

# Appendices



# Appendix A – Risk assessment

Risk ID	Potential threat and effect on the environment	INITIAL RISK								RESIDUAL RISK								Reasoning
		Initial EPR	Magnitude of consequence			Overall consequence	Likelihood	Risk level	Reasoning	Final EPR	Magnitude of consequence			Overall consequence	Likelihood	Risk level		
			Extent	Severity	Duration						Extent	Severity	Duration					
CONSTRUCTION																		
SW01	Construction activities causing an increase in flood frequency, velocity or level which affects users or assets within the floodplain.	SW5, SW6, SW8	Local	High	2-7 years	Moderate	Possible	Medium	This impact refers to the rise of flood levels in a peak storm event on private property. This may effect the inundation of dwellings and private infrastructure or the flooding of property that would otherwise not have been inundated.	SW5, SW6, SW8	Local	High	2-7 years	Moderate	Possible	Medium	These are standard risks with standard controls, hence no change in residual risk.	
SW02	Construction activities on existing flow paths including piped flow, causing a change in flow to downstream water quality assets impacting on the performance of the asset.	SW1, SW4, SW5	Municipality	Low	2-7 years		Minor	Unlikely	Low		SW1, SW4, SW5	Municipality	Low		2-7 years	Minor	Unlikely	Low
SW03	Construction activities causing unintended damage to drainage assets resulting in an unacceptable increase in flooding risk.	SW5, SW10, B3	Local	Medium	2-7 years	Moderate	Possible	Medium		SW5, SW10, B3	Local	Medium	2-7 years	Moderate	Possible	Medium	These are standard risks with standard controls, hence no change in residual risk.	
SW04	Construction activities resulting in bed or bank erosion causing instability of assets adjacent to the waterway.	SW5, SW8, SW9, SW10	Local	High	2-7 years		Moderate	Likely	Medium	Realignment of Koonung Creek and Banyule Creek. Local impact due to the works.	SW5, SW8, SW9, SW10	Local	Medium		2-7 years	Moderate	Likely	Medium
SW05	Construction activities resulting in bed or bank erosion impacting on the beneficial uses of the receiving water.	SW1, SW4, SW5, SW9, SW10	Wider region	Medium	2-7 years	Major	Unlikely	Medium	Realignment of Koonung Creek and Banyule Creek	SW1, SW4, SW5, SW9, SW10	Wider region	Medium	2-7 years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.	
SW06	Hazardous materials during construction of the project being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	SW1, SW4, SW5	Wider region	High	2-7 years	Major	Unlikely	Medium	Accidental release of hazardous materials e.g. fuels, machine lubricants etc. that are transported overland in a rainfall event or via an existing flow path to receiving waters.	SW1, SW4, SW5	Wider region	High	2-7 years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.	
SW07	Construction activities causing sediment or contaminants to be released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	SW1, SW4, SW5	Wider region	High	2-7 years	Major	Unlikely	Medium	Through construction, contaminants already present in soils can be released to the environment e.g. heavy metals, waste products or even organic contaminants. The impact will vary depending on the type of contaminant at the site, the quantity of the contaminant present and the amount of exposure or transfer to a surface water environment.	SW1, SW4, SW5	Wider region	High	2-7 years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.	
SW08	Construction activities leading to changes to water storages or supplies of irrigation assets affecting users.		Local	Low	2-7 years	Minor	Likely	Medium		SW12	Local	Low	2-7 years	Minor	Unlikely	Low	EPR SW12 added to account for maintaining stormwater storage for irrigation.	



OPERATION																	
SW09	Project assets causing an increase in flood frequency, velocity or level which affect users or assets within the floodplain.	SW6,	Local	High	7+ years	Major	Unlikely	Medium	Surface water inflows to a drainage asset (e.g. wetland) may change if the flow is diverted for the project. This has a direct impact on the function of this asset from both a water quality and functionality perspective.	SW6, SW13	Local	High	7+ years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW10	Diversion of stormwater, causing a change in flow to downstream water quality assets impacting on the performance of the asset.	SW6, SW11,	Local	Medium	7+ years		Moderate	Likely		Medium	SW6, SW11, SW12, SW13	Local	Medium		7+ years	Moderate	Unlikely
SW11	Increase in impervious area resulting in an increase in flow discharge leading to bed or bank erosion causing instability of assets adjacent to the waterway.	SW6, SW9, SW11	Local	Medium	7+ years	Moderate	Unlikely	Low		SW6, SW9, SW11	Local	Medium	7+ years	Moderate	Unlikely	Low	EPR SW6 modified to make reference to include flow regime.
SW12	Increase in impervious area resulting in an increase in flow discharge leading to bed or bank erosion impacting on the beneficial uses of the receiving water.	SW1, SW6, SW9, SW11	Wider region	Low	7+ years	Moderate	Unlikely	Low		SW1, SW6, SW9, SW11	Wider region	Low	7+ years	Moderate	Unlikely	Low	EPR SW6 modified to make reference to include flow regime.
SW13	Change in drainage alignment or discharge location concentrating flow and leading to bed or bank erosion causing instability of assets adjacent to the waterway.	SW6, SW8, SW9, SW11	Local	Medium	7+ years	Moderate	Possible	Medium	Realignment of Koonung Creek and Banyule Creek	SW6, SW8, SW9, SW11	Local	Medium	7+ years	Moderate	Possible	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW14	Change in drainage alignment or discharge location concentrating flow and leading to bed or bank erosion causing increased sediment loads impacting on the beneficial uses of the receiving water.	SW1, SW6, SW8, SW9, SW11	Wider region	Medium	7+ years	Major	Unlikely	Medium	Realignment of Koonung Creek and Banyule Creek	SW1, SW6, SW8, SW9, SW11	Wider region	Medium	7+ years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW15	Spills from traffic during operation of the project being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	SW2	Wider region	High	7+ years	Severe	Possible	High.	EPR is only for new roads and ramps.	SW2	Corridor	High	7+ years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW16	Increase in impervious area leading to an increase in contaminants being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	SW1, SW9, SW11	Wider region	Very low	7+ years	Moderate	Likely	Medium		SW1, SW9, SW11	Wider region	Very low	7+ years	Moderate	Likely	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW17	A flood event occurring during the operation of the tunnel causing inundation of the tunnel resulting in an impact to public safety.	SW7	Local	Very High	7+ years	Major	Rare	Medium		SW7	Local	Very high	7+ years	Major	Rare	Medium	PMF protection originally on all tunnel portals. Now, PMF protection is only on the northern tunnel. Longer time to peak flood allows greater opportunity to evacuating people, therefore lower likelihood.
SW18	Water from tunnel drainage system being discharged to waterways resulting in adverse impacts on the beneficial uses of the receiving water.	SW1, SW3	Wider region	Medium	7+ years	Major	Unlikely	Medium		SW1, SW3	Wider region	Medium	7+ years	Major	Unlikely	Medium	These are standard risks with standard controls, hence no change in residual risk.
SW19	Insufficient capacity of road drainage design due to increased rainfall intensities from climate change resulting in an impact to public safety		Corridor	Medium	7+ years	Major	Possible	High.		SW13	Corridor	Medium	7+ years	Major	Unlikely	Medium	New EPRs reduce risk
SW20	Project assets leading to changes to water storages or supples of irrigation assets affecting users.		Local	Low	7+ years	Minor	Likely	Medium		SW12, SW13	Local	Low	7+ years	Minor	Unlikely	Low	New EPRs reduce risk
SW21	Project assets reducing the effectiveness of water quality treatment resulting in adverse impacts on the beneficial uses of the receiving water.		Wider region	Medium	7+ years	Major	Likely	High.		SW14	Wider region	Medium	7+ years	Major	Unlikely	Medium	New EPRs reduce risk



## Appendix B – Melbourne Water standards for infrastructure projects in flood-prone areas

# Melbourne Water standards for infrastructure projects in flood-prone areas

## 1. Purpose

Melbourne Water as the Floodplain Manager for the Port Phillip and Westernport catchments is responsible under the Water Act (1989) to oversee development works that have the potential to change the characteristics of the floodplain. This document provides the minimum requirements for any proposed project works that have the potential to impact on any flood-prone area within Melbourne Water's (MW) area of responsibility.

Melbourne Water requires a proponent to meet these standards or otherwise demonstrate why they cannot and how they have appropriately mitigated or minimised any associated flood risks.

## 2. Melbourne Water's Guiding Principles

Melbourne Water has five guiding principles for the assessment of development in flood-prone areas:

- a) Risk to people and property must not increase as a result of the development.
- b) Any development within a flood-prone area must be suitably designed for conditions that might be experienced and to reduce the reliance on emergency service personnel when flood events occur.
- c) Climate change must be considered in the design.
- d) Proponents must identify existing flood risk and should work with Melbourne Water to identify opportunities to reduce these risks.
- e) Flood risk must be assessed at both the local and regional scale.

## 3. Melbourne Water's Standards


Melbourne Water uses these standards to guide its flood risk assessment:

- a) **Flood Flow: Works or structures should not affect floodwater flow capacity.**  
This ensures that existing flood levels are not made worse by alterations to the flow characteristics of a floodplain or overland flow path.
- b) **Flood Storage: Works or structures should not reduce floodwater storage capacity.**  
This prevents higher flood levels that may occur if the available storage volume is reduced.
- c) **Freeboard: Works or structures should not reduce minimum freeboard<sup>1</sup>.**  
This ensures there is no adverse impact on existing property and infrastructure.

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<sup>1</sup> For new structures Melbourne Water requires 600mm and 300mm freeboard for Waterway and drainage flood extents respectively; where the structure is designed for 100 years or more, climate change must be included with freeboard.



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- d) **Site Safety Requirements: Works or structures should not create new hazards or increase existing hazard.**  
Development will not be allowed where the depth and flow of floodwaters would create new hazard or increase existing hazards.
- e) **Access Safety Requirements: Access safety requirements should be taken into account.**  
Development cannot be allowed in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.
- f) **Climate Change Requirements: Flood plain impacts of works or structures must be considered, consistent with the approach specified in ARR2016, for the following climate change scenarios:**
- i. **Sea-level rise** – An increase of 0.8m by the year 2100 is the current standard for sea level rise assessments.
  - ii. **Increase in rainfall intensity** – A rainfall intensity increase figure must be derived from either the AR&R 2016 Book or the AR&R Data Hub. The adopted figure must reflect the project's asset life and the project's flood protection technical performance requirements.

#### 4. Other applicable standards and guidelines

Melbourne Water requires the proponent to consider and address, where applicable, any additional requirements specified in Melbourne Water and industry best practice standards and guidelines, including but not limited to:

- Australian Rainfall & Runoff 2016<sup>2</sup>.
- Melbourne Water's Land Development Manual.
- Melbourne Water's Guidelines for development in flood-prone areas.
- Melbourne Water's Shared user path guidelines.
- Melbourne Water's Guidelines for Development within the Koo Wee Rup Flood Protection District
- Melbourne Water Corporation Flood Mapping Projects Guidelines and Technical Specifications November 2018

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<sup>2</sup> Melbourne Water has adopted the information and approaches defined in the draft Australian Rainfall and Runoff 2016 (ARR2016) guidelines as current best practice for the development and analysis of hydraulic and hydrological models for the purpose of stormwater and flood flows simulations. As stated by Geoscience Australia (Commonwealth of Australia, Geoscience Australia 2016) where relevant the draft ARR2016 can be used in practice prior to finalisation.



## 5. Deliverables

### 5.1 Scenarios

Melbourne Water requires the proponent to model or assess the risks of the following scenarios at applicable stages (reference design, preliminary and detailed design/for construction):

- a) Pre-existing flood conditions (the 'base case') should be modelled at each stage
- b) Project ultimate design flood conditions (the 'proposed' case) including any variation from the 'base case' should be modelled at each stage. Mitigation options should be presented where project works adversely impact flooding.
- c) Temporary construction works flood condition (inclusive of the works method steps/staging, site access, haul roads etc.)<sup>3</sup> should be risk assessed at the reference design stage and modelled at each subsequent stage.

Melbourne Water will provide advice through our comments and specified requirements but will not undertake model reviews of structural and methodological changes between major milestones.

### 5.2 Parameters

The following results must be presented where the effects of the proposed design and temporary works can be assessed against the pre-existing conditions. All pre and post assessments must be done at several locations for at least the following:

- Flows (in m<sup>3</sup>/s)
- Velocities (in m/s)
- Product of Velocity and Depth ( $V \times D$  in m<sup>2</sup>/s)
- Flood Levels to m AHD
- Depth in metres (m)
- Any cut and fill balance information
- Clearly showing where the flooding conditions have changed and how much
- All manning's values used in modelling and assessment should be accompanied by justification in a summary modelling note.
- For ease of assessment these must be provided in three separate MapInfo tables representing each scenario.
- Site specific detailed design model should be created for the project. Melbourne Water's regional model should be updated.

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<sup>3</sup> At reference design, if the staging of construction is known the risks must be identified through qualitative measures. A flood management plan will be required for any temporary works.



### 5.3 Hydrology and hydraulic submissions

Hydrology and hydraulic submissions must include:

- A design model. This must include project specific and local detail.
- Melbourne Water's regional model must be updated with the design information. If the design changes during construction the model must be resubmitted incorporating the changes.
- Models must be submitted for the following AEP events (20%, 10%, 5%, 2% and 1% and climate change).
- Where rarer events are run, models and results of these runs.
- Where deemed necessary an independent peer review of submissions must be undertaken. This independent peer review would be managed by Melbourne Water at the expense of the proponent.
- A log file must be submitted detailing model runs/scenarios.
- Modelling assumptions and parameters must be submitted with reference to the standards.
- The submitted model must be error free and stable.
- A report outlining the modelling methodology and results must be provided in a report format.
- Data must be supplied in digital format - MW can provide the proponent with the file types to submit on request.

## 6. Timeframes

Please allow the following timeframes when submitting information to MW for review:

SUBMISSION	REVIEW PERIOD
Preliminary Advice	28 Business Days or Subject to number of models and size of reports
Detailed Design Reports & Models	28 Business Days
Final Detailed Designs	10 Business Days
General queries (1 – 2 pages)	5 Business Days

## Document History

Date	Reviewed/ Actioned By	Version	Action
May 2018	Ruwan Jayasinghe, Principal Flood Modelling & Mapping	1.0	
July 2018	Jean-Michel Benier, Team Leader Flood Information	2.1	
February 2019	Jean-Michel Benier, Team Leader Flood Information	2.2	



# Appendix C – High level preliminary review of surface water features

The following table provides a high level review of surface water features including waterways, drains and other surface water bodies in close proximity to North East Link. It was prepared to identify which sites were potentially impacted by the project and in particular to help direct focus on areas where additional assessment and controls may be required to investigate and manage these potential impacts.

				Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Surface water feature	Brief description	Interaction with project	Potential surface water impact				
Rivers and creeks (including associated floodplains)							
Banyule Creek	Small ephemeral urban creek upstream of Lower Plenty Road	The entire length of this section of creek would be realigned to either side of the road. Works would include a tunnel portal and a retarding basin.	Changes to flood conveyance, storage and attenuation, water quality treatment and erosion potential	✓	•✓	✓	•
	An urban creek downstream of Lower Plenty Road discharging to the Yarra River	Twin tunnels would run roughly parallel to the creek occasionally passing at depth beneath it.	None	•	•	✓	•
Yarra River	Major waterway with considerable upstream catchment	Twin tunnels would pass beneath the Yarra River at depth.	None	•	•	•	•
		Eastern Freeway bridge over the Yarra River would be widened	Relatively minor bridge widening	✓	•	✓	•
		Tunnel portals and associated infrastructure within the floodplain	Loss of floodplain storage. Level of flood protection for tunnels	✓	•	✓	•
Merri Creek	Major urban creek which passes beneath the Eastern Freeway before discharging to the Yarra River	Near the western extent of the project. Line marking works only.	None	•	•	•	•
Plenty River	Significant tributary of the Yarra River	No direct interaction, receiving water for Yando, Kempston and Watsonia drains. Project boundary would extend along railway to Greensborough railway station to facilitate railway works with no impact on surface water.	None	•	•	•	•
Glass Creek	Yarra River tributary which passes beneath the Eastern Freeway to the west of Burke Road	Additional lanes at this location within the footprint of the existing freeway.	Additional Pavement	✓	✓	•	•

Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Koonung Creek	A significant but highly modified urban tributary of the Yarra River with reaches varying from underground arches to semi-naturalised.	Diversions and realignment along sections of the Eastern Freeway to accommodate road widening	Potential loss of storage, attenuation, treatment and change in flows and waterway stability	✓	✓	✓	•
Main Drains (including associated overland flow paths)							
Yando Street	Tributary of Plenty River	Project earthworks would reduce flood storage, extend culverts and change drainage inlets. Shared use path bridge and piers would interact with floodplain	Potential increase in flood frequency and levels	✓	•	•	•
Kempston Street	Tributary of Yando Street	The shared use path underpass would reduce the storage within the retarding basin immediately upstream (south) of Grimshaw Street. Further floodplain storage may be removed as a result of the northbound entrance ramp from Grimshaw street.	Potential increase in flood frequency and levels	✓	✓	•	•
		Potentially temporary construction compound in vicinity	Potential impact during construction				
Banksia Street	Yarra tributary	None	None	•	•	•	•
Alexandra Parade	Merri Creek tributary	None	None	•	•	•	•
Kew Mental Hospital	Yarra tributary which passes beneath the Eastern Freeway to the west of Burke Road	Additional lanes at this location within the footprint of the existing freeway	Additional Pavement	•	✓	•	•

Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Kew	Yarra tributary which passes beneath the Eastern Freeway to the west of Burke Road	Additional lanes at this location within the footprint of the existing freeway	Additional Pavement	•	✓	•	•
Glass Creek	Yarra tributary which passes beneath the Eastern Freeway to the west of Burke Road	Additional lanes at this location within the footprint of the existing freeway	Additional Pavement	•	✓	•	•
Aquia St	Yarra tributary which passes beneath the Eastern Freeway between Burke Road and Bulleen Road	Additional lanes at this location within the footprint of the existing freeway	Additional Pavement	•	✓	•	•
Minerva Ave	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Ayr Street	An urban tributary of Koonung Creek which passes beneath the Eastern Freeway from the north side	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected. Potential loss of flood storage and afflux.	Potential loss of flood storage and afflux on the north side. Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Gardenia Road	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•

Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Elms Grove	An urban tributary of Koonung Creek which passes beneath the Eastern Freeway from the north side	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected. Potential loss of flood storage and afflux.	Potential loss of flood storage and afflux on the north side. Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Bushy Creek	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Box Hill North	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Nothing specific. Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Lees Road	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Blackburn Road	An urban tributary of Koonung Creek	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected	Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•

Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Dunlavin Road	An urban tributary of Koonung Creek which passes beneath the Eastern Freeway from the south side	Indirect interaction with project is possible given that downstream connection to Koonung Creek may be affected. Potential loss of flood storage and afflux.	Potential loss of flood storage and afflux on the south side. Any changes would be part of the Koonung Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Other surface water bodies							
Kalparrin Gardens wetland and retarding basin	Wetlands on Yando St MD, downstream of the works	Upstream works can affect the flows incoming	Could be affected by increased flow or pollutants	•	•	•	•
Grimshaw Street Retarding Basin	RB south and upstream of Grimshaw Street (north of AK Line Reserve)	Shared use path might reduce storage in the basin	Loss of flood storage, possible afflux in the basin and increased flooding over Grimshaw St	✓	•	•	•
Watsonia Station and rail line	Rail line under Greensborough Hwy	Minimal if no extra runoff is directed to the rail corridor	None	•	•	•	•
Simpson Barracks wetlands	Informal wetlands within Simpson Barracks	Minor	Any changes would be part of the Banyule Creek works which would need to consider all tributaries and drainage inflows.	•	•	•	•
Banyule Flats	At the confluence of Banyule Creek and the Yarra River	Tunnelling under	None	•	•	•	•
Annulus Billabong	Billabong south of Manningham Road and north of Bolin Bolin Billabong	Across the river from works and temporary construction compound to be investigated in vicinity	None	•	•	•	•

Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Bolin Bolin Billabong	A billabong of high ecological and cultural significance to the north of the Veneto Club and Bulleen Park to the west of Bulleen Road.	No project interaction from a surface water perspective. Potential groundwater impacts are discussed in EES Technical report N – Groundwater.	None	.	.	.	.
Bolin Bolin Storage and Wetland	Recently constructed on Crown Land immediately south of Bolin Bolin Billabong to the Bulleen Road	Change in local drainage network upstream of the system	Potential change in flow to stormwater harvesting system.				✓
Trinity Grammar School Sporting Complex irrigation storage	Irrigation dam located on Banyule Road with overflow to Yarra River.	Irrigation storage is intersected by the alignment	Loss of irrigation storage	.	.	.	✓
Trinity Grammar School Sporting Complex wetlands	Wetlands upstream of irrigation storage	Potential for changed outlet conditions or modifications to upstream diversion structure.	Potential change in flow regime.				
Chandler Park Wetlands	Proposed wetlands near eastbound entrance to Eastern Freeway from Chandler Highway	Extension of wetlands being investigated to allow for treatment of road runoff from the Eastern Freeway	Improve water quality treatment	.	✓	.	.
The Kew Billabong	North of Eastern Freeway west of Willsmere Park	Being investigated for water quality treatment use	Very minor loss of flood storage or increased pollutants	.	✓	.	.
Kew Golf Club Storage	Located immediately north of where Glass Creek cross beneath the Eastern Freeway	Being investigated for water quality treatment use		.	✓	.	.
Burke Road Billabong Reserve	north west of Burke Road crossing of Eastern Freeway	None	None	.	.	.	.

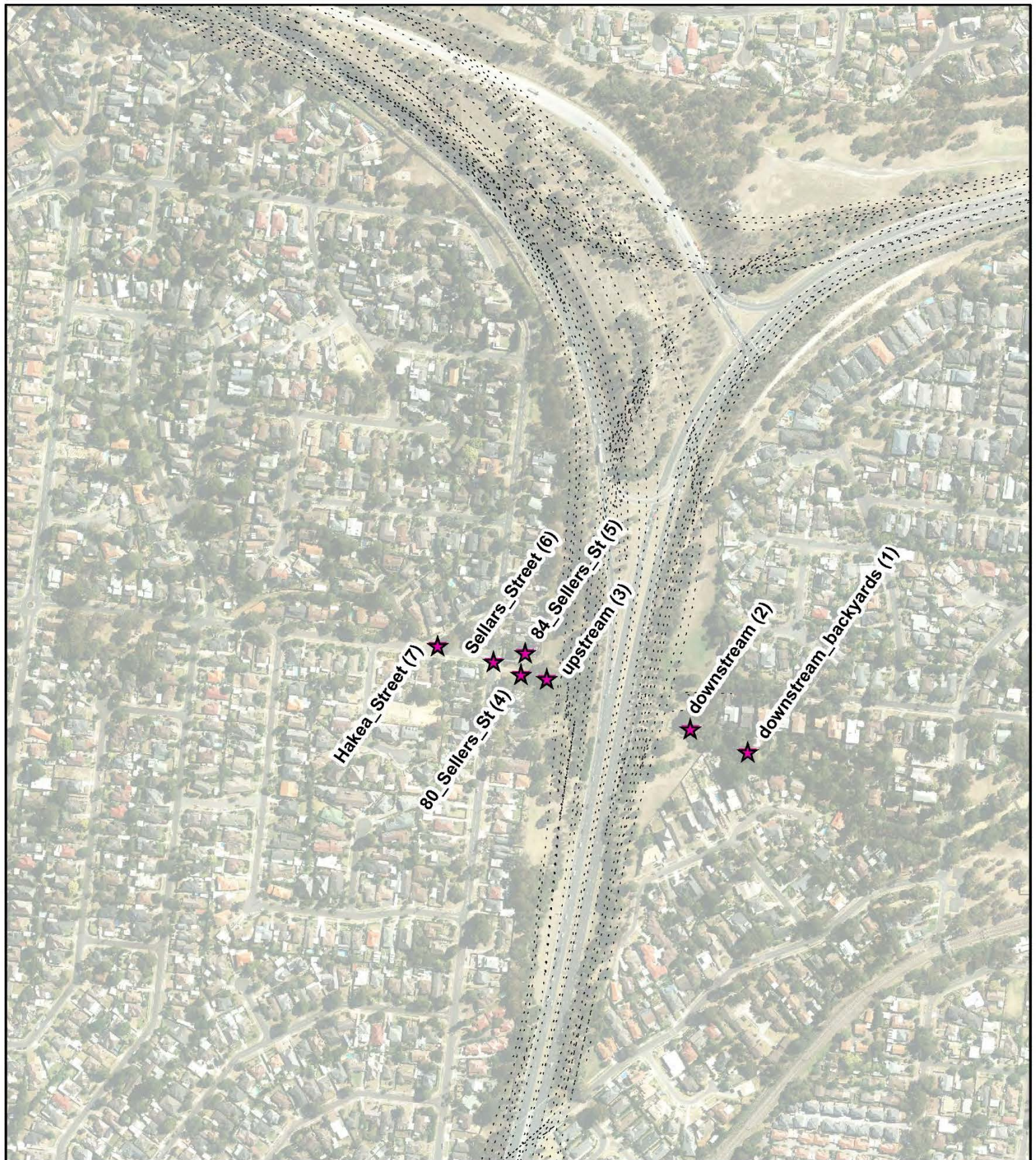
Surface water feature	Brief description	Interaction with project	Potential surface water impact	Further assessment			
				Flooding	Water quality	Geomorphology	Water supply
Freeway Public Golf Course Wetlands	Immediately north of the Eastern Freeway within the Yarra River floodplain	Being investigated for water quality treatment use		•	✓	•	•
Koonung Creek Wetlands (Wilburton Parade)	Wetlands on Koonung Creek, south of the Eastern Freeway	Relocation of wetland needs to be investigated		•	✓	•	•
Koonung Creek Wetlands (Valda Avenue)	Wetlands on Koonung Creek, south of the Eastern Freeway	Relocation of wetland needs to be investigated		•	✓	•	•
Koonung Creek Wetlands (Middleborough Road)	Wetlands on Koonung Creek, north of the Eastern Freeway	Being investigated for water quality treatment use		•	✓	•	•



## Appendix D – Comparison of select model results at select locations.

D1	Yando Street Main Drain
D2	Kempston Street Main Drain
D3	Watsonia Station drain
D4	Banyule Creek
D5	Yarra River
D6	Koonung Creek





## LEGEND

★ Selected Locations



Paper Size A4  
0 30 60 120  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	D
Date	13/11/2018

