HYDRAULICS IN THE WATERSHED

OR… HOW TO CARRY ON FROM, OR WITH, PRIOR EFFORTS

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ACKNOWLEDGEMENTS

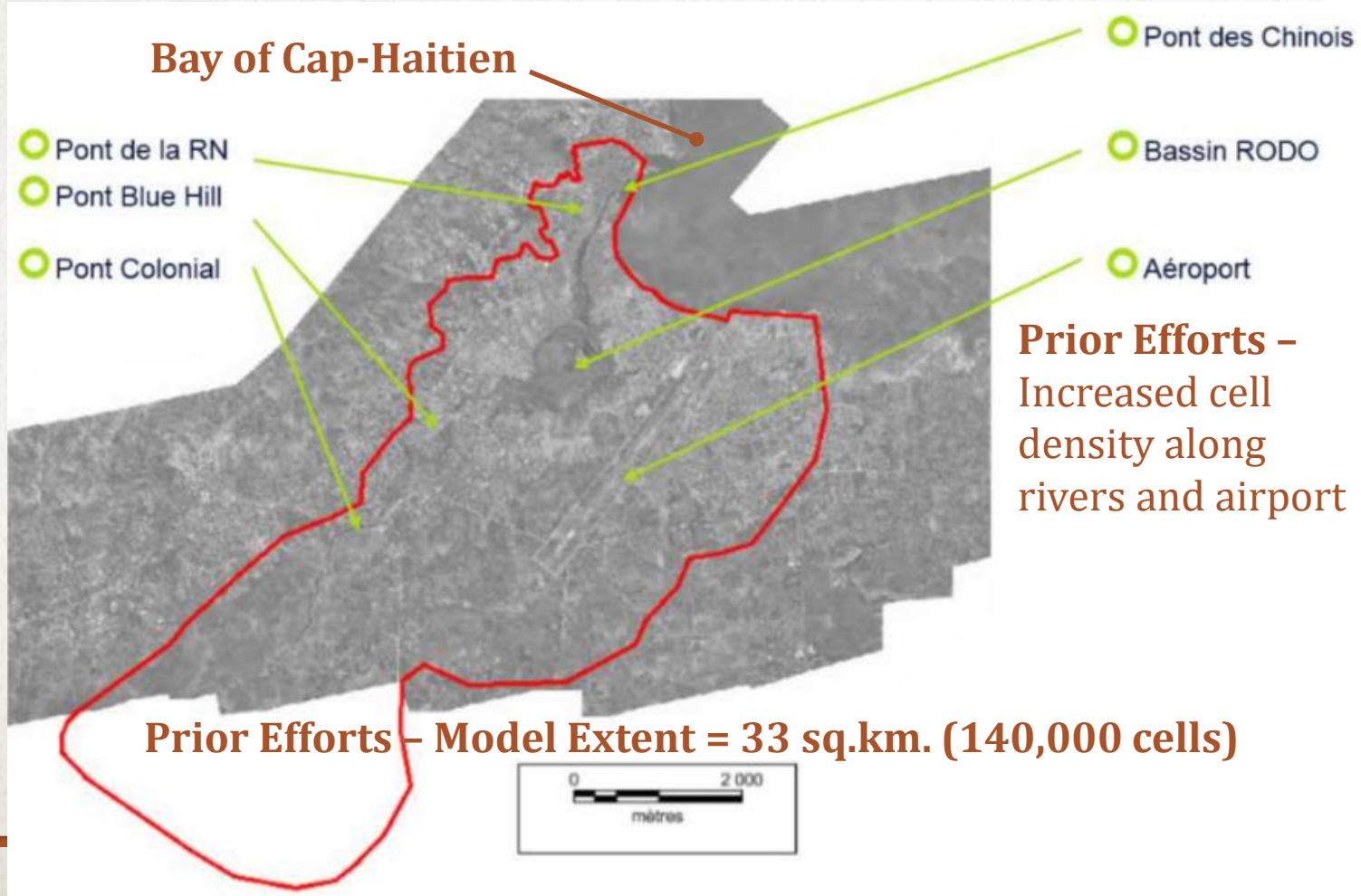
- V3 Companies – Thank you for a place to practice the science and art of Engineering
- IAFSM – Thank you for the opportunity to present a few thoughts…

IAFSM
Illinois Association for Floodplain and Stormwater Management

INTRODUCTION

- In some ways this is a follow up conversation from the previous Hydrology session
- Our current technology allows significant opportunities to advance engineering efforts
  - GIS Platform – Big data best performed in this platform versus CAD platform
  - HEC-HMS – *filename*.DSS implementation (hydrology inputs)
  - HEC-RAS – Better topography and surface revision = better model results (hydraulic calculations)
- Example watershed – Cap-Haitien, Haiti
  - Approximately 200 sq.km.
  - Known flooding occurrences involving at least Nov 2012, Nov 2014, Nov 2016 and Jan 2022
  - Changes in watershed over time – in particular, airport security wall and bridge construction
  - Prior engineering studies showed representative flooding extent, but not calibration

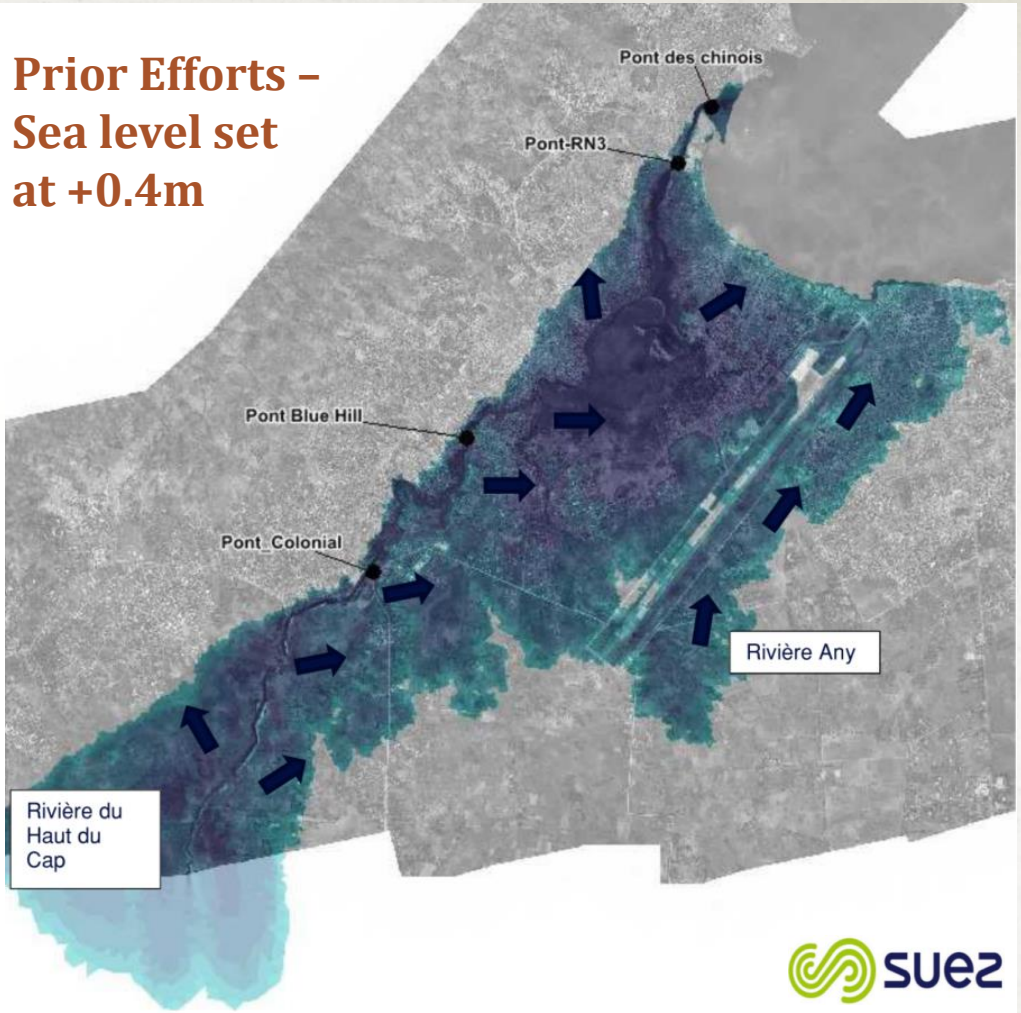
INTRODUCTION: EXAMPLE WATERSHED



Prior Efforts – Increased cell density along rivers and airport

Prior Efforts – Model Extent = 33 sq.km. (140,000 cells)

