

Use Case of the Concept and Detailed Design Approach proposed by PIANC InCom WG 141

Navigability of class Va vessels on the Nimy-Blaton-Peronnes canal (CNBP) in Wallonia (Belgium)

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Study objective

- Main objective: assess navigability of class Va vessels (110m x 11.50m, draft 2.50m) on part of the Nimy-Blaton-Peronnes canal, between Pommeroeul and Maubray
 - Method : desktop study (WG141 concept design) followed by real-time navigation simulations (WG 141 detailed design)
- Simulations results give insights on the accuracy of (some of) the desktop study results



Project stakeholders

Client :

- SPW Mobility & Infrastructure (manager of Walloon waterways)



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l'Union européenne

Consultants:

- IMDC : project management, nautical desktop study
- Ghent University - Ships & Marine Technology / Flanders Hydraulics : real-time navigation simulations



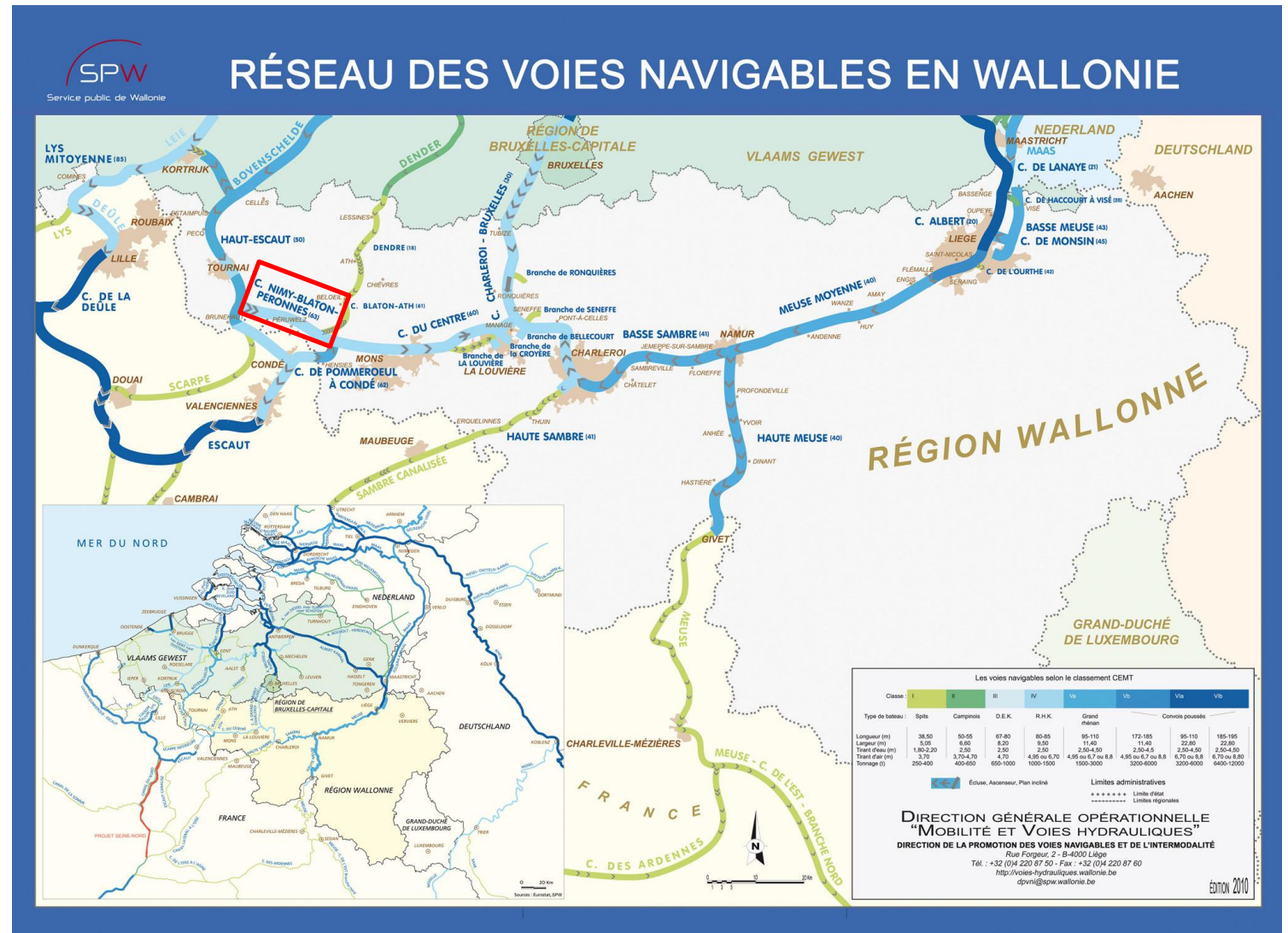
Flanders
Hydraulics



Flanders
State of the Art

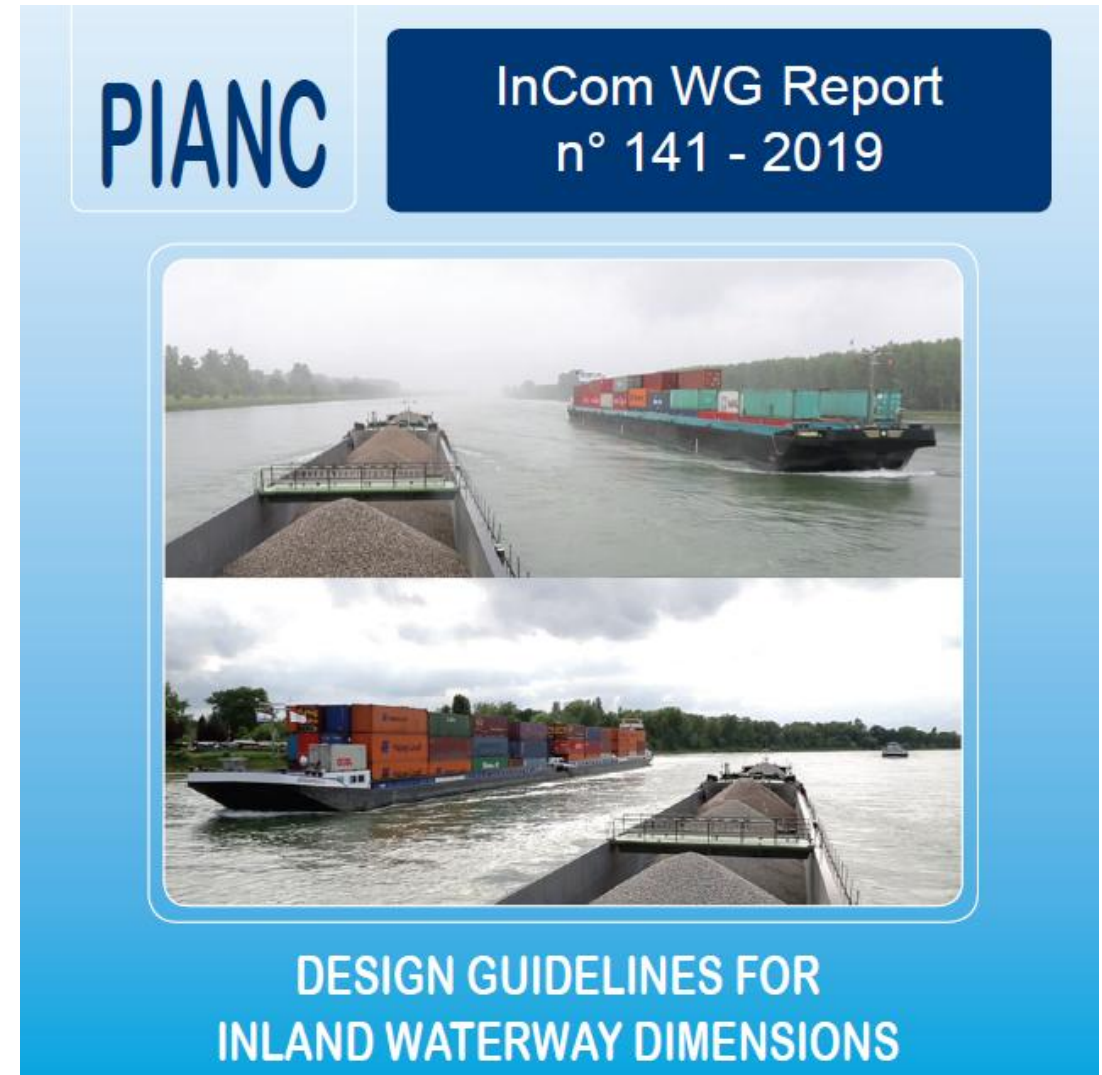
Nimy-Blaton-Peronnes Canal, Pommeroeul-Maubray Sector

