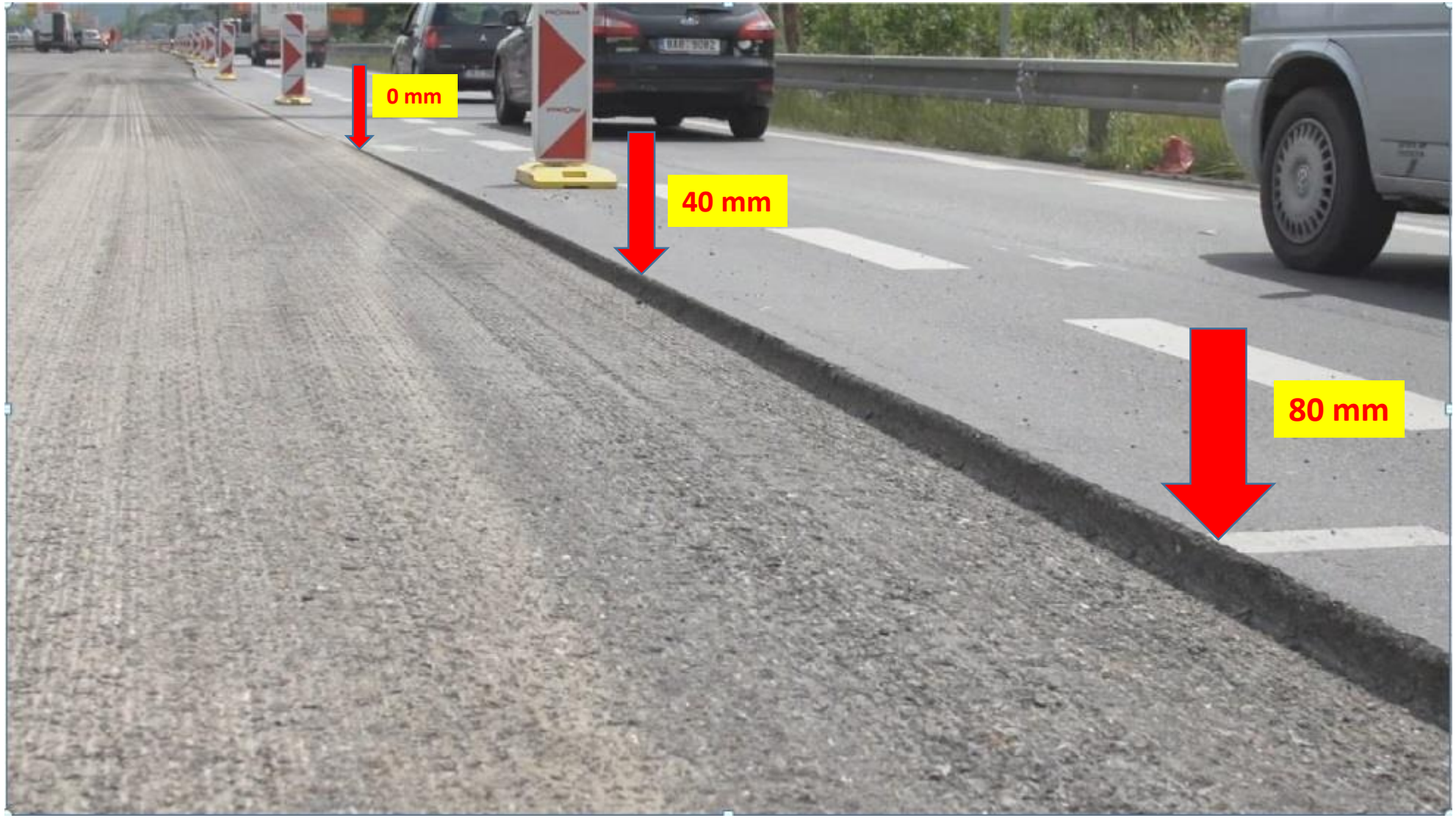


Original design: 70mm milling depth.

EXACT street design:
-only 26% of the project actually required 70mm
-the other 50% required less than 63 mm
-and 22% required more than 77mm.

Exact Street System can help solve the problem of removing (milling) too much asphalt from some locations and not enough asphalt from other locations.