Prior Efforts – Sea level set at +0.4m



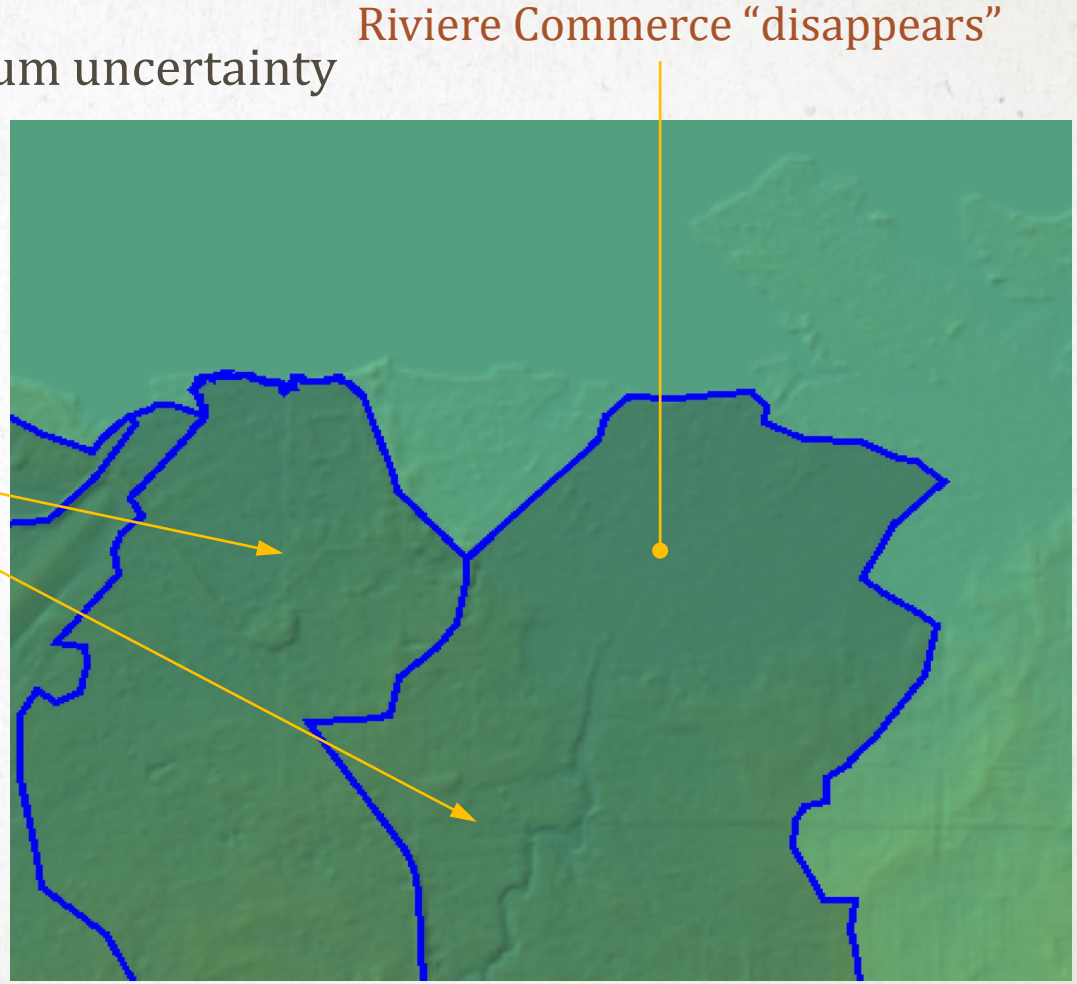
Prior Efforts – Comparison of flood elevations in combination of surface roughness adjustments did not yield completely satisfactory results

PRACTICAL'S

HYDRAULIC CONSIDERATIONS – UNGAUGED, TIDAL

HYDRAULIC CONSIDERATIONS & CONSTRAINTS

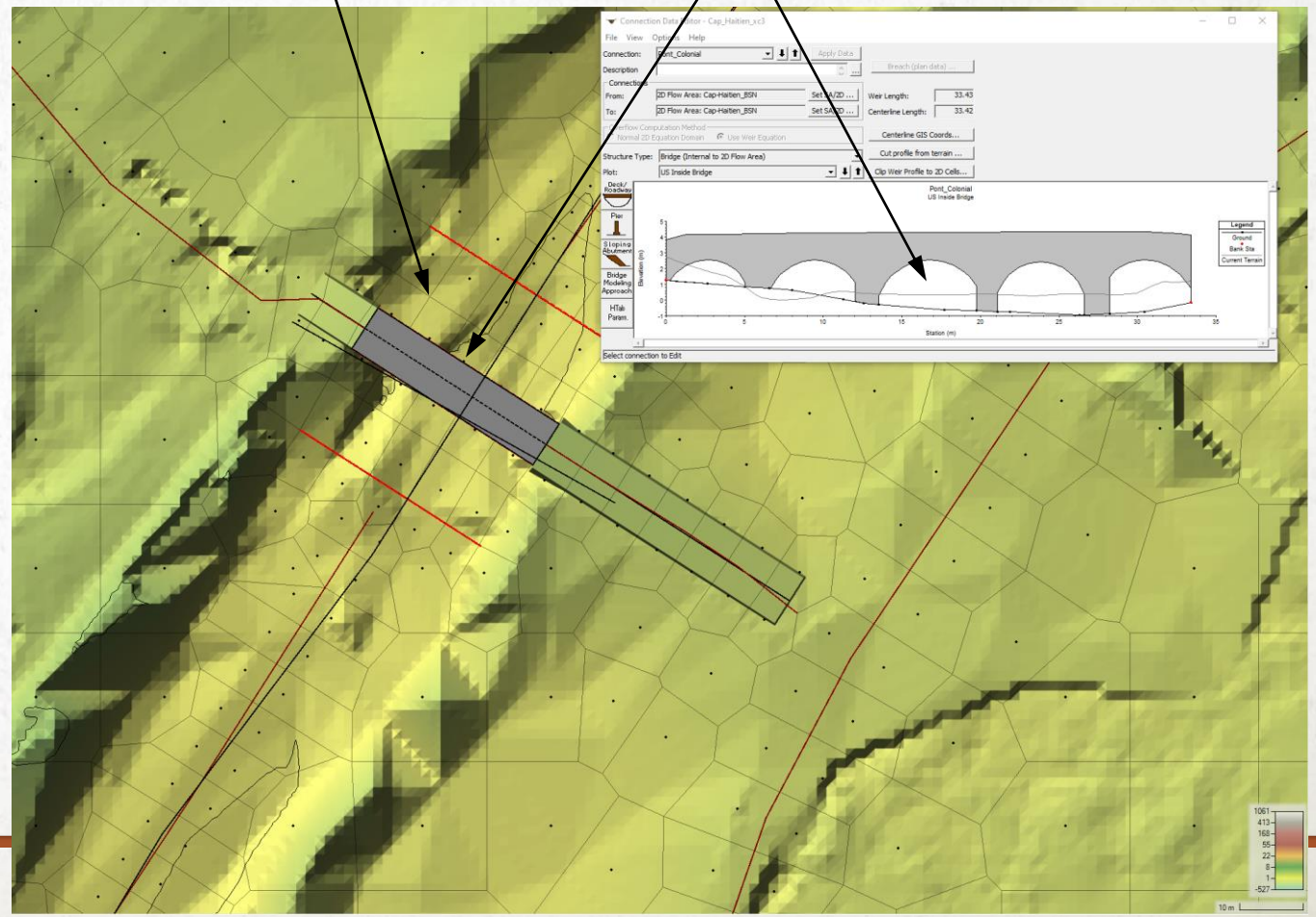
- Topography – 2014 LiDAR data set with base datum uncertainty
  - LiDAR grid square variations
  - Bathymetry – Rivers, Canals and Bay of Cap Haitien
  - Bridge and embankment representations
- Tidal variations
- Watershed changes over time
  - Dredging activities completed for Haut du Cap
  - Bridge construction, present or not present
  - Airport security wall construction and completion
  - River and Mangrove encroachments
  - Debris maintenance



HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Topography – Use 2014 LiDAR data set with adjustments in and out of HEC-RAS
  - GIS preferred platform
    - Add Bathymetry with varying levels of complexity, larger system, dredging = more detail required
    - Bridge and embankment representations