- Length : 19.8 km
- Class IV waterway

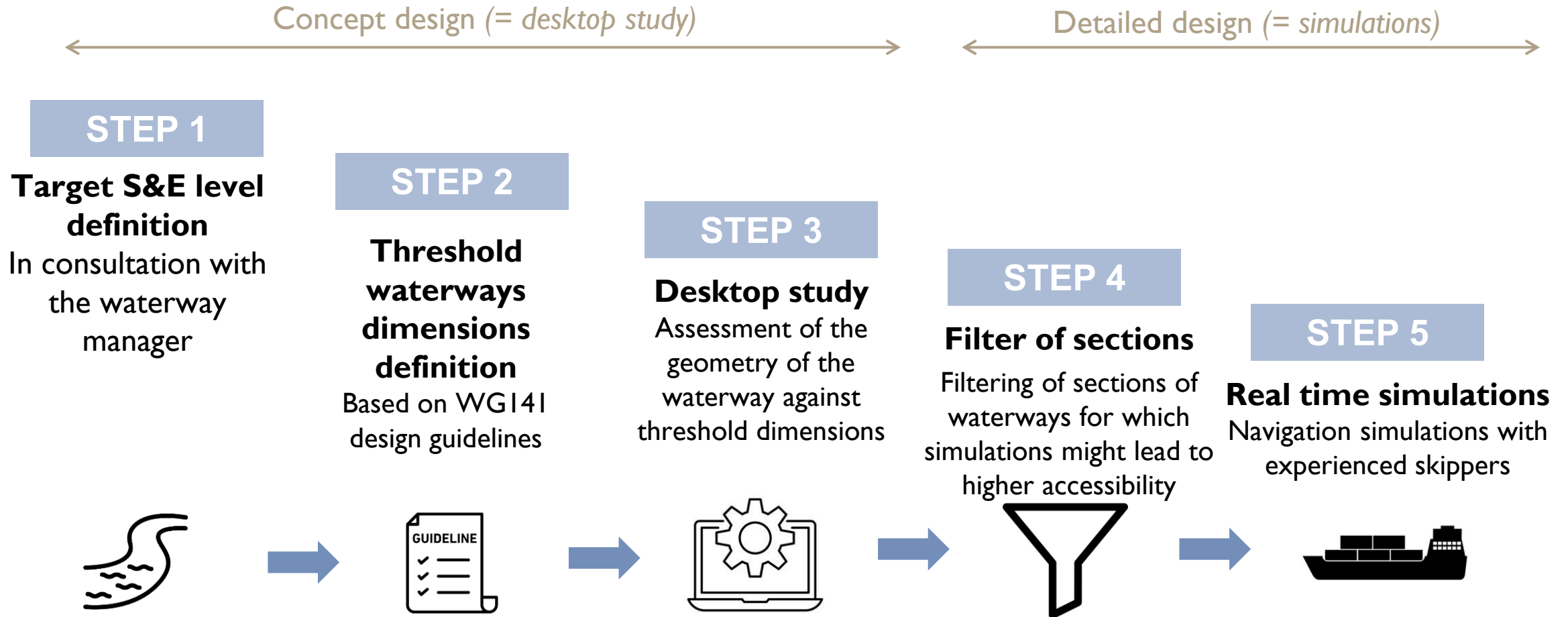


PIANC InCom WG I4I Design guidelines for inland waterway dimensions

- A standardized approach for inland waterway design
- Particularity valuable in Belgium (no national directive)
- Evidence based waterway dimensions for given Safety and Ease (S&E) level categories
 - Category A: unrestricted navigation
 - Category B: moderately restricted navigation
 - Category C: navigation with severe constraints



Study methodology



Definition of the target S&E level

- Used PIANC WGI4I questionnaire tool
- Scoring based on:
 - Waterway characteristics (e.g., presence of current, regularity of riverbanks, etc.)
 - Vessel/pilots characteristics (e.g., vessel equipment, pilot experience, etc.)
 - Expected traffic (e.g., # vessels/year, etc.)
 - Operational objectives (e.g. sailing speed)
- Scoring result: -0,1 to -0,2 points or category B “moderately restricted navigation”

Ease category (quality)	restrictions										
	almost no			moderate to strong				strong			
	A			B				C			
	easy sailing			not really easy easiness				tricky drive			
Score	+1.0	+0.8	+0.6	+0.4	+0.2	0.0	-0.2	-0.4	-0.6	-0.8	-1.0
	2/3			1/3				-1/3			-2/3