Yando Street Main Drain  
Comparison Locations

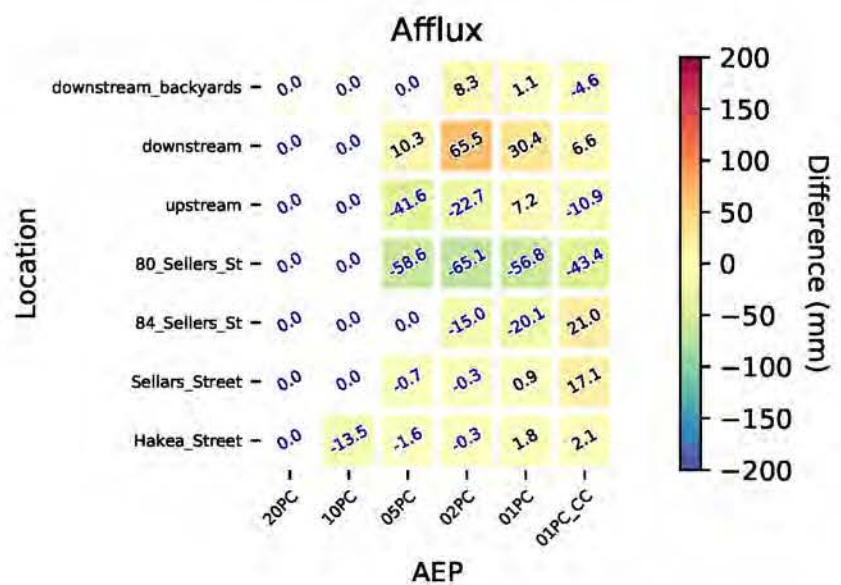
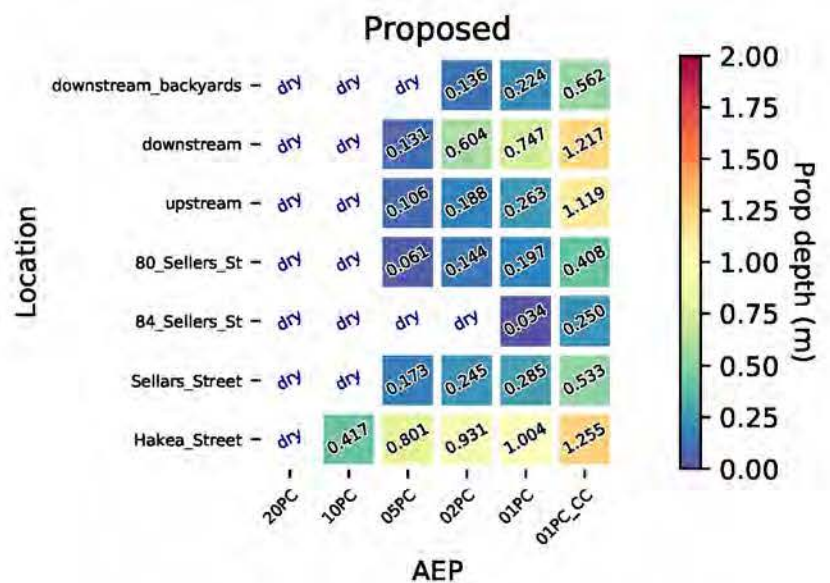
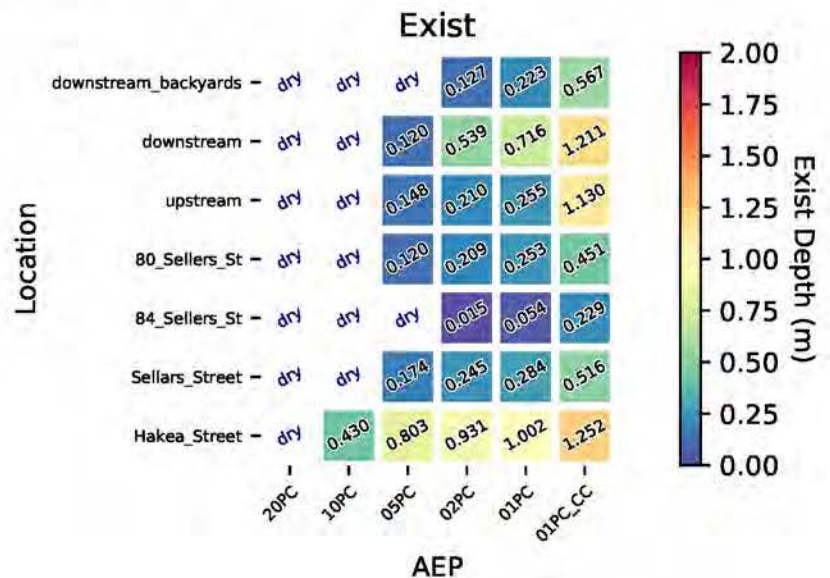
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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

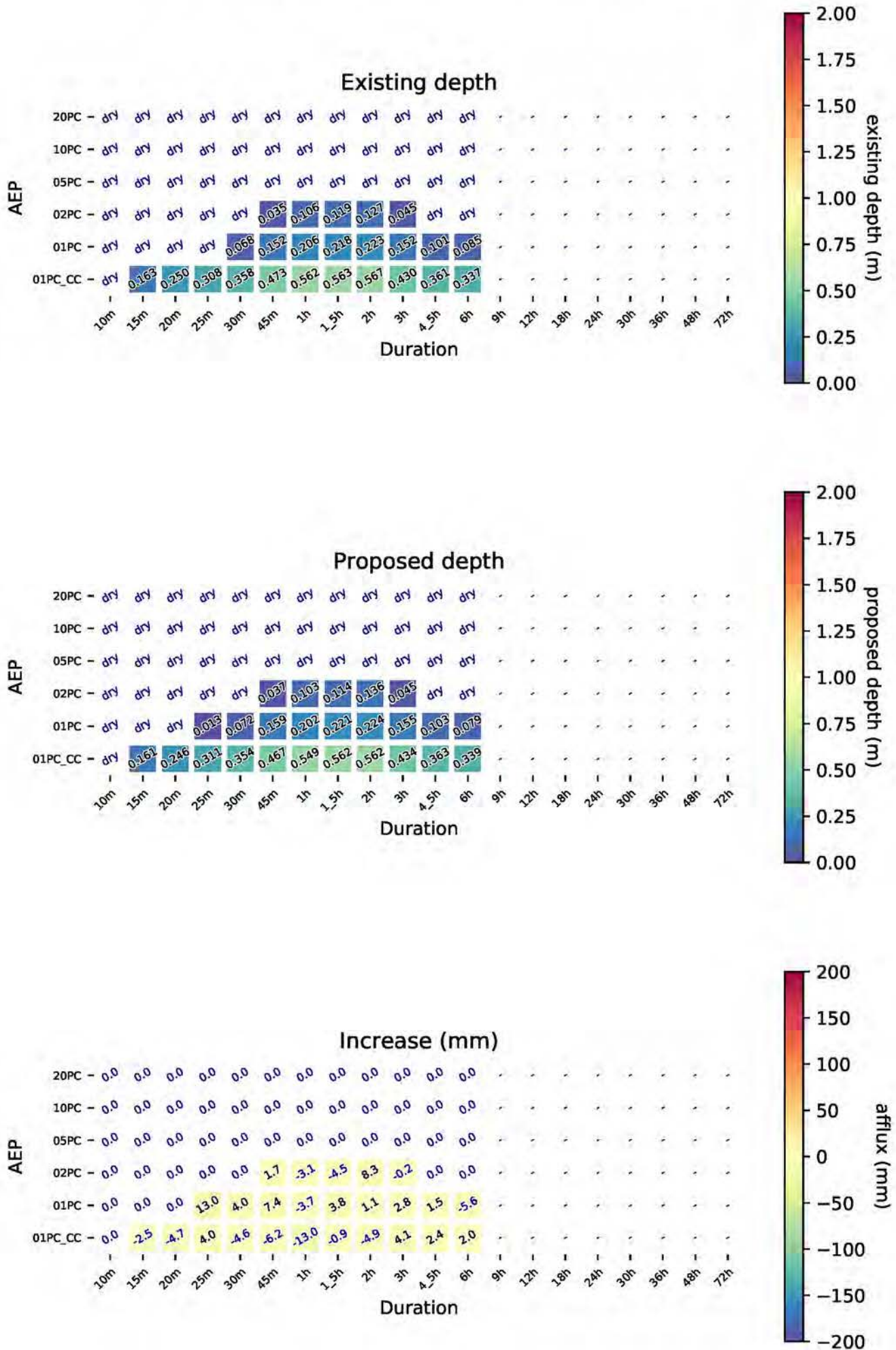
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# Yando Main Drain - Overview

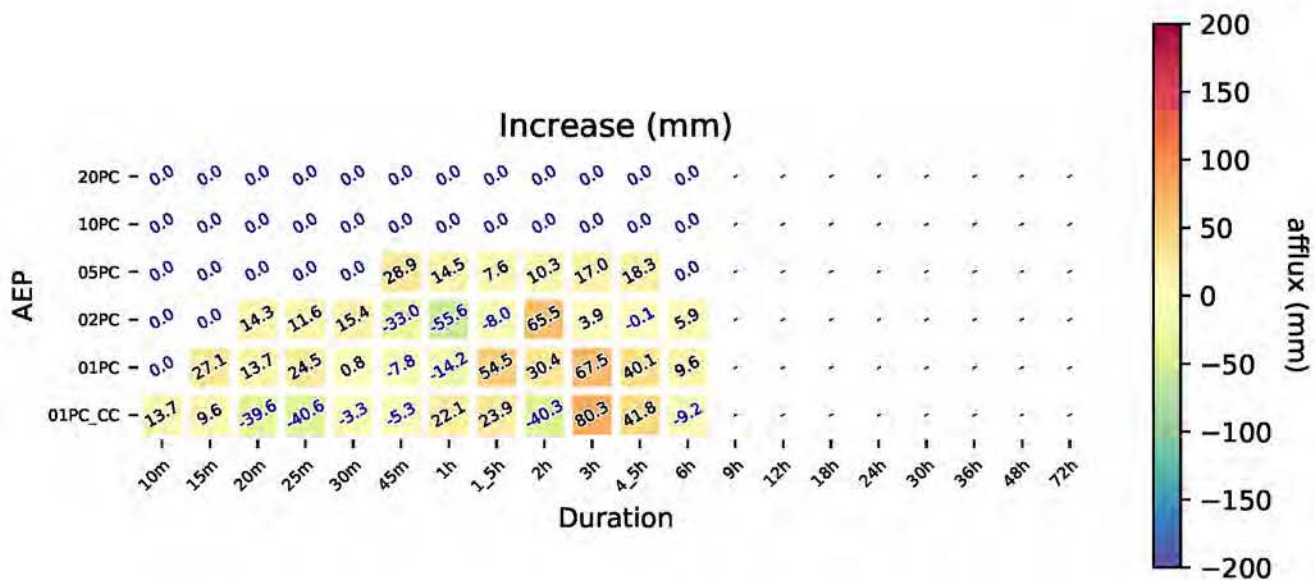
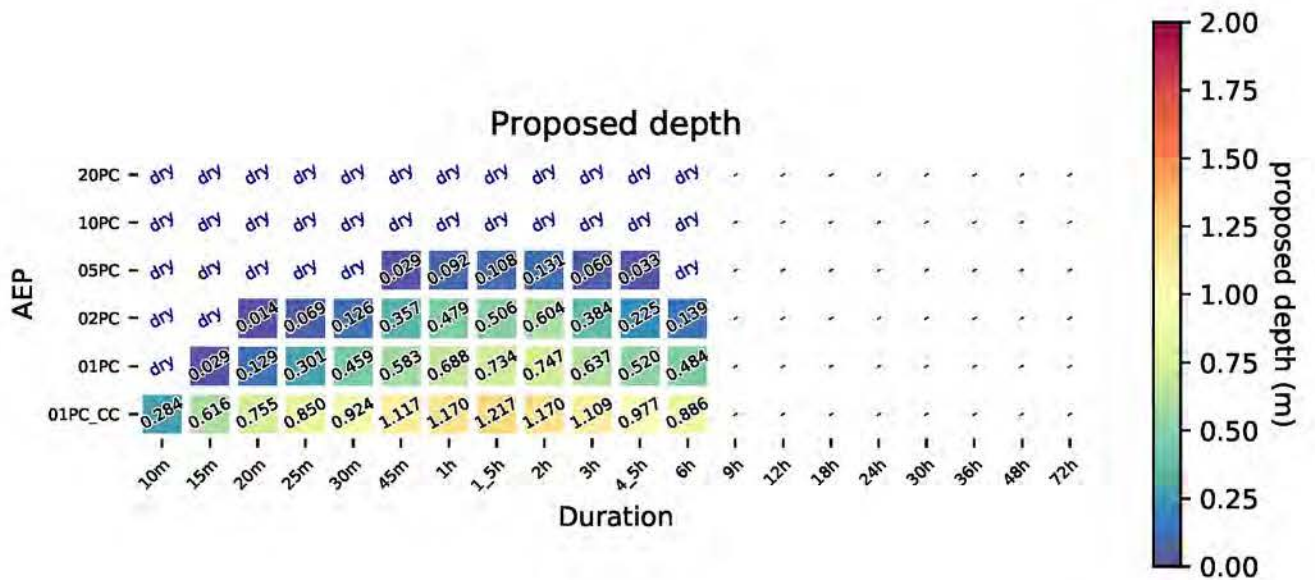
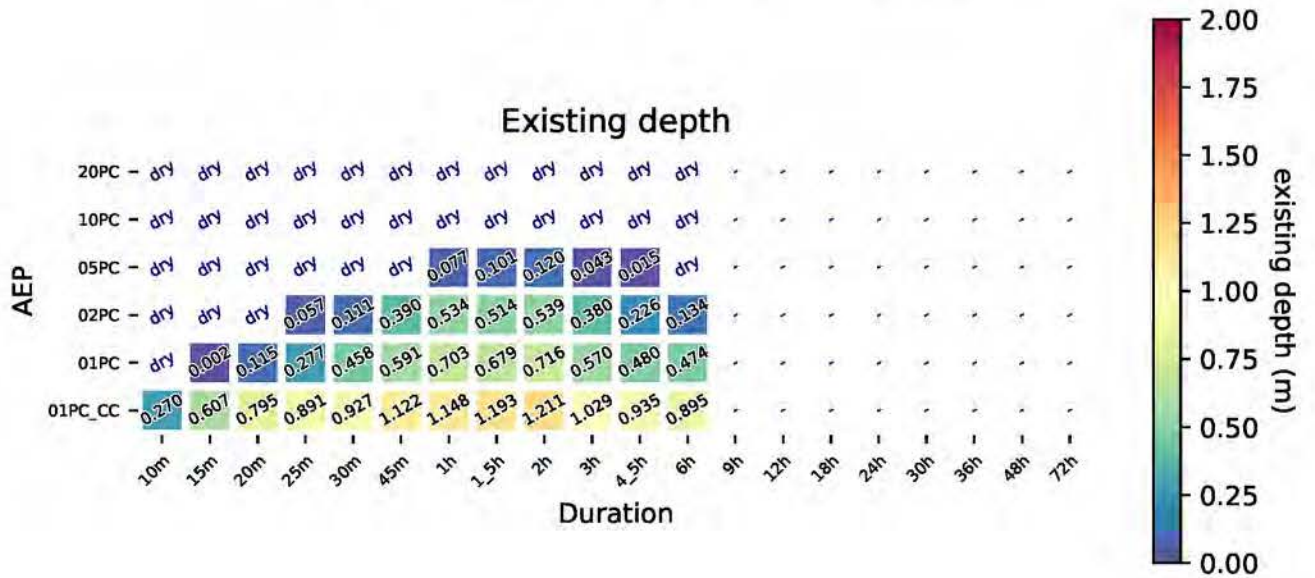


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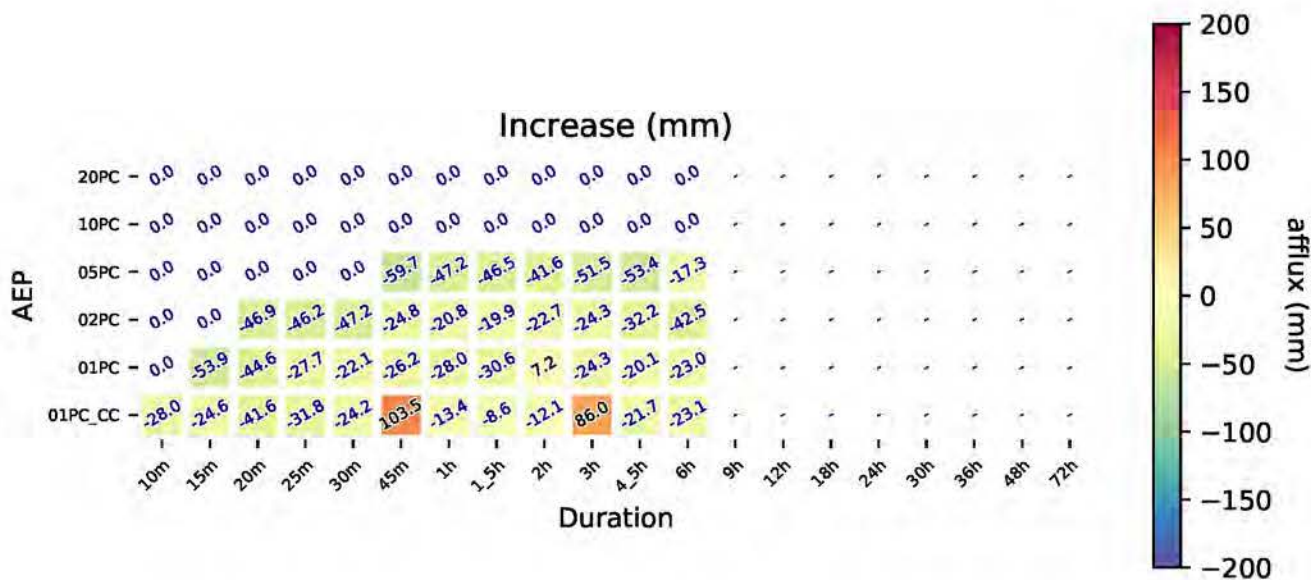
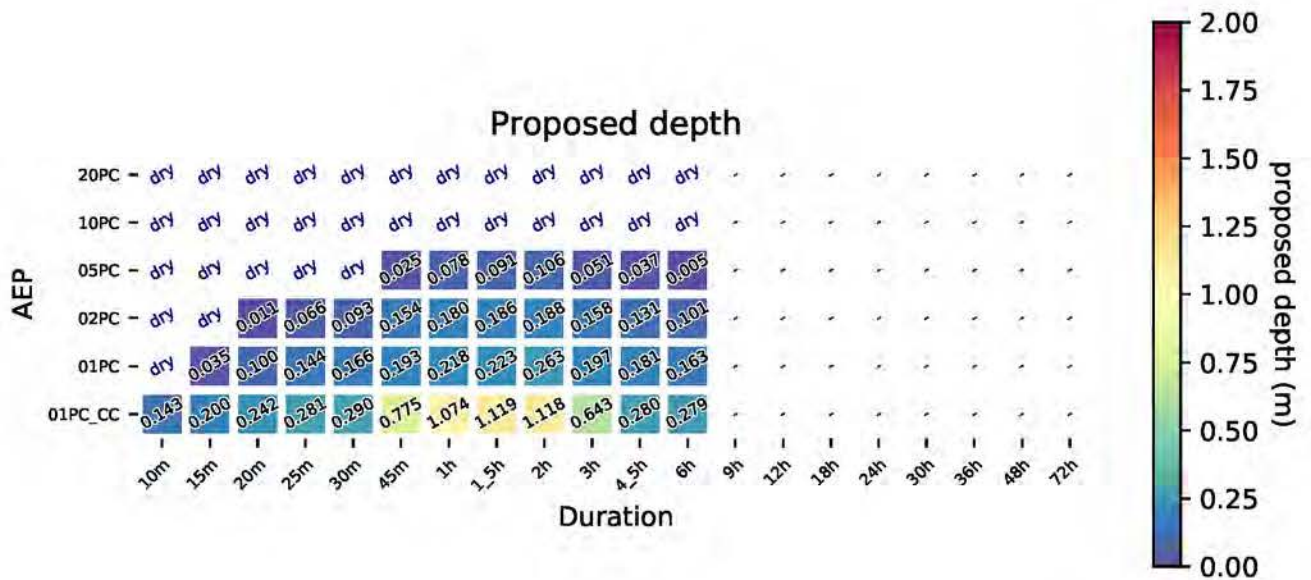
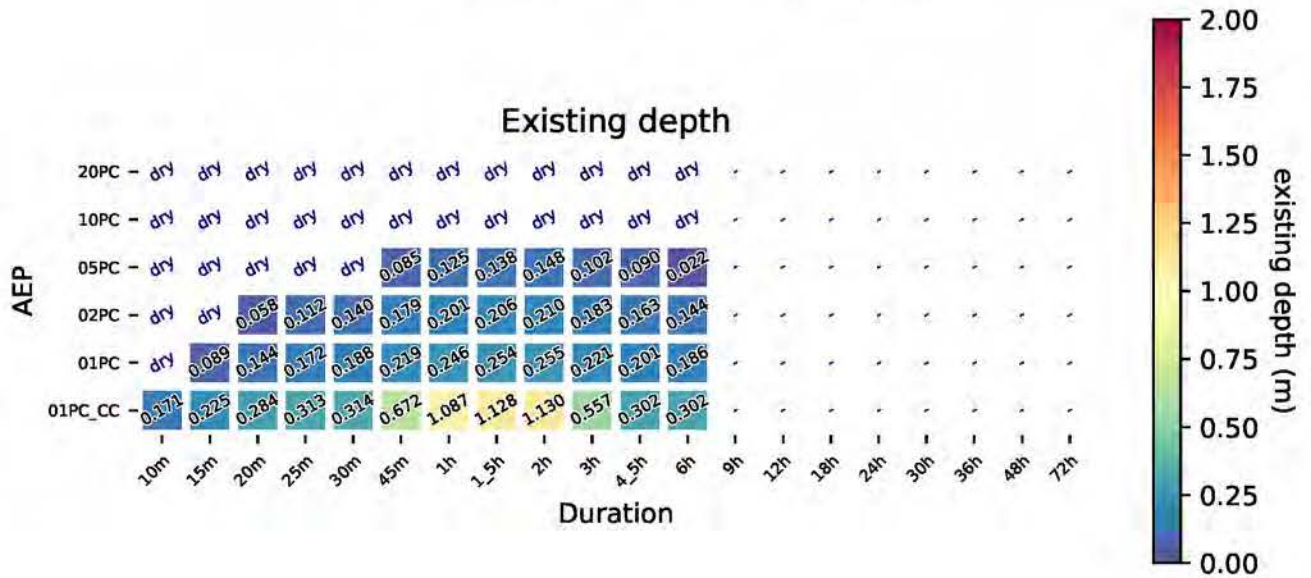




# Yando Main Drain - downstream

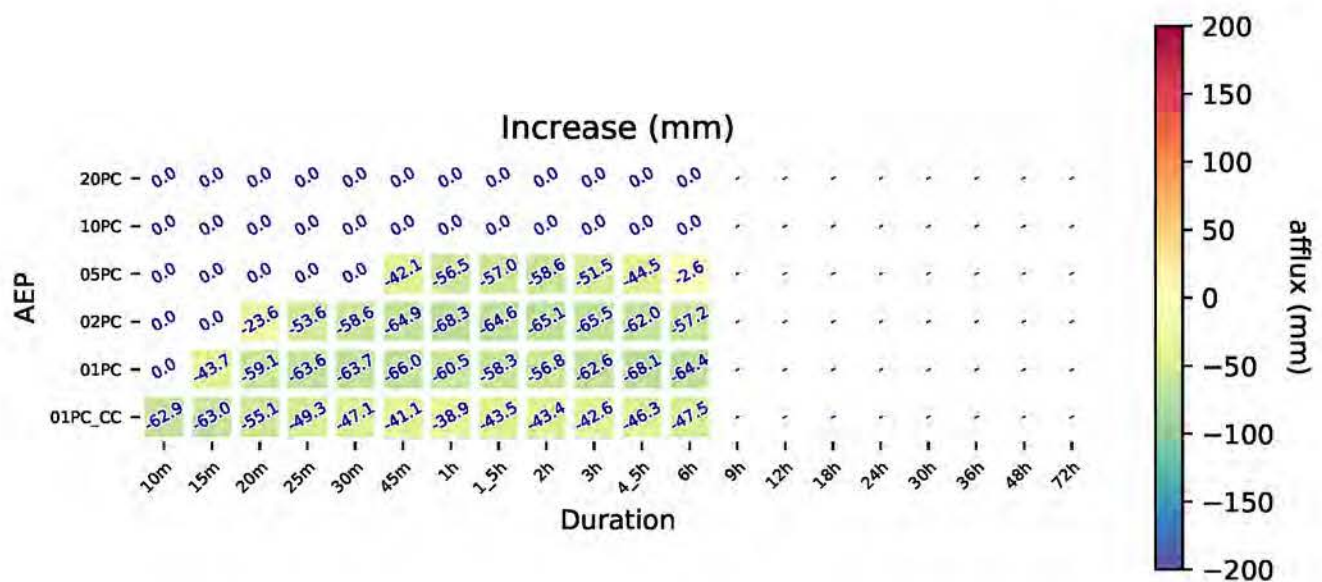
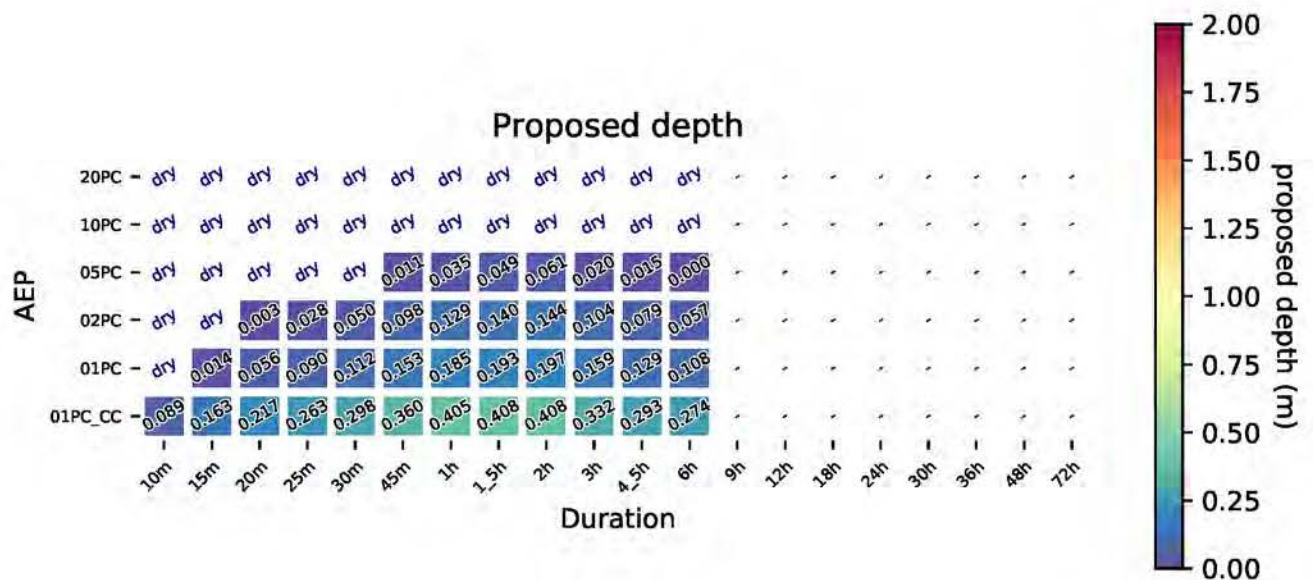
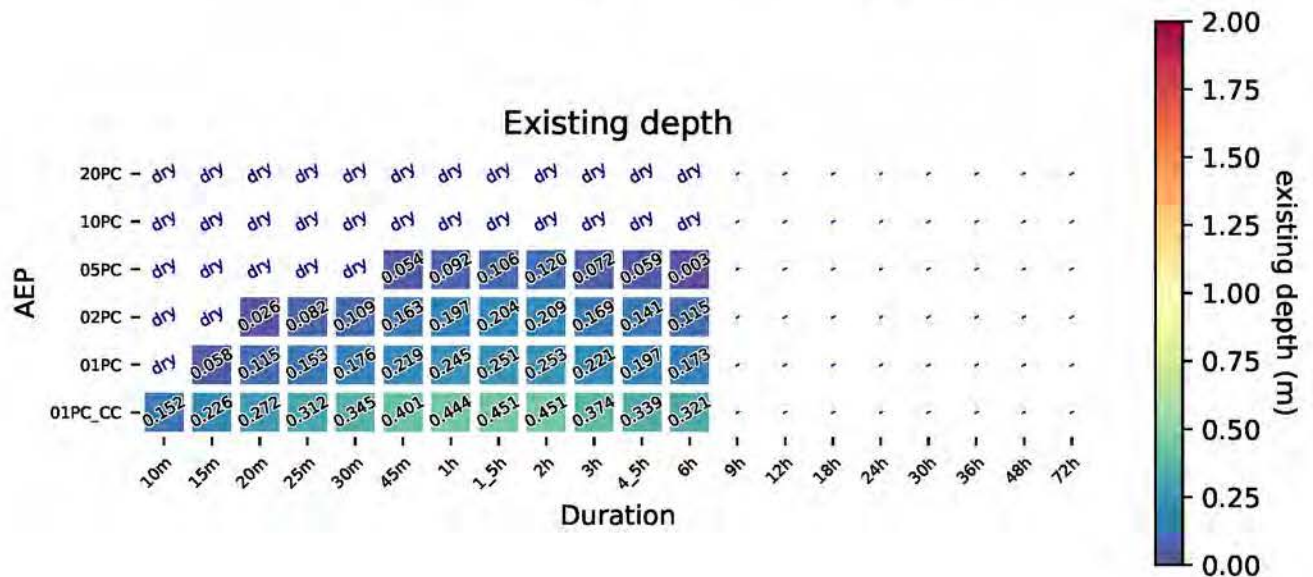