Line up cell boundaries and cell “centers” with bridge openings



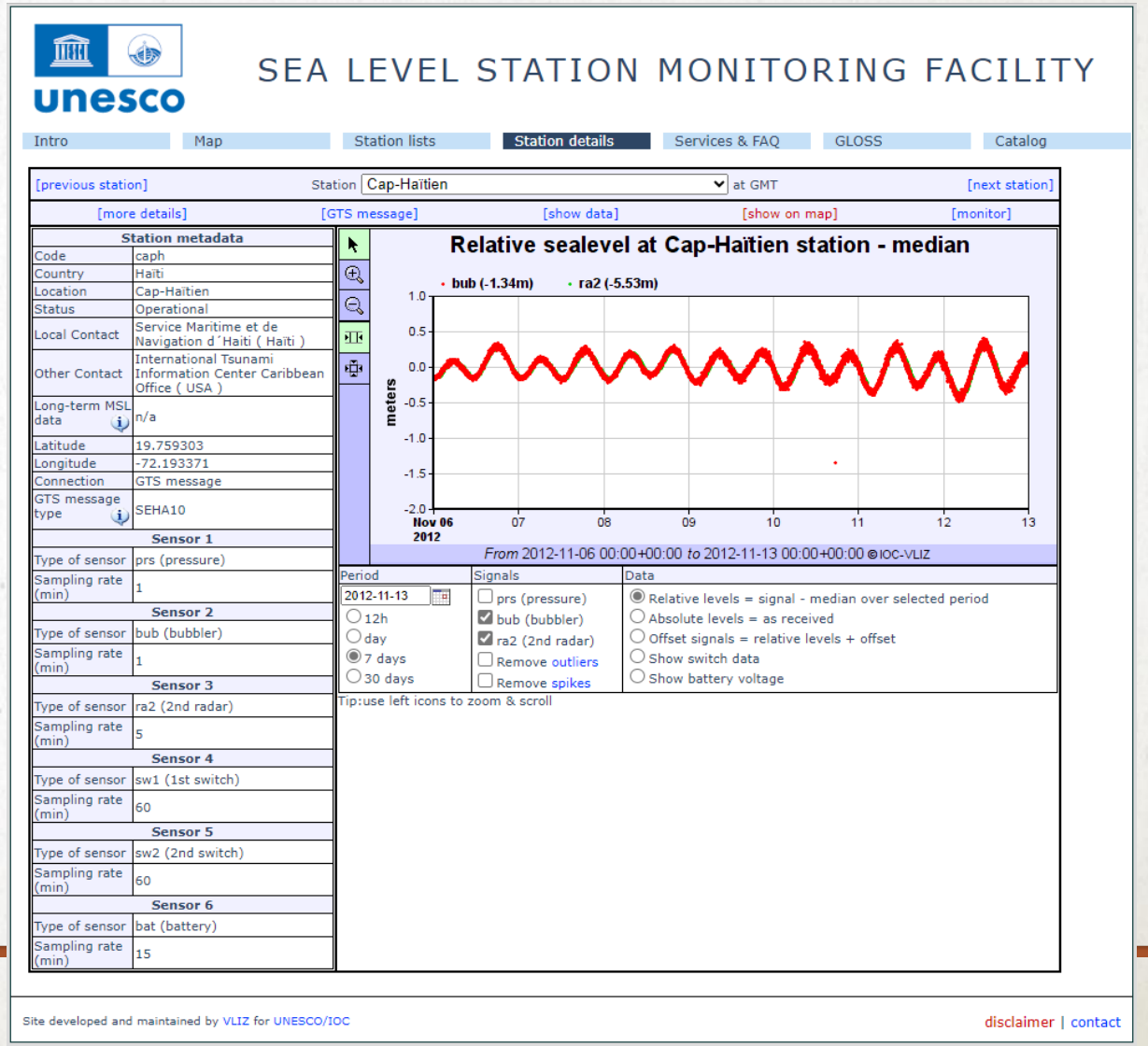
HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Bridge construction
  - Chinese Bridge (2013-2016)
  - Blue Hill (2013-2014)

Chinese Bridge Causeway

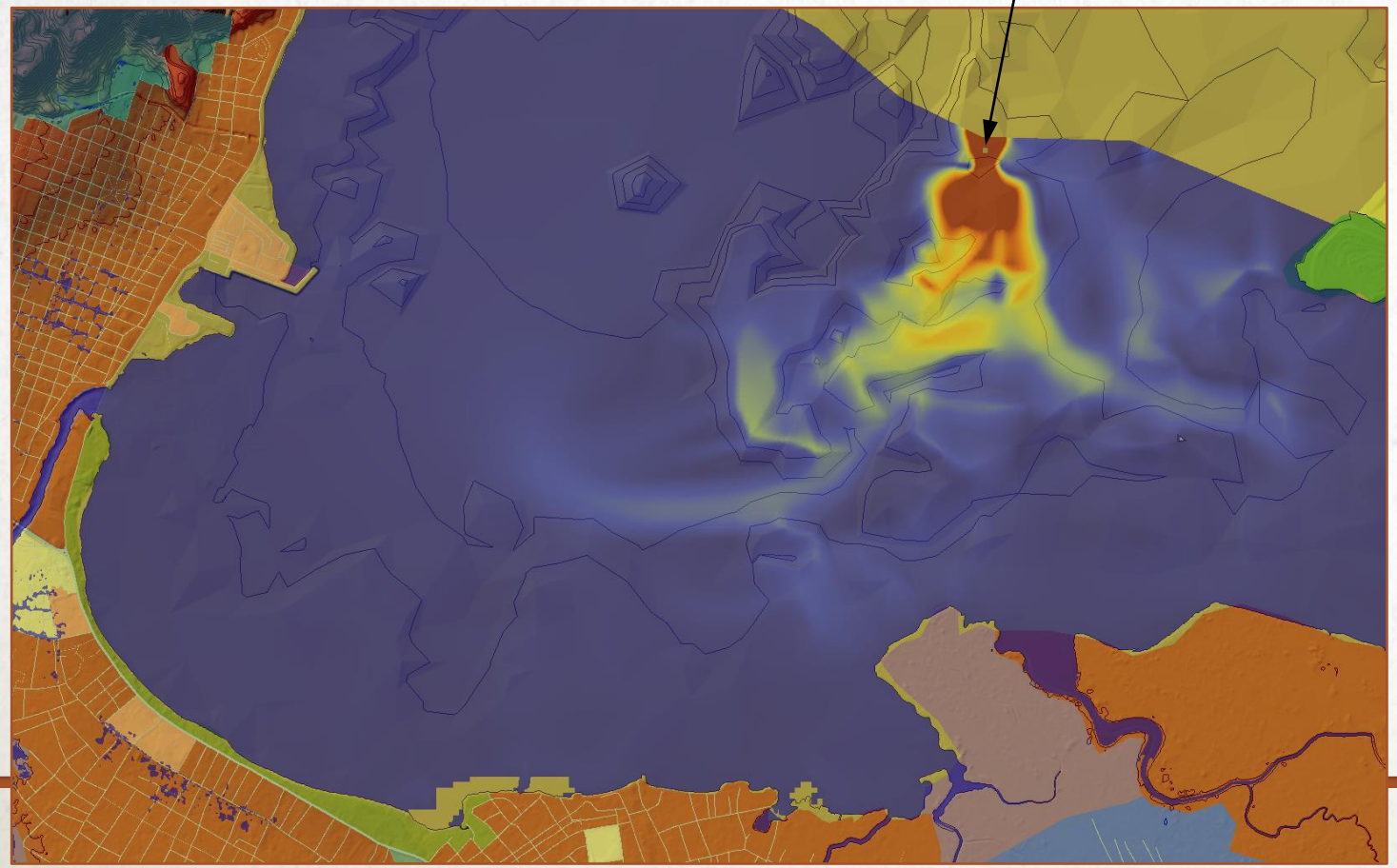
HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Tidal variations
  - UNESCO Sea Level Gauge Reporting
  - LiDAR 2014 topography bay = +0.15m sea level
  - Prior Efforts used fixed +0.4m sea level
  - Prior Efforts included bathymetry at Haut du Cap mouth only



HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Tidal variations
  - HEC-RAS boundary conditions