Criterion	Arguments speaking for a higher necessary ease score for design				Cases where a lower ease quality may be acceptable for design				Score			
	The score is +1, if the argument in the red coloured left column is true, it is -1, if the argument in the right green coloured column is true. The score is 0, if neither the left or right arguments are true, or both are true. Interpolate where appropriate.										Single	Group
1 st rating group: Waterway related criteria	1	Depth exploitation of waterway and type of load	Deep draught vessels, especially with dangerous goods in very shallow water (even after design as in free-flowing rivers at low water)	Empty or ballasted vessels, no dangerous goods, sufficient water depth (e.g. after design)						1/7	7/20 = 35%	
	2	Level of training, personnel skills and experience	Poorly trained pilots, low knowledge on waterway features and infrastructure	Optimally qualified and experienced helmsman						1/7		
	3	Attention level, distraction and stress	Long time or boring drive, permanent manoeuvring conditions	Short manoeuvre situation, e.g. during a meeting or by passing a bridge opening						1/7		
	4	Width exploitation of waterway, danger level, possible damages	Small space outside of the fairway to be designed, buildings, quay walls, floating facilities, vessel berths in vicinity of the navigational area, danger of life and limb in case of accidents	Sufficient space outside of the fairway to be designed, sloped banks, guiding walls, parallel dikes or short groynes besides the fairway						1/7		
	5	Uncertainty of waterway conditions	Turbulence, secondary currents, irregular banks, long groynes, rocky or stony river bed, often wind, fog	Regular shoreline, sloped sand or gravel banks, predominantly low wind speed or wind protections						1/7		
	6	Traffic situation, interaction vessel + bank	One-lane traffic, many manoeuvres as overtaking	2 or more navigational lines, accepted interaction forces						1/7		
	7	Vessel equipment and instrumentation	Main rudders only or weak bow thrusters, sea going ships, low engine power, no information systems	Strong powered bow thruster or passive bow rudder, high engine power, dual propellers, optimal information systems						1/7		
2 nd group: Vessel speed	Choose the score according to the numbers given below (in brackets) or interpolate.											
	8	Strived vessel speed over ground, individual drive	≥ 13 km/h (+1)	10-12 km/h (+0.5)	5-9 km/h (0)	< 4 km/h (-1)				2/4	4/20 = 20%	
9	Feasible speed range relative to water between v _{crit} and min. speed to ensure steerability	≤ 2 km/h (+1)	3-4 km/h (+0.5)	4-5 km/h (-0.5)	≥ 8 km/h (-1)				2/4			
3 rd rating group: Traffic density	Choose the score according to the values given in brackets below or interpolate.											
	10	Hindrance due to recreational boating, especially human powered such as rowing boats	Strong negative effect especially on possible average speed (+1)	Average hindrance of commercial navigation (0)				No significant influence on speed of freight vessels (-1)				4/9
11	Restriction of necessary speed reduction in case of high traffic density of commercial navigation	> 30,000 vessels per year (+1)	15,000-30,000 vessels per year (+0.5)	5,000-15,000 vessels per year (-0.5)	< 5,000 vessels per year (-1)				5/9			
Average (total) score: Sum of single scores (second last column), multiplied by the weighting factor (last column) =												

Define threshold dimensions for level B navigation

- Derived from WG 141 recommendations, with some small adjustments
 - Waterway cross section
 - Width at keel depth
 - Overwidths in bends, as function of R (*reduced overwidth in bends of small opening angle, no over width in bends of large R (R>10L)*)
 - Depth
 - Blockage ratio
 - Waterway axis
 - Radius of curvature
 - Length of straight line between two bends in opposite directions*
 - Bridges : opening width, clearance
 - Berthing places : layback

Waterway	Fairway width for alternate single-lane			Remarks	Fairway width for two-way (approximately also for two-lane, including overtaking manoeuvres)			Remarks
	Base quality				Base quality			
	C	B	A		C	B	A	
min W_F in draught depth (straight canal sections)	2-B ¹⁾ 1.9-B	2.1-B	2.3-B	For security reasons	3-B ²⁾ 2.8-B	4-B ³⁾ 3.5-B	4.5-B	2.5 B can damage the canal
min n	2.5	3.5	4.5	To maintain speed	3.5	5	7	To maintain speed
min h (over bottom width)		1.3 T	1.4 T	Because of squat & efficiency of bow thrusters		1.3 T	1.4 T	Because of squat & efficiency of bow thrusters
min R (ΔF needed for R $\neq \infty$)	4 L	7 L	10 L		4 L	7 L	10 L	
max v_{row} (longitudinal)	0.5 m/s				0.5 m/s			
max v_{cross} (averaged over L, ΔF needed for $v_{cross} \neq 0$)	0.3 m/s				0.3 m/s			
design v_w (inland) (ΔF needed for empty/ballasted or container vessels at $v_w \neq 0$)	5-6 BF (8.0-13.9 m/s; 10.5 m/s according to Dutch Guidelines)				5-6 BF (8.0-13.9 m/s; 10.5 m/s according to Dutch Guidelines)			
design v_w (costal) (ΔF needed for empty/ballasted or container vessels at $v_w \neq 0$)	6-7 BF (10.8-17.2 m/s; 13.5 m/s according to Dutch Guidelines)				6-7 BF (10.8-17.2 m/s; 13.5 m/s according to Dutch Guidelines)			

Waterway width, blockage factor, depth, minimum radius, etc.