# Yando Main Drain - upstream

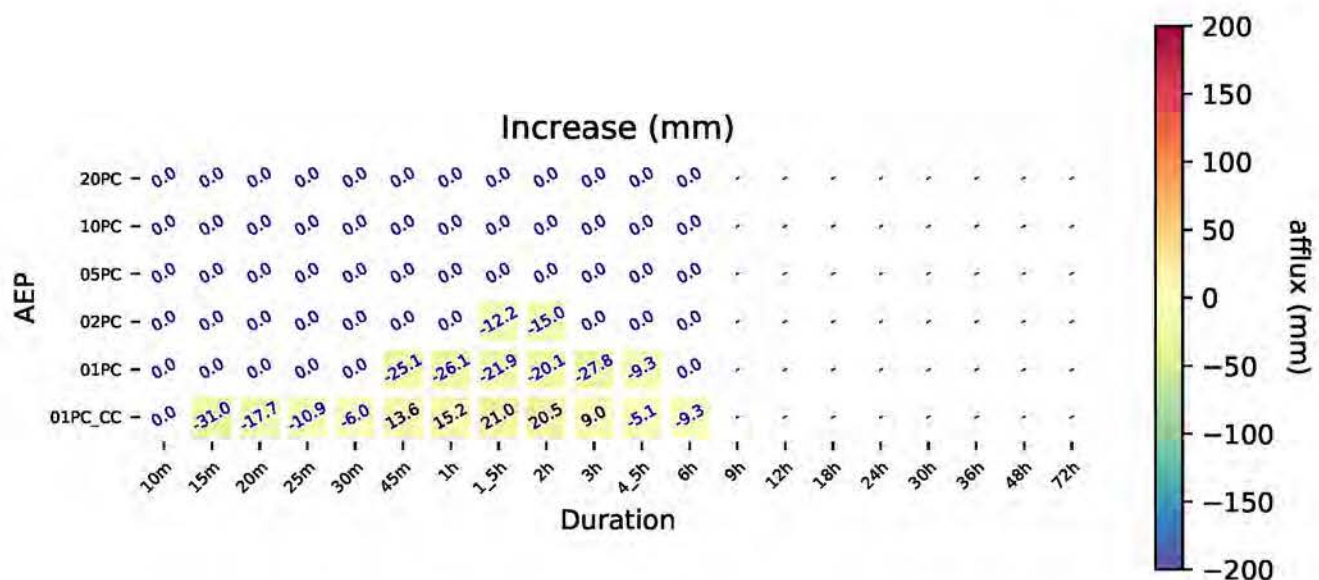
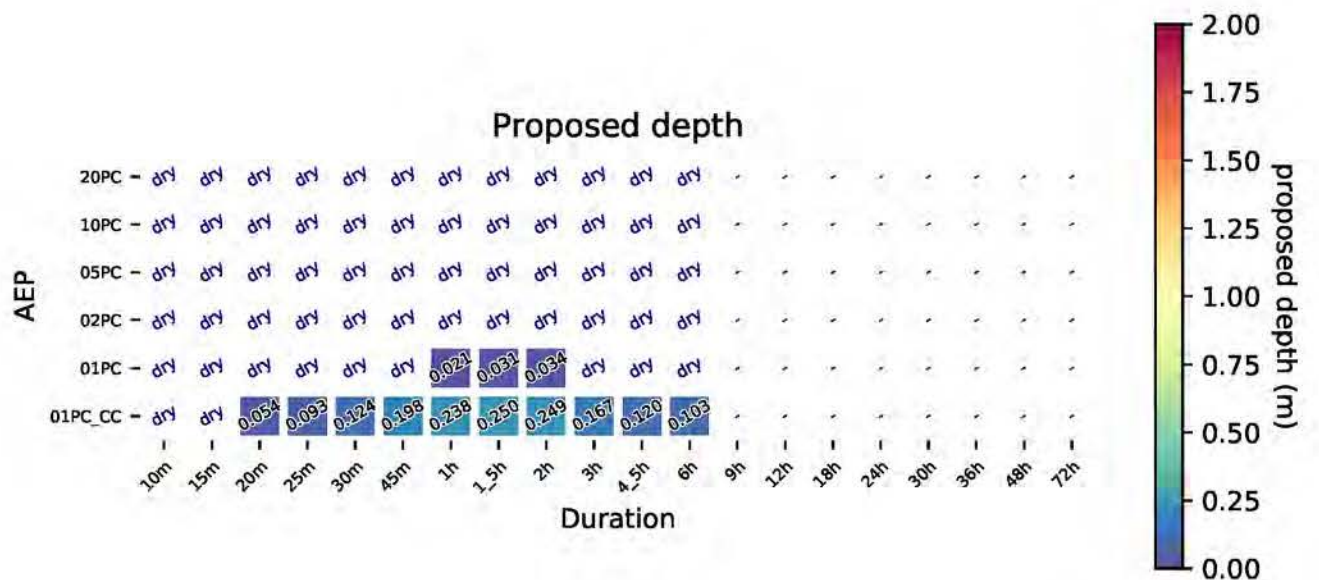
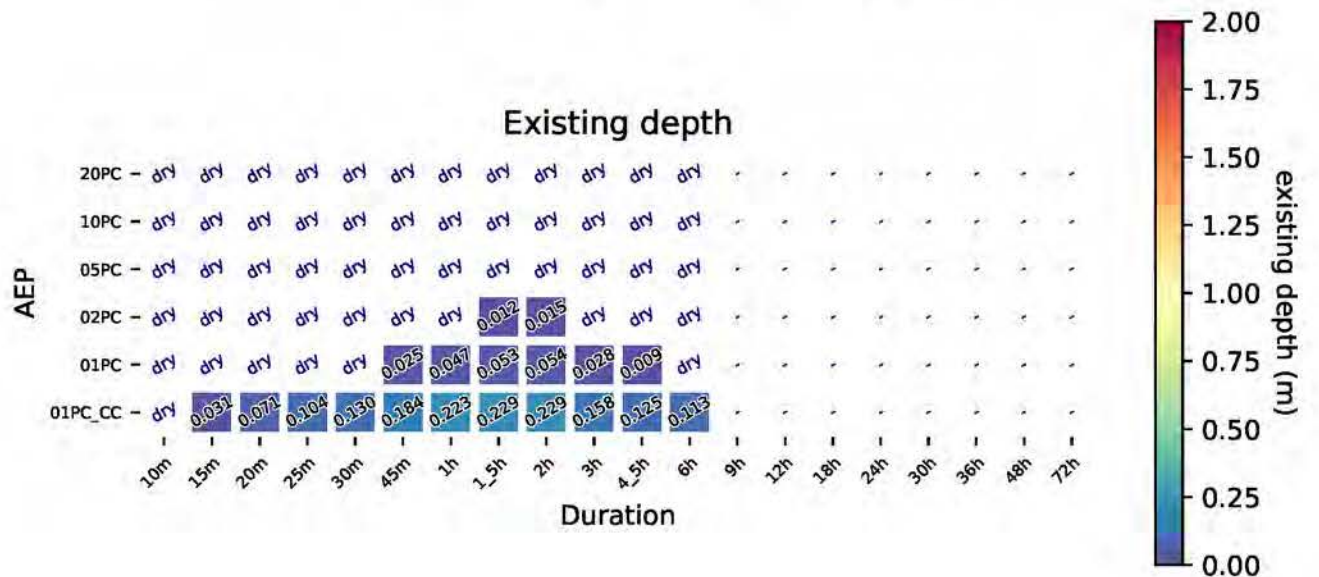




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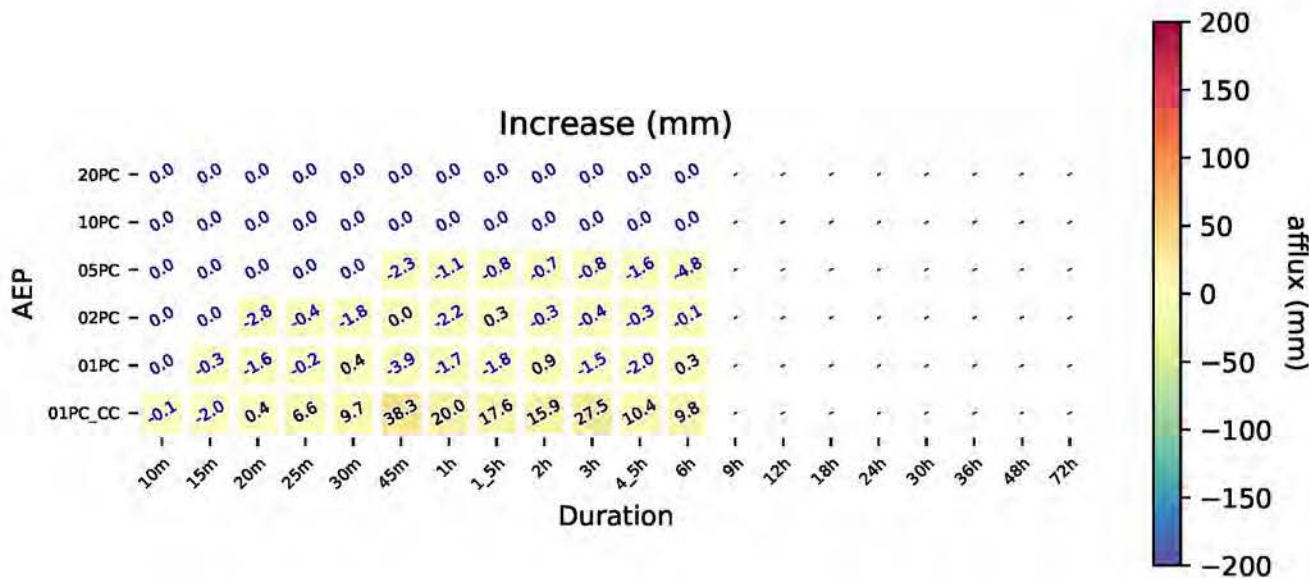
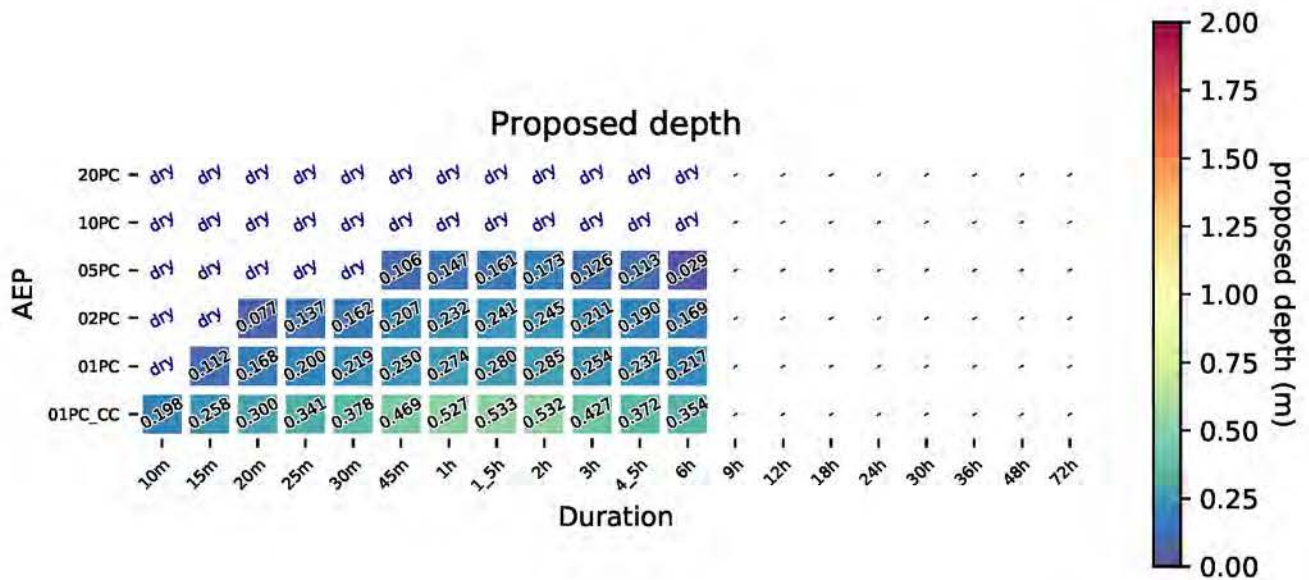
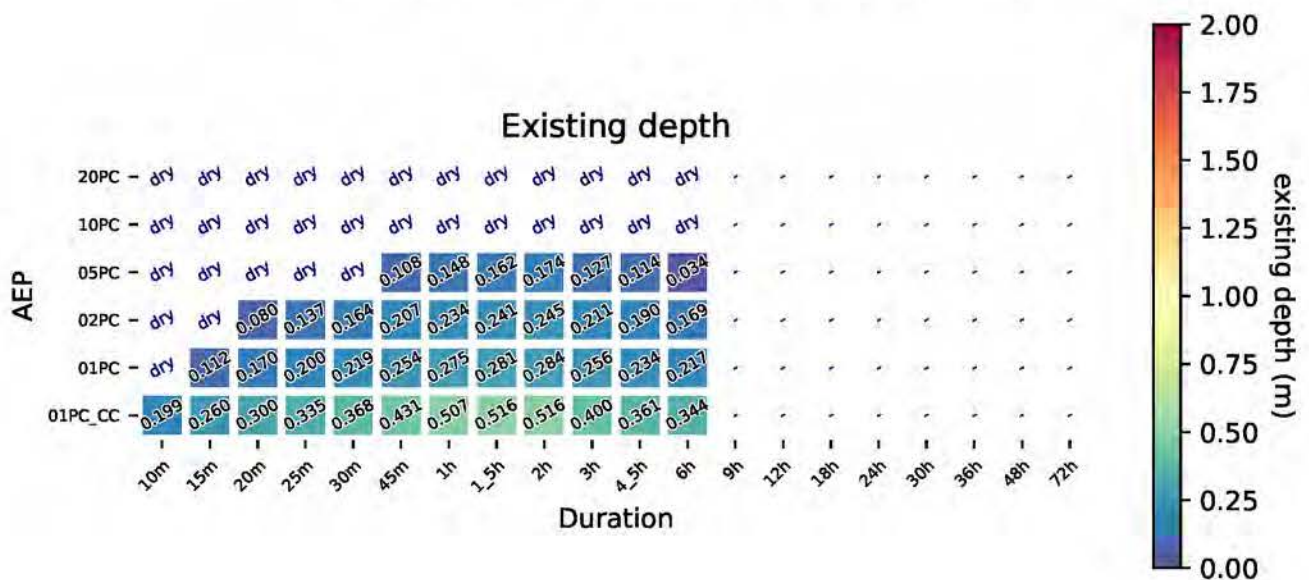


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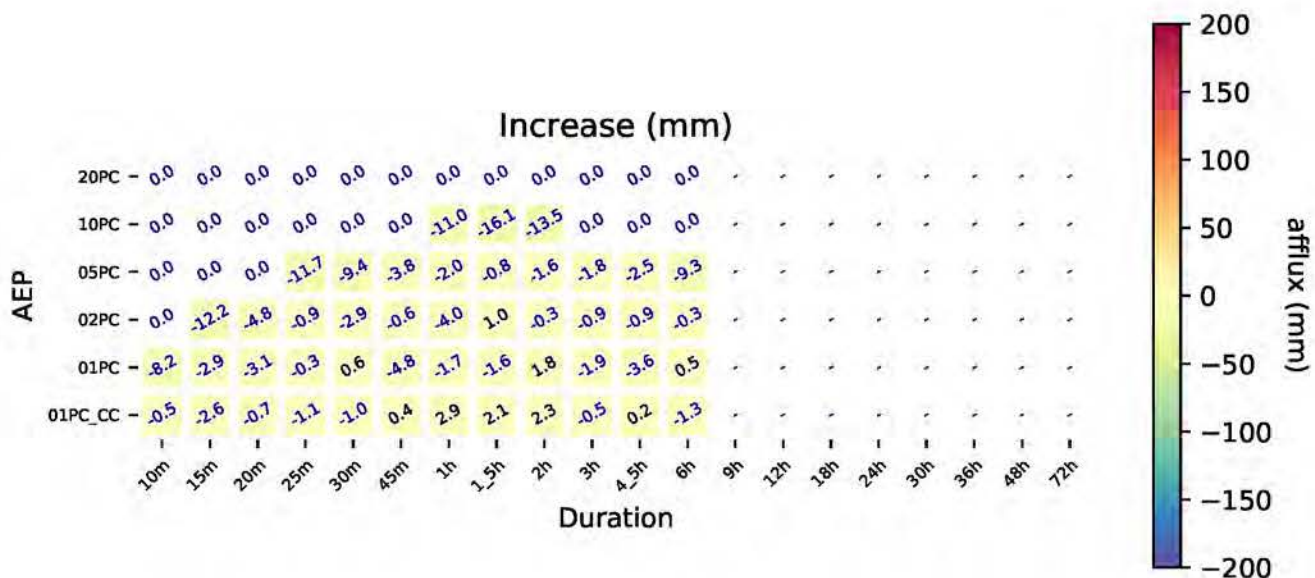
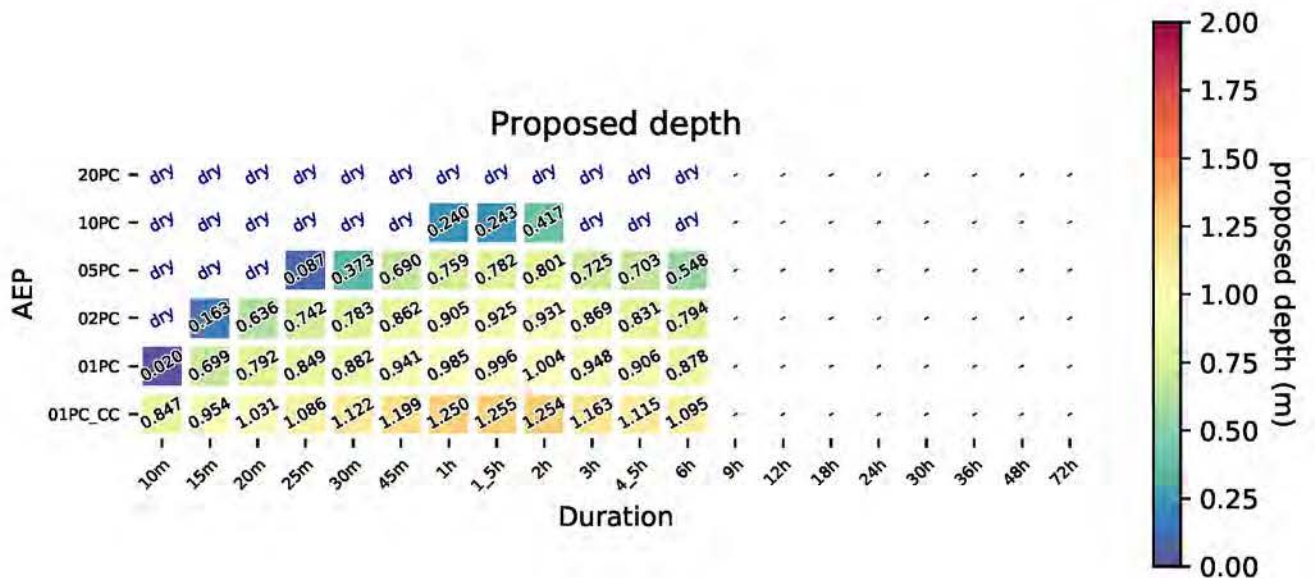
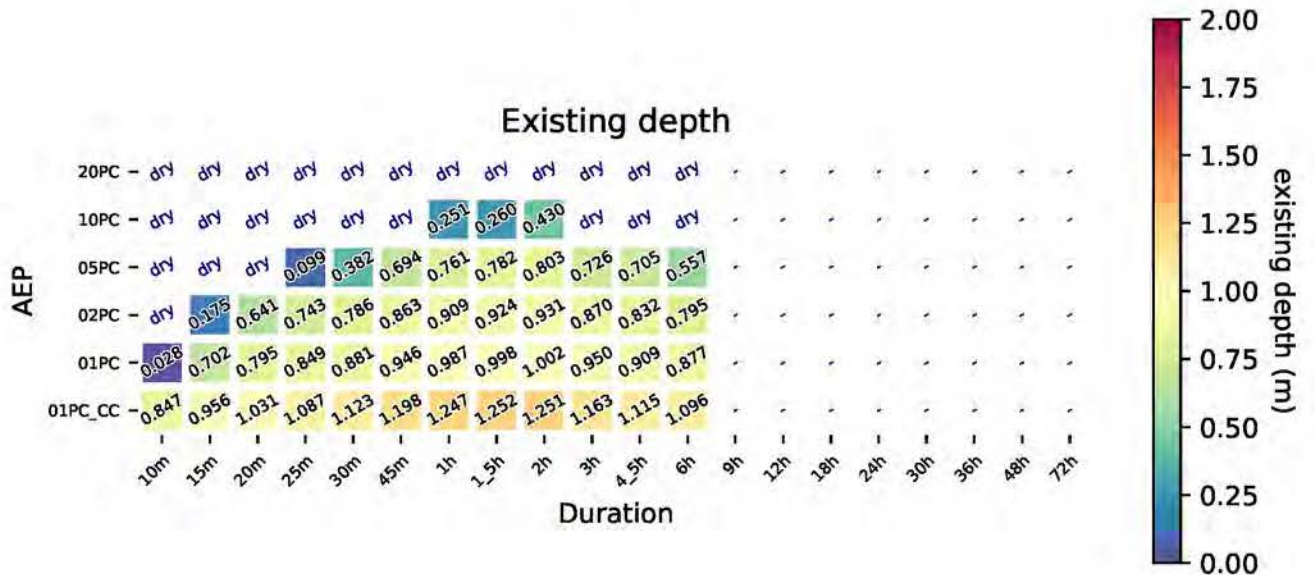




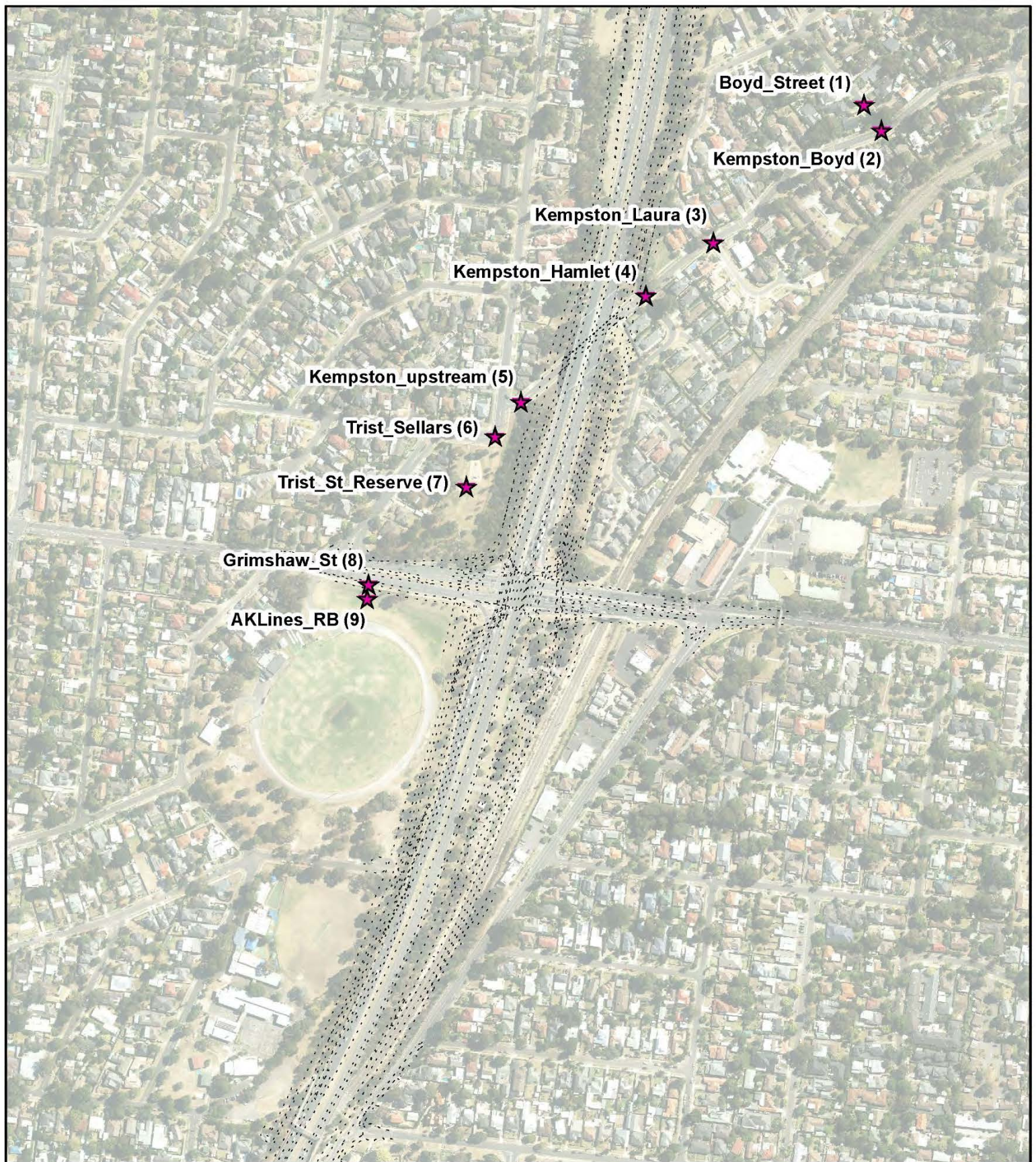
Yando Main Drain - Sellars\_Street



# Yando Main Drain - Hakea\_Street







## LEGEND

★ Selected Locations



Paper Size A4  
0 30 60 120  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	C
Date	13/11/2018