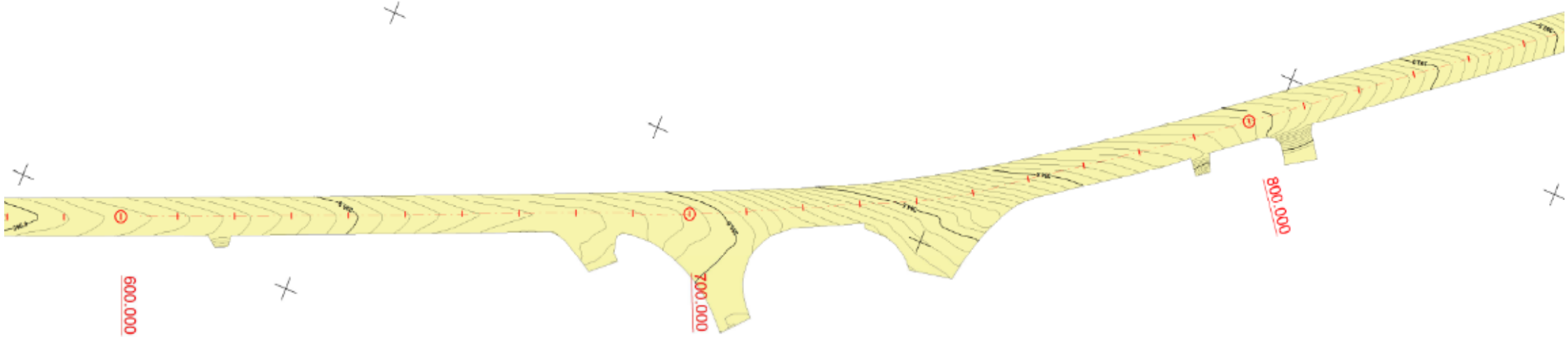
Smart Milling = Re-profiled road



Passion for precision

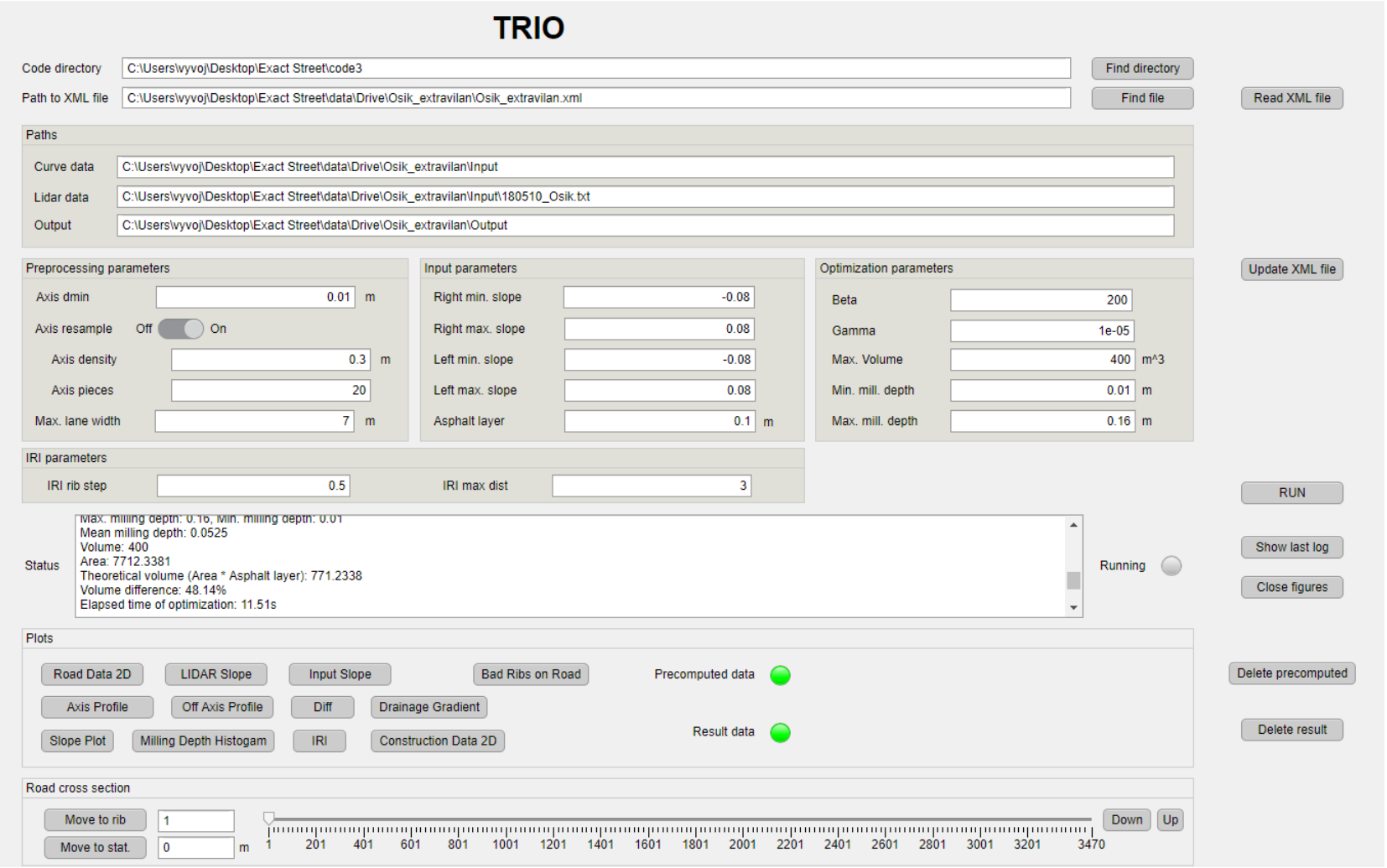
Road II/359 Dolni Ujezd - Osik

Model Reality



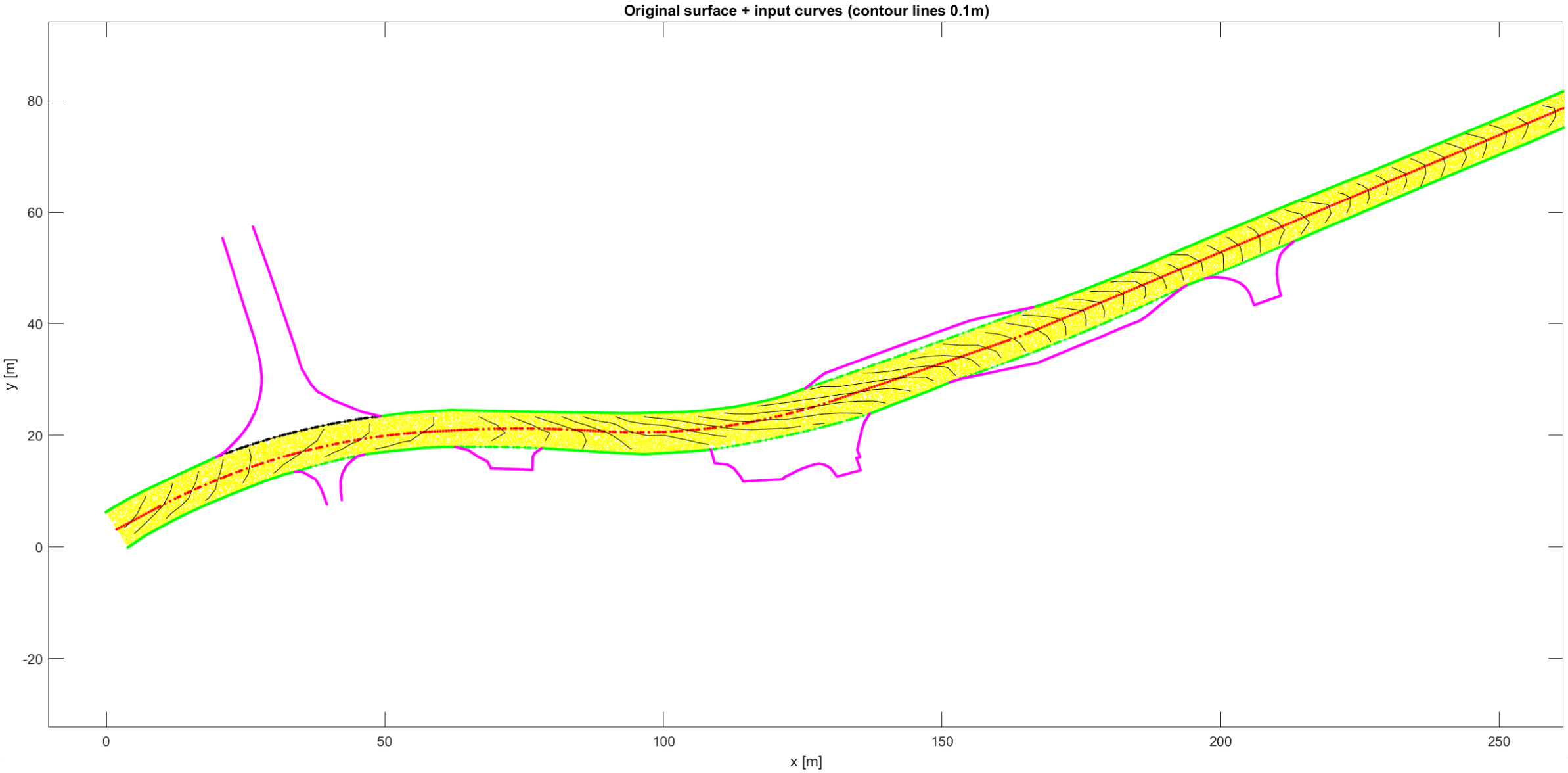
Road II/359 Dolni Ujezd – Osik

SW GUI – DATA INPUT

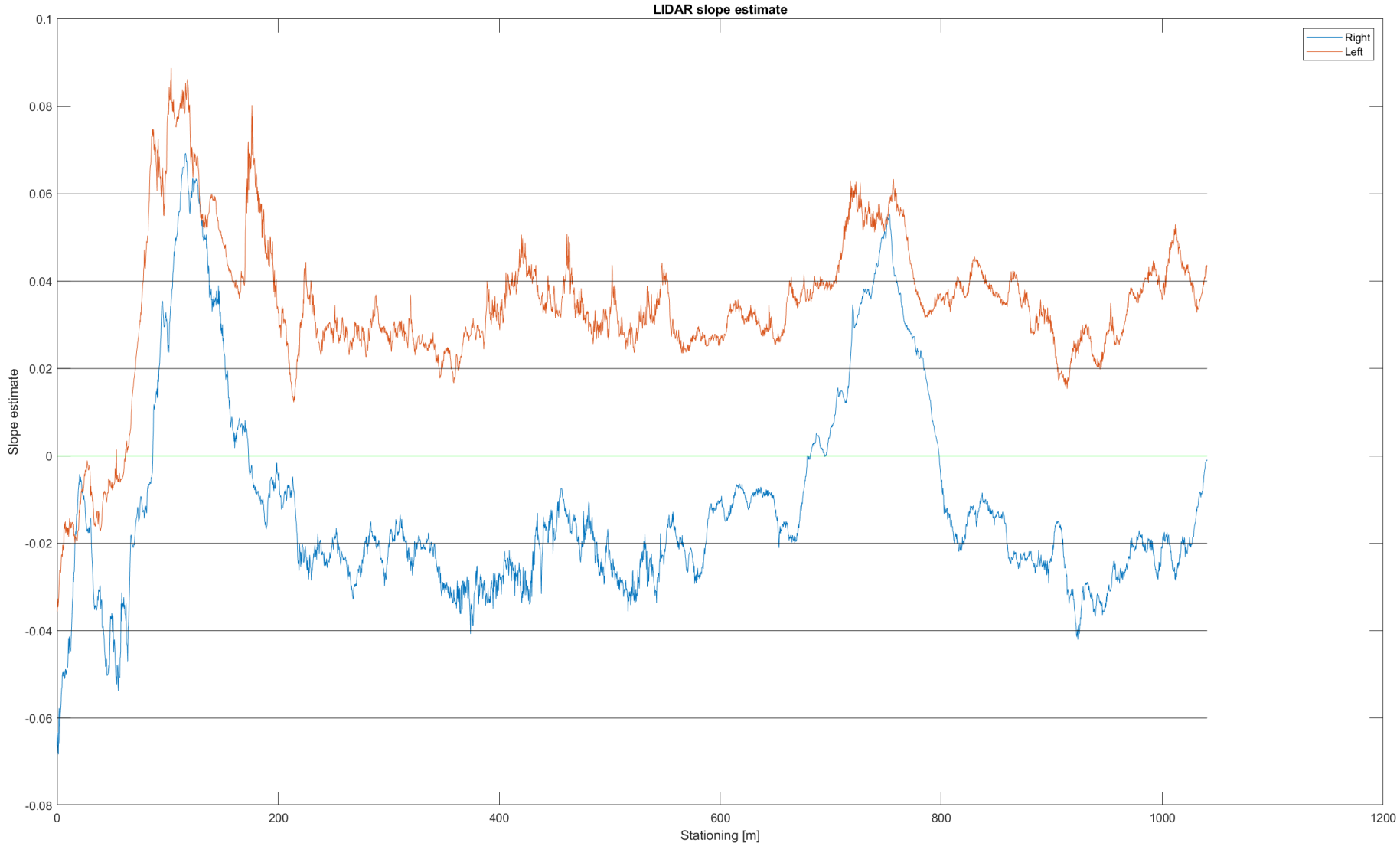


Passion for precision

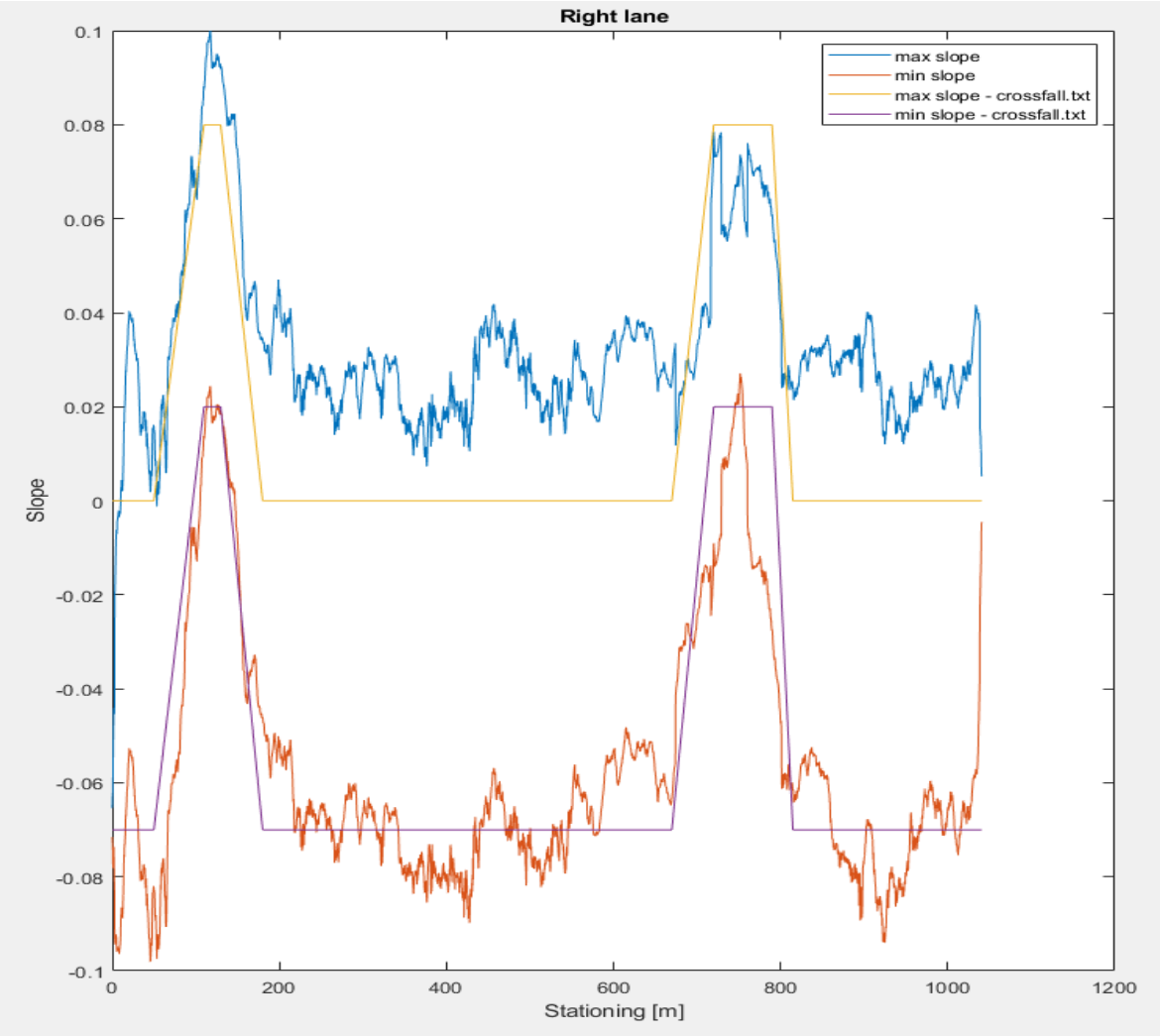
Road II/359 Dolni Ujezd – Osik



Road II/359 Dolni Ujezd – Osik: Cross-slope diagram



Alignment, cross-slope & mil. depth max./min. definition:



		STA (from)	STA (to)	R % min.	R % max.	R % opt.	L % min.	L % max.	L % opt.
1	Curve	0	60	-2,5	-10	0	-1	-3	0
2	Transition	60	90	0	0	0	0	0	0
3	Curve	90	145	2,5	1,5	10	2,5	1,5	10
4	Transition	145	200	0	0	0	0	0	0
5	Straight	200	675	-2,5	-10	-1,5	2,5	1,5	4
6	Transition	675	715	0	0	0	0	0	0
7	Curve	715	750	2,5	1,5	10	2,5	1,5	10
8	Transition	750	800	0	0	0	0	0	0
9	Straight	800	1031	-2,5	-10	-1,5	2,5	1,5	10
10	Straight	1031	1041	-2,5	-10	0	2,5	0	10

A. POŽADOVANÉ PARAMETRY NA MODEL:

- Předpis příčných **sklonů** – min a maximální hodnoty
- Předpis hodnot **hloubek** frézování – min a max pro mačna bodů i linie
- Projektovaná **tloušťka** následného nového krytu
- Maximální **objem** frézovaného materiálu
- Parametr **podélného a příčného vyhlazení** dle norem s využitím lineární kombinace normy derivací výšky nivelety a sklonu v pravém a levém jízdním pruhu.
- **Vstupní parametry IRI**