Waterway	Bridge opening single-lane			Remarks	Bridge opening two-way			Remarks
	Base quality				Base quality			
	C	B	A		C	B	A	
min W_B	2-B	2.2-B	2.4-B	Minimum safety margin 5.0 m	3.2-B	4.0-B	4.8-B	Minimum safety margin 5.0 m
min H_B	1.0 H + s			Add minimum safety margin s = 0.3 m	1.0 H + s			Add minimum safety margin s = 0.3 m

Remark: It will be generally assumed that the pilots sail very carefully and will reduce speed while passing the bridge opening

Bridge opening

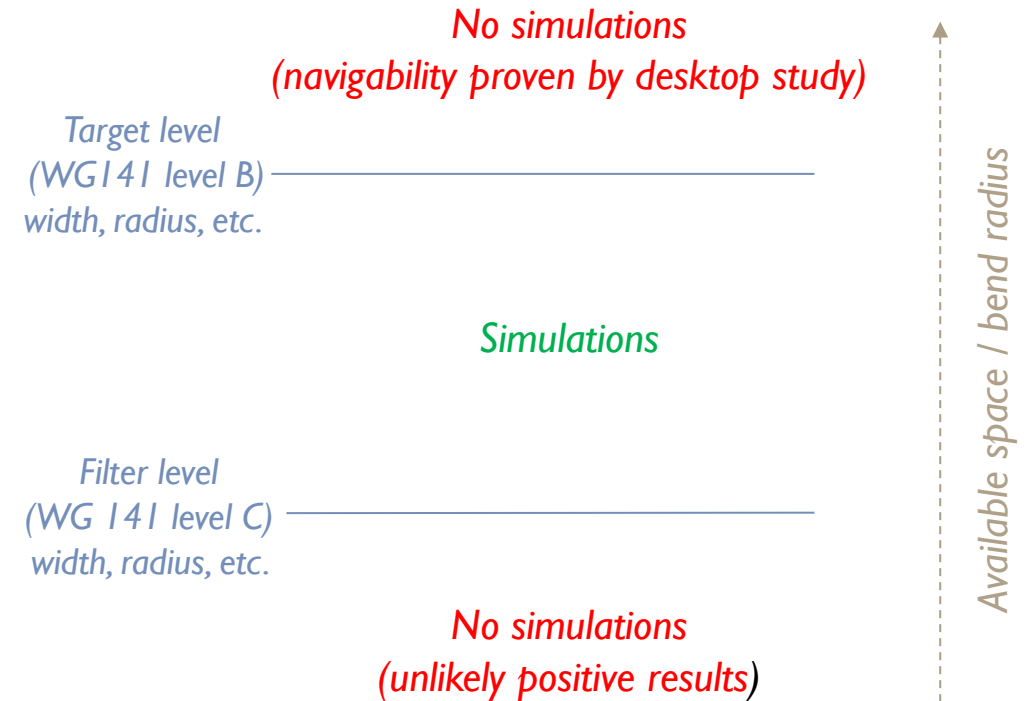
Define threshold dimensions for level B navigation

- Defined for single lane (Va), 2-way (Va/Va) and hybrid (Va/IV) crossing

	Waterway								
	Cross section						Axis		
	Width in straight line [m]			Over width, coef C_c [-]			Blockage ratio single lane* [-]	Minimum curve radius [m]	Min. length straight line between curves in opposite directions [m]
	Single lane (Va)	Hybrid crossing (Va/IV)	Two-way (Va/Va)	Single lane (Va) (L = 110 m)	Hybrid crossing (Va/IV) ($L_{avg} = 97,5$ m)	Two-way (Va/Va) (L = 110 m)			
Traget S&E level (WG 141 S&E B)	24,2	36,8	40,3	0,6 with overwidth reduction if opening <30°, no overwidth if R>10L	0,9 with overwidth reduction if opening <30°, no overwidth if R>10L	0,9 with overwidth reduction if opening <30°, no overwidth if R>10L	3,5	770	165**
	(2,1 B)	(3,5 B_{avg})	(3,5 B)					(7 L)	(1,5 L)**

Selection of sections to be studied with simulator

- Simulations are relatively expensive and time consuming
 - Need to rationalize the usage of simulators
 - Introduction of a “filter level” (set of smaller threshold dimensions) under which it is believed that navigation is impossible.
- Selected filter level is ~ PIANC level C (highly constrained navigation)