Kempston Street Main Drain  
Comparison Locations

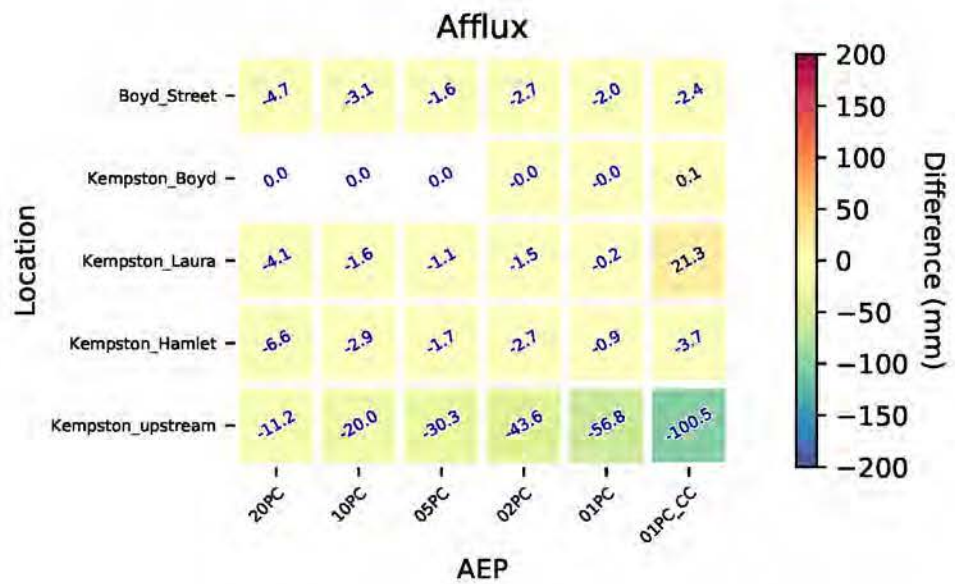
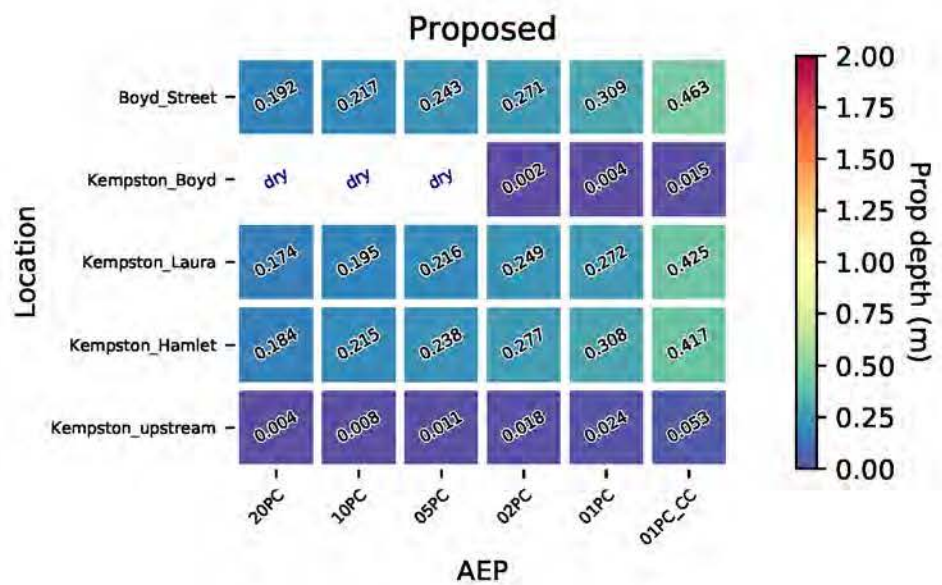
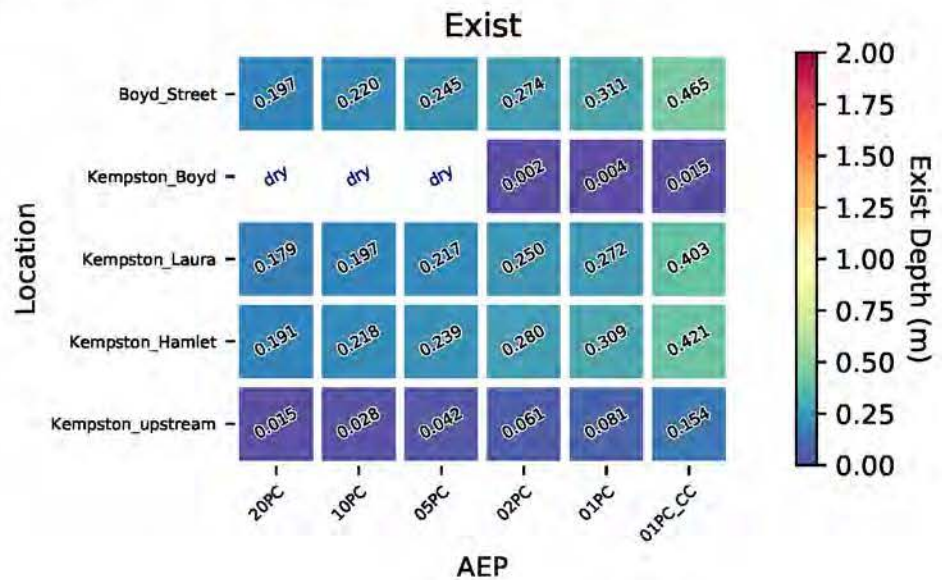
Appendix D-2

G:\3135006\GIS\Maps\Working\Specialist Submission\EESS\Groundwater and Hydrology\Surface\_Water\35006\_Hydraulic\Kempston Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com  
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

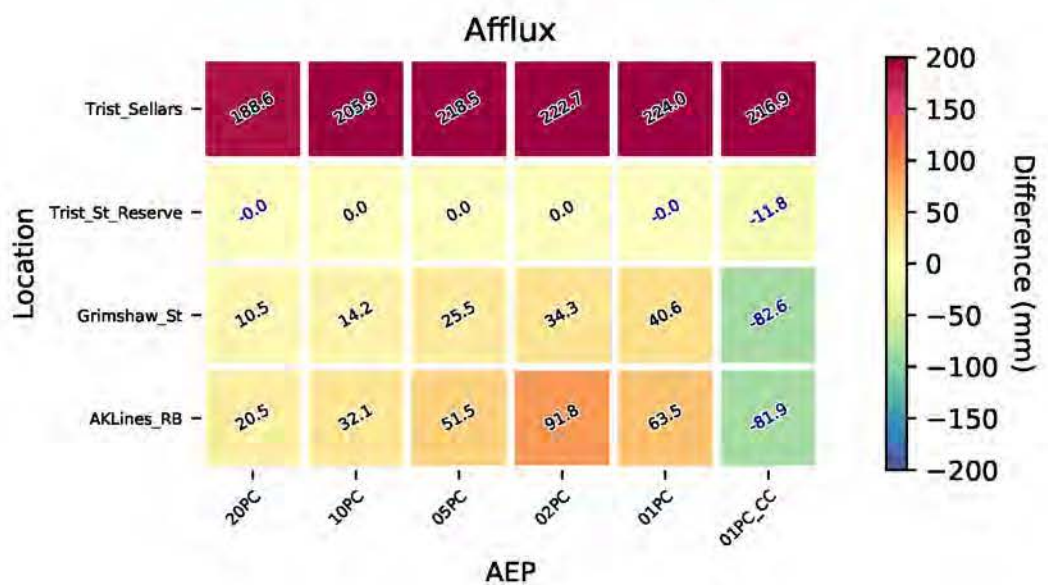
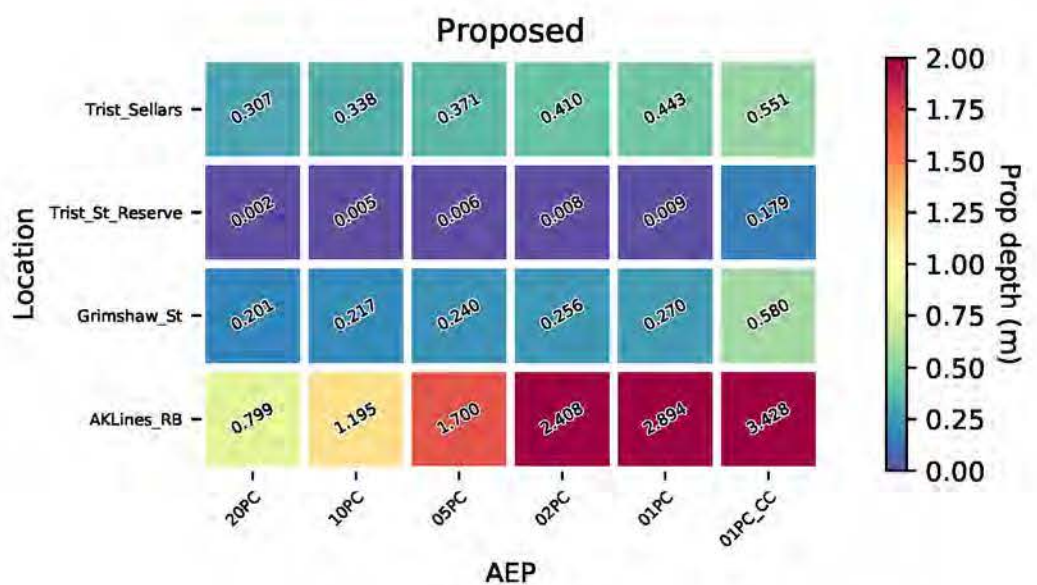
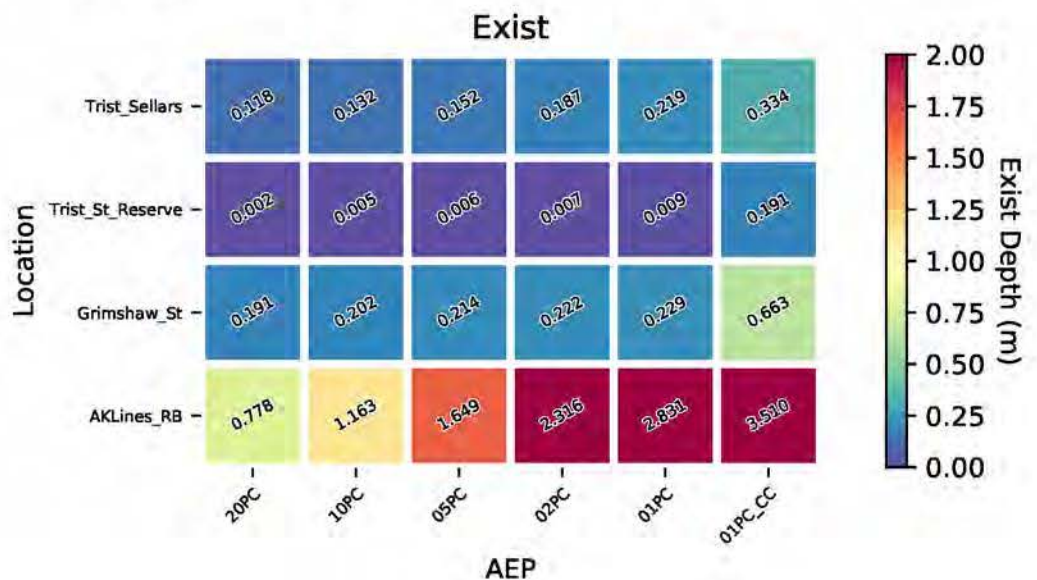
© 2018. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.



# Kempston Main Drain - Overview

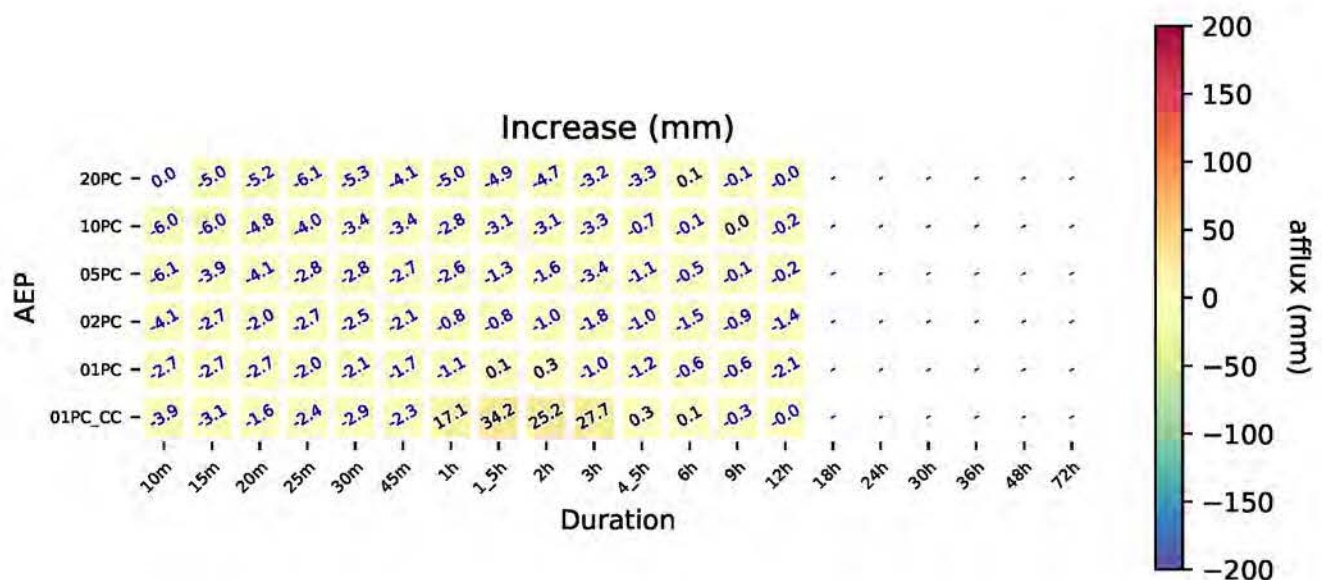
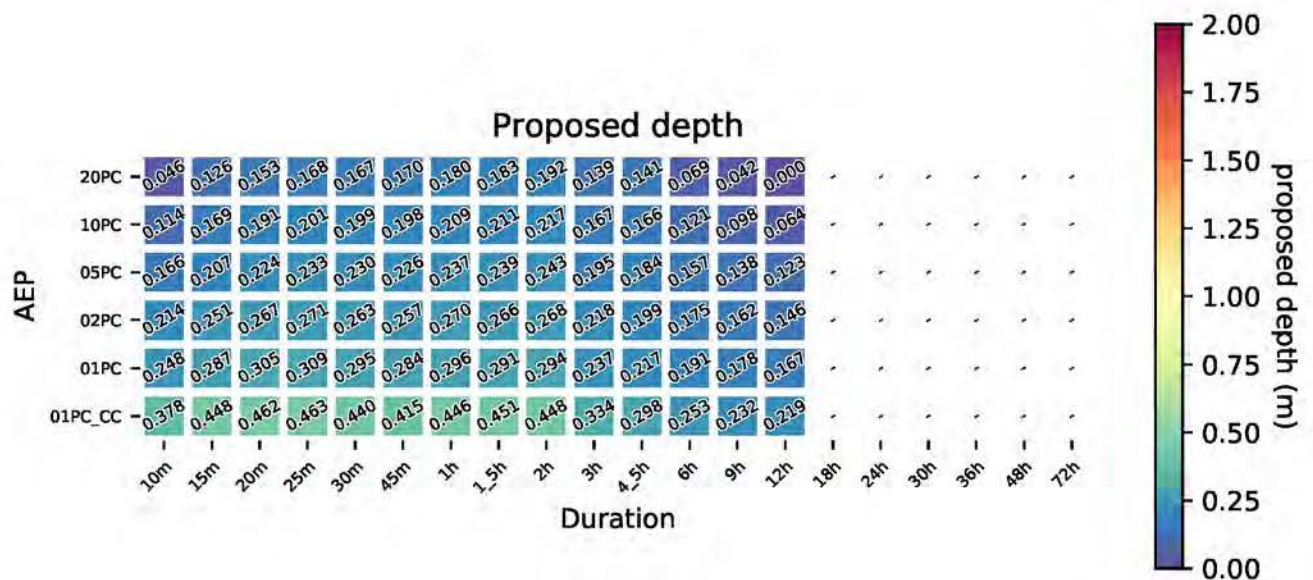
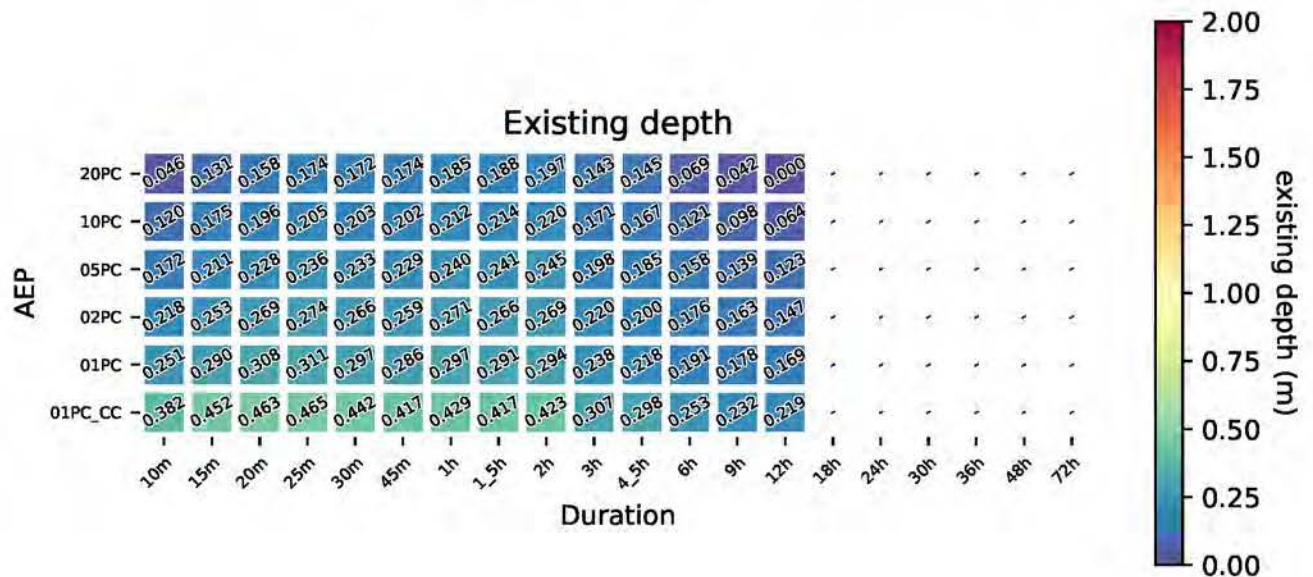


# Kempston Main Drain - Overview

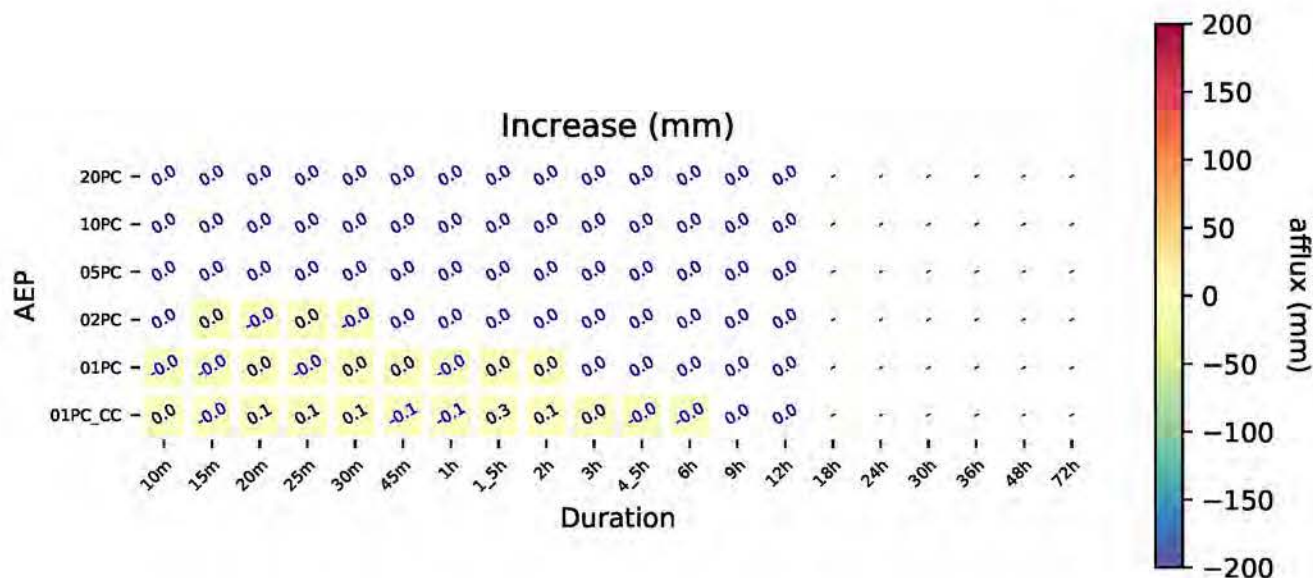
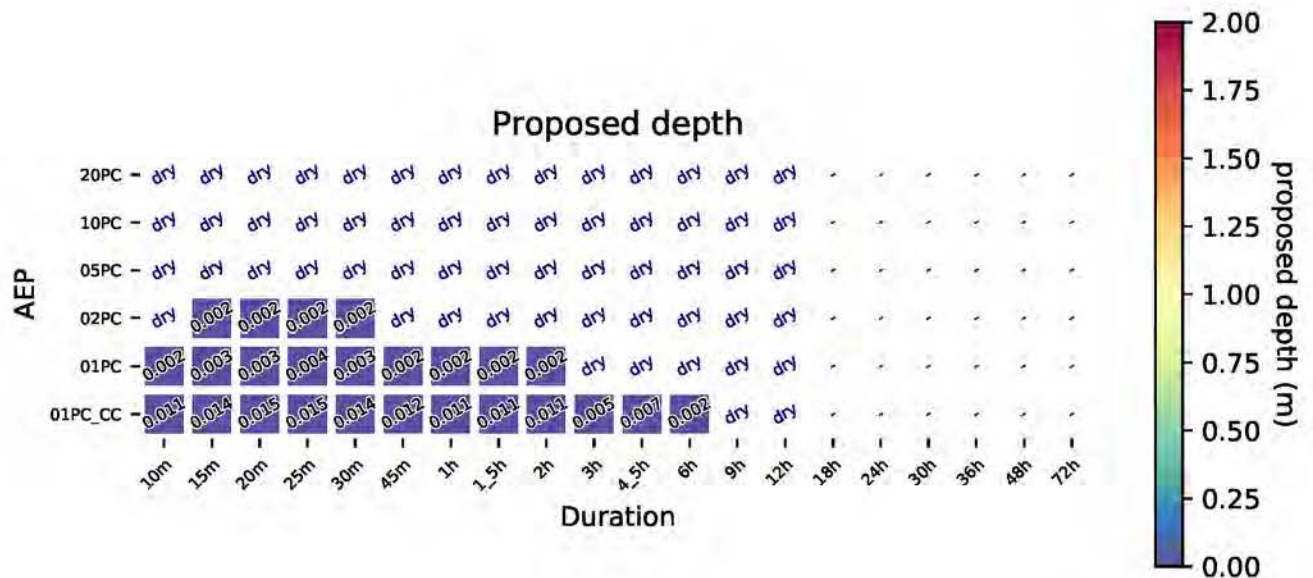
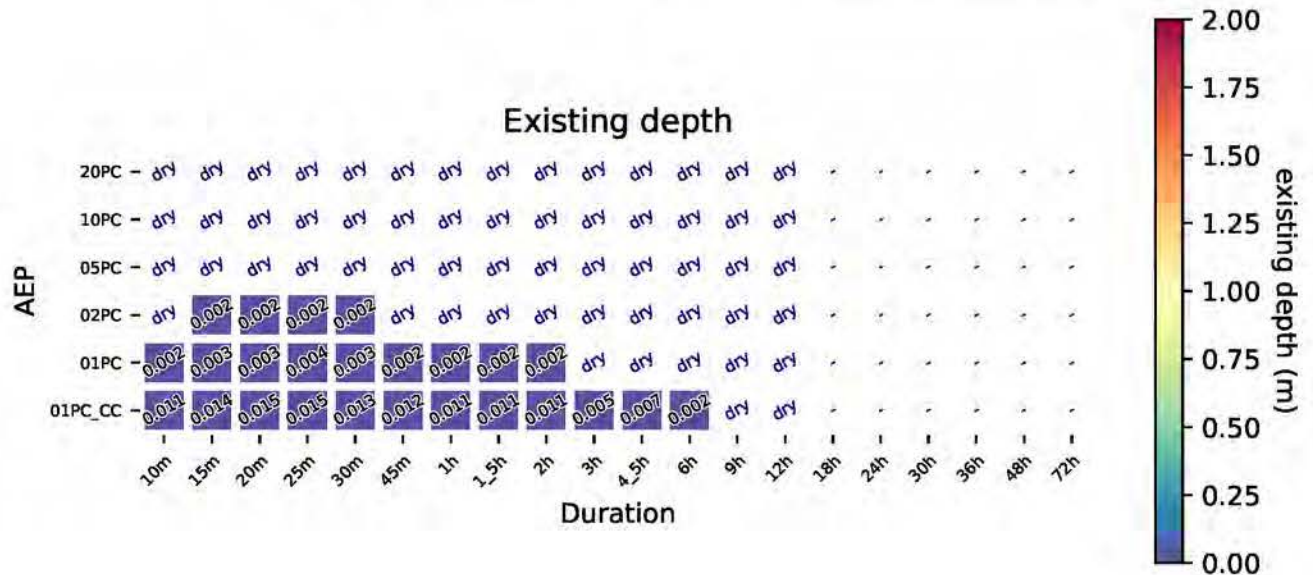