Road II/359 Dolni Ujezd - Osik

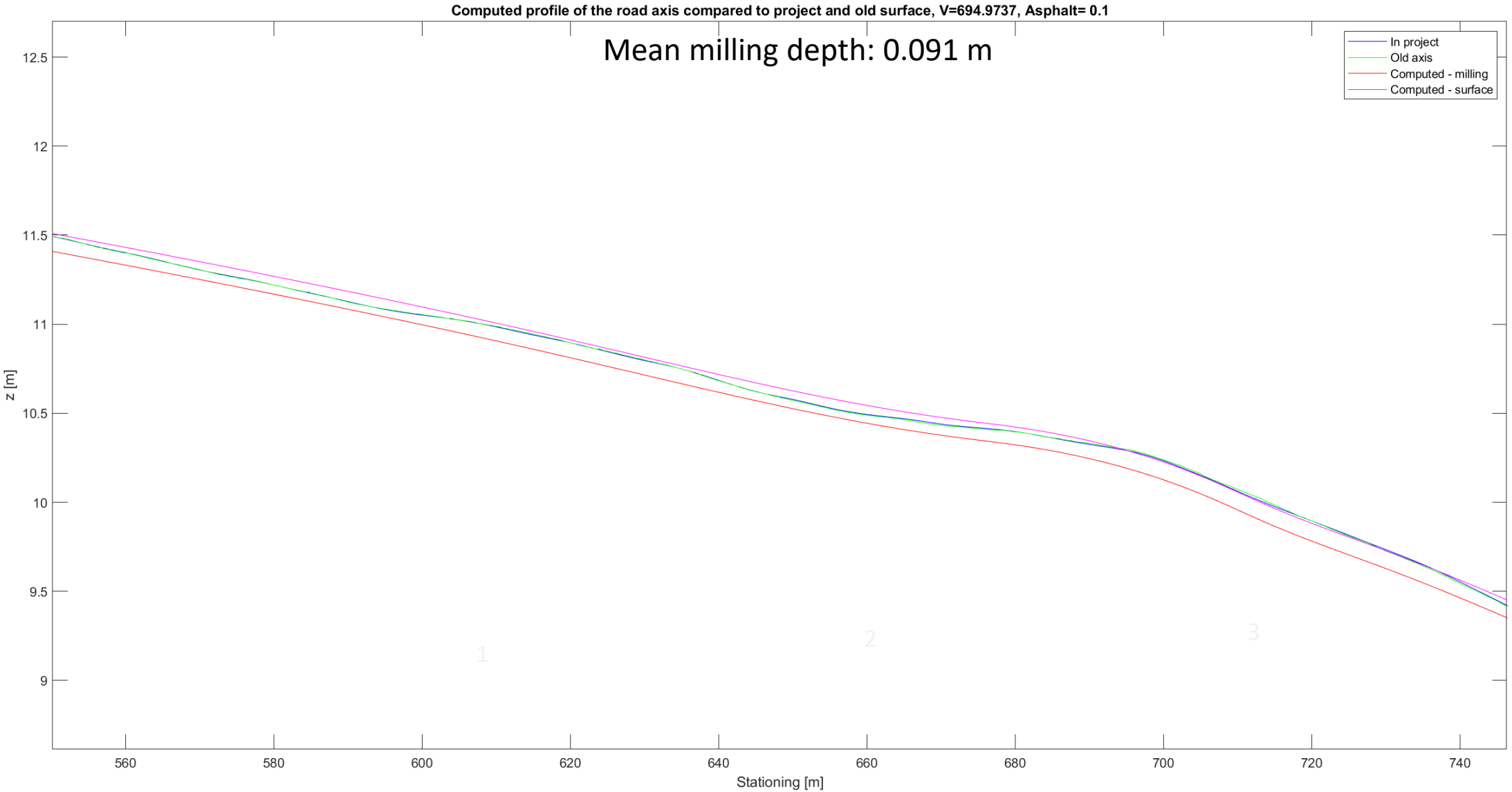
Best smoothness (IRI)

Optimization converged, exit flag 1
Smoothness z: 2.3816e-06
Smoothness s1: 1.5457e-08
Smoothness s2: 1.1266e-08
Max. milling depth: 0.16, Min. milling depth: 0.01
Mean milling depth: 0.0905
Volume: 694.9737
Area: 7712.3381
Theoretical volume (Area * Asphalt layer): 771.2338
Volume difference: 9.89%
Mean orig. IRI: 2.75
Mean IRI: 0.35
Elapsed time of optimization: 10.27s

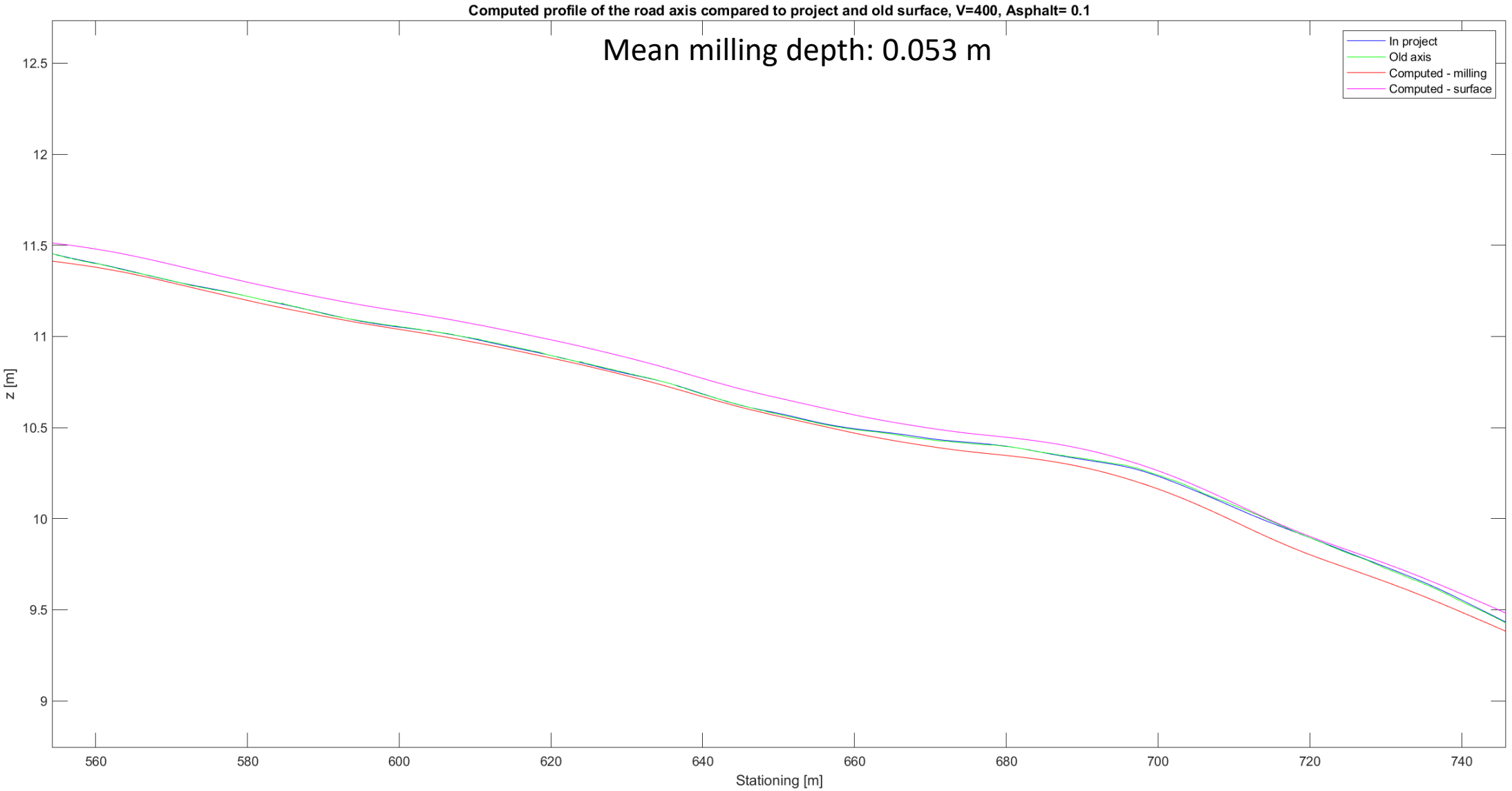
Max. saving (milled asphalt)

Optimization converged, exit flag 1
Smoothness z: 4.921e-06
Smoothness s1: 1.6135e-08
Smoothness s2: 1.3169e-08
Max. milling depth: 0.16, Min. milling depth: 0.01
Mean milling depth: 0.0525
Volume: 400
Area: 7712.3381
Theoretical volume (Area * Asphalt layer): 771.2338
Volume difference: 48.14%
Mean orig. IRI: 2.75
Mean IRI: 0.65
Elapsed time of optimization: 11.44s

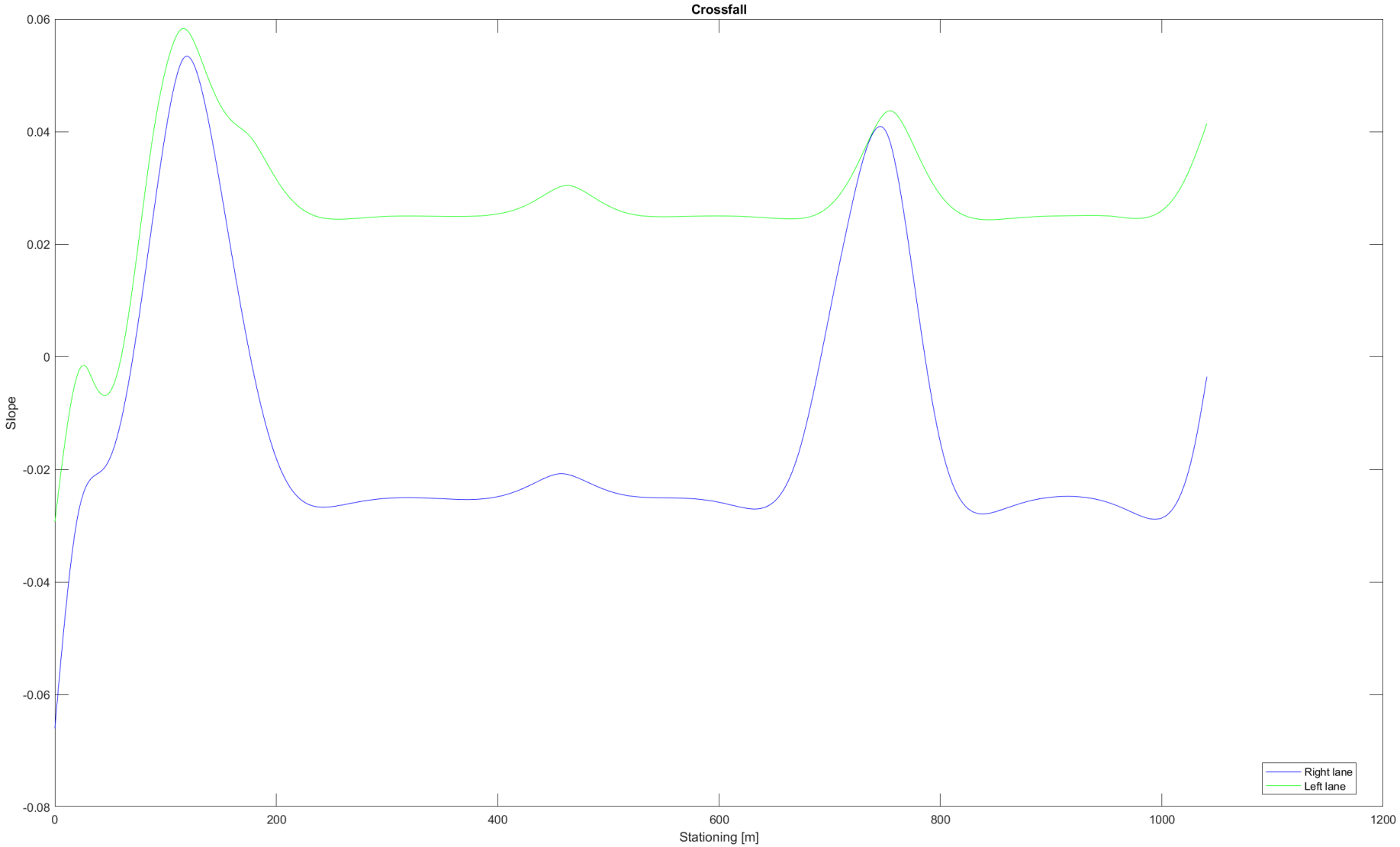
Longitudinal profile: re-profiling – best IRI