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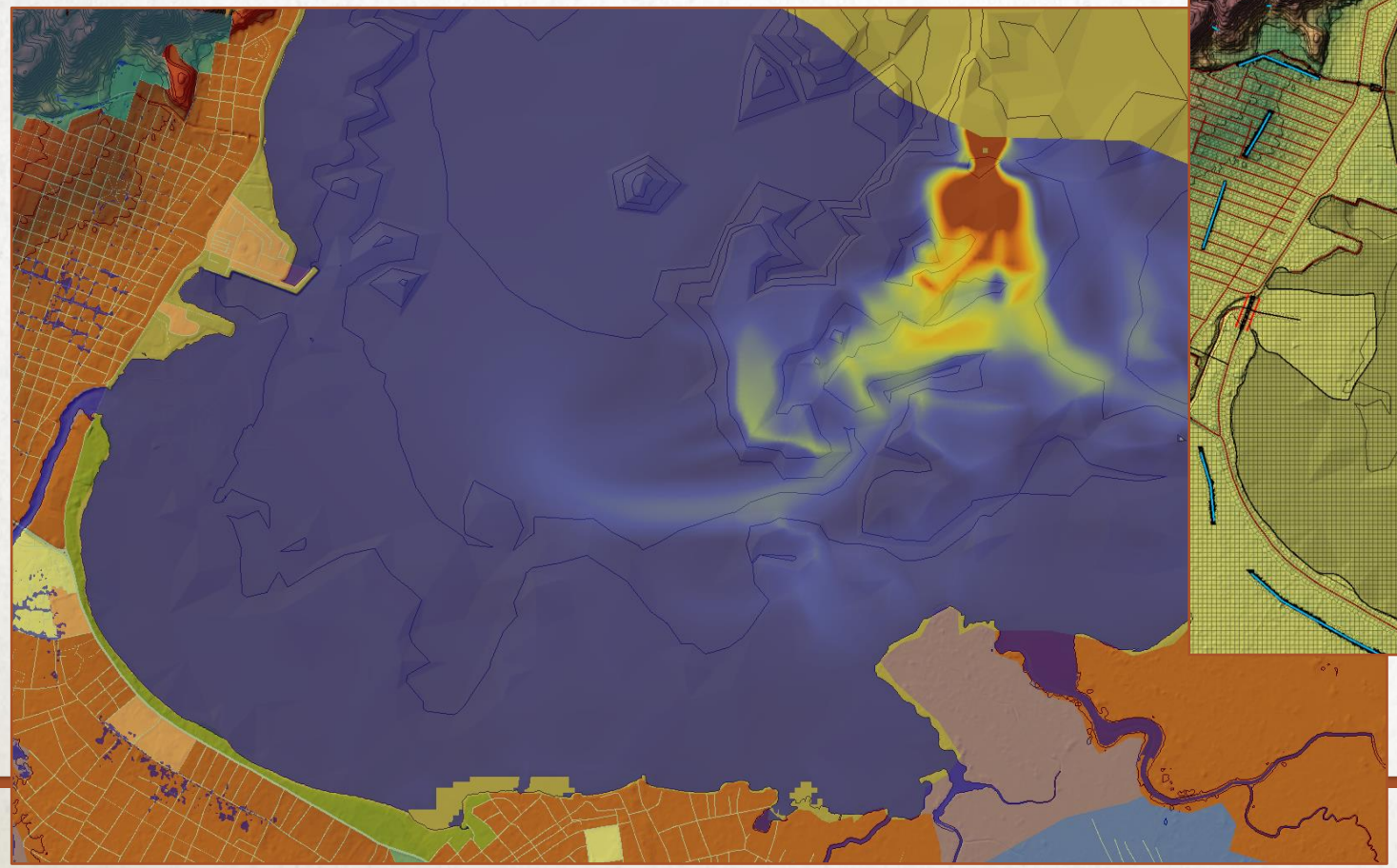
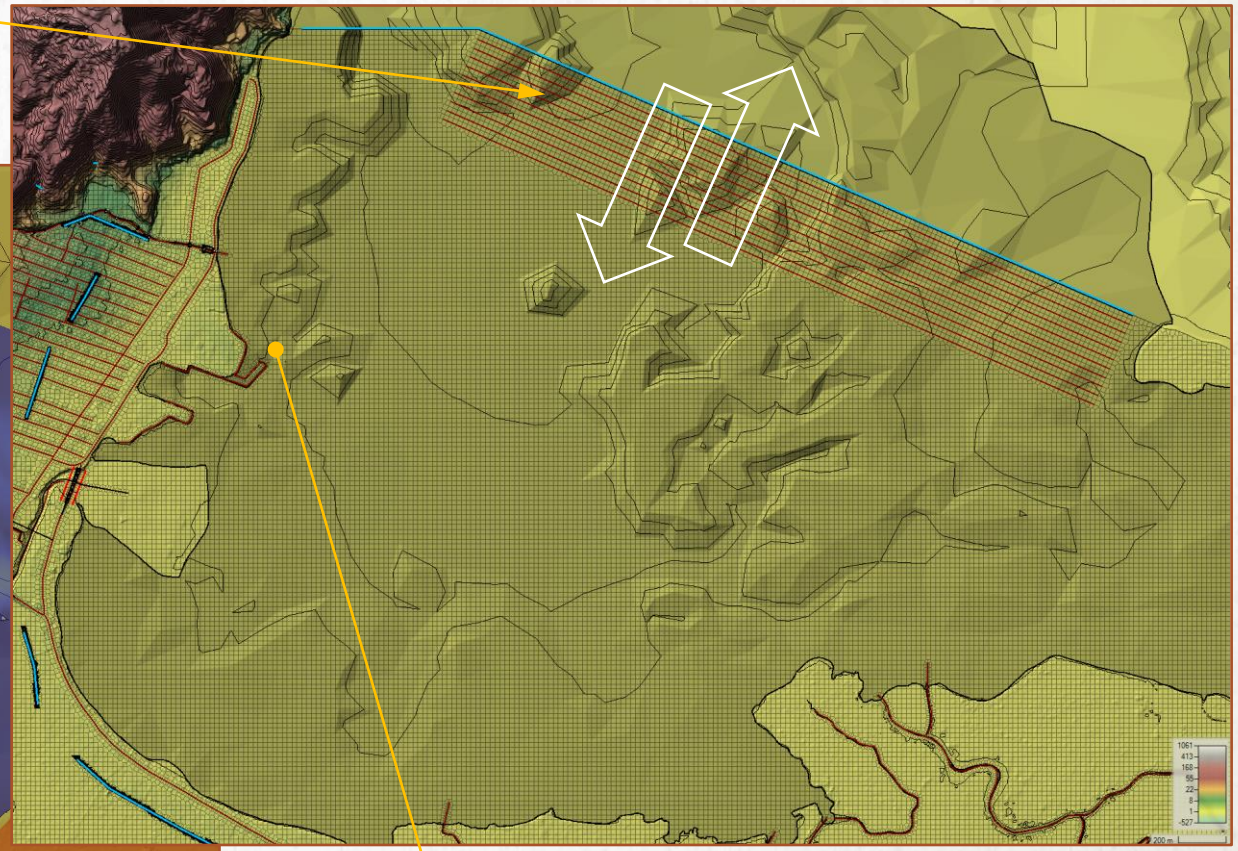
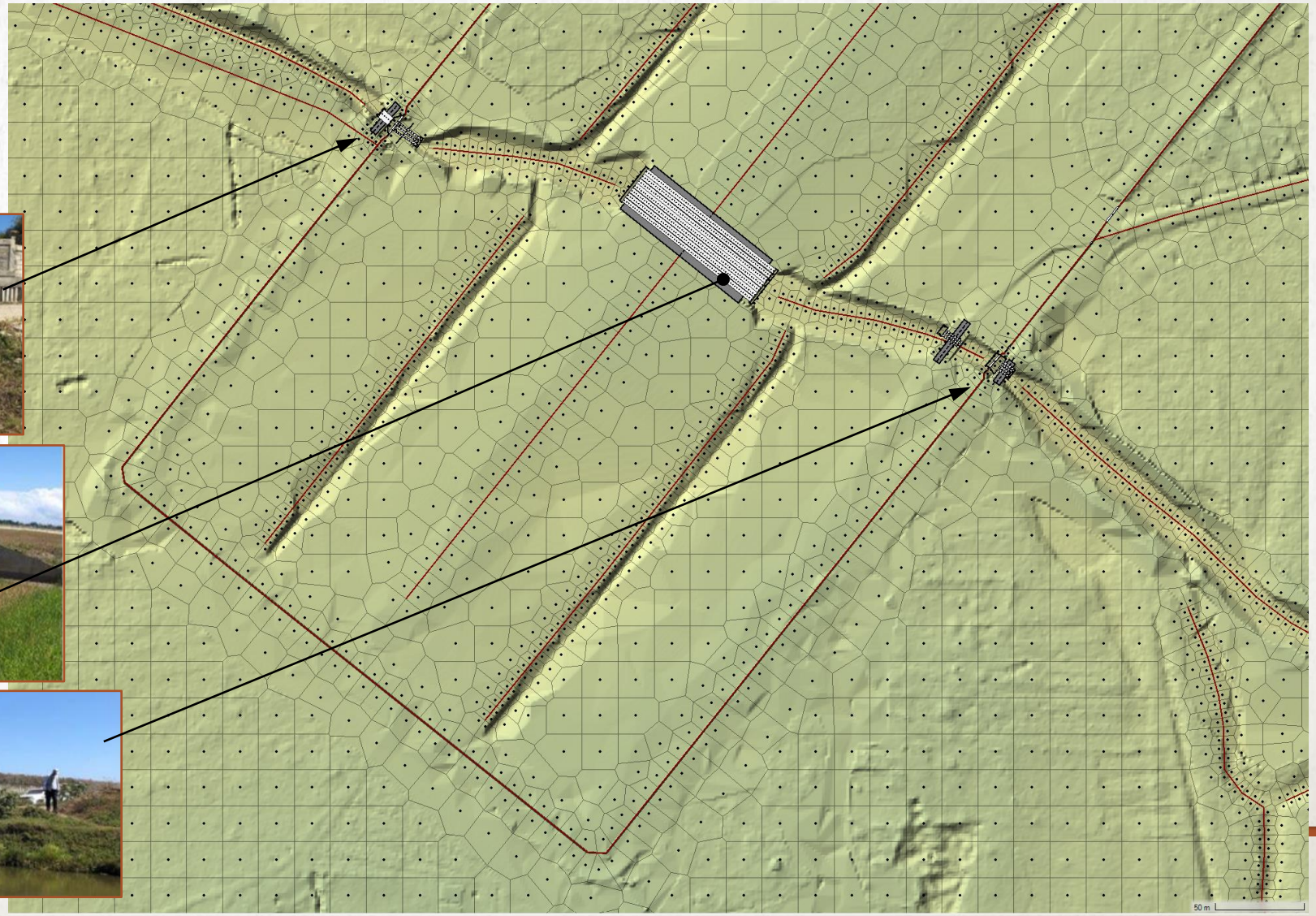




HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Watershed changes
  - Airport security wall completion

Security wall – Perhaps a dozen or so small openings about 0.5 m above surrounding grade

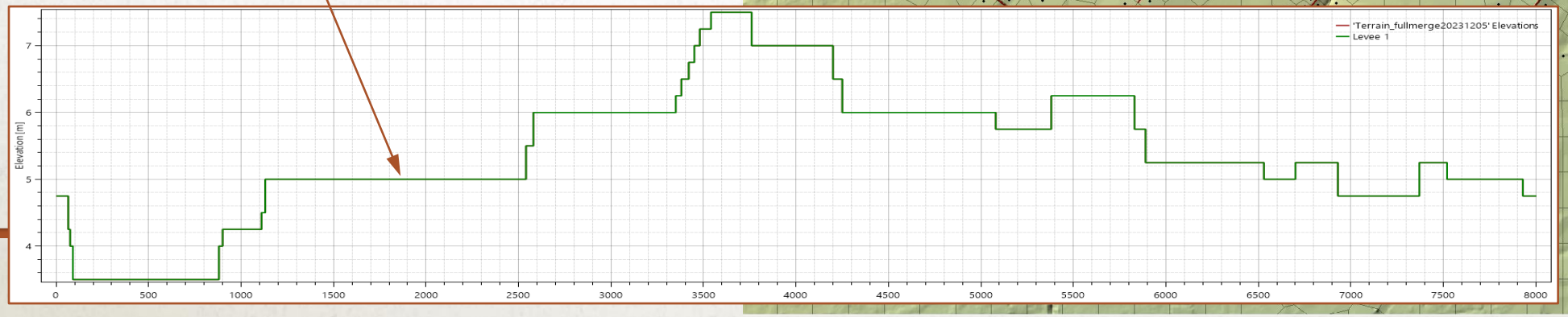


Airport outfall culvert under RN3– Perhaps as large as 2m x 2m

HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Watershed changes
  - Airport security wall completion

Security wall – declare surface modification perhaps 0.5m wide and minimum 3m above surrounding grade. The key is to align cell faces carefully within the 0.5m or the wall will "leak" flow



HYDRAULIC CONSIDERATIONS & CONSTRAINTS

- Watershed changes – Rivers and Ravines
  - River and Mangrove encroachments
  - Debris maintenance