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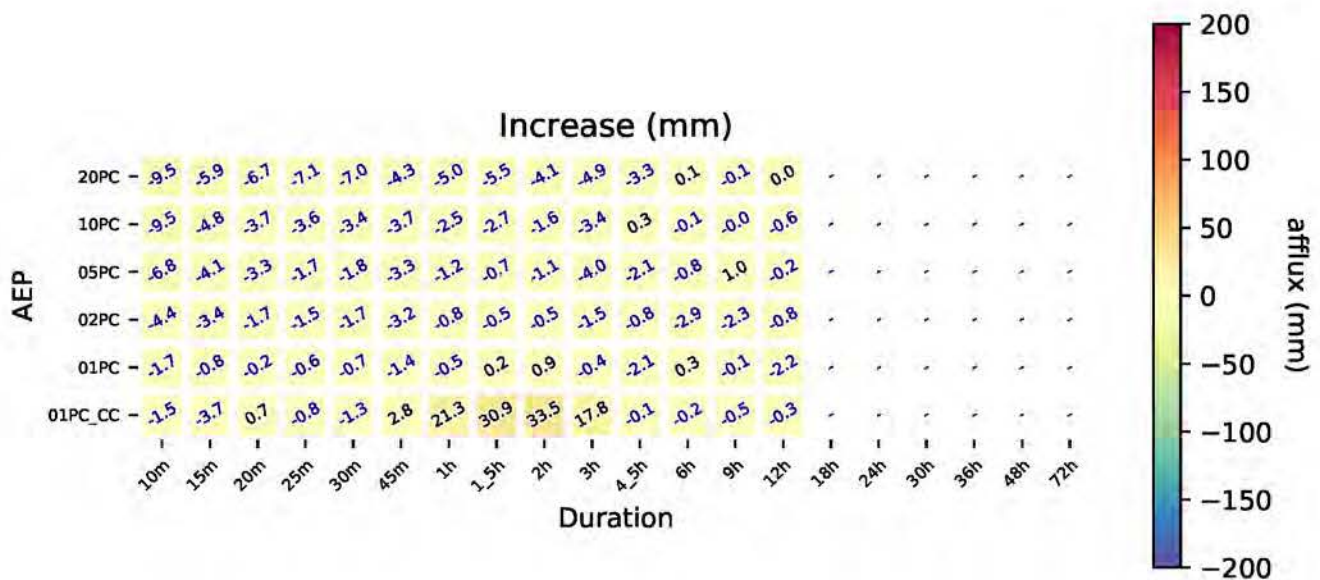
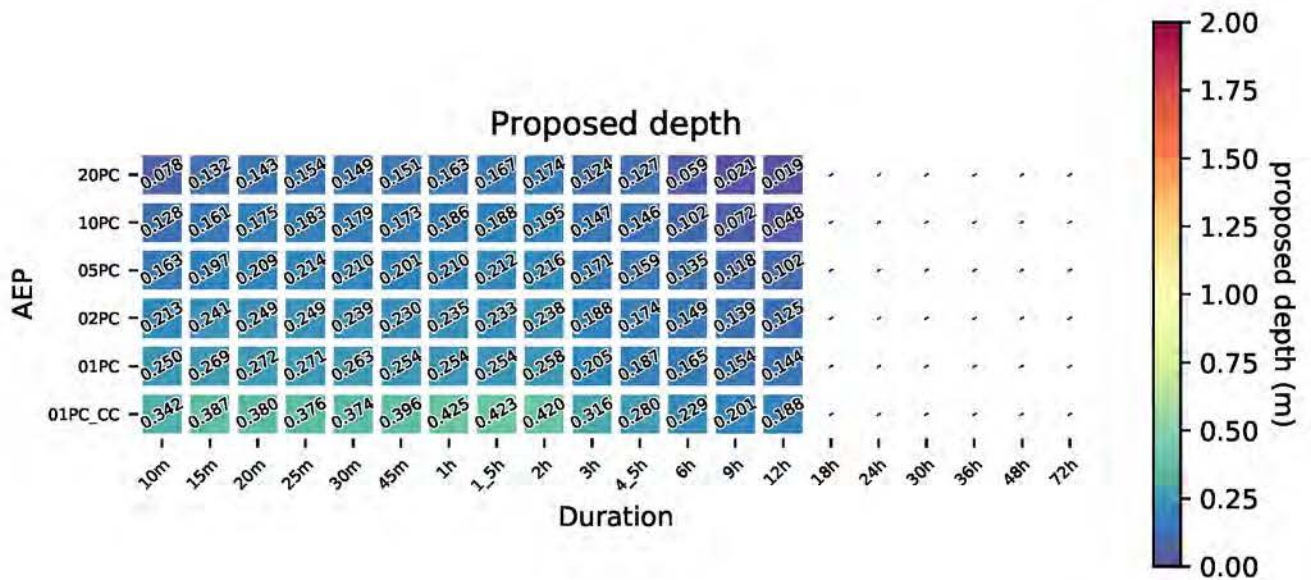
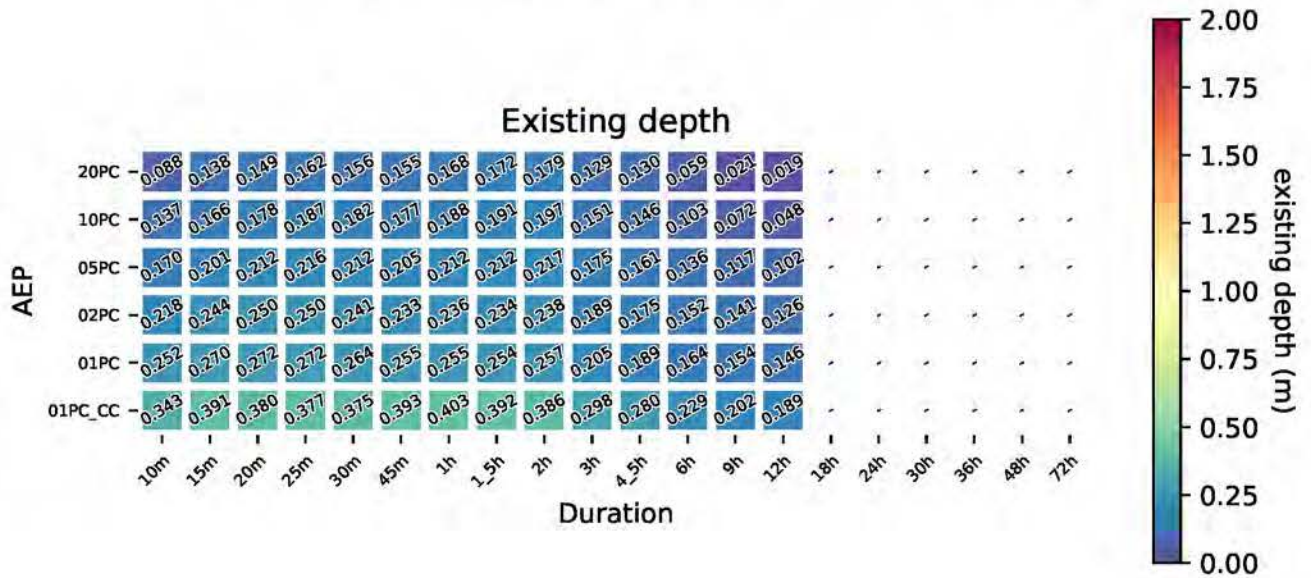


# Kempston Main Drain - Kempston\_Boyd



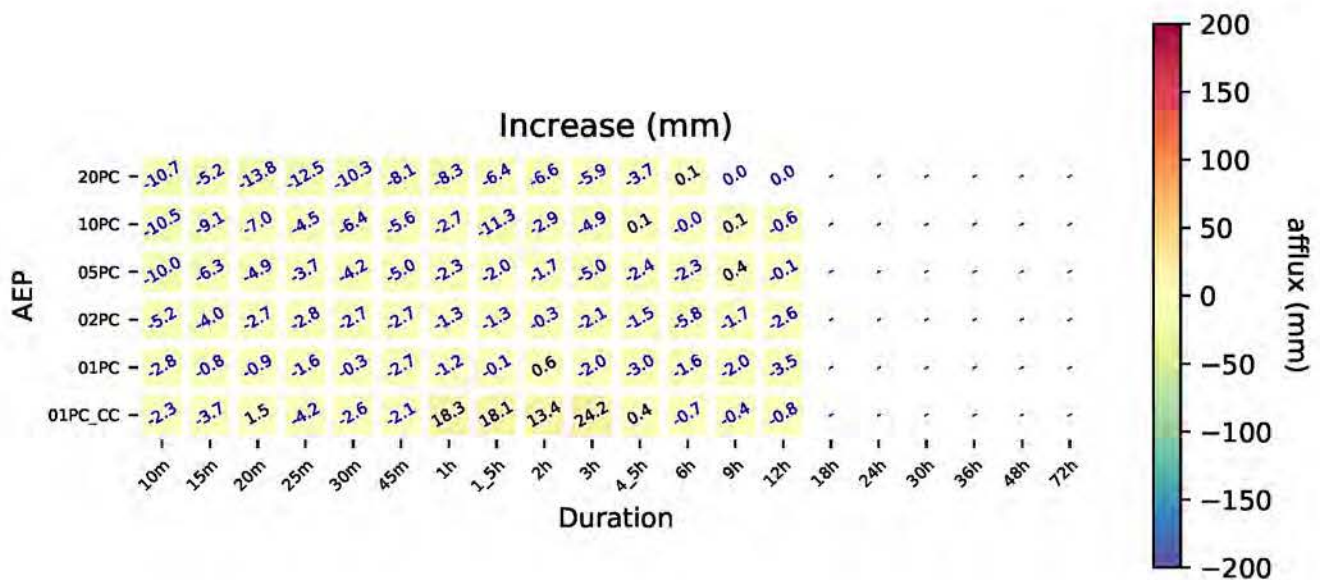
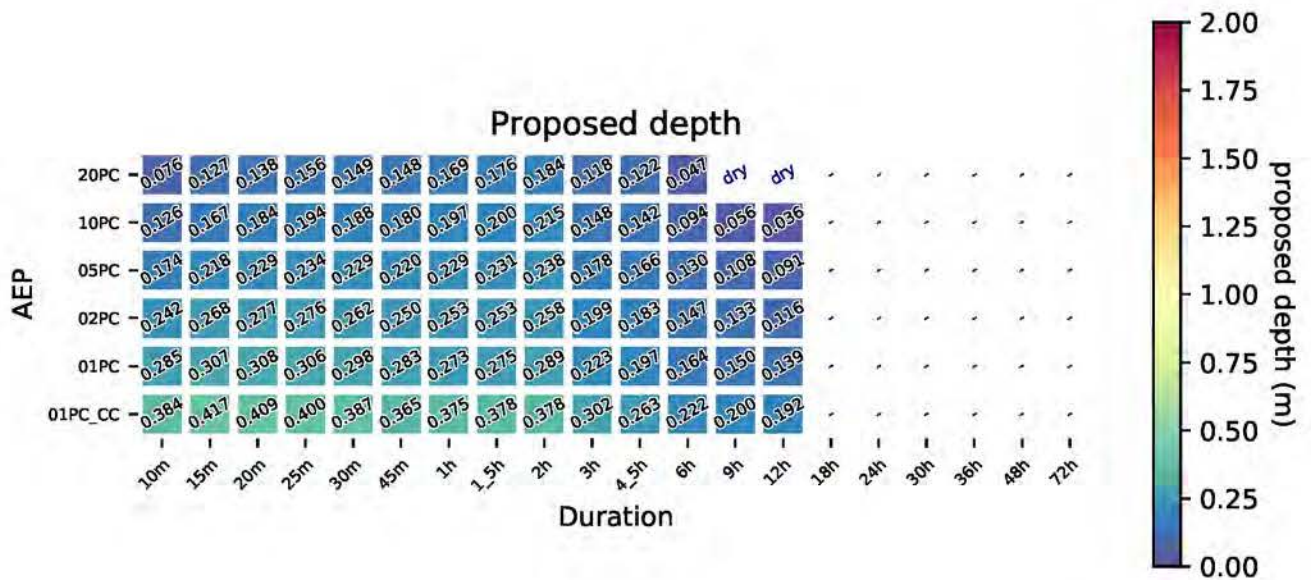
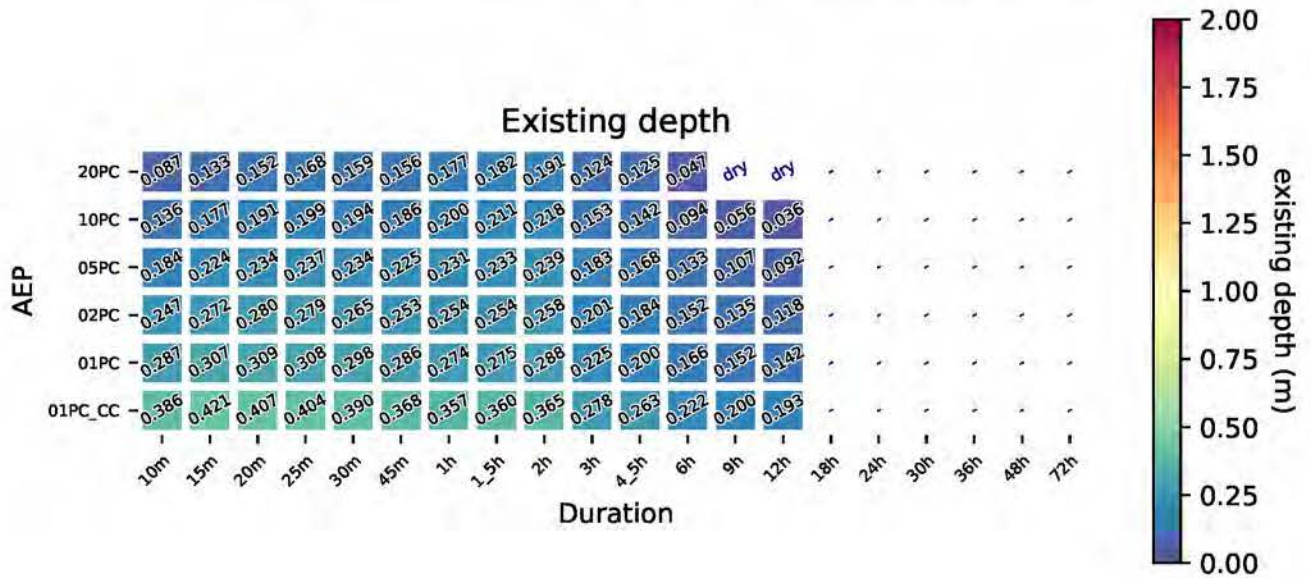


# Kempston Main Drain - Kempston\_Laura

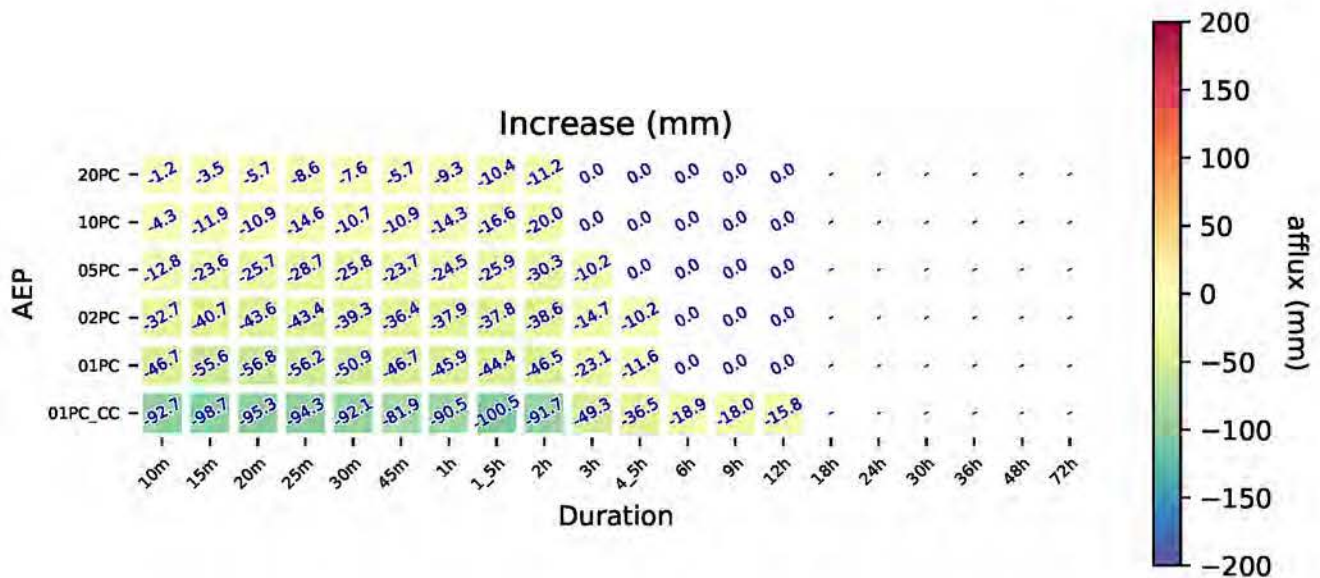
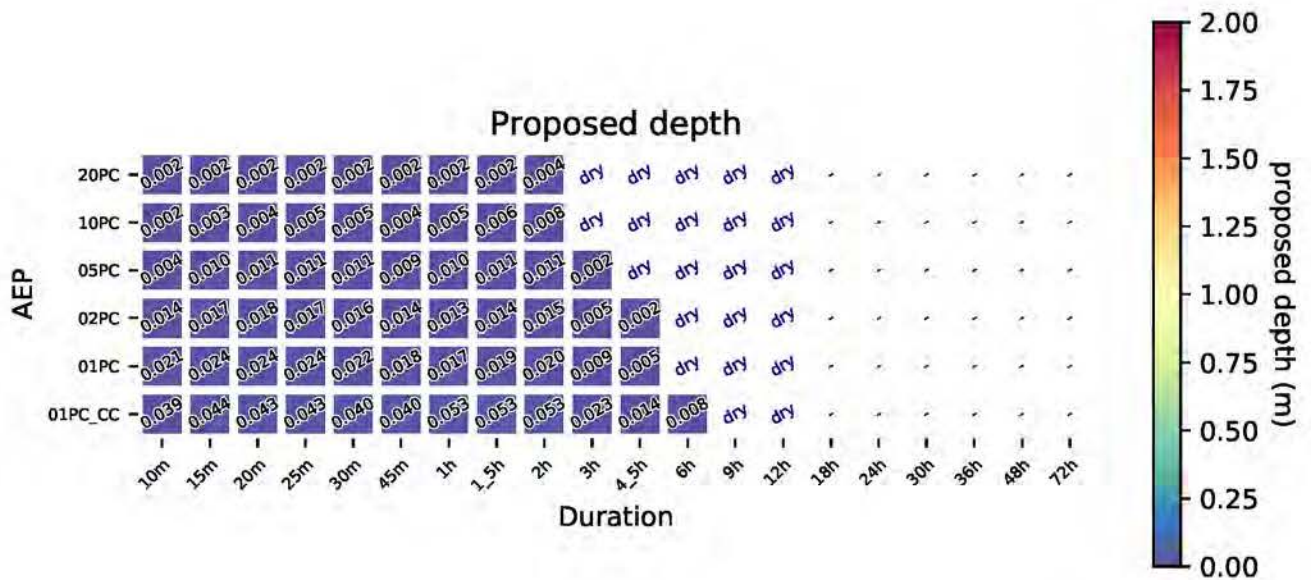
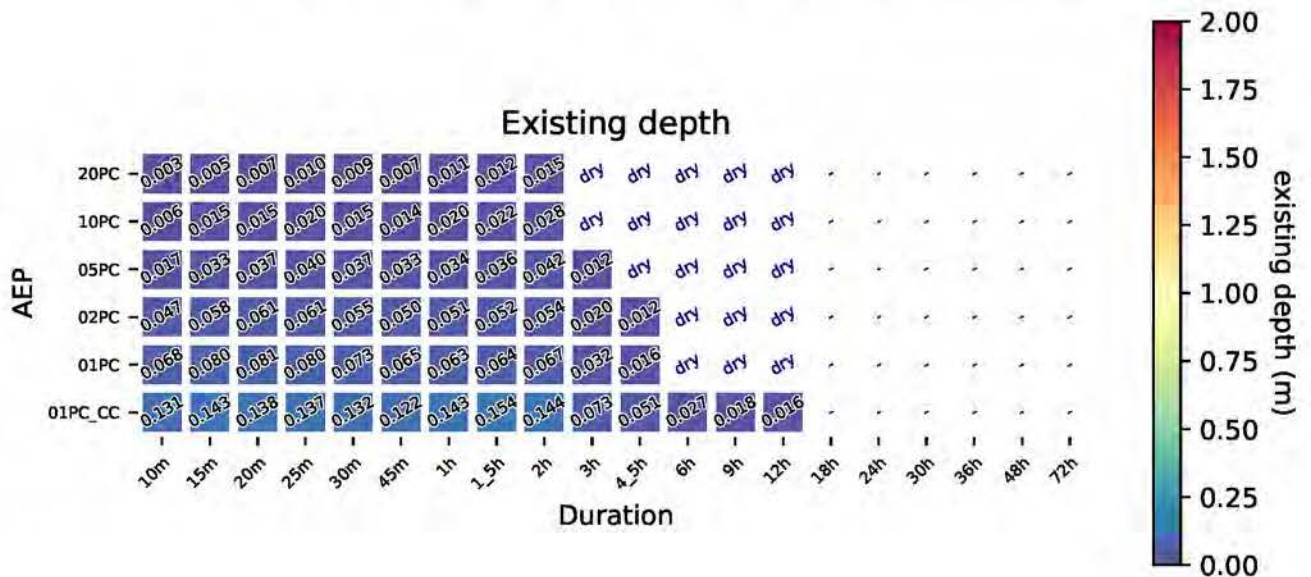




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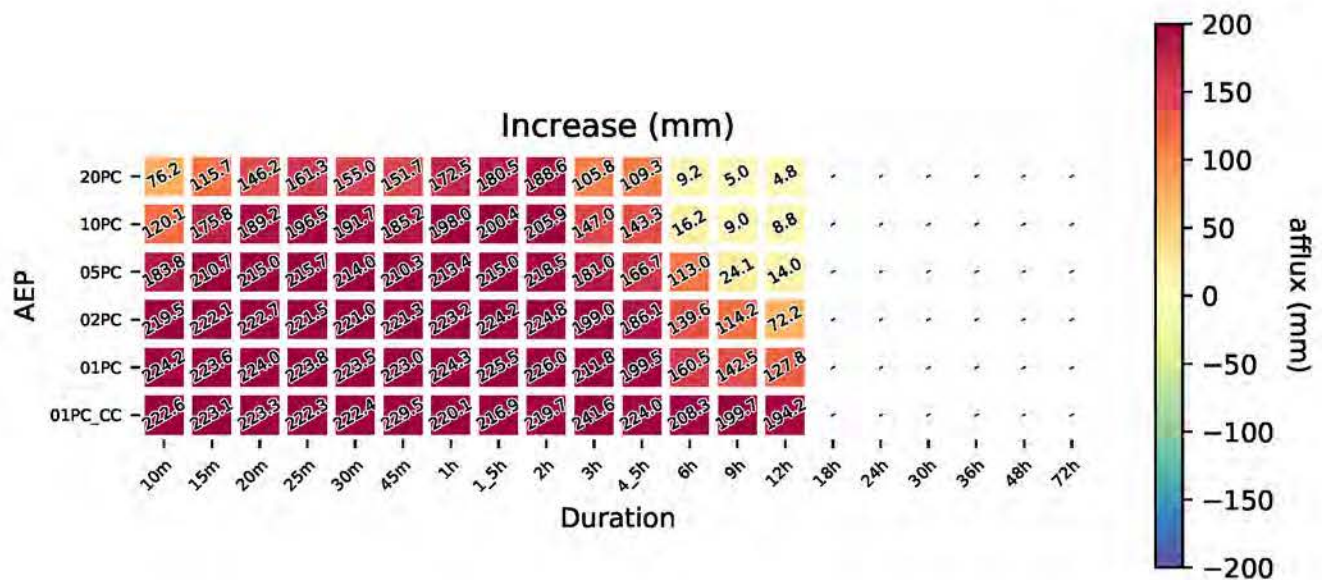
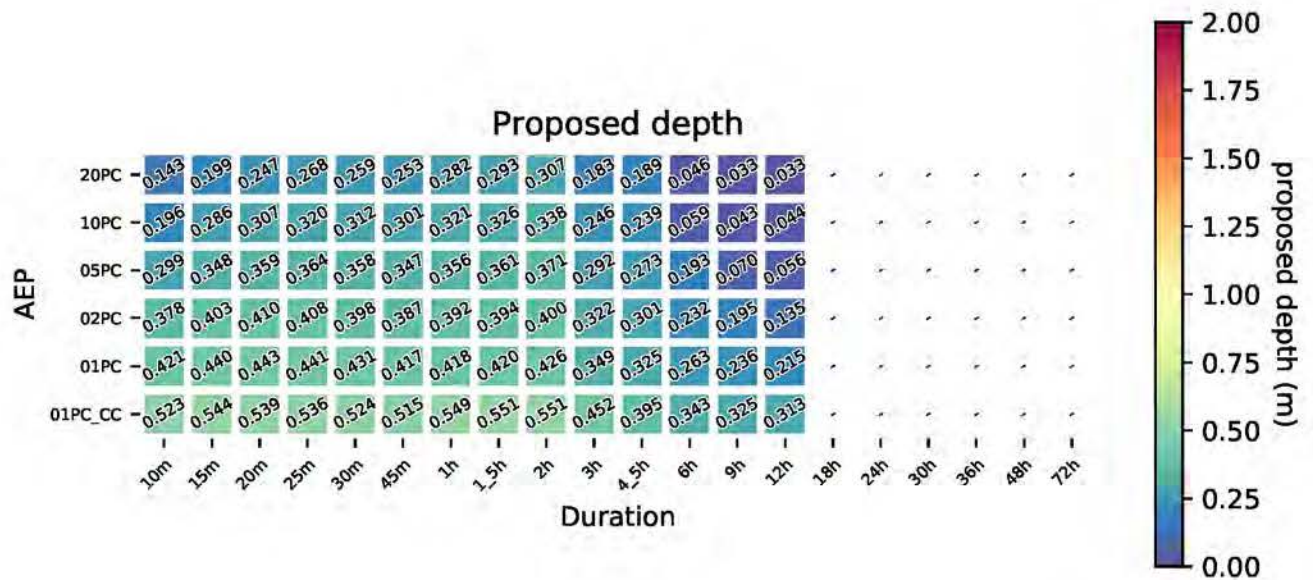
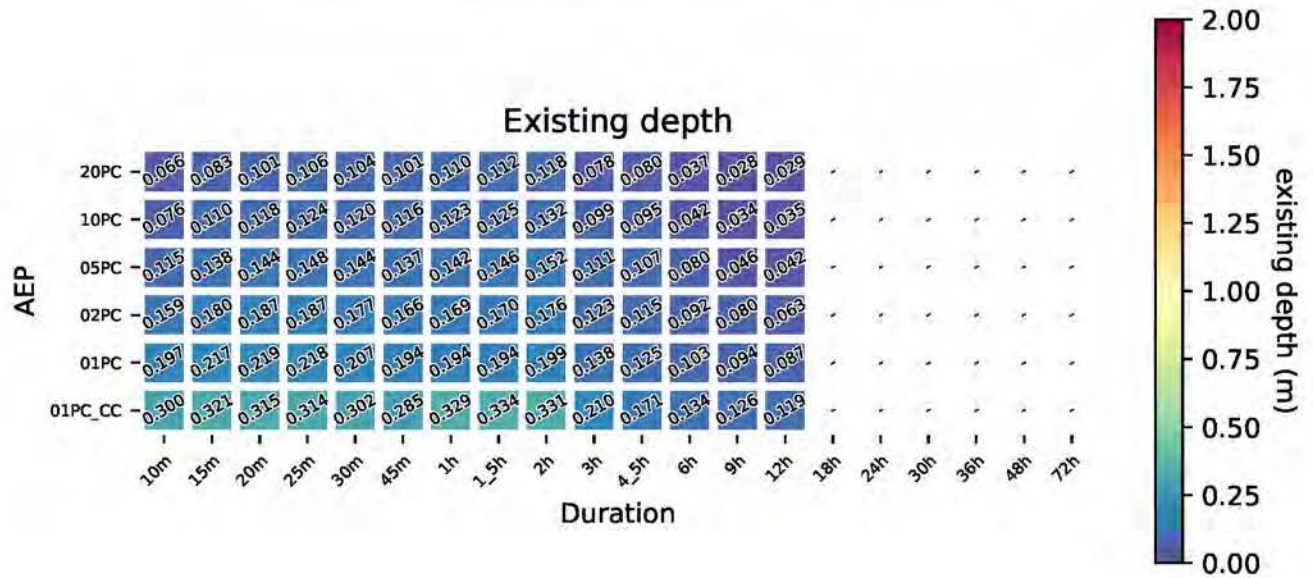