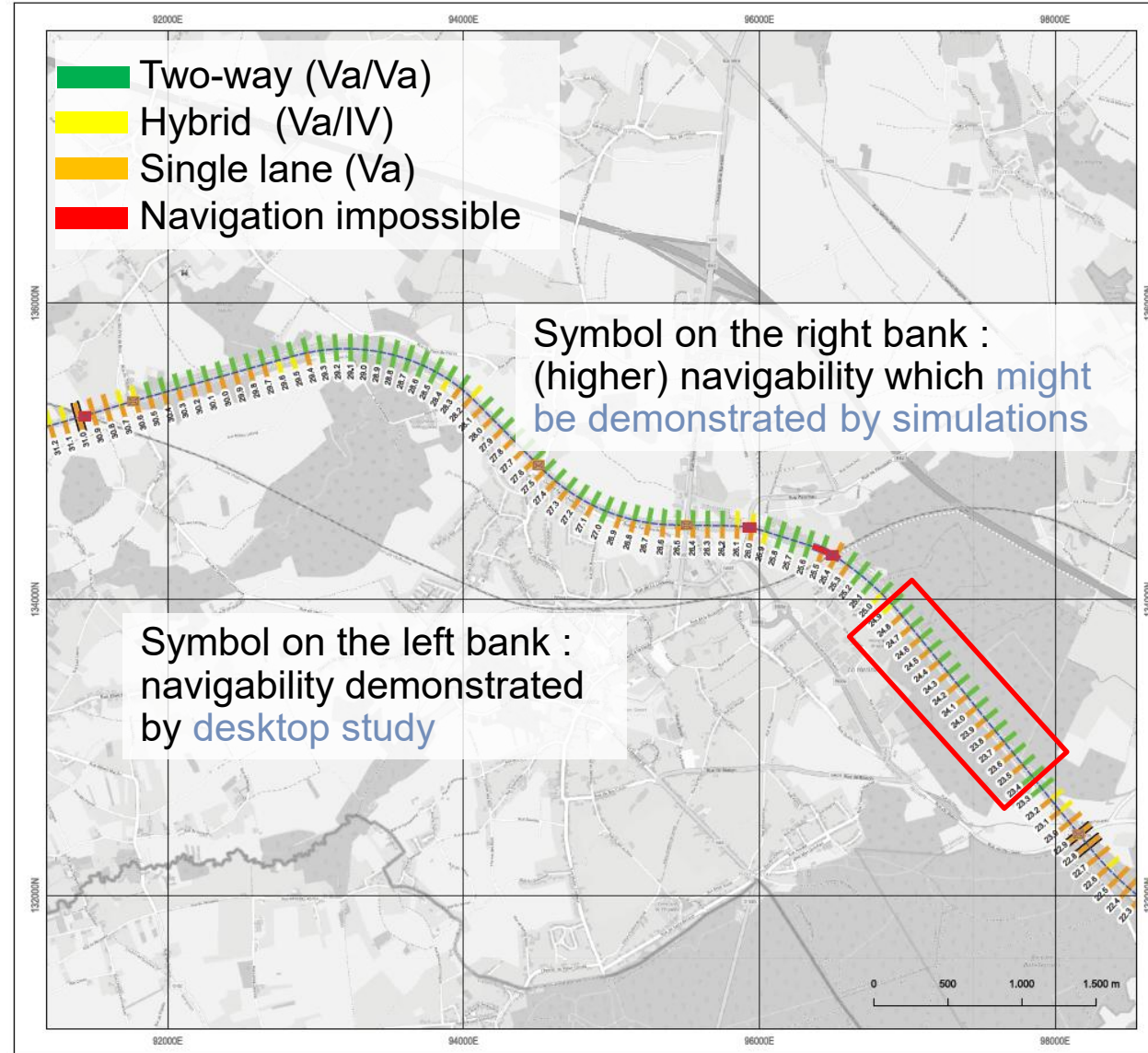
Selection of sections to be studied with simulator

	Waterway								
	Cross section							Axis	
	Width in straight line [m]			Over width, coef C_c [-]			Blockage ratio single lane* [-]	Minimum curve radius [m]	Min. length straight line between curves in opposite directions [m]
	Single lane (Va)	Hybrid crossing (Va/IV)	Two-way (Va/Va)	Single lane (Va) (L = 110 m)	Hybrid crossing (Va/IV) ($L_{avg} = 97,5$ m)	Two-way (Va/Va) (L = 110 m)			
Traget S&E level (WG 141 S&E B)	24,2	36,8	40,3	0,6 with overwidth reduction if opening <30°, no overwidth if R>10L	0,9 with overwidth reduction if opening <30°, no overwidth if R>10L	0,9 with overwidth reduction if opening <30°, no overwidth if R>10L	3,5	770	165**
	(2,1 B)	(3,5 B_{avg})	(3,5 B)					(7 L)	(1,5 L)**
Filter level (~ WG 141 S&E C)	No filter level for single lane	29,3	31,9	No filter level for single lane	0,75 with overwidth reduction if opening <30°, no overwidth if R>10L	0,75 with overwidth reduction if opening <30°, no overwidth if R>10L	No filter level for single lane	No filter level for single lane	No filter level for single lane