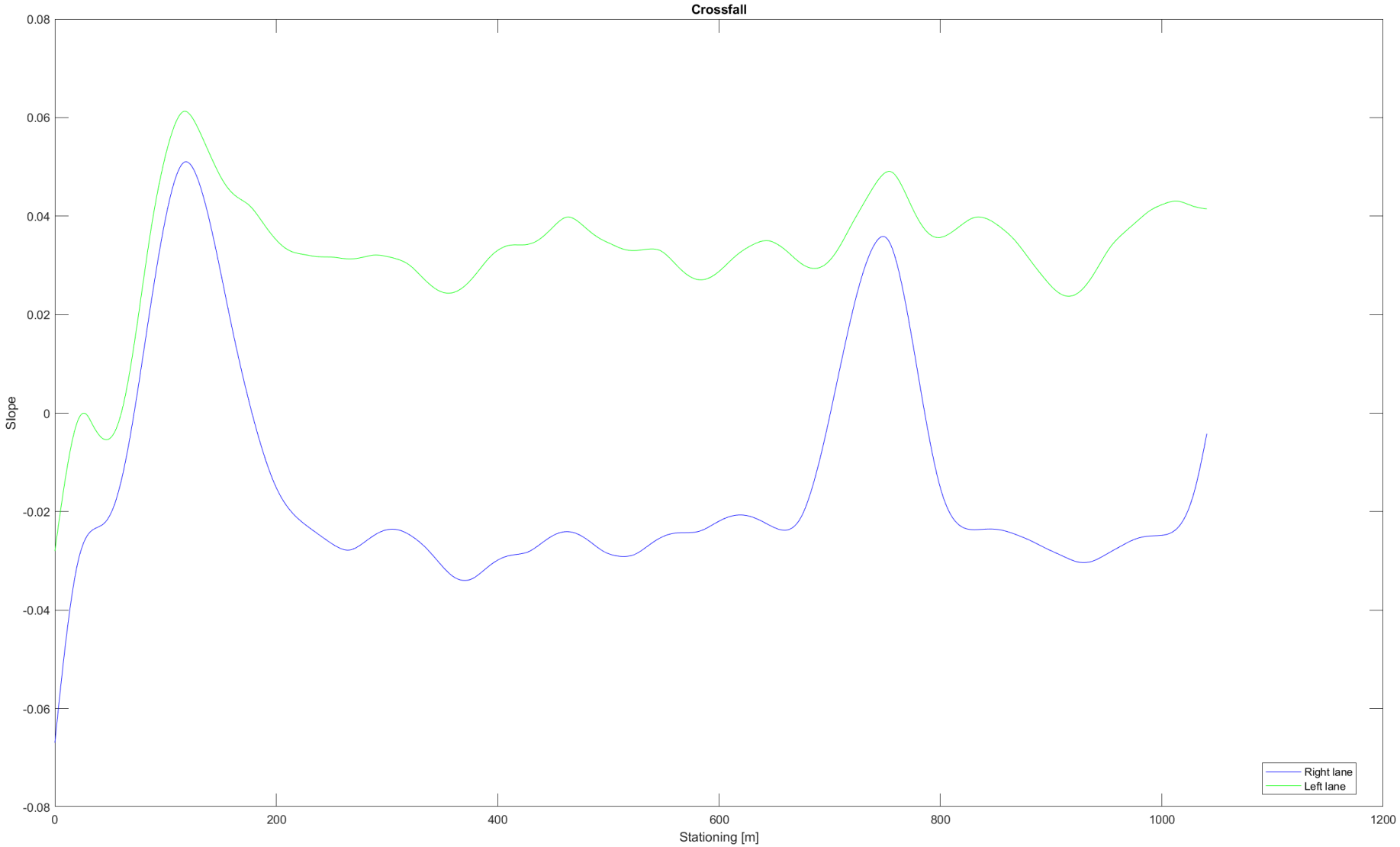
Longitudinal profile: re-profiling – Max savings



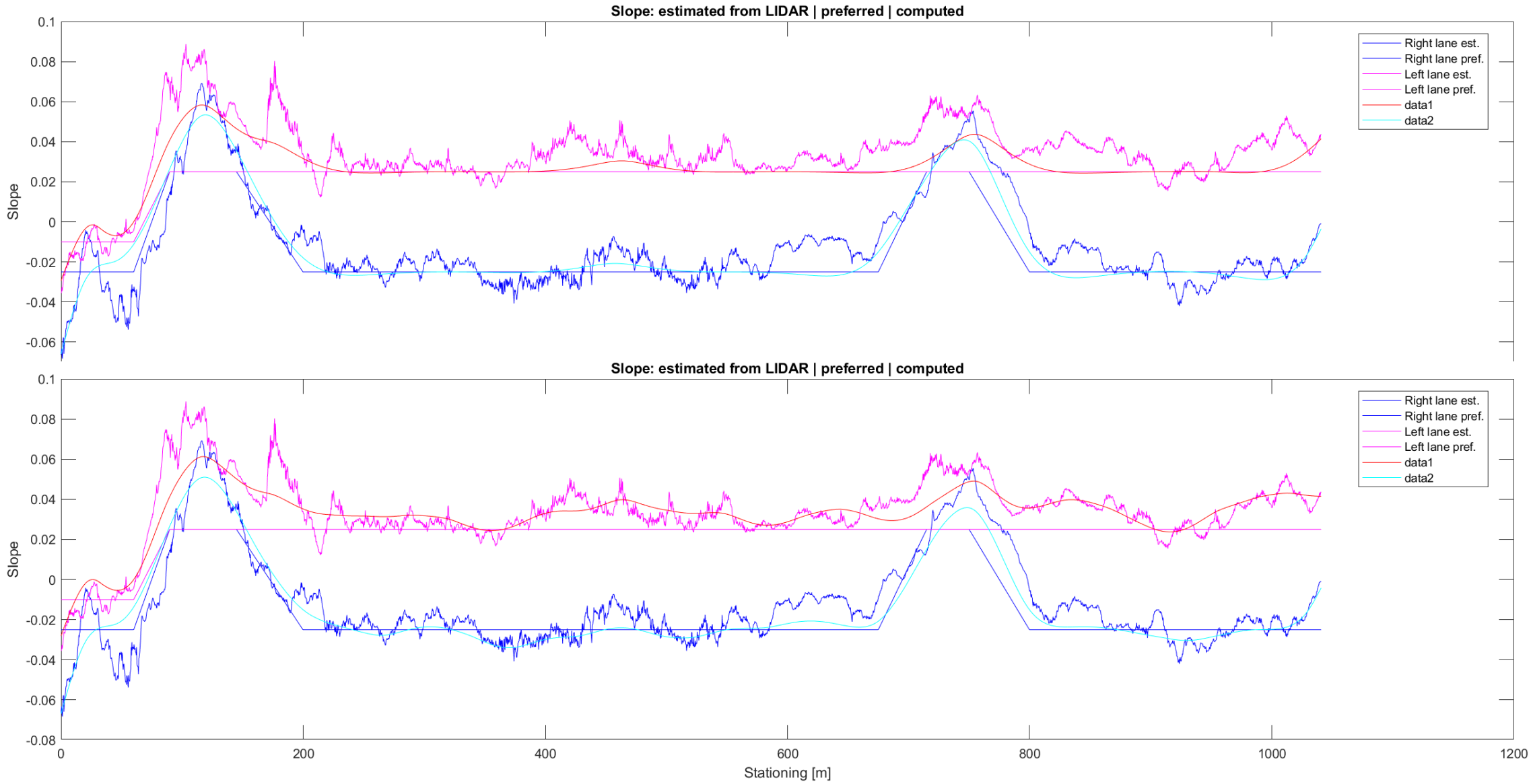
Cross slope changes in longitudinal ride – Best IRI