Ravine Goya at RN1

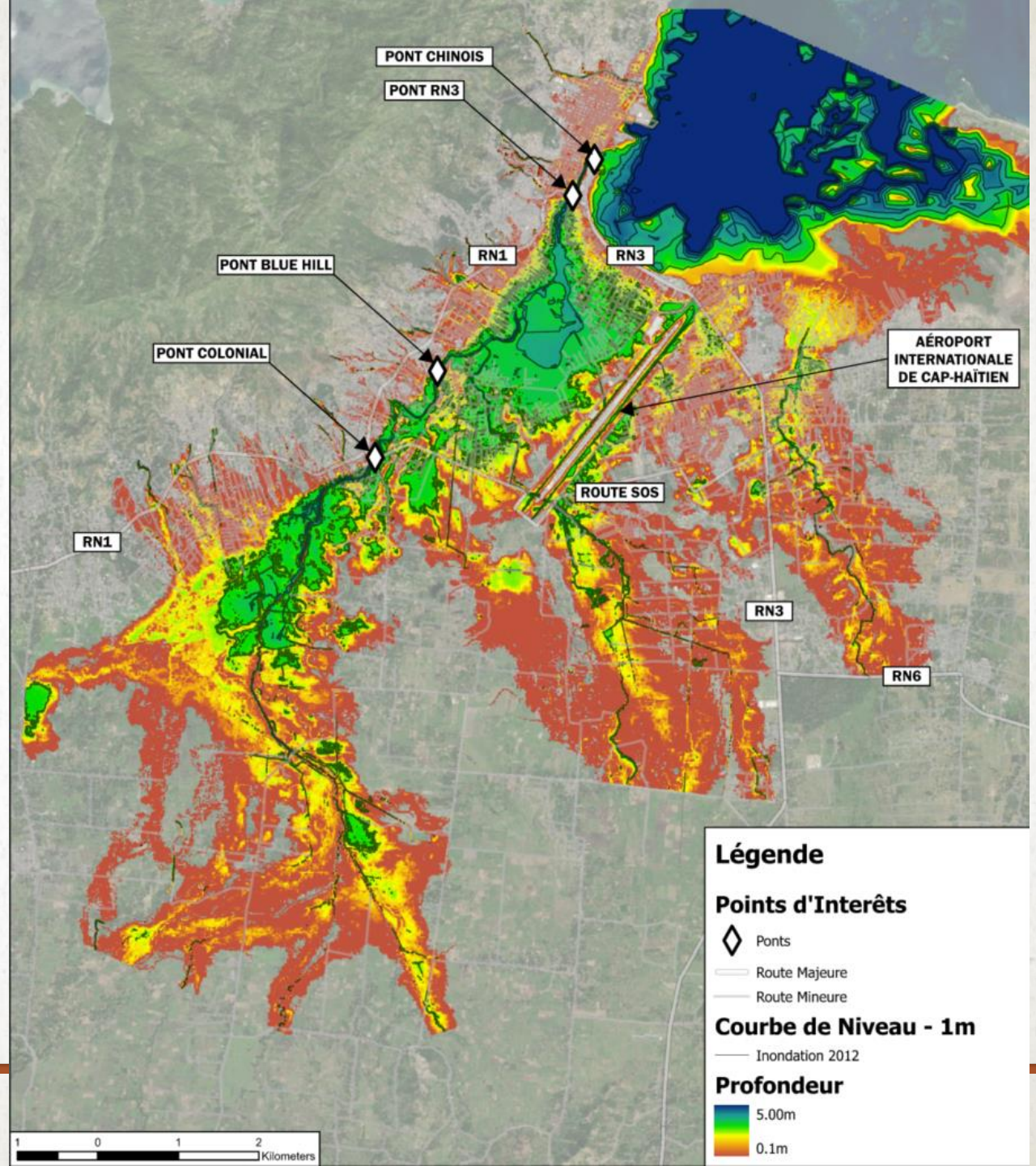
Ravine Belle Hotesse at Rue D

HEC-RAS RESULTS

CAP-HAITIEN INUNDATED TO VARYING DEGREES

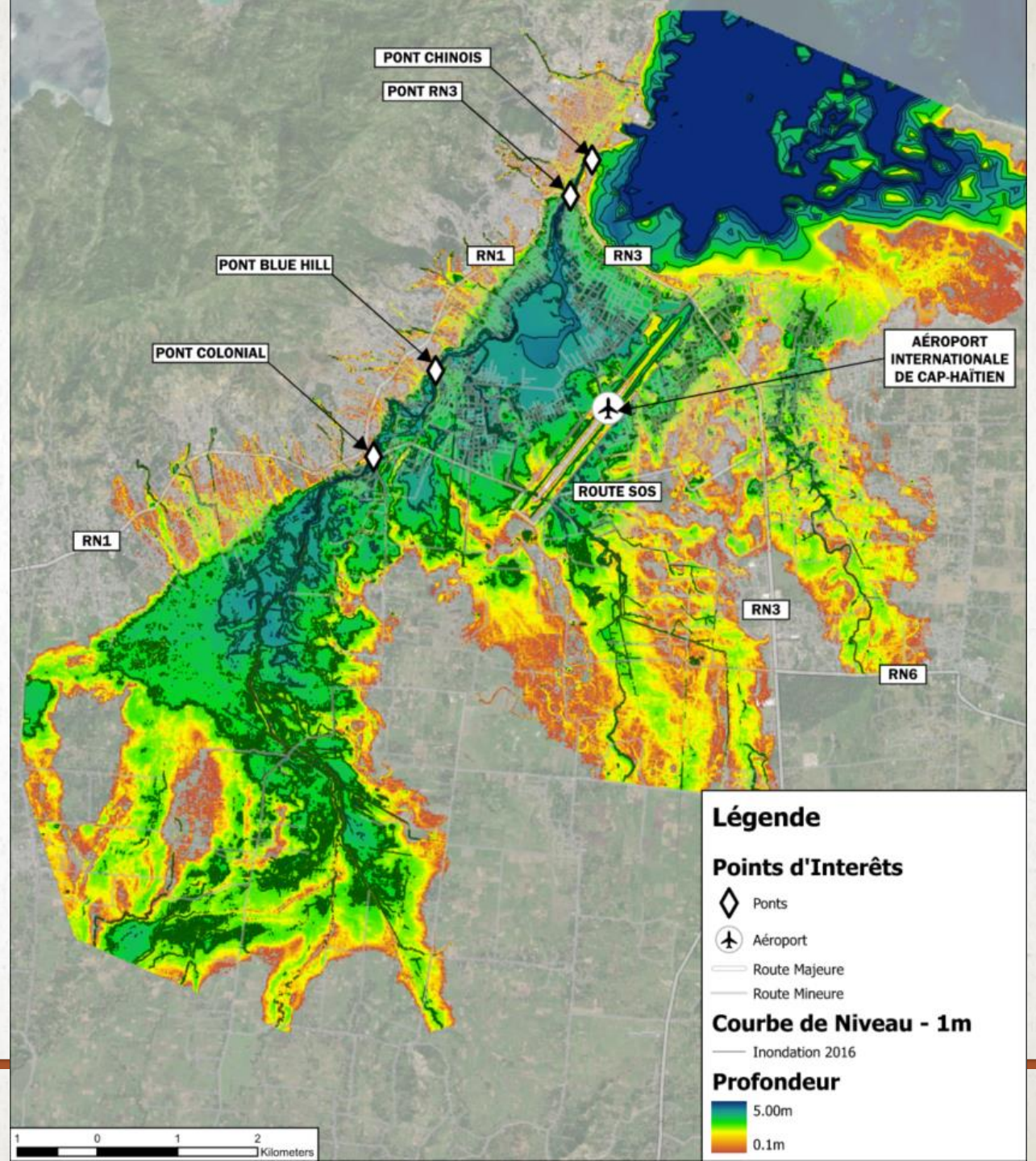
WATERSHED

- Calibration run: Nov 2012
- Contours 1m
- Model Extent 97 sq.km.
- Computational Cells ~ 304,000
- Using 99 identified inundation points overlapping HEC-RAS RASMapper coverage, average deviation of -0.15m with a standard deviation of 0.51m



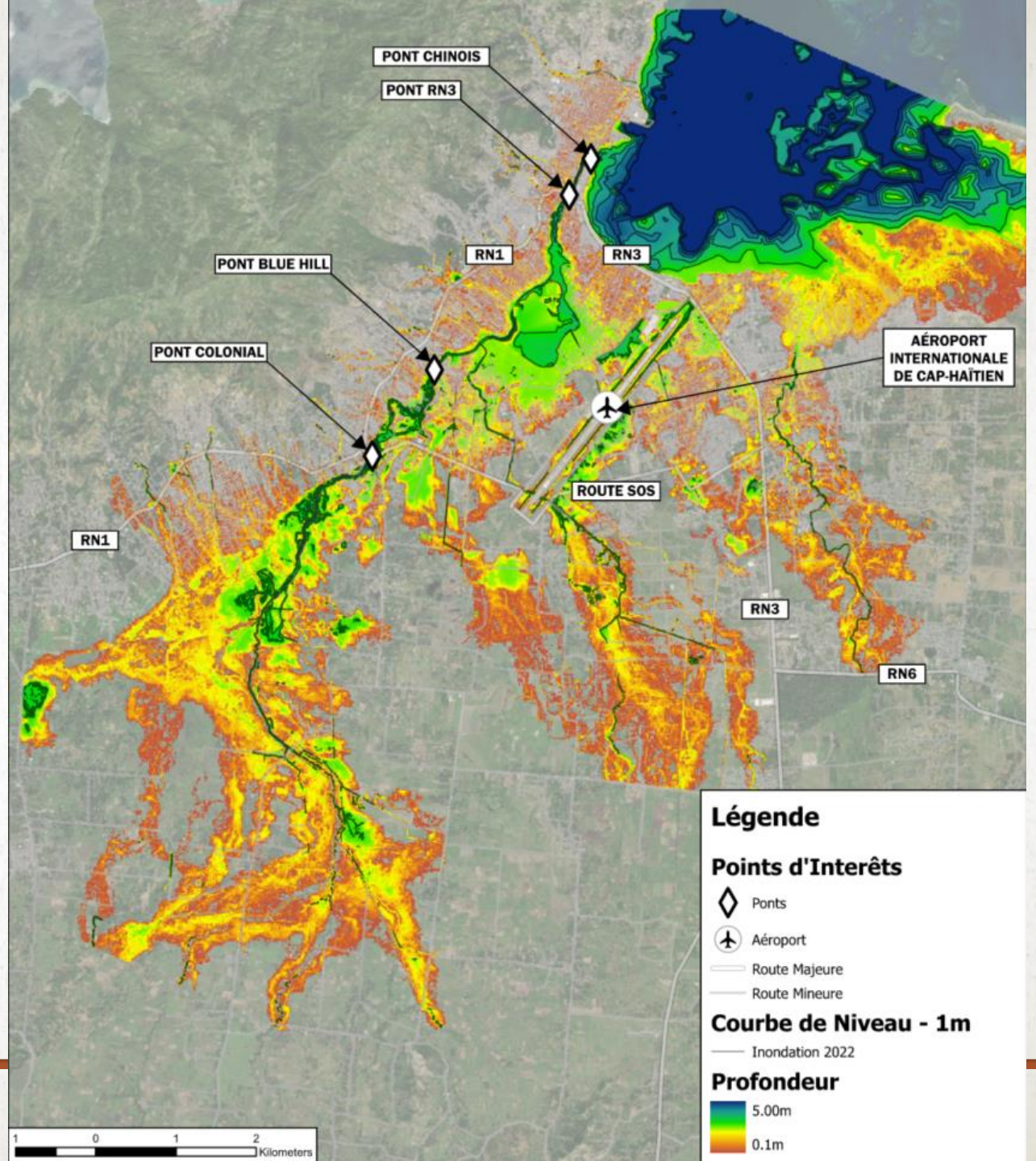
WATERSHED

- Validation run: Nov 2016
- Contours 1m
- Model Extent 97 sq.km.
- Computational Cells ~ 304,000
- Using 24 identified inundation points overlapping HEC-RAS RASMapper coverage, average deviation of +0.23m with a standard deviation of 0.51m



WATERSHED

- Validation run: Jan/Feb 2022
- Contours 1m
- Model Extent 97 sq.km.
- Computational Cells ~ 304,000
- Comparative based on video and photographic records