Desktop study results

- Sampling and geometry check every 100 m

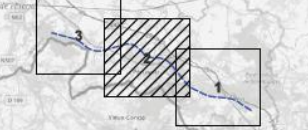
→ Homogeneous stretches identified for simulations





Etudes de navigation et de trajectographie sur le réseau navigable wallon
 Canal Nimy-Blaton-Péronnes, secteur Pommerou-Maubray : bateaux de 110 m
Navigabilité après études sur plan

Version	Date	Concept	Int



 Canal Nimy-Blaton-Péronnes, secteur Pommerou-Maubray_23-01-24
 Rapport no: WL2024R22_012_5 24/01/2024



Légende

 Ecluses





Analyse nautique de l'axe

 Axe adapté


 Axe inadapté

Analyse nautique des profils en travers




Largeur disponible à la quille

 Double sens (Va/Va) Gauche de l'axe (sens avalant): navigabilité garantie
 Alternat sélectif (Va/IV) Droite de l'axe (sens avalant): navigabilité à étudier
 Alternat strict (Va)
 Navigation impossible (Va)

Facteur de blocage

 Facteur de blocage insuffisant pour l'alternat strict

Analyse nautique des ponts, viaducs et passerelles

 Double sens (Va/Va)
 Alternat sélectif (Va/IV)
 Alternat strict (Va)
 Navigation impossible (Va)
 Piles hors de la voie d'eau

Real time navigation simulations

- SIM225 / Lara simulators of Flanders Hydraulics
 - Realistic wheelhouse environment with full controls
 - Mathematical models based on physical tests
 - Coupled simulations for study of crossings
 - Bank effects and vessel interaction modelling
- Skippers with experience on the Walloon network