Cross slope changes in longitudinal ride – Max savings

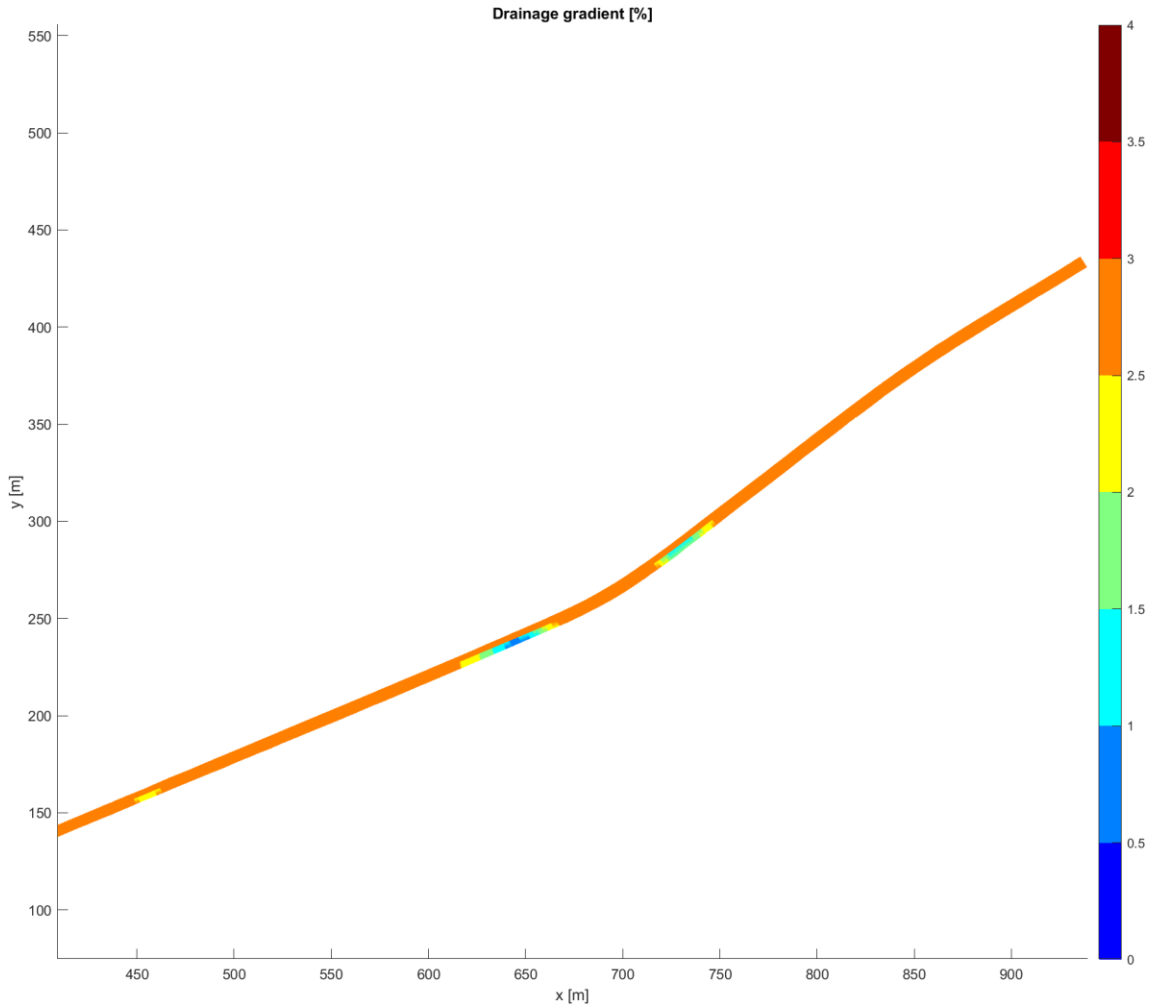


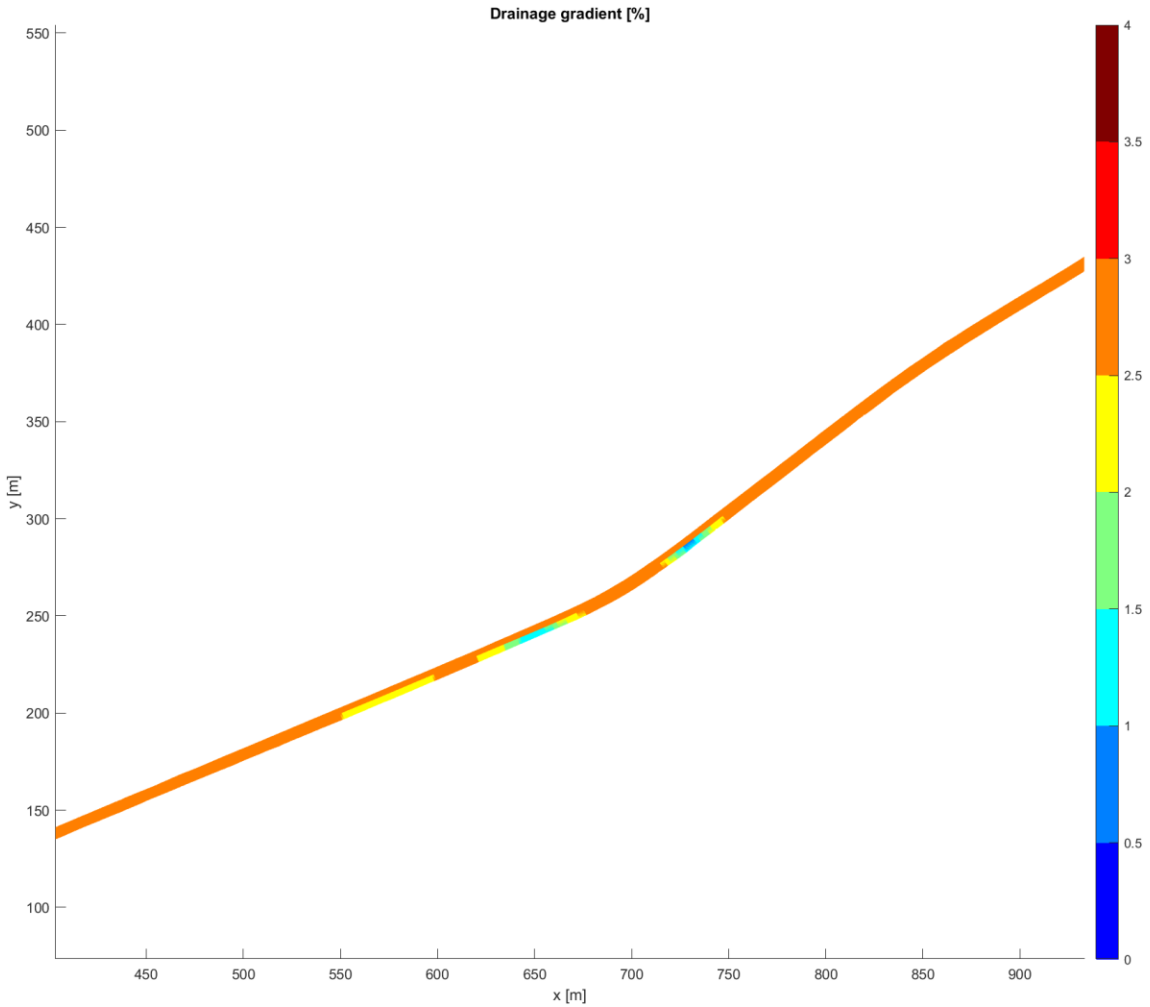
Road II/359 Dolni Ujezd – Osik: Cross-slope overview



Passion for precision

Road II/359 Dolni Ujezd – Osik: Drainage analyses

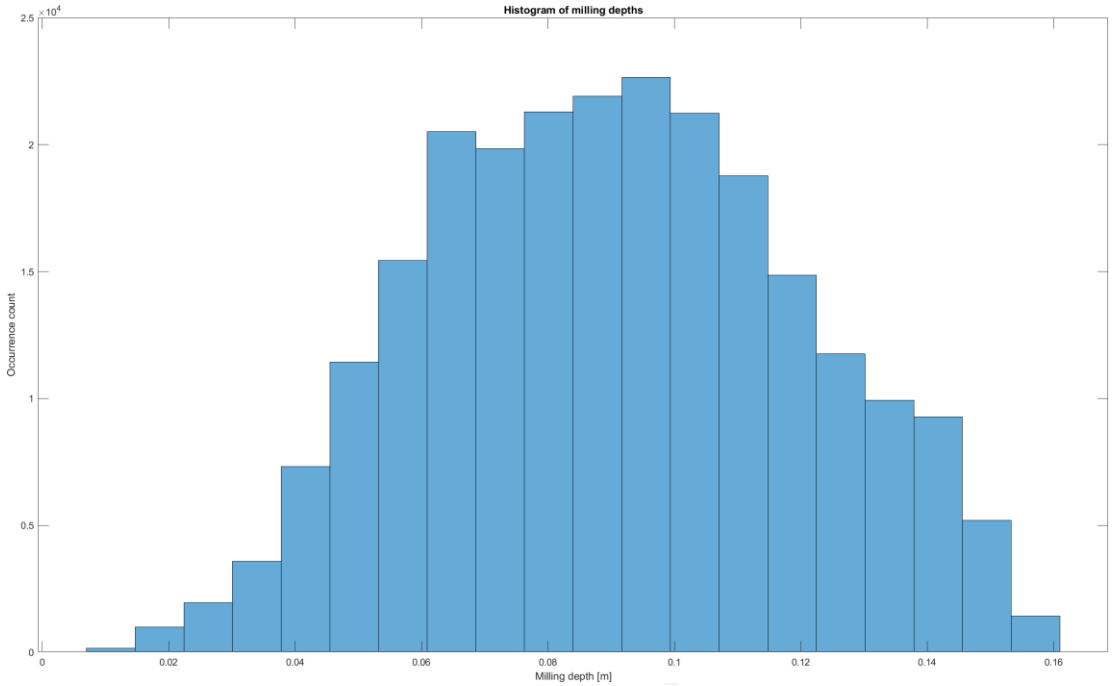




Road II/359 Dolni Ujezd – Osik:

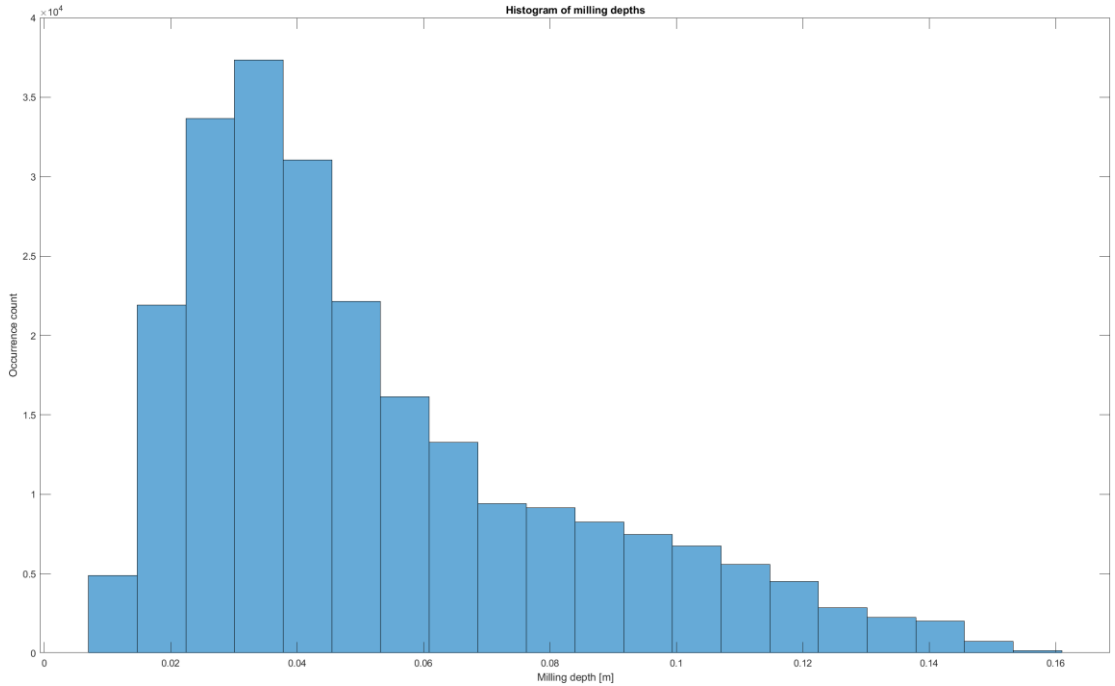
Volume Histogram:

Mean milling depth: 0.091 m
Volume: 695 m3



Best smoothness (IRI)

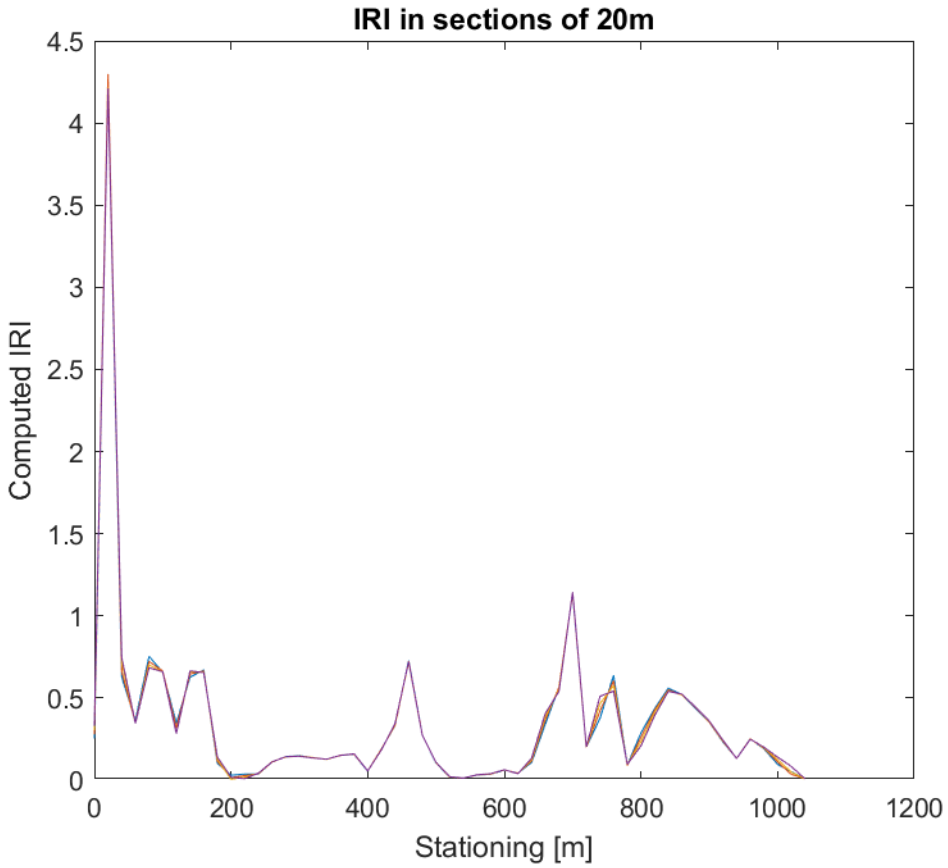
Mean milling depth: 0.053 m
Volume: 400 m3