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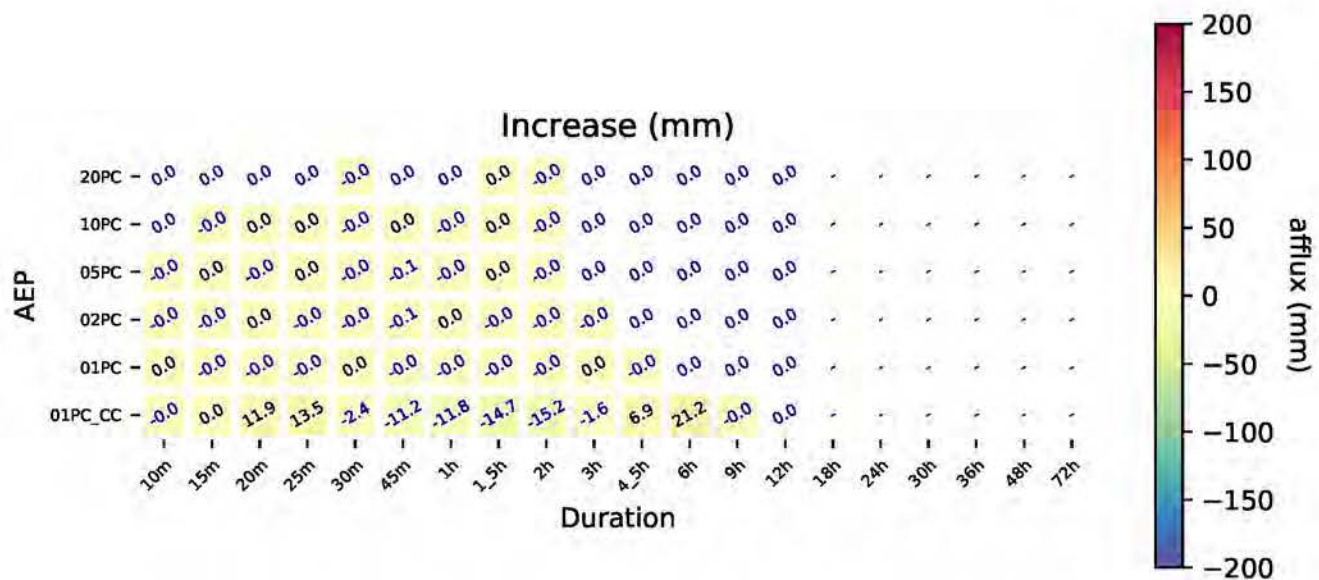
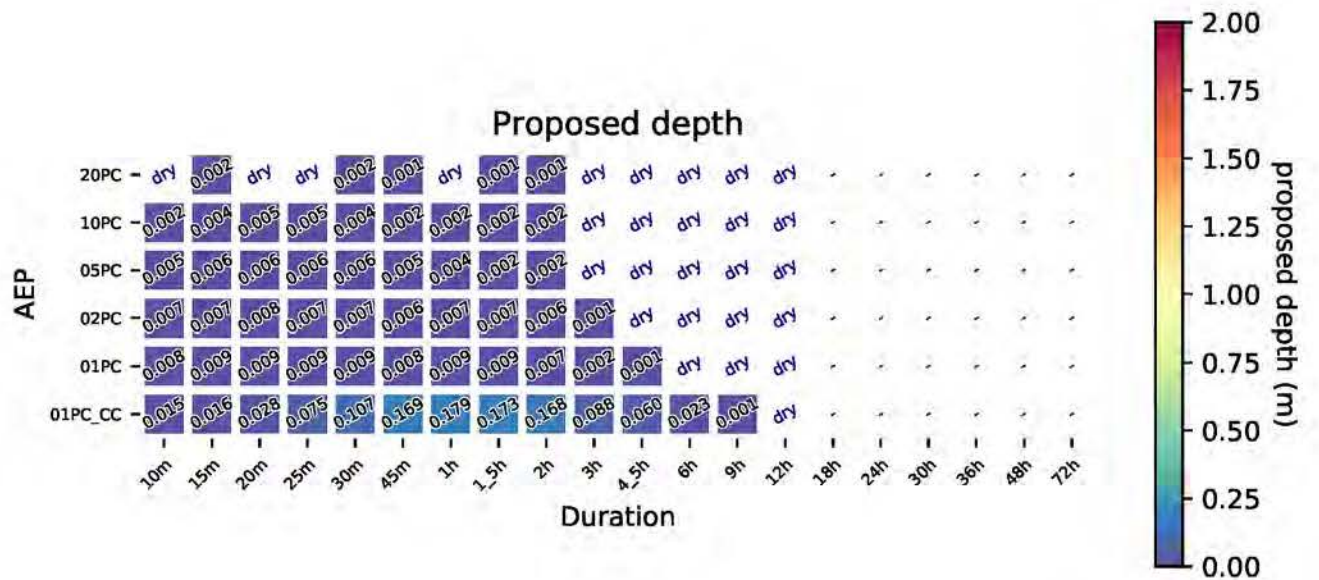
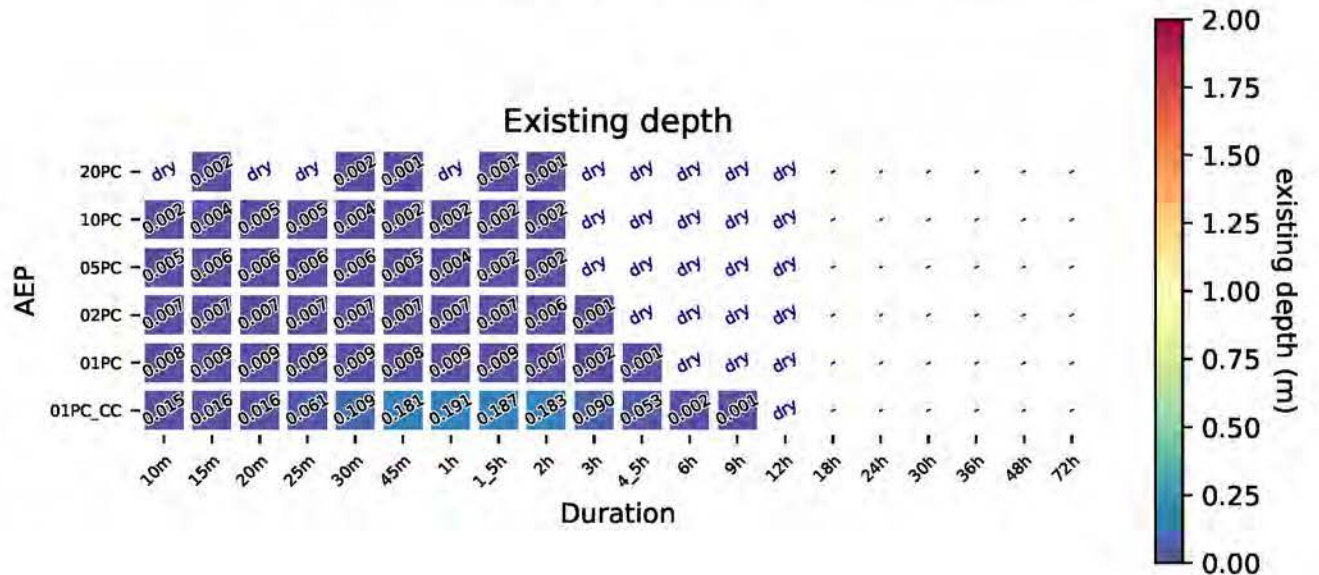




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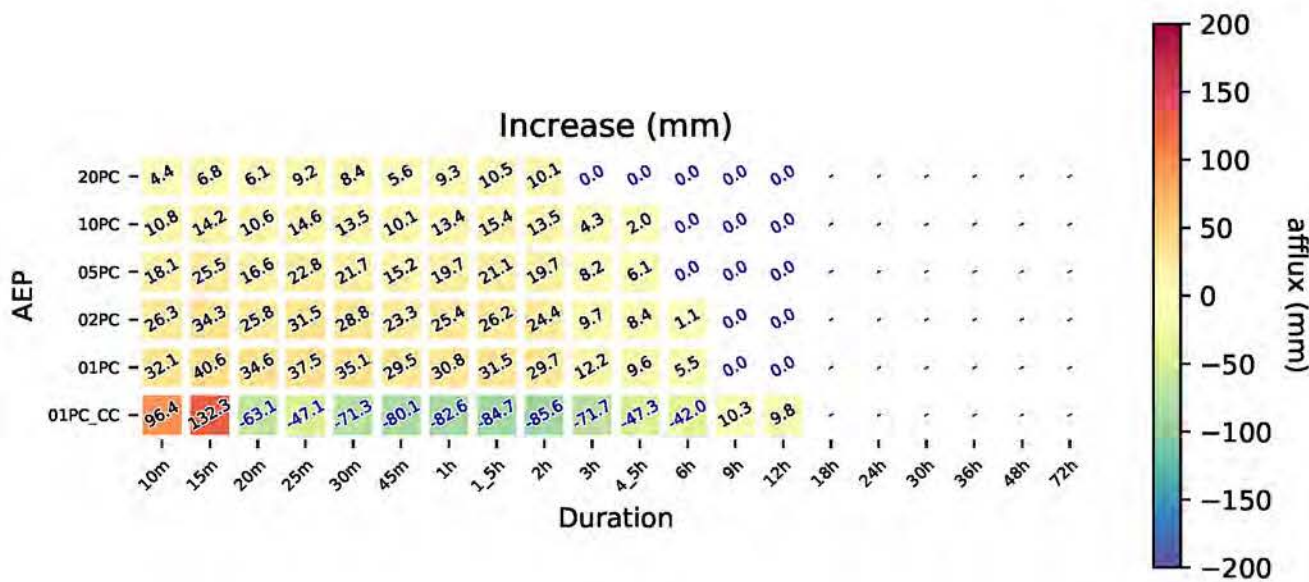
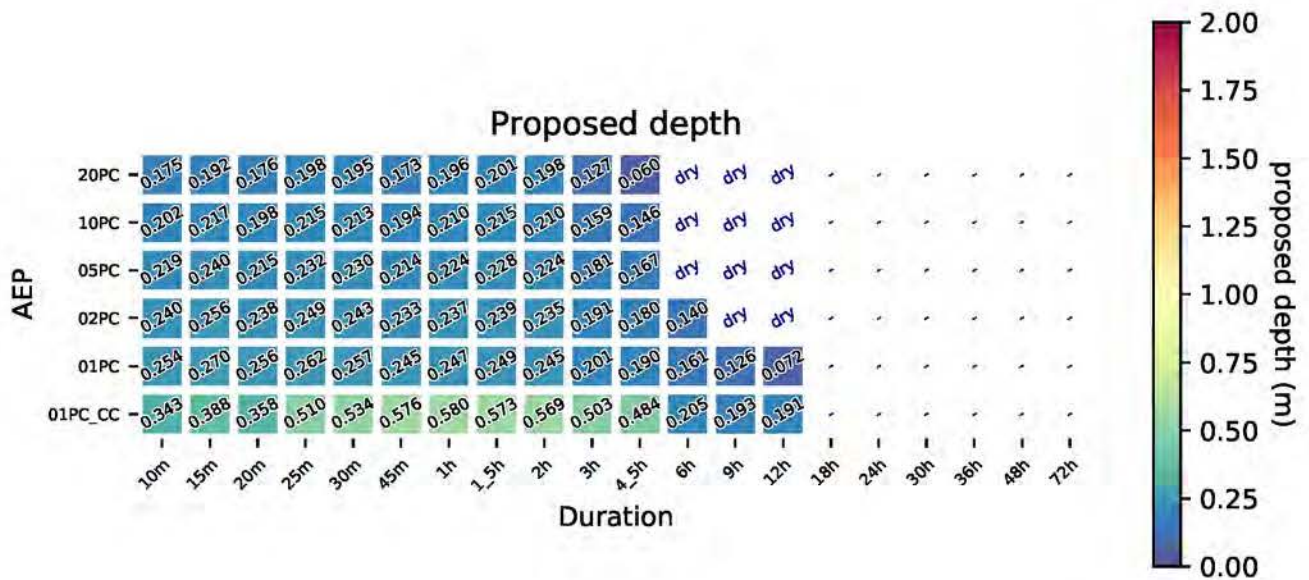
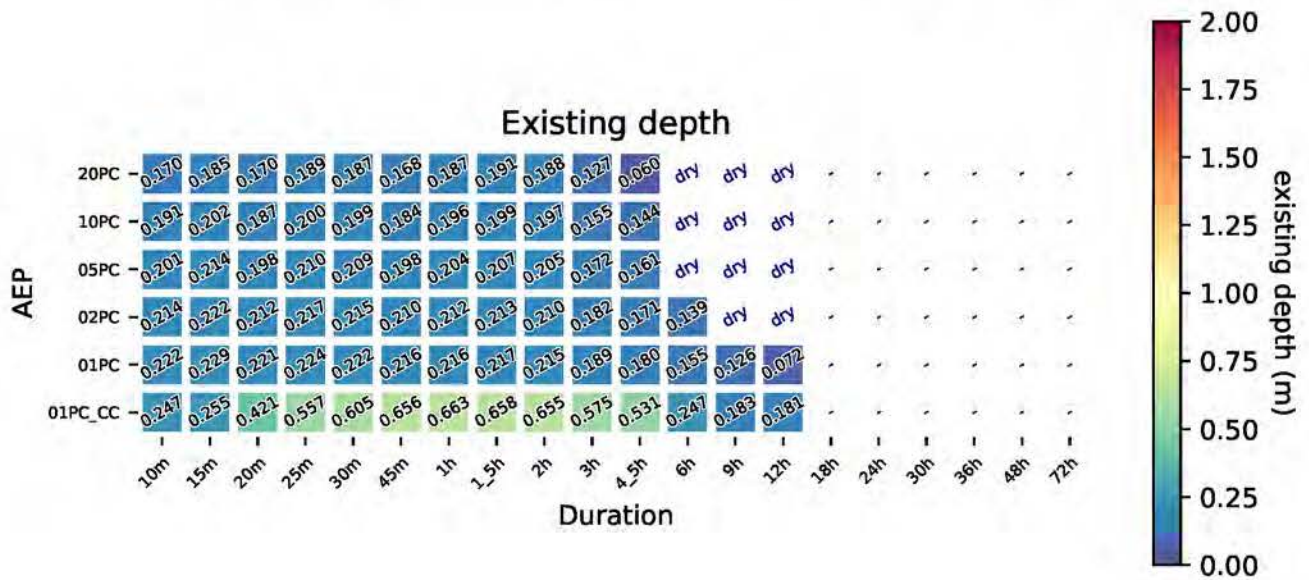


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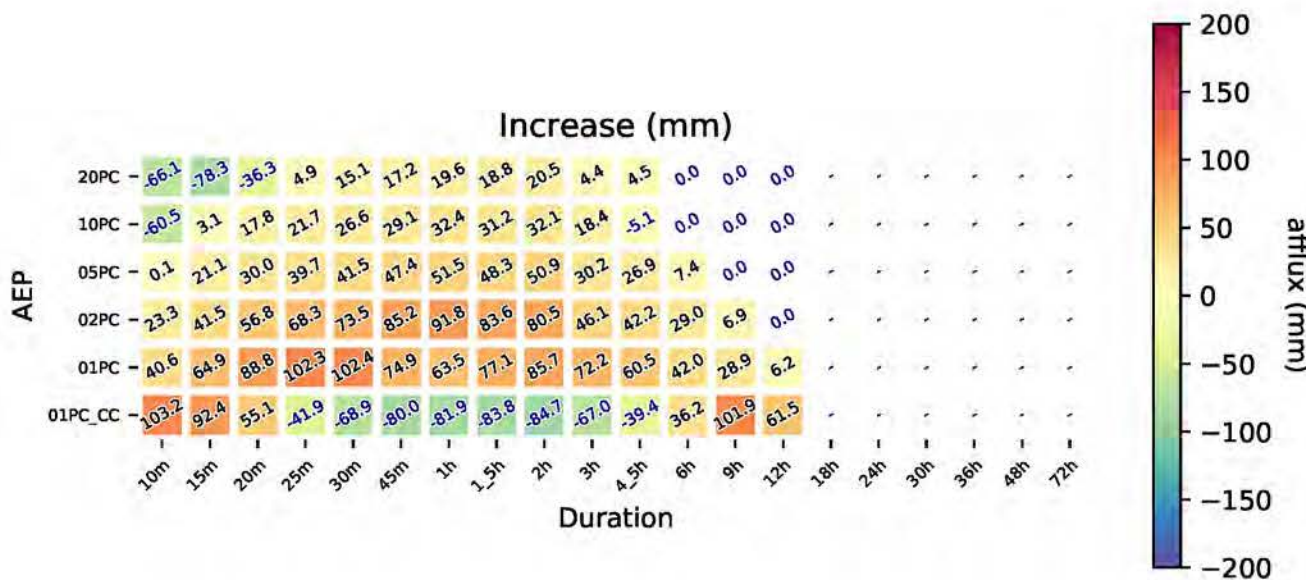
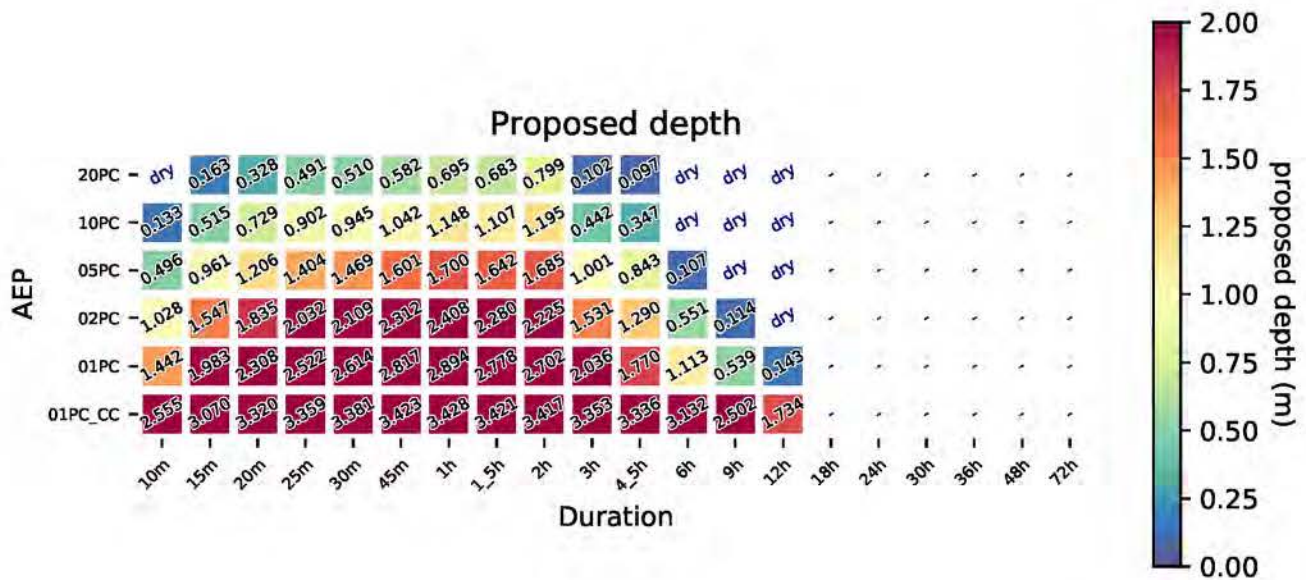
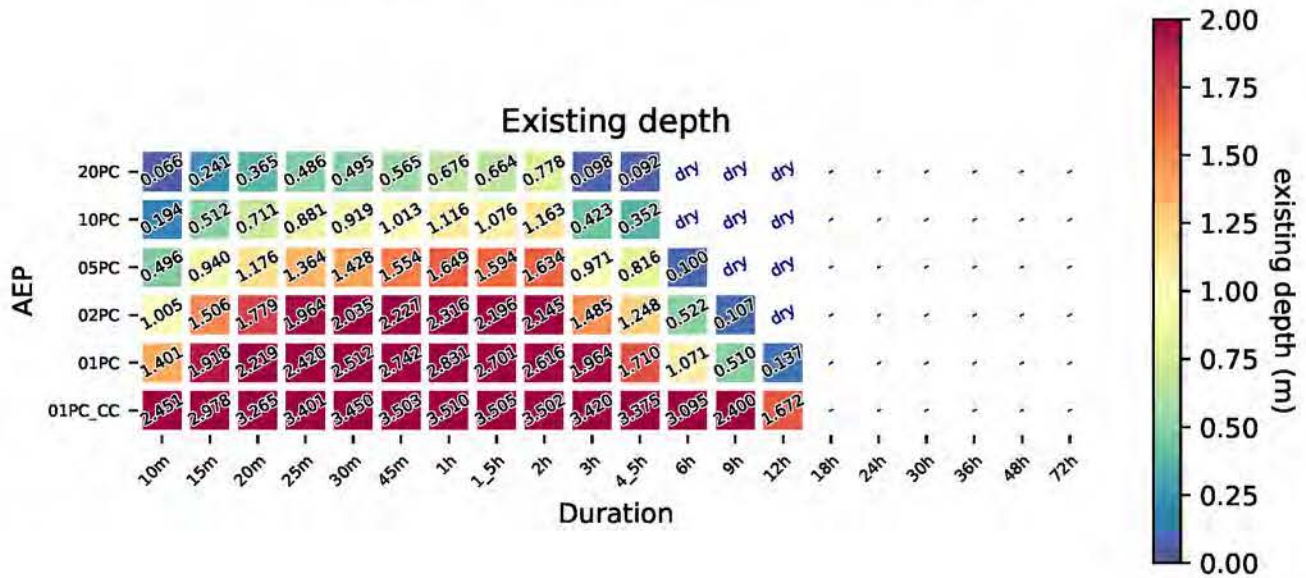




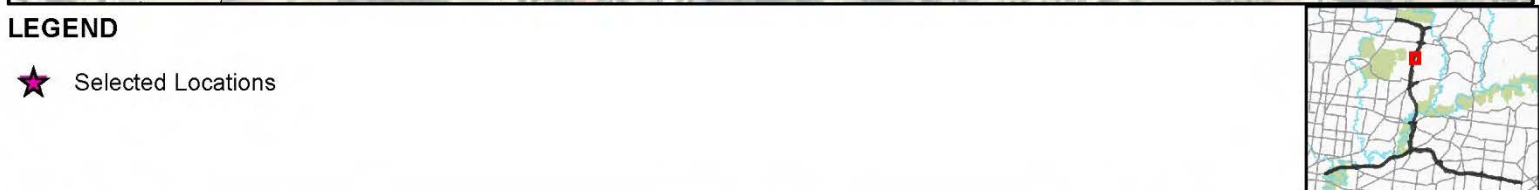
Kempston Main Drain - Grimshaw\_St



# Kempston Main Drain - AKLines\_RB





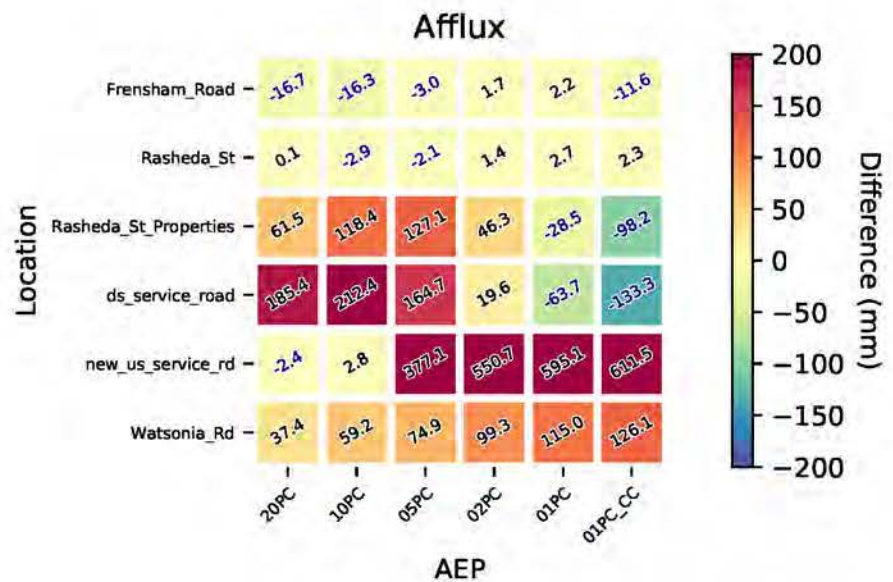
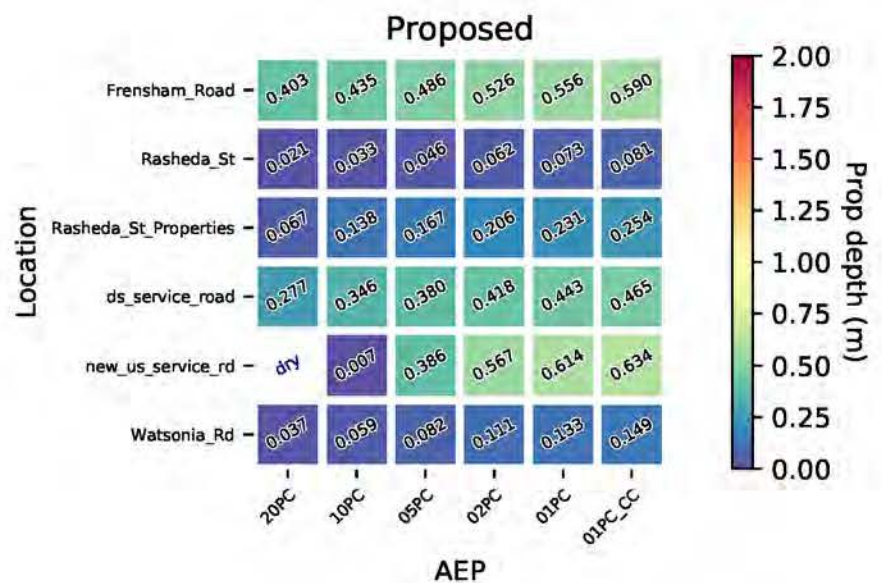
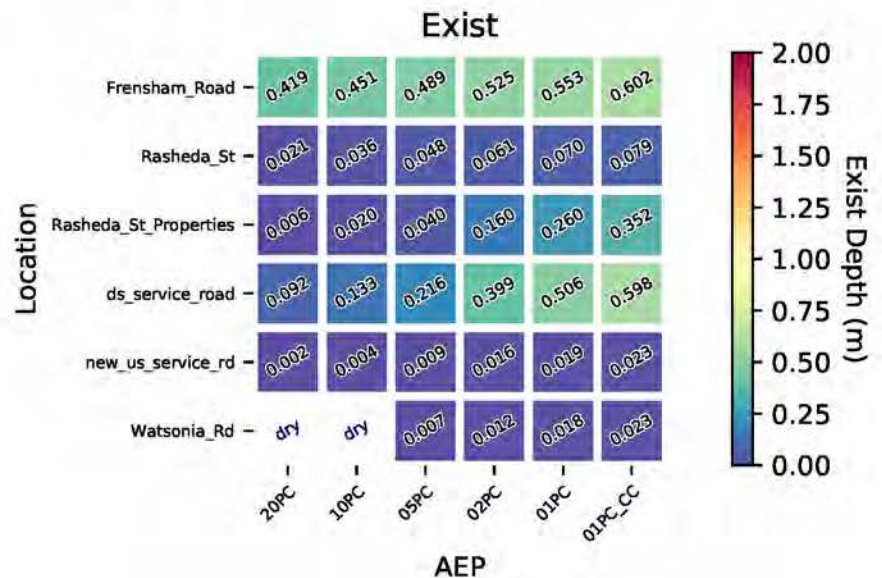