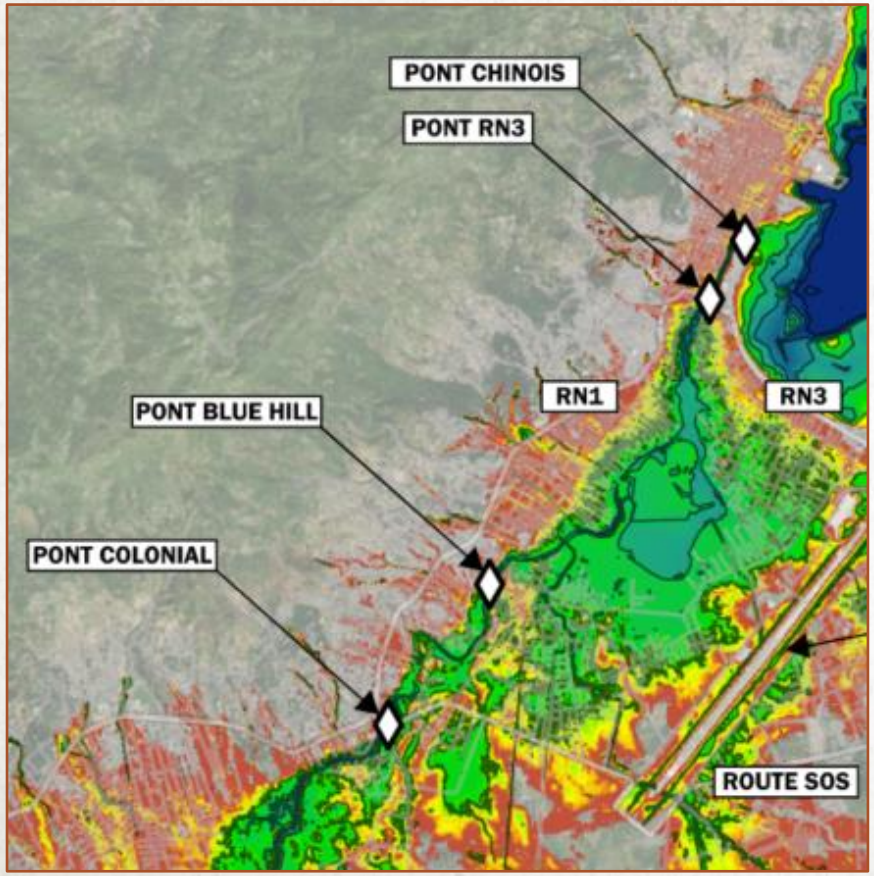


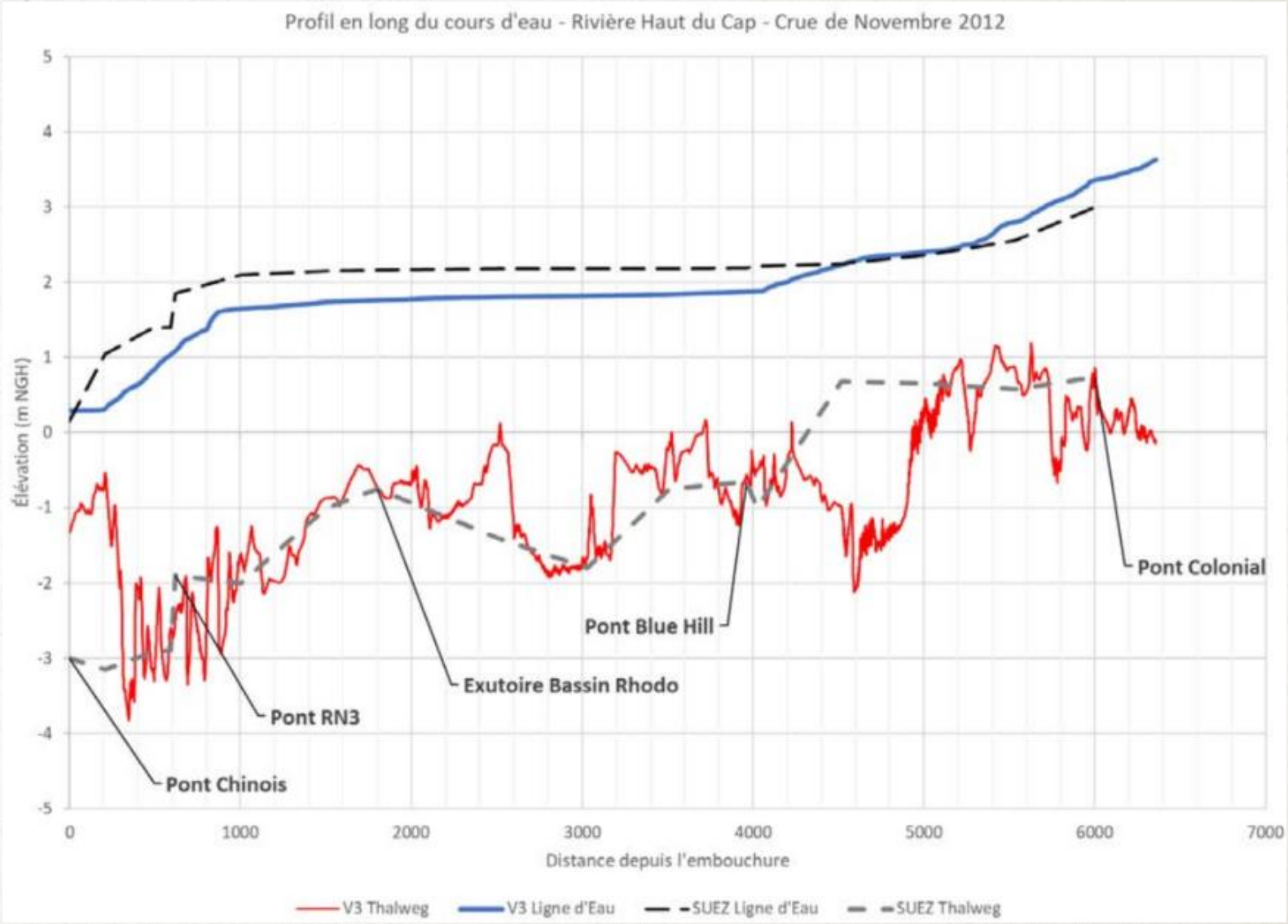
CLOSURE

REMAINING ITEMS, CONCLUSIONS

HAUT DU CAP

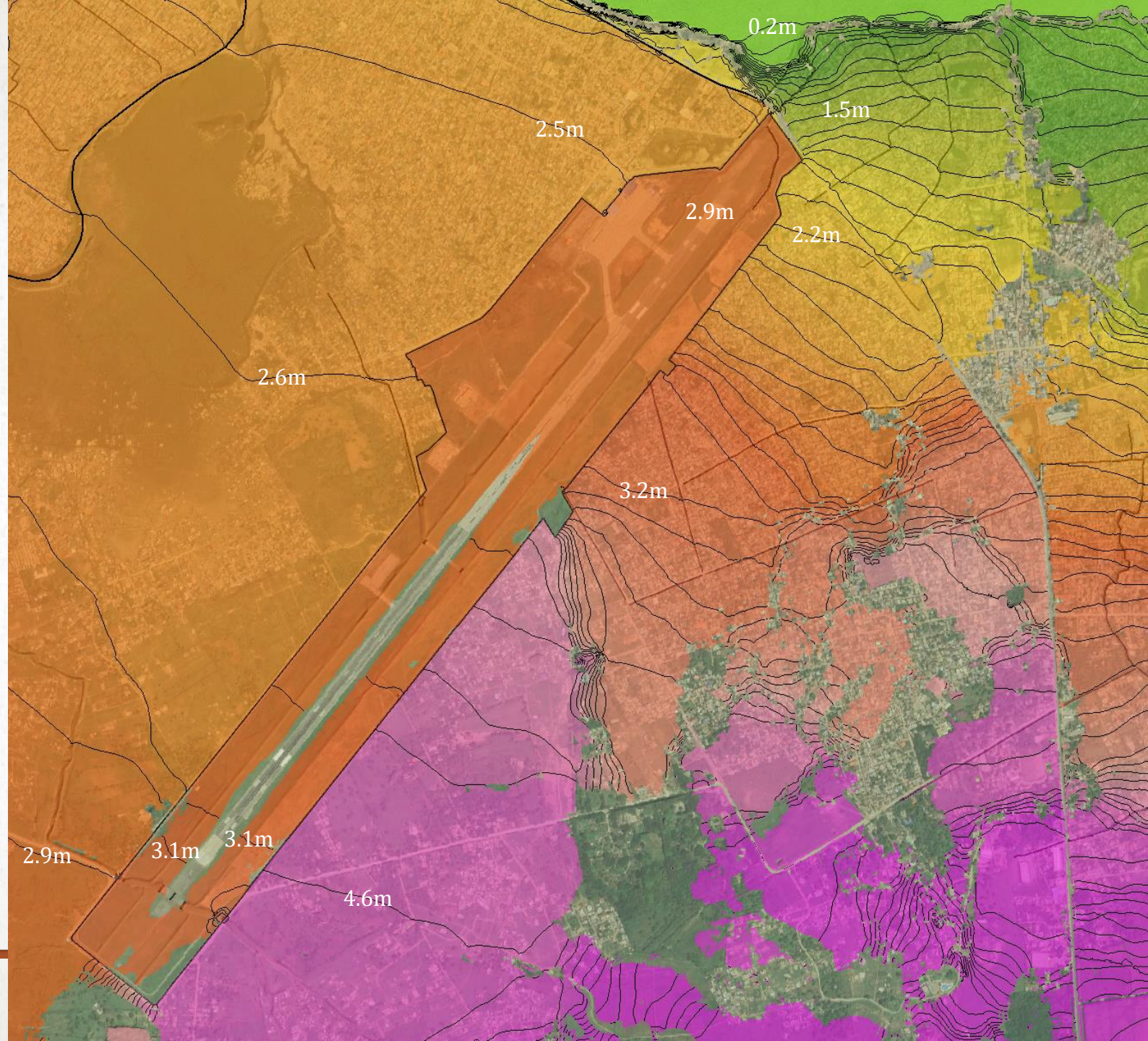
- Calibration run: Nov 2012





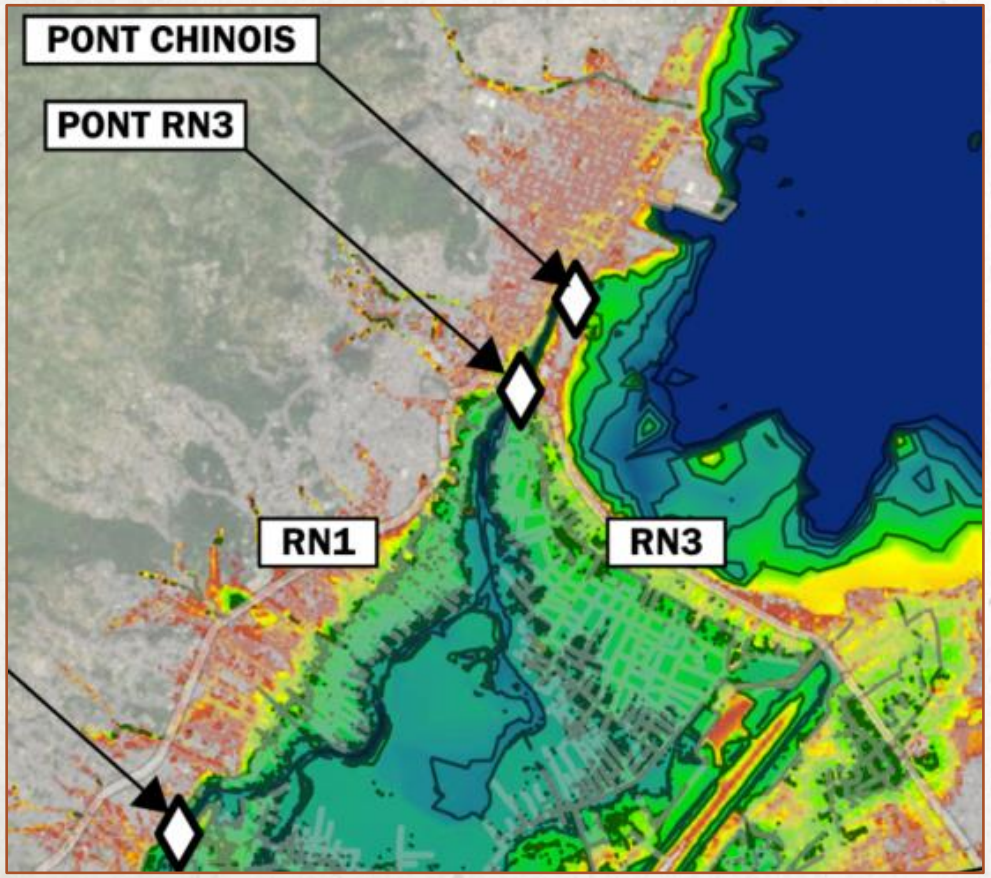
AIRPORT

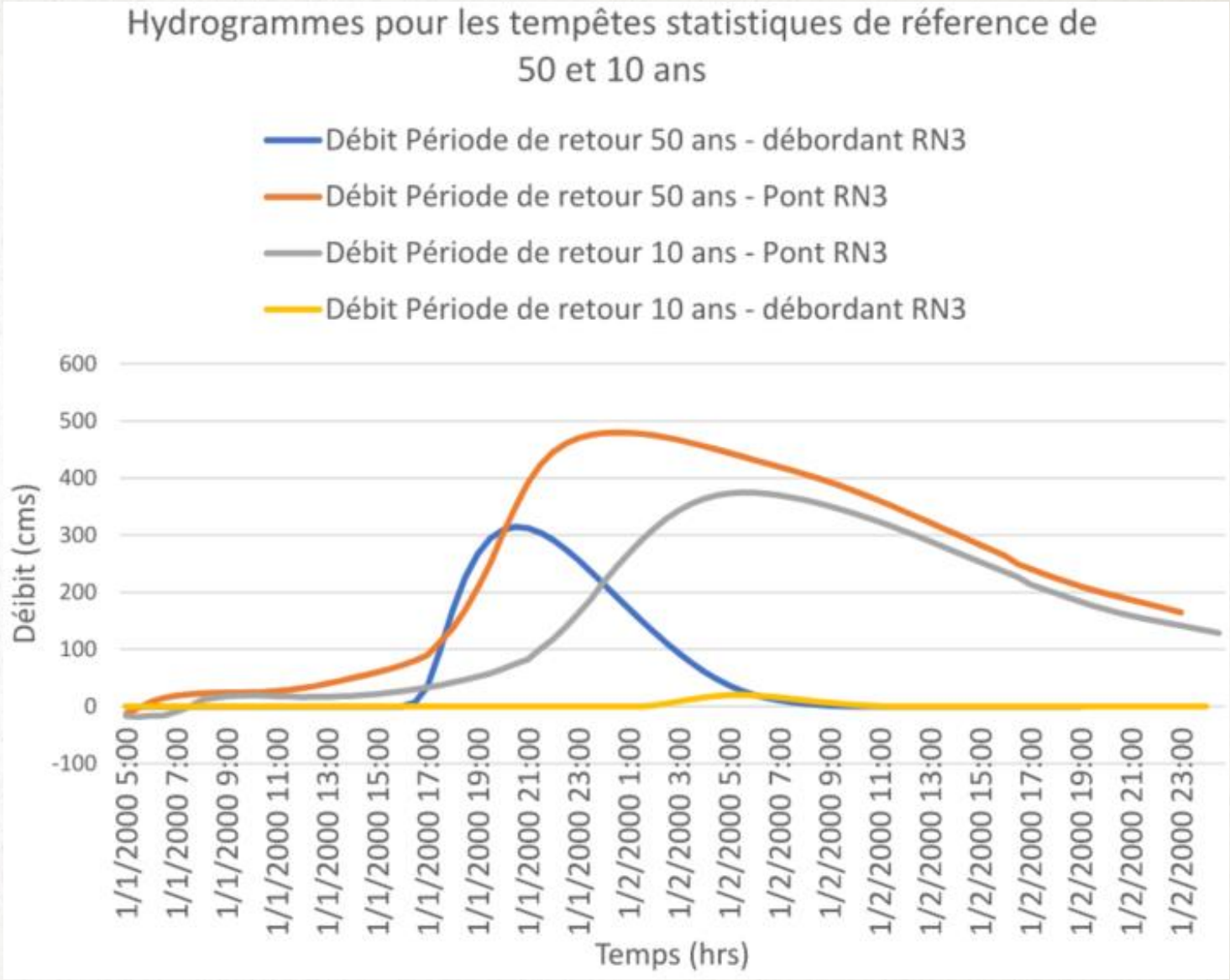
- Validation run: Nov 2016
- Contours 0.1m



NATIONAL ROUTE 3

- Design Storms: 10 & 50-year





CONCLUSIONS

- GIS is an important tool for data manipulation, calculation and exhibit production
- USACE HEC-RAS 2D is a powerful tool for computing larger data sets
  - We note that HEC-RAS v 6.5 beta was used for these calculations as v 6.4.1 seemed to choke at some point, but it could just be me… ☺
  - Surface modifications are becoming easier and more useful
  - The 1D bridge routine is useful, but take care in cell layout and orientation – it's important
- Proper Calibration and Validation may lead to recognition of interesting results
  - At a minimum, we can feel more confident that our results are "in the ballpark"
- We do the best we can – prior or follow-on
  - Understand context of prior efforts
  - Respect prior efforts

QUESTIONS

ENJOY THE REST OF THE CONFERENCE…

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