Max. saving (milled asphalt)

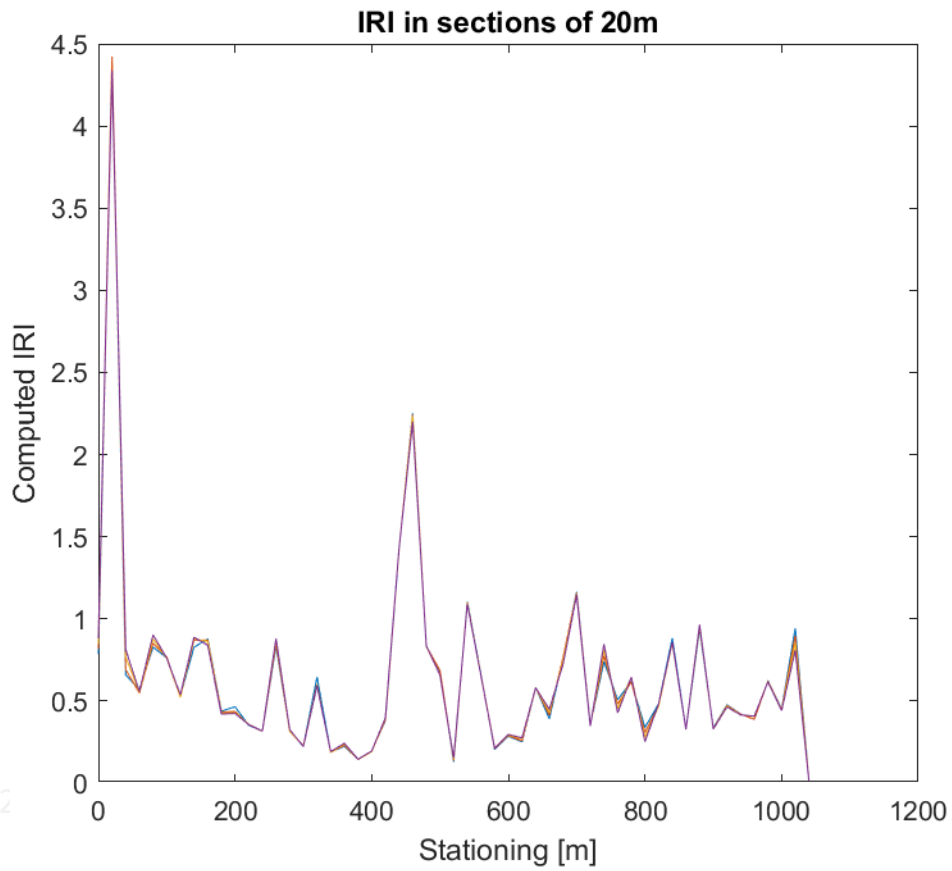
Road II/359 Dolni Ujezd – Osik: IRI analyses

Mean IRI: 0.35



Best smoothness (IRI)

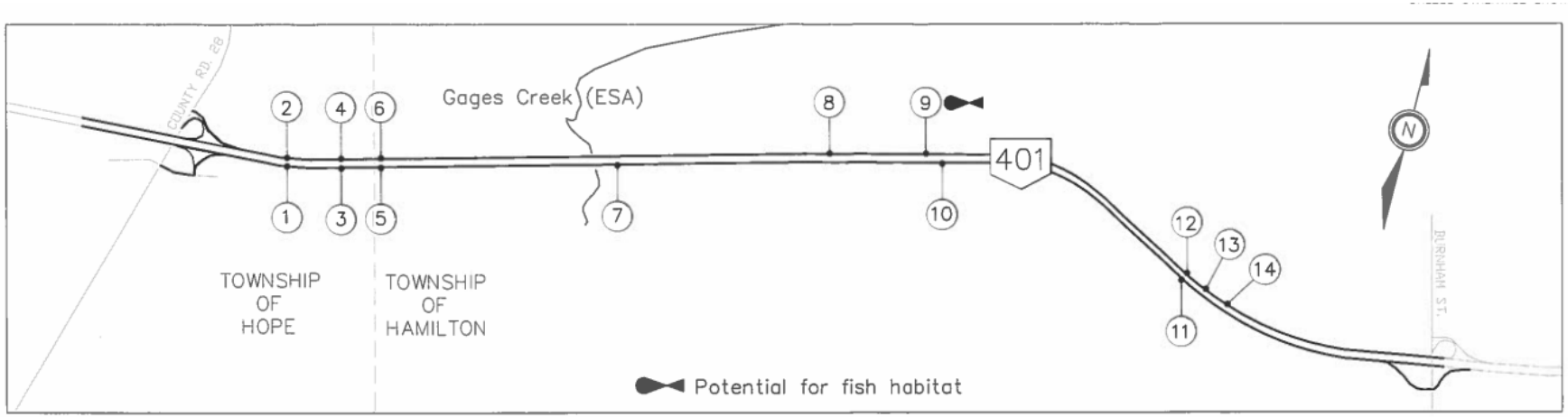
Mean IRI: 0.65

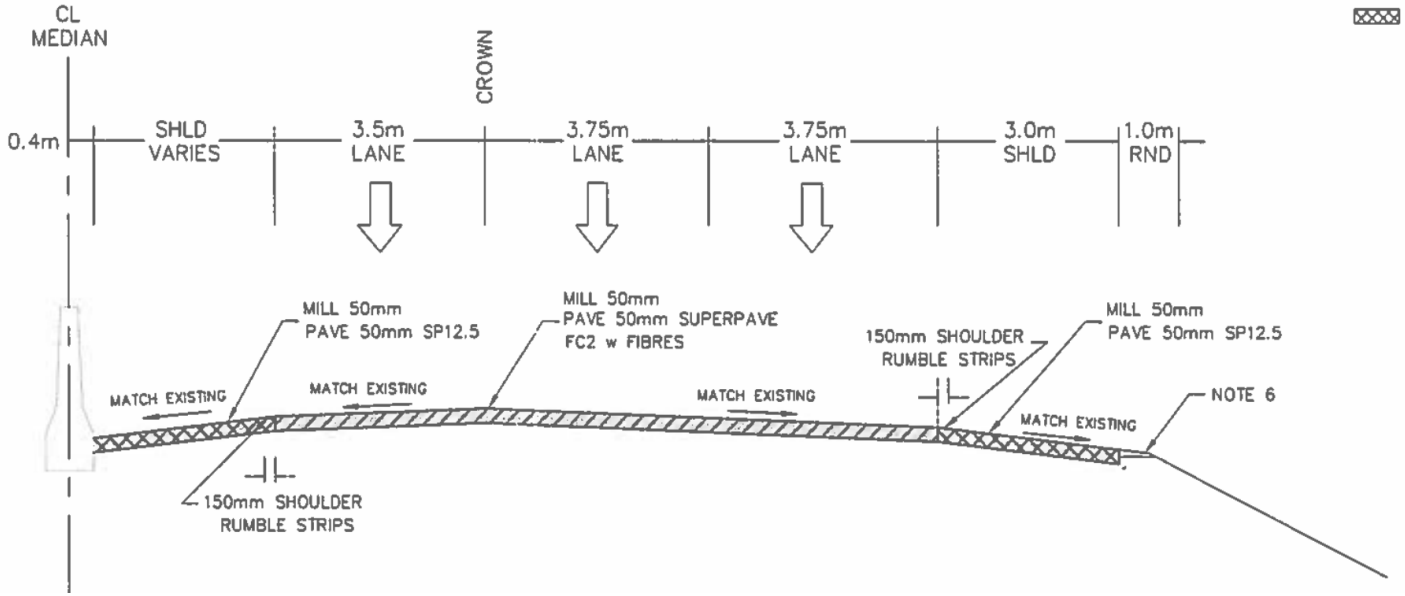


Max. saving (milled asphalt)