**NORTH EAST LINK PROJECT**  
 North East Link  
 North East Link Project  
 Job Number 31-35006  
 Revision C  
 Date 13/11/2018  
**Watsonia Station drain**  
**Comparison Locations**

G:\3135006\GIS\Maps\Working\Specialist Submission\EE5\Groundwater and Hydrology\Surface\_Water\35006\_Hydraulic\BOM\444\Site Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com  
 Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanza.dehnafari  
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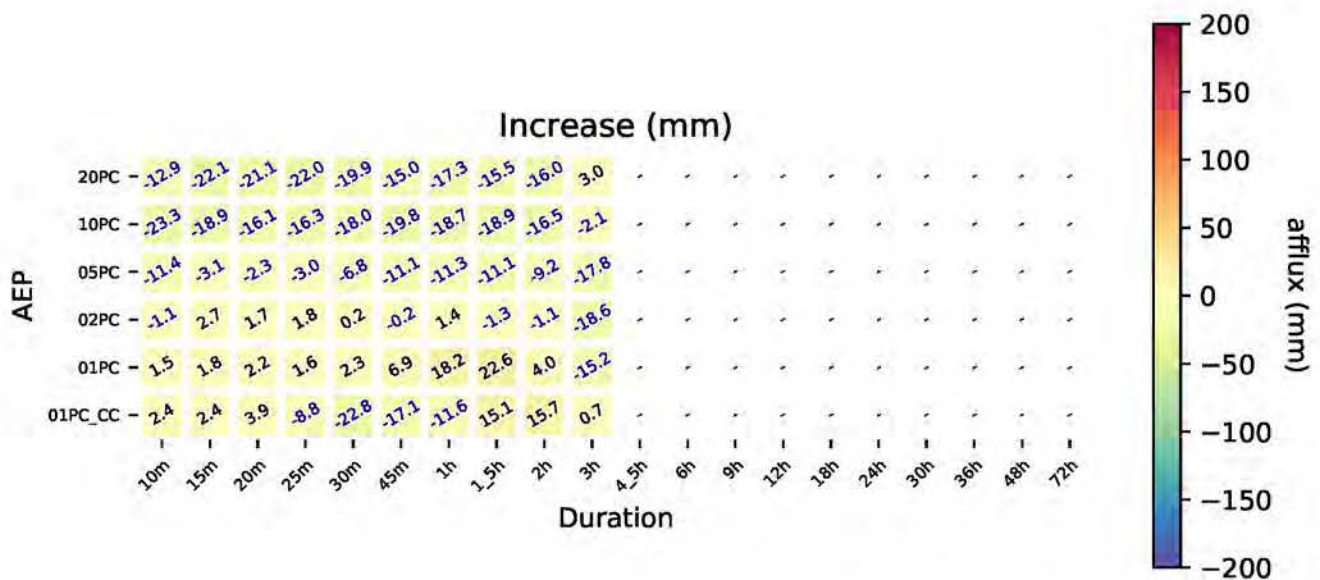
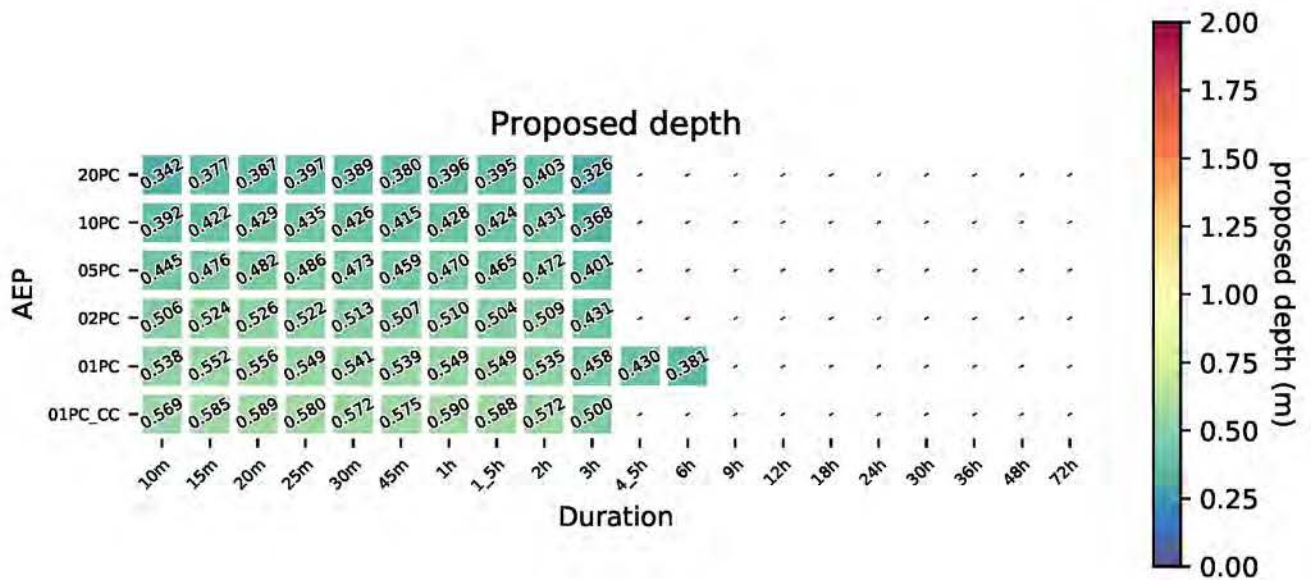
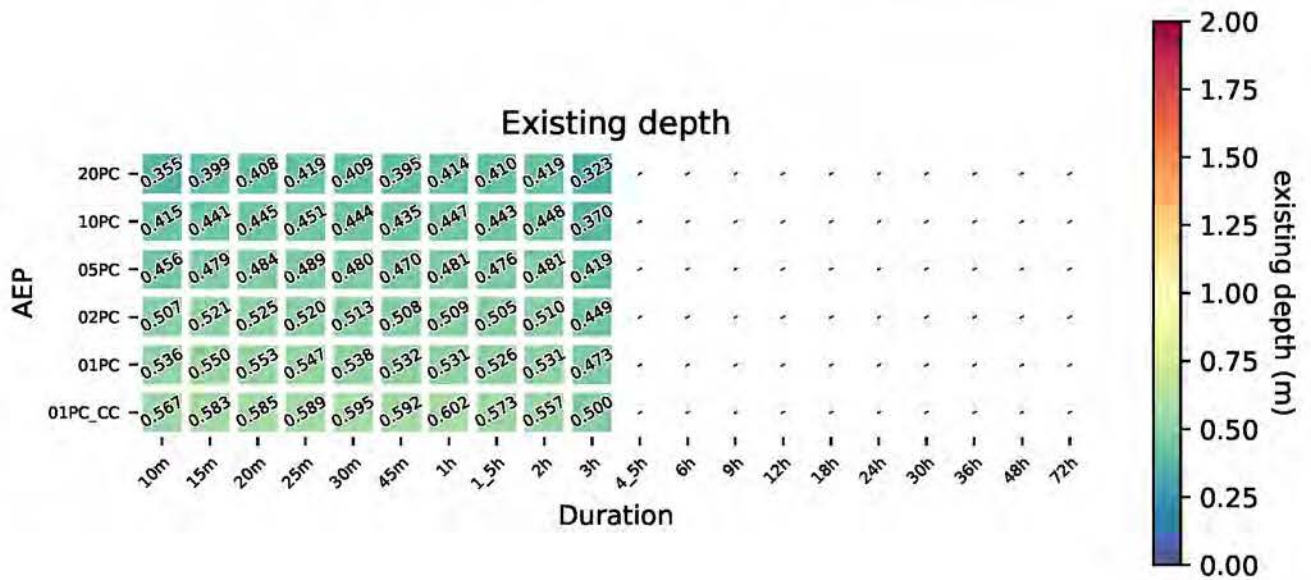


# Watsonia Drain - Overview

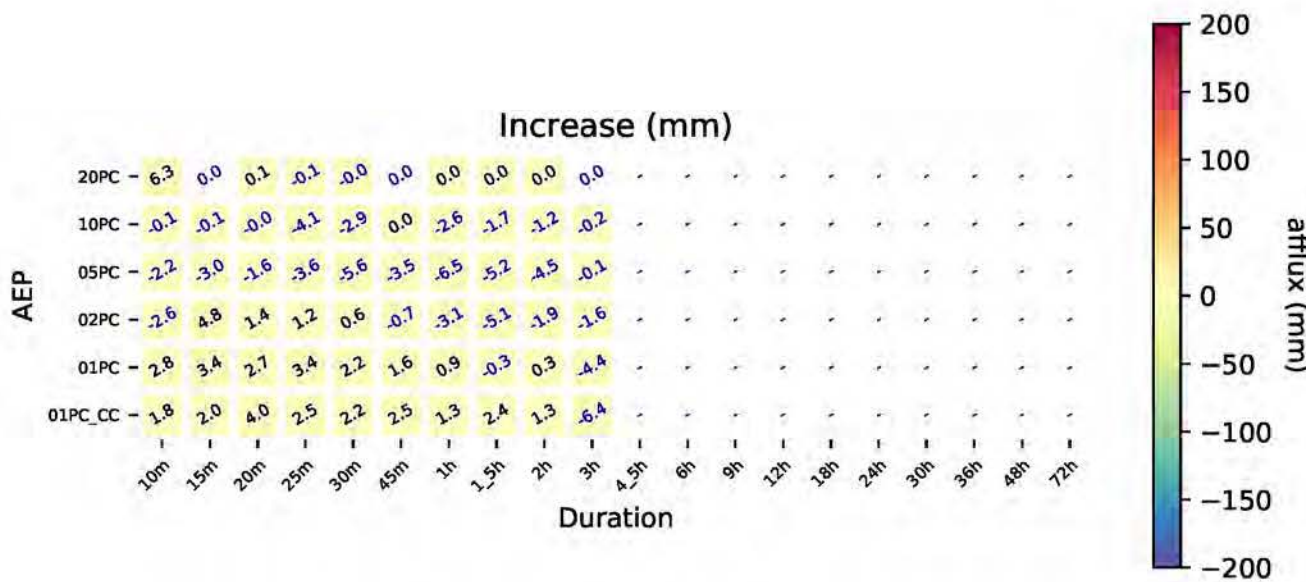
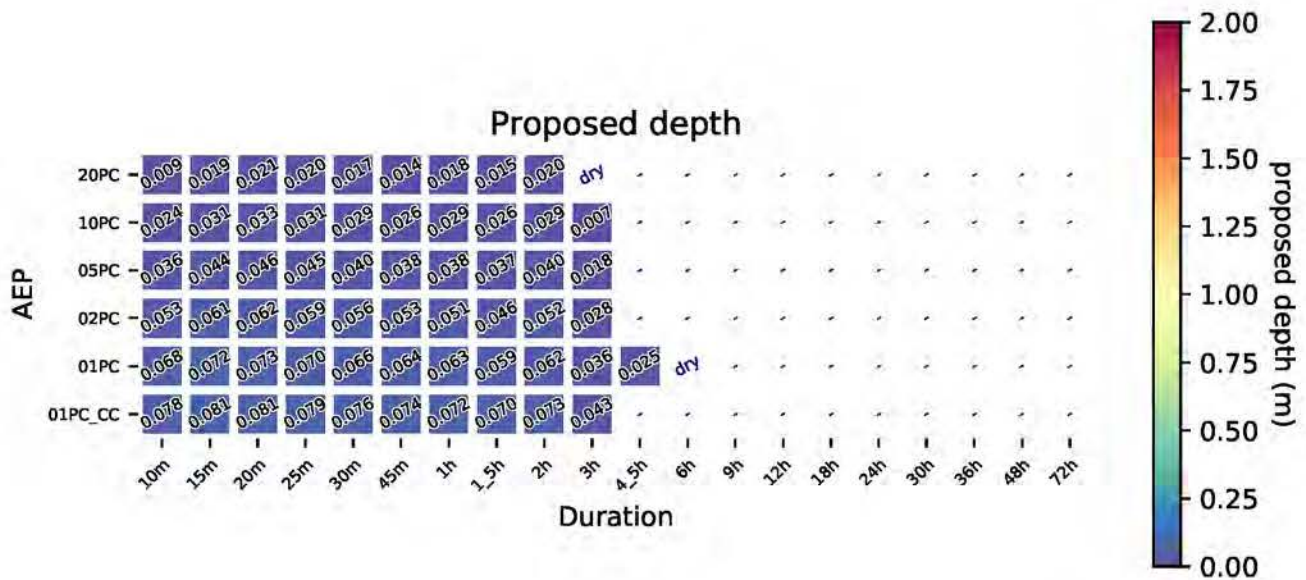
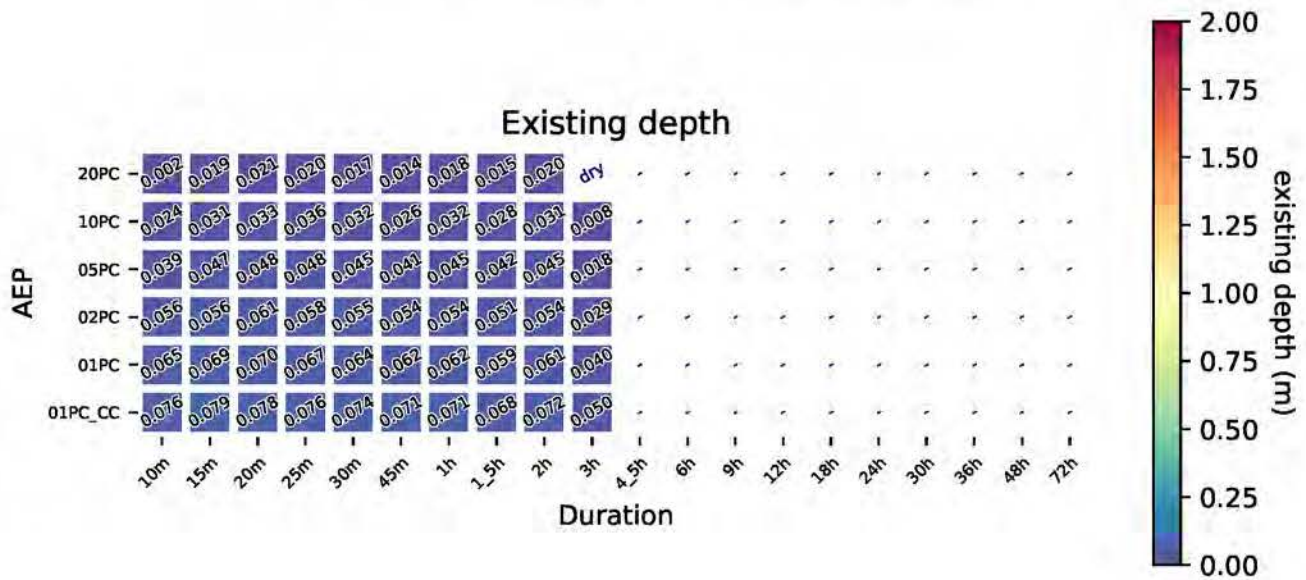




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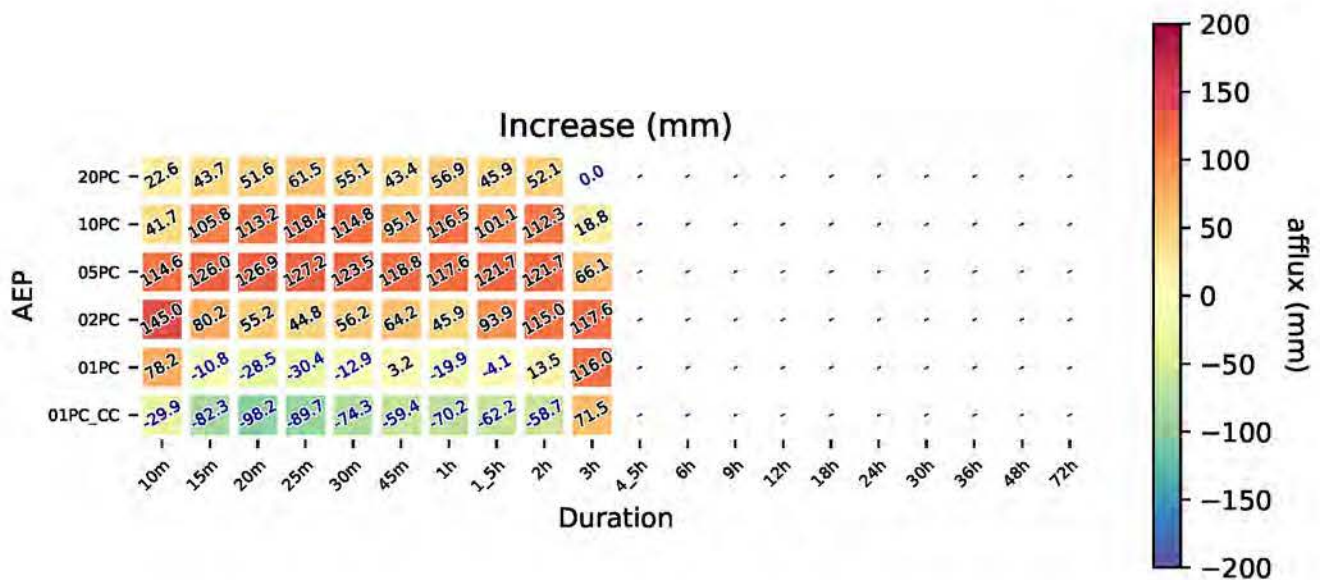
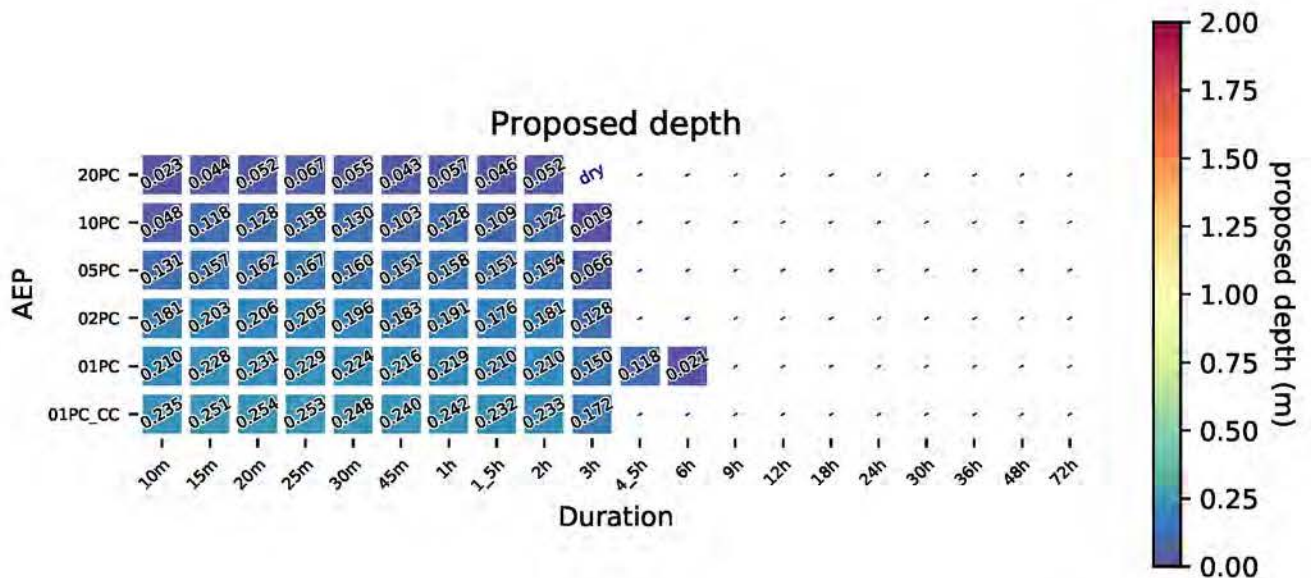
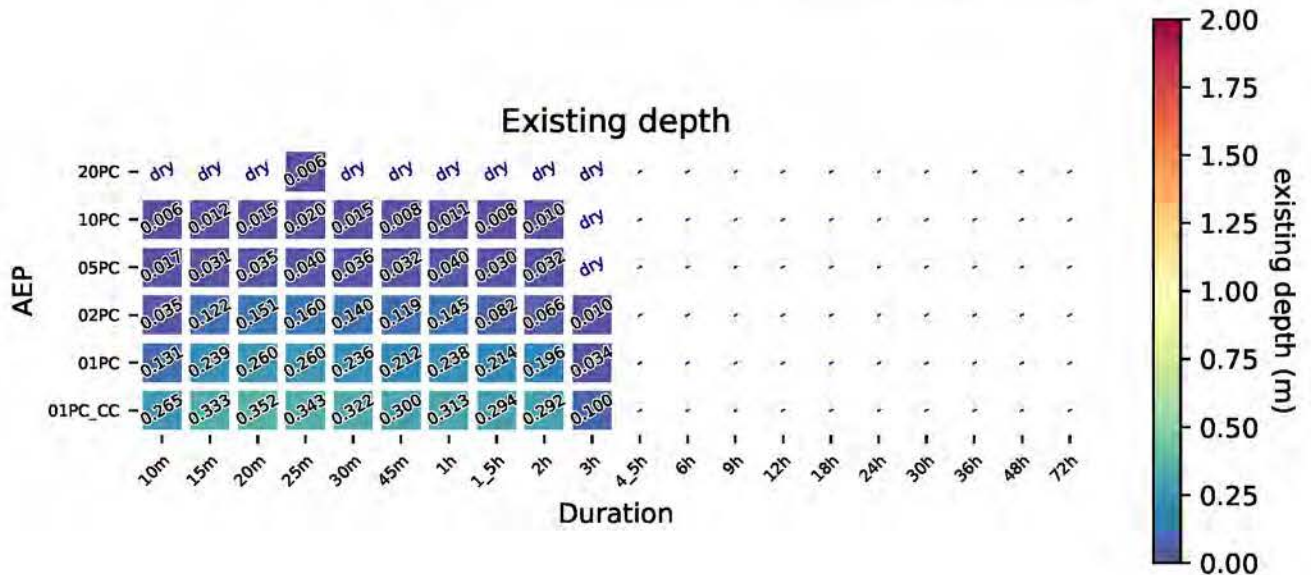