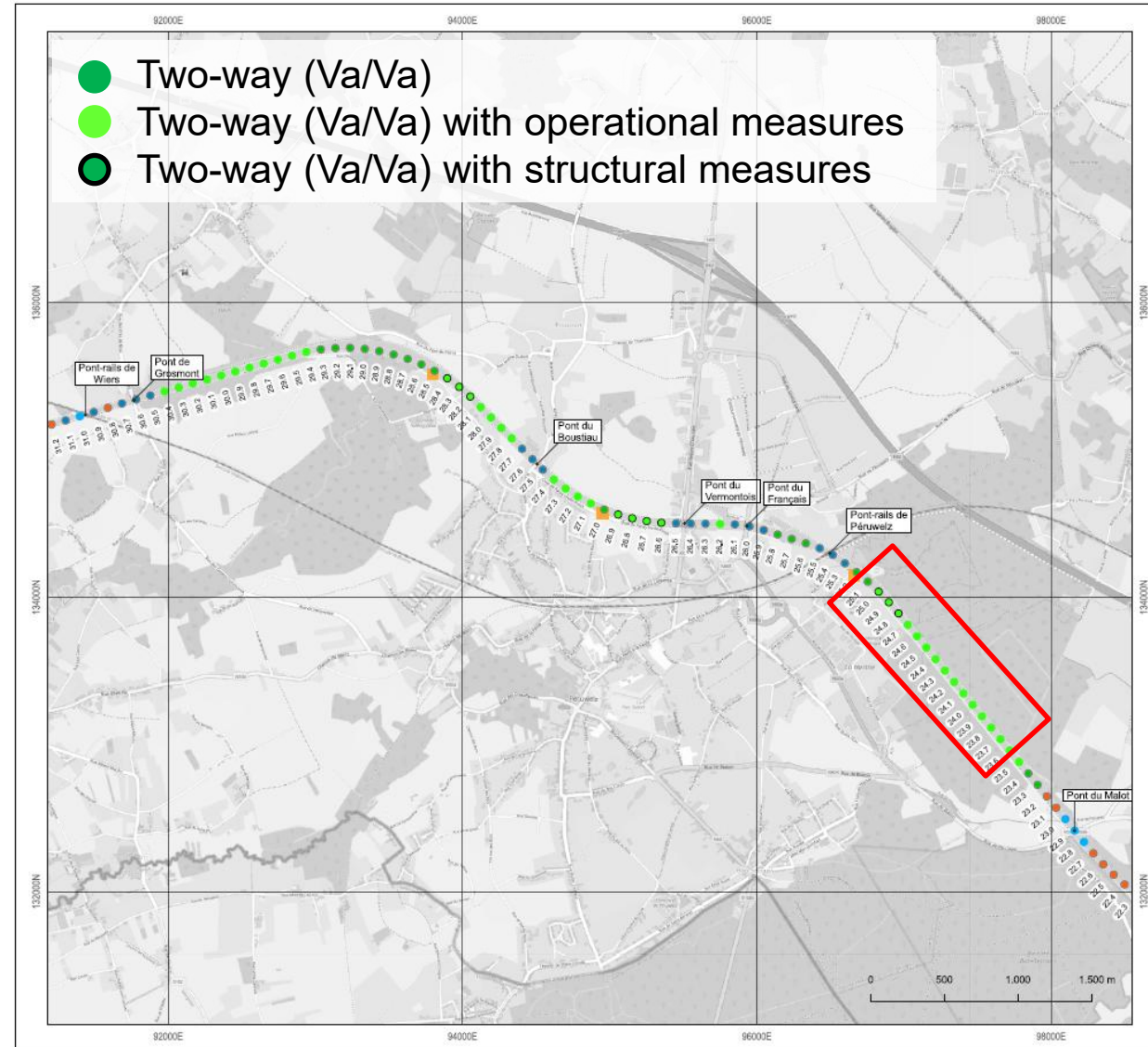
SIM225 simulator



Lara simulator

Simulations results

- Result map
- Includes recommendations of measures to improve navigability
 - Operational measures: mostly speed reduction
 - Light structural measures: mostly maintenance dredging



- Two-way (Va/Va)
- Two-way (Va/Va) with operational measures
- Two-way (Va/Va) with structural measures

Etudes de navigation et de trajectographie sur le réseau navigable wallon
Canal Nimy-Blaton-Péronnes, secteur Pommeroeul-Maubray : bateaux de 110 m

Navigabilité réelle après simulations de navigation

Version	Date	Concept	Int

Canal Nimy-Blaton-Péronnes, secteur Pommeroeul-Maubray, SdN_23-01-24
Rapport nr: WL2024R22_012_5 27/02/2024

Légende

- Ecluses
- Navigabilité quais inoccupés**
- Double sens Va-Va
- Double sens Va-Va après mesures d'exploitation
- Double sens Va-Va après mesures structurelles
- Alternat sélectif Va-IV
- Alternat sélectif Va-IV après mesures d'exploitation
- Alternat strict Va
- Alternat strict Va après mesures d'exploitation
- Alternat naturel Va (pont)
- Alternat naturel Va (pont) après mesures
- Navigation impossible Va
- Navigabilité quais occupés**
- Alternat Va
- Alternat Va après mesures

POST ANALYSIS OF THE DESKTOP STUDY RESULTS

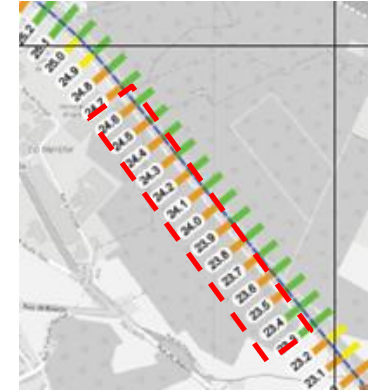
Post-analysis of the results of the desktop study

Validity of the guaranteed navigability results

Simulation results without operational/light structural measures

E.g. single lane :

- Desktop study : 28 sections single lane (Va) with potential for higher navigability
 - Simulations results :
 - 26 sections unchanged
 - 2 sections with two-way (Va/Va) traffic possible (desktop study underestimated navigability)



Good results also for sections with “impossible navigation”, not enough cases for other scenarios (Va/IV)

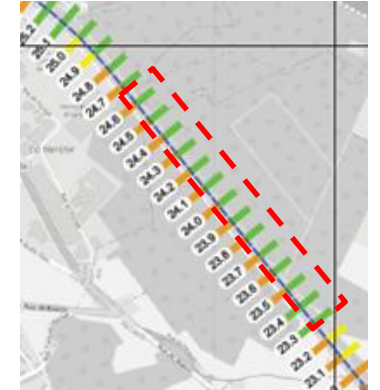
Post-analysis of the relevance/efficiency of the methodology

Quality of the filtering of sections to be simulated

Simulations results including operational/light structural measures

E.g., single lane :

- Desktop study : 28 sections single lane (Va) with potential for higher navigability
 - Simulations results :
 - 5 sections need further analysis
 - 2 sections with two-way (Va/Va) traffic possible (without the need of measures)
 - 14 sections with two-way (Va/Va) traffic possible if measures are put in place
 - 7 sections unchanged (simulations did not improve navigability in 30% of cases)
- (simulations helped improve navigability in 70% of cases)



Conclusion

- Good validity of the results of the desktop study according to simulations results
- Good filtering of the sections to be simulated. Filter level could have been slightly “higher”
- WG I4I S&E level B is a relevant choice for Walloon waterways as desktop studies results match the expectations of skippers sailing on the network
- Applicability is good for Walloon waterways, but would be interesting to test it in other locations/conditions (e.g., North/South America, Asia, etc.)



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ENGIE

Questions & discussion

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