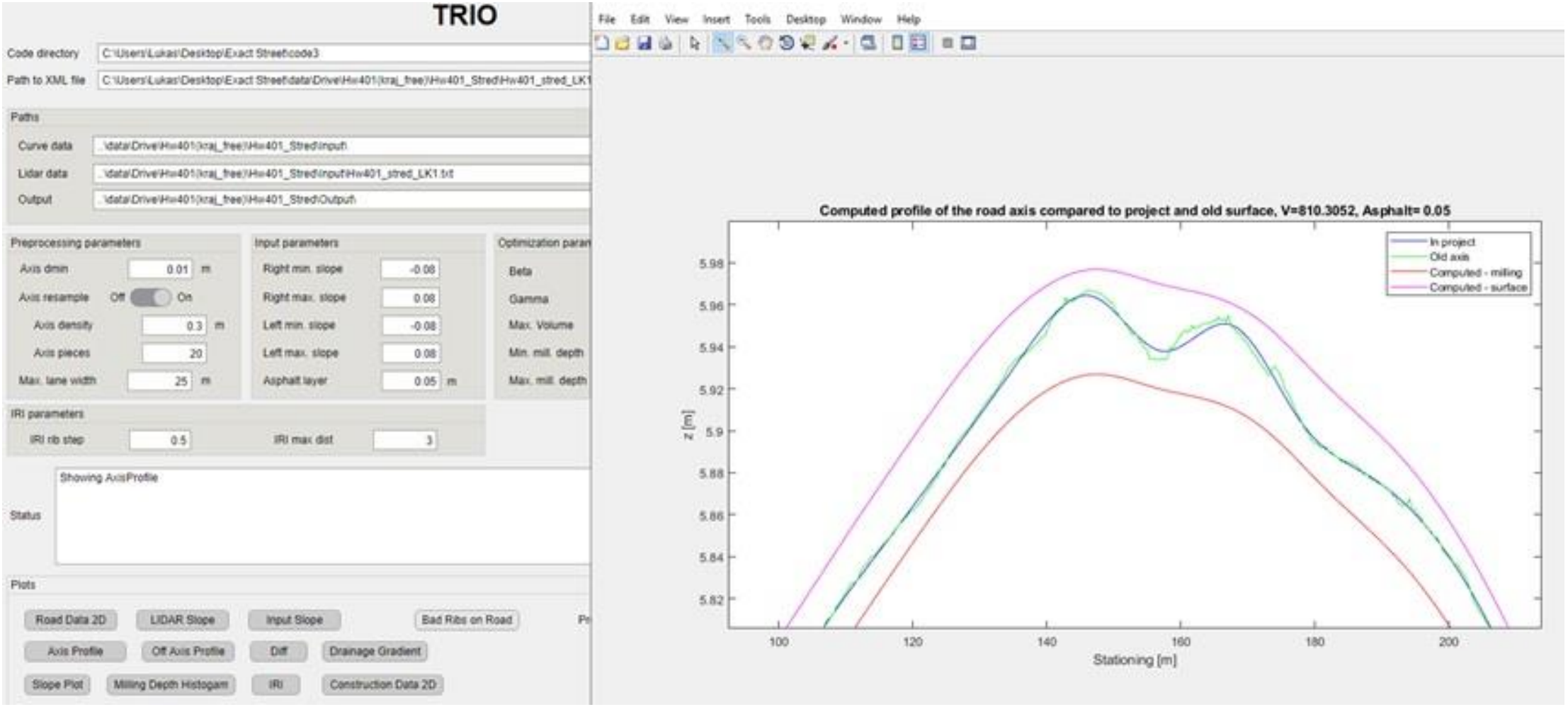
Passion for precision

Hwy 401 Port Hope - Cobourg



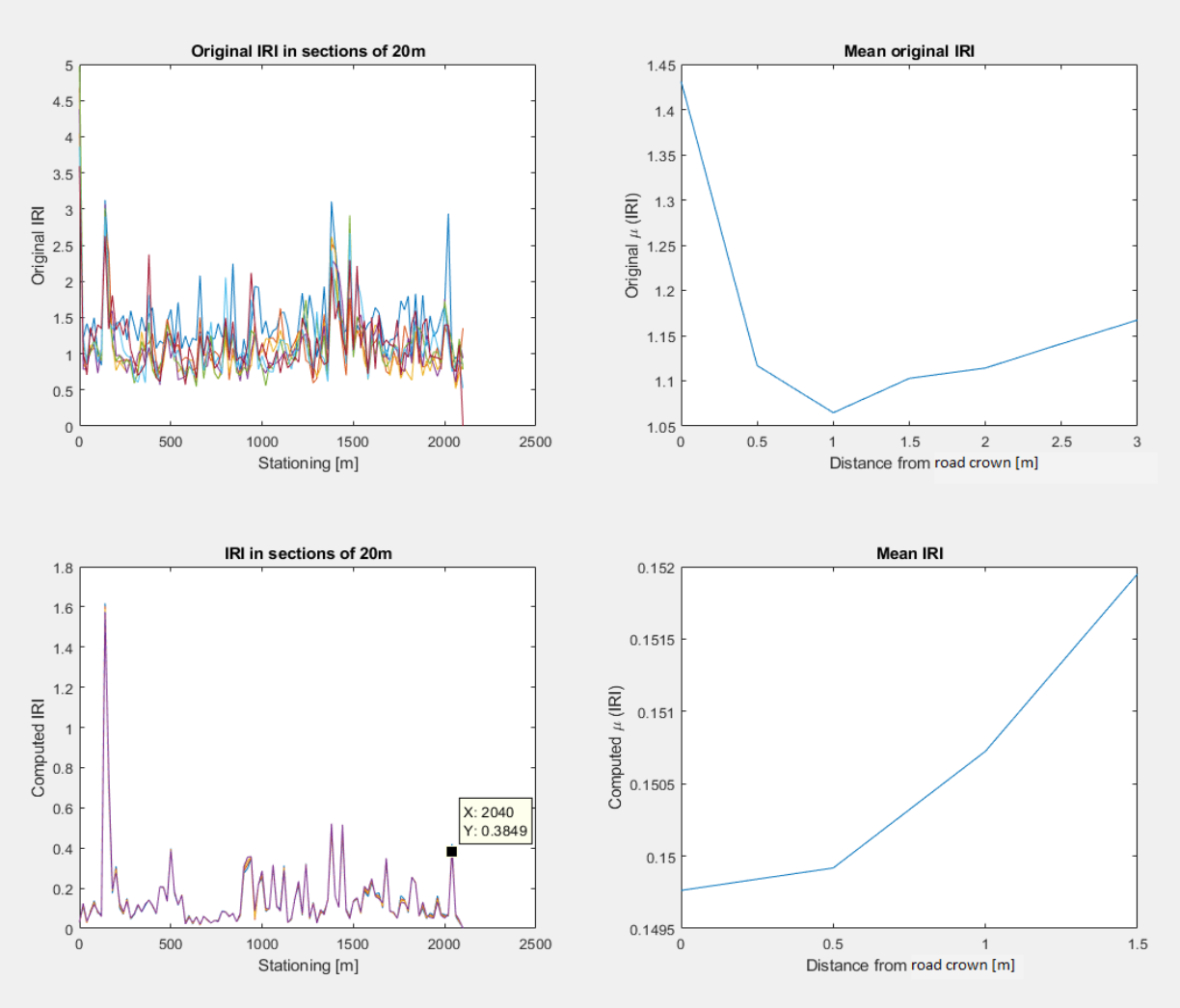


Hwy 401 Port Hope - Cobourg



Passion for precision

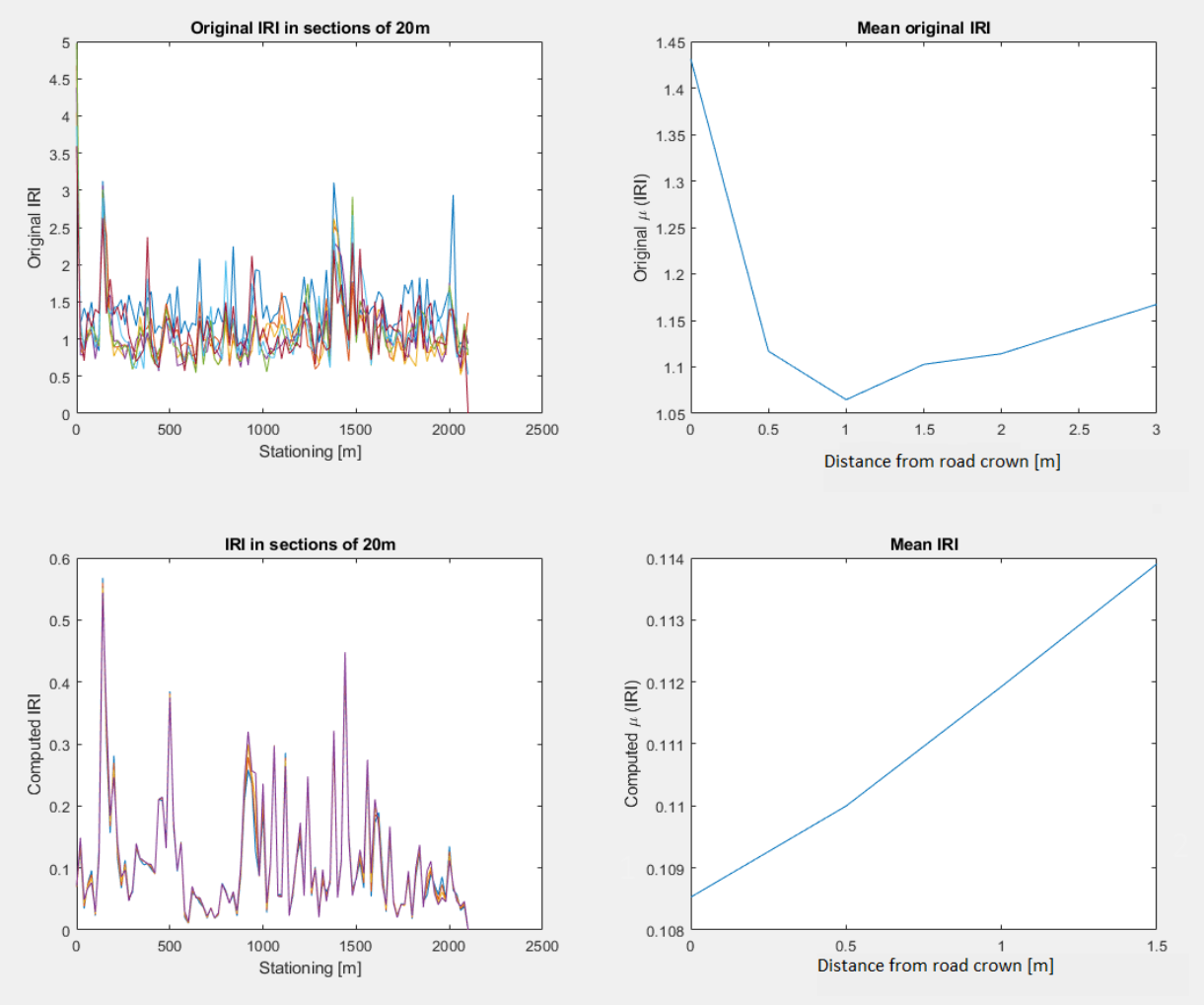
Hwy 401 Port Hope - Cobourg



Average existing road IRI was around 1.2 with extremes over 3
Our new road design average IRI is 0.15
Maximum new rod design IRI is 1.6 (section 140m from beginning of our scanning)
Material saving is 20% (average milling dept 40mm)

Passion for precision

Hwy 401 Port Hope - Cobourg

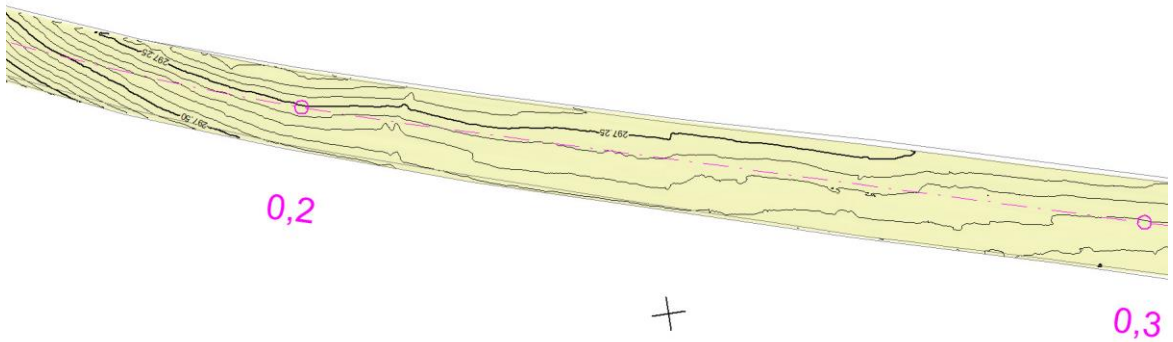


Average existing road IRI was around 1.2 with extremes over 3
Our new road design average IRI is 0.15
Maximum new rod design IRI is 1.6 (section 140m from beginning of our scanning)
Material saving is 20% (average milling dept 40mm)

Average existing road IRI was around 1.2 with extremes over 3
Our new road design average IRI is 0.11
Maximum new rod design IRI is 0.58
Material saving **is 36%** (average milling dept 33mm)

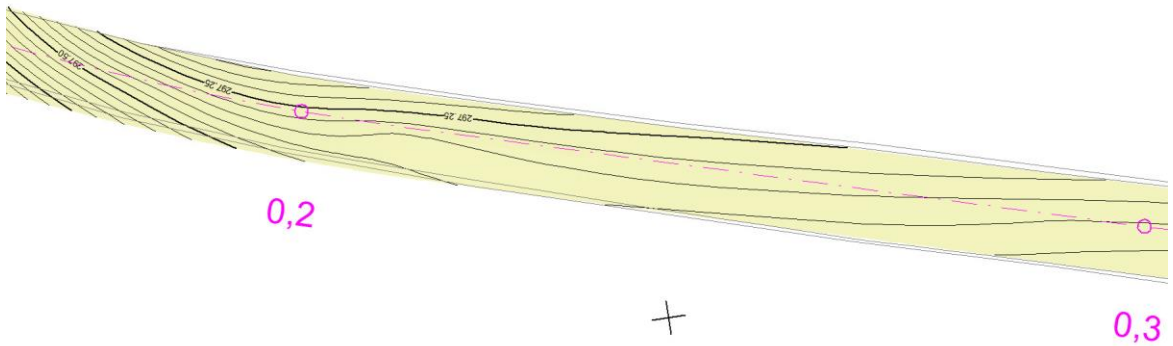
Post-processing I. Reality model

(Kunraticka; Region Prague, Czech Republic)