Watsonia Drain - Rasheda\_St

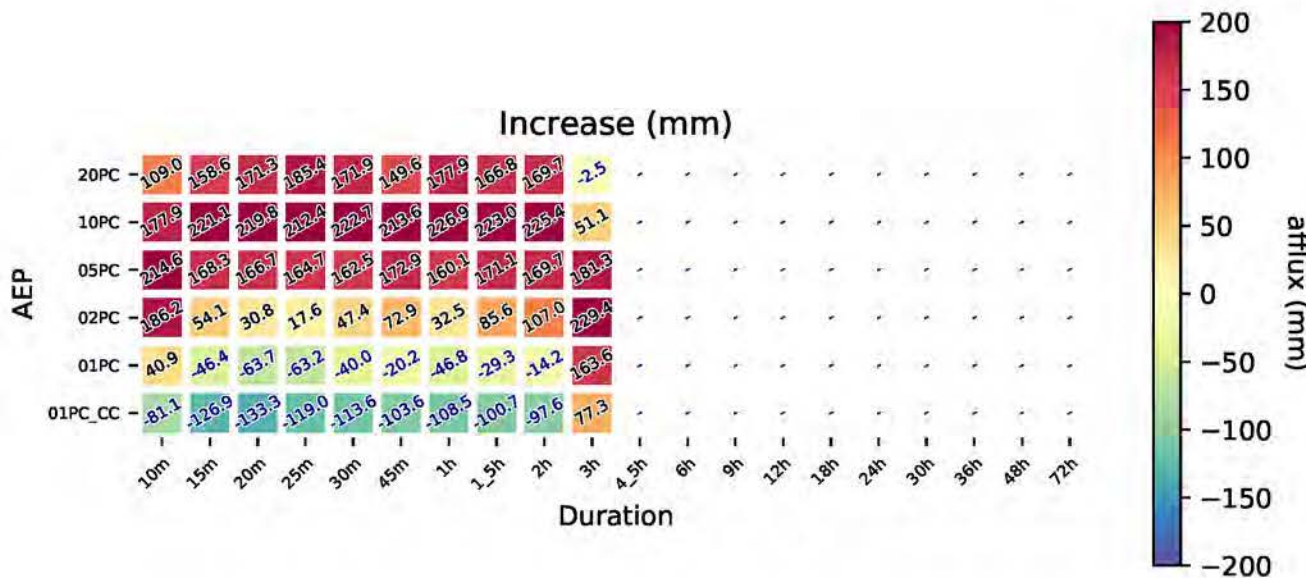
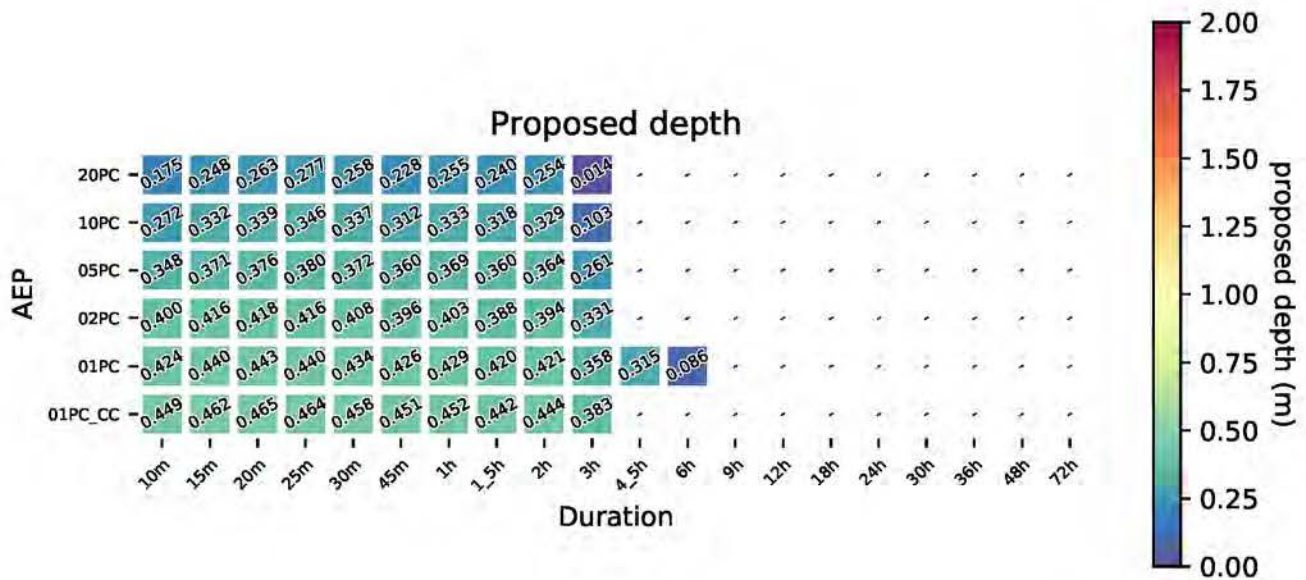
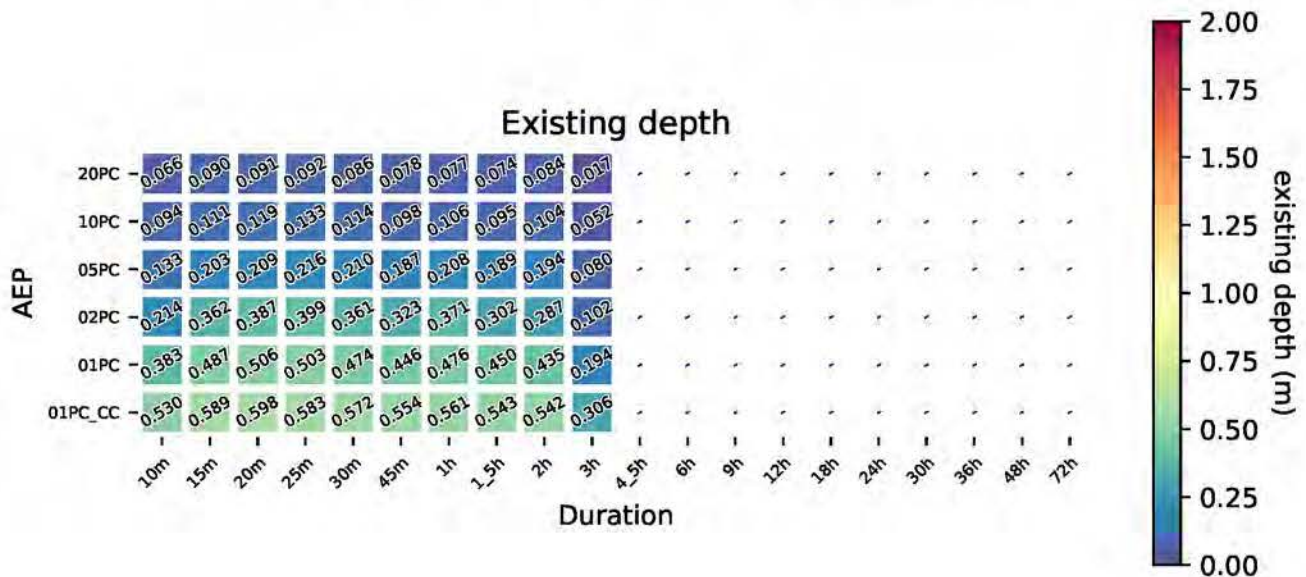




# Watsonia Drain - Rasheda\_St\_Properties

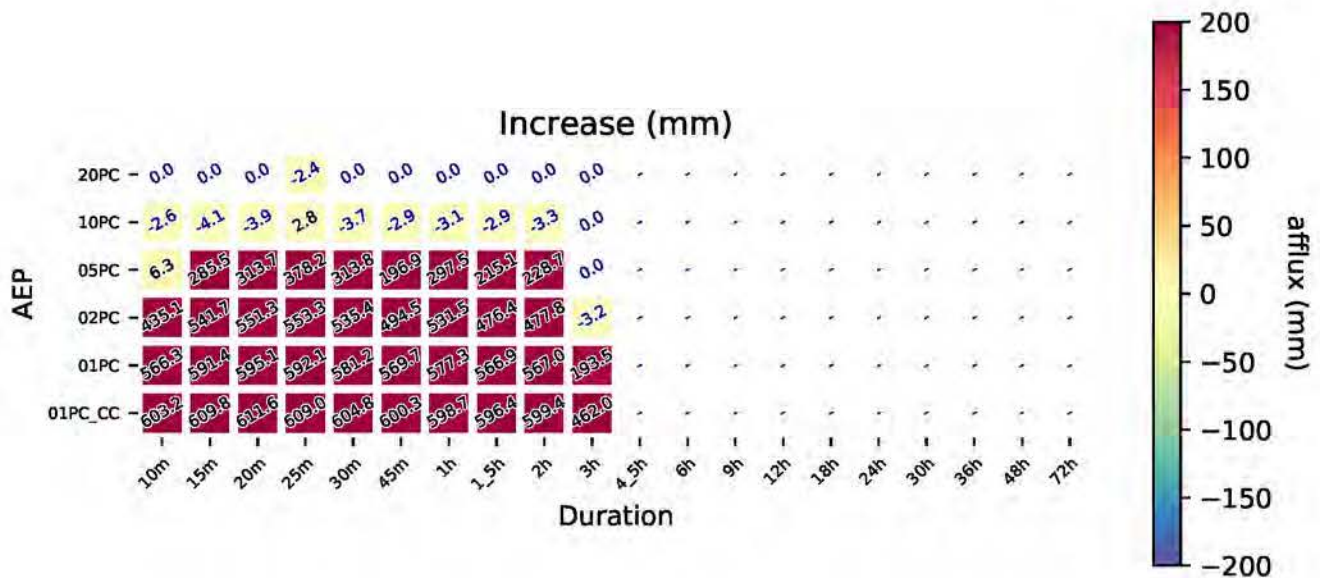
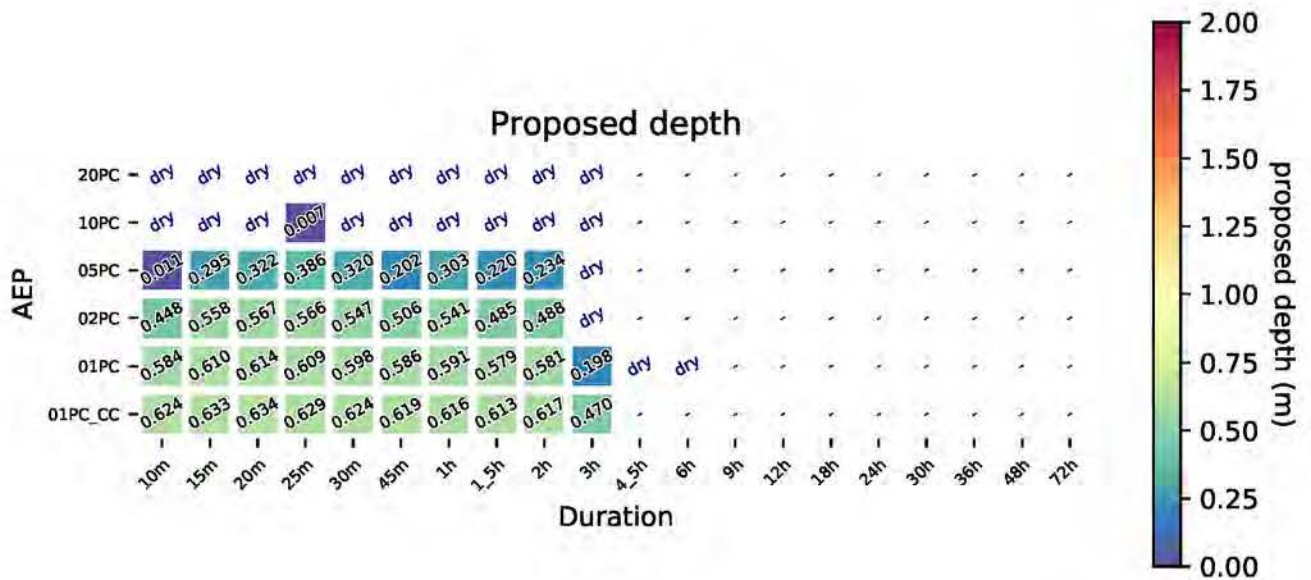
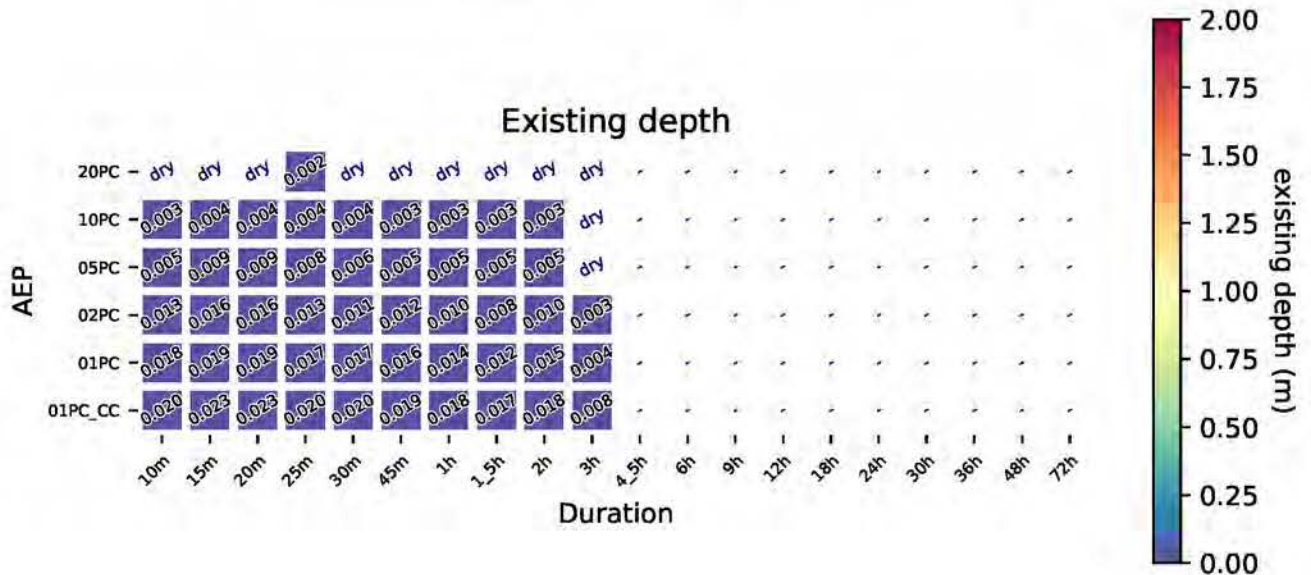


# Watsonia Drain - ds\_service\_road

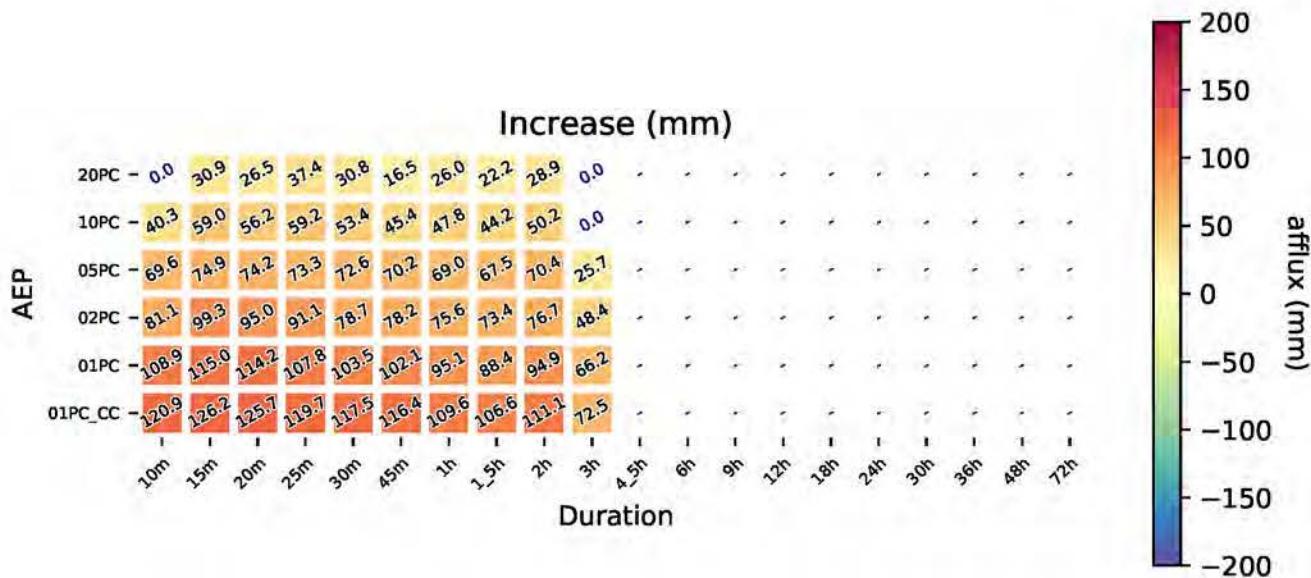
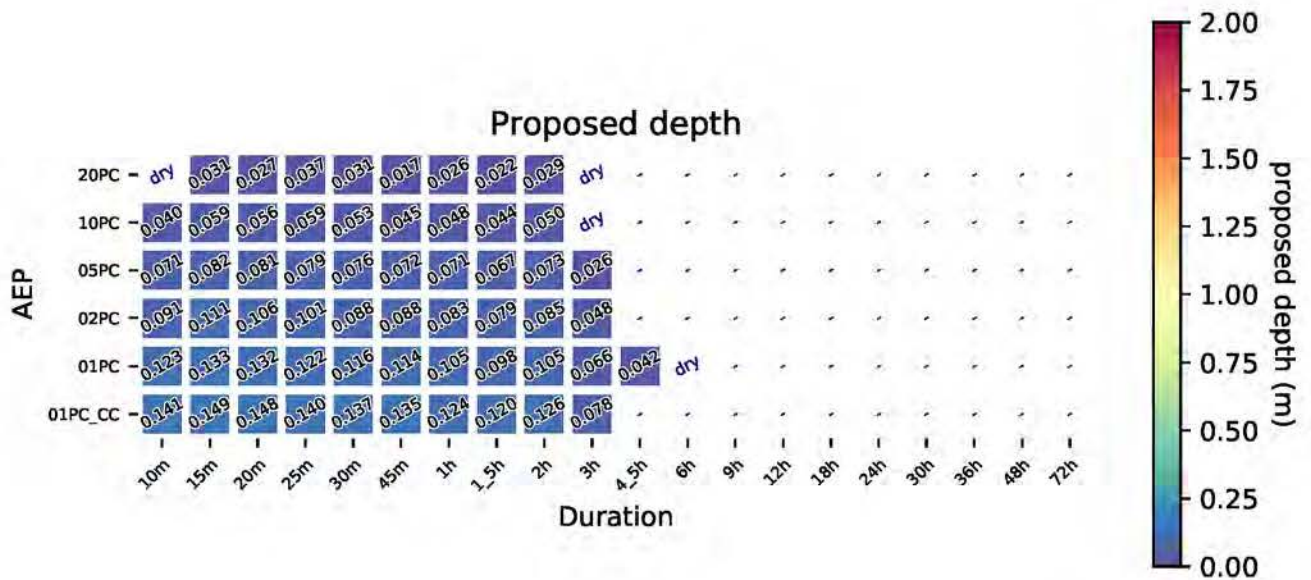
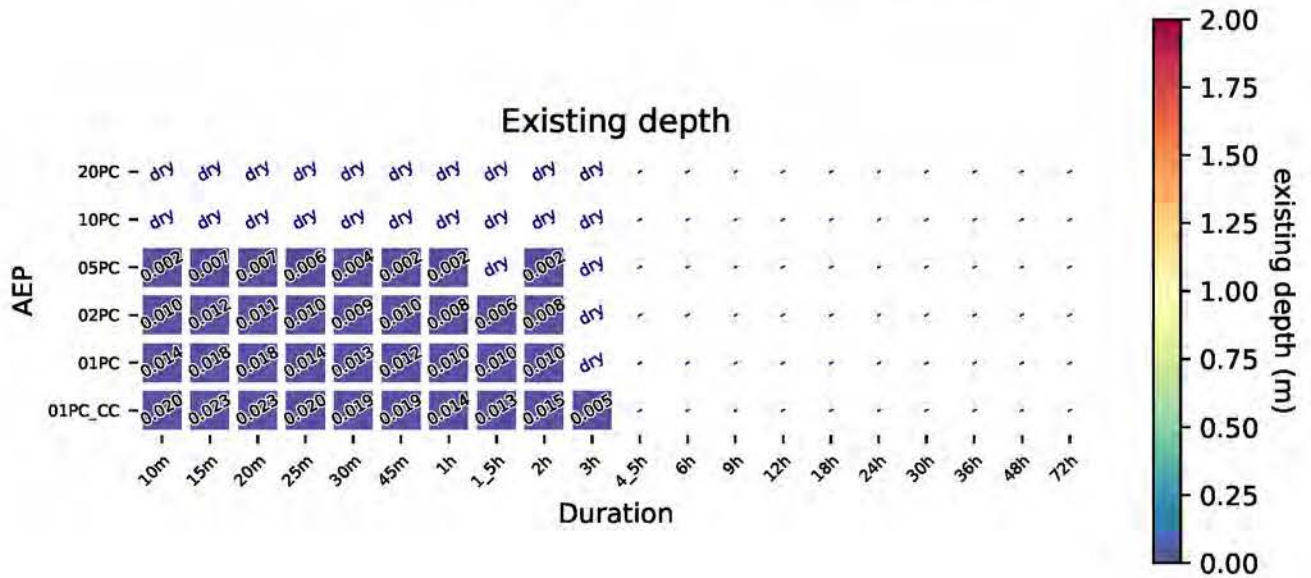




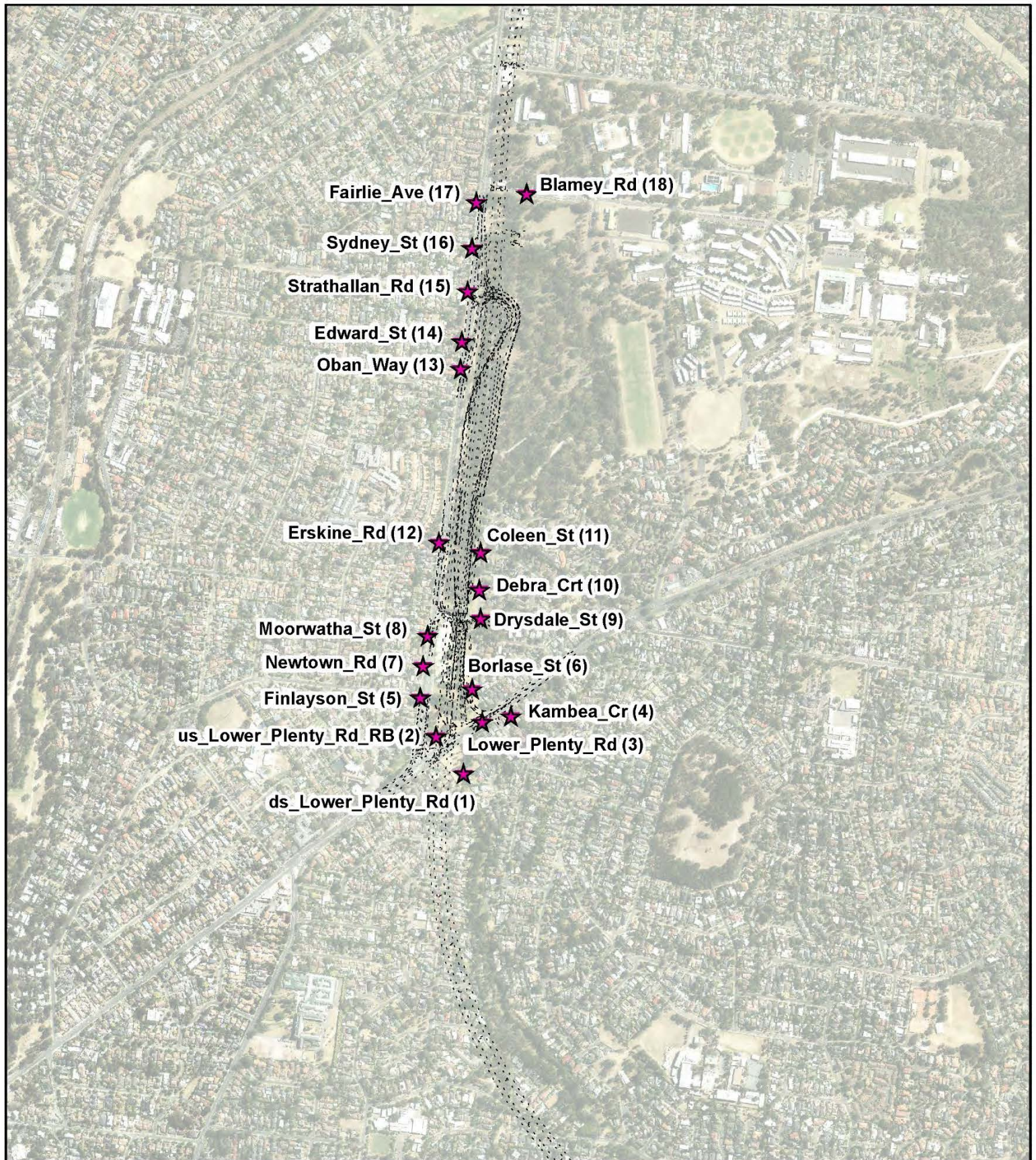
# Watsonia Drain - new\_us\_service\_rd



# Watsonia Drain - Watsonia\_Rd







## LEGEND

★ Selected Locations



Paper Size A4  
0 85 170 340  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	C
Date	13/11/2018

Banyule Creek  
Comparison Locations

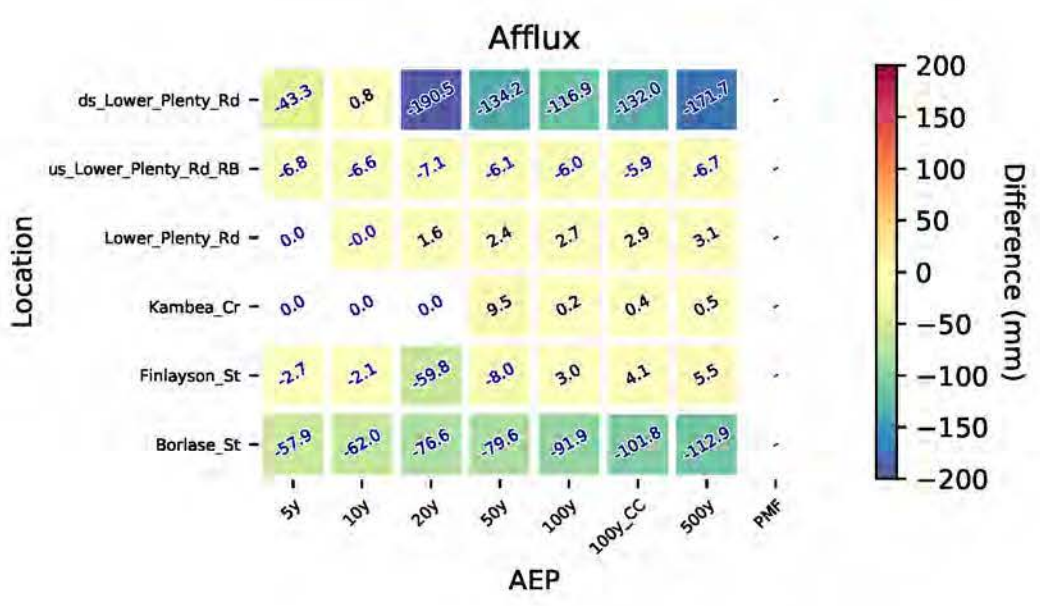
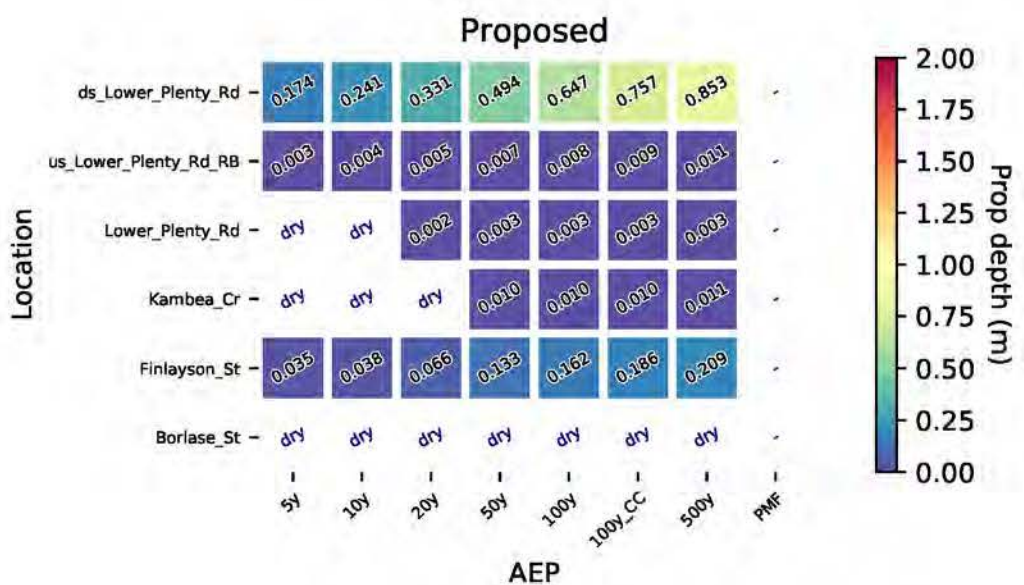