Post-processing II. Construction model
Manual design

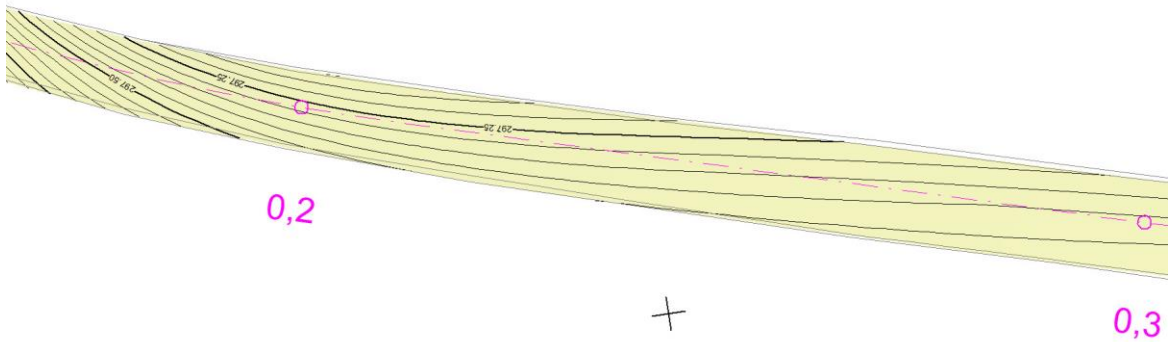
(Kunraticka; Region Prague, Czech Republic)



Post-processing II. Construction model

Automatic design – EXACT

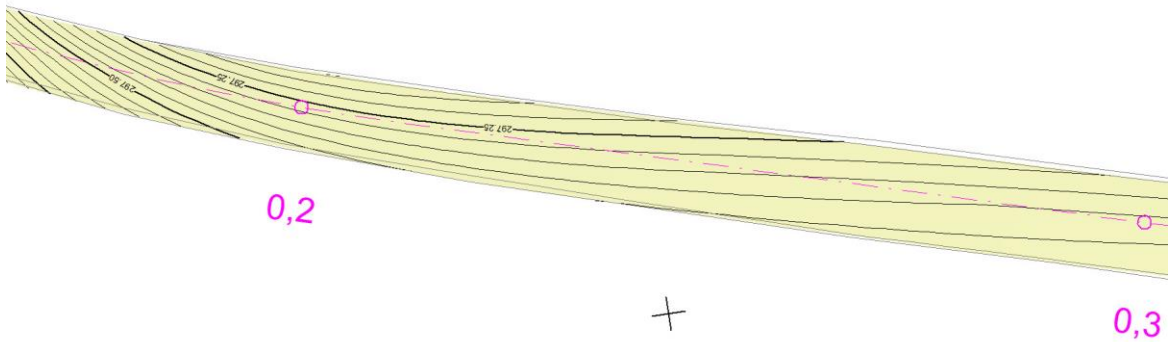
(Kunraticka; Region Prague, Czech Republic)



Post-processing II. Construction model

Automatic design – EXACT

(Kunraticka; Region Prague, Czech Republic)

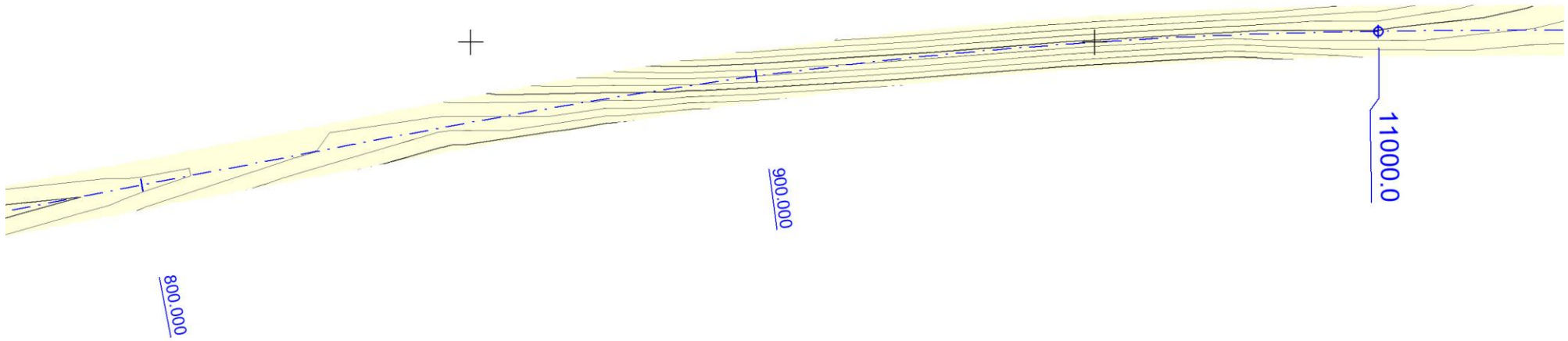


	Milled material [m3]	Saving	IRI
Constant dept milling	840	0	
Skanska AutoCAD Civil Design	796	5%	0,51
Exact Street Automated Design	687	19%	0,24

Post-processing II. Construction model

Manual design – MTO

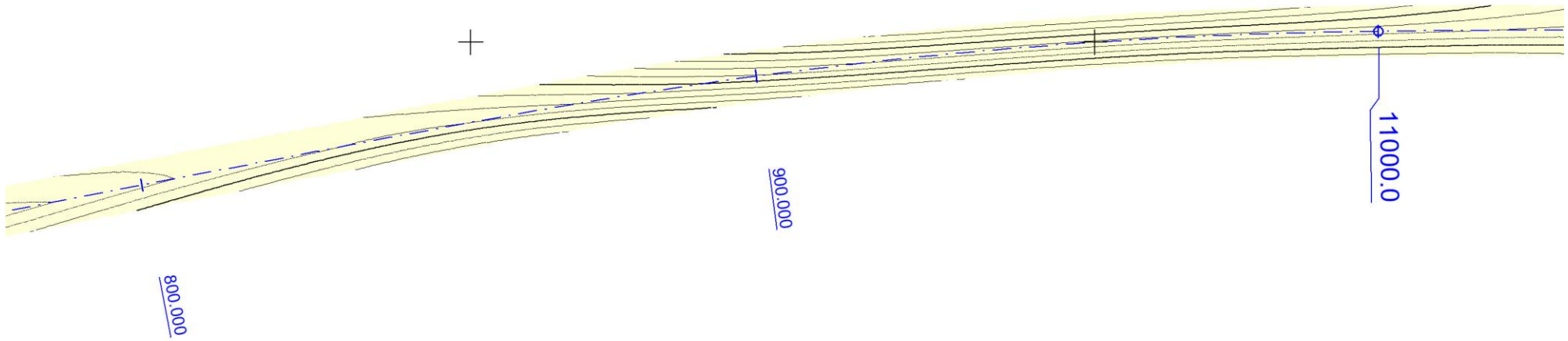
(Hwy11 STA 10.300 – 11.300; ON, Canada)



Post-processing II. Construction model

Automatic design – EXACT

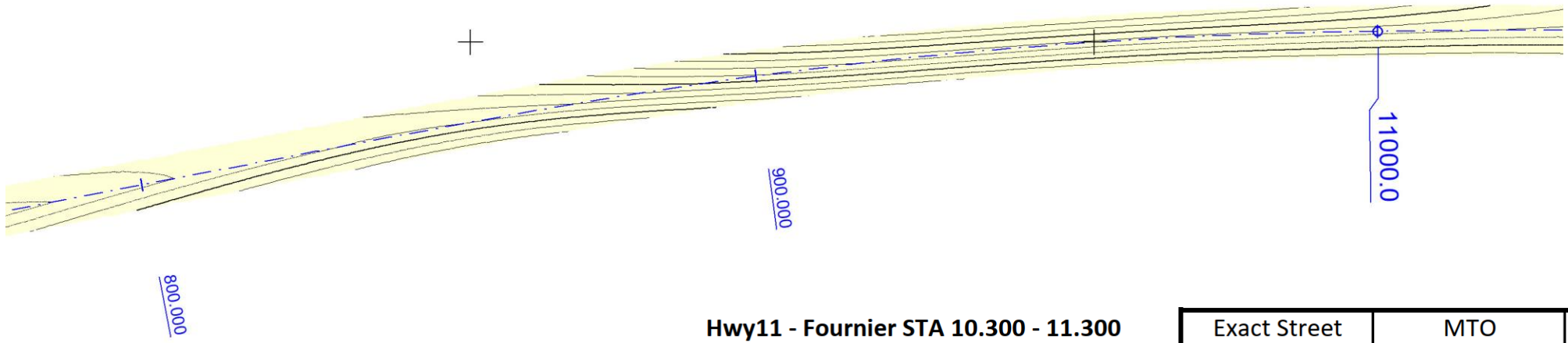
(Hwy11 STA 10.300 – 11.300; ON, Canada)



Post-processing II. Construction model

Automatic design – EXACT

(Hwy11 STA 10.300 – 11.300; ON, Canada)



Hwy11 - Fournier STA 10.300 - 11.300	Exact Street design (V1)	MTO design	MTO constant depth
IRI*:	0.53		
Surface [m2]:	8630 m^2	8630 m^2	8630 m^2
average milling depth [mm]:	47 mm	58 mm	60 mm
SUM [m3]:	409 m^3	505 m^3	518 m^3
Difference from MTO constant depth [m3]:	109 m^3	13 m^3	0 m^3
Saving [%]:	**22%**	**3%**	**0%**

**) IRI is calculated from projec design data*

Passion for precision

Benefits:
Road closure cost/saving

10% from:

(saving)

cost:

C$46 billions/ year

Toronto: 84 hours in traffic / year

Tax loss from incomes, loss of wages or lost profit, higher fuel costs and increased car wear, damages caused by delays, e.g. expenses of companies when goods arrive late or when somebody misses their ride or plane. This also includes health and psychological problems

$53 billions / year

Los Angeles: 90 hours in traffic / year

$750 billions / year

Germany: 8 days in traffic / year

Road life time benefit

LTPP – Long Term Pavement Performance

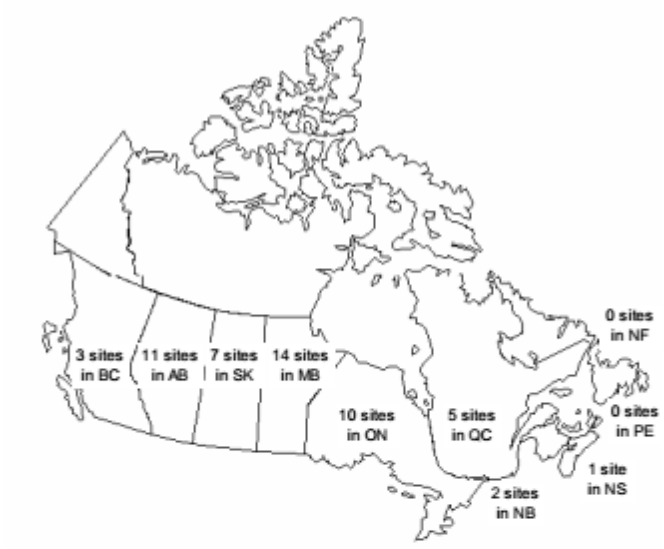


Figure 1. Distribution of LTPP test sites.

Table 1. LTPP test site identification numbers.

BC	AB	SK	MB	ON	QC	NB	PE	NS	NF
82-1005	81-502	90-6405	83-502	87-1620	89-1021	84-1684		86-6802	
82-6006	81-503	90-6410	83-503	87-1622	89-1125	84-6804			
82-6007	81-504	90-6412	83-504	87-1680	89-1127				
	81-505	90-6420	83-505	87-1806	89-9018				
	81-506	90-6801	83-506	87-2811	89-A310				
	81-507	90-A310	83-507	87-2812					
	81-508	90-B310	83-508	87-A310					
	81-509		83-509	87-A311					
	81-1804		83-3802	87-B310					
	81-1895		83-6450	87-B311					
	81-8529		83-6451						
			83-6452						
			83-6454						
			83-A310						

12 years longevity
=> 18 years

+50%

LONGEVITY

Who Benefits? People …

- Drivers – higher comfort and safety, lower costs … (remember closures shorter by 30%?)

- **Government budgets** and therefore **tax payers** – savings in construction and repairs spending (**more efficient spending**)

- Everyone, including future generations – better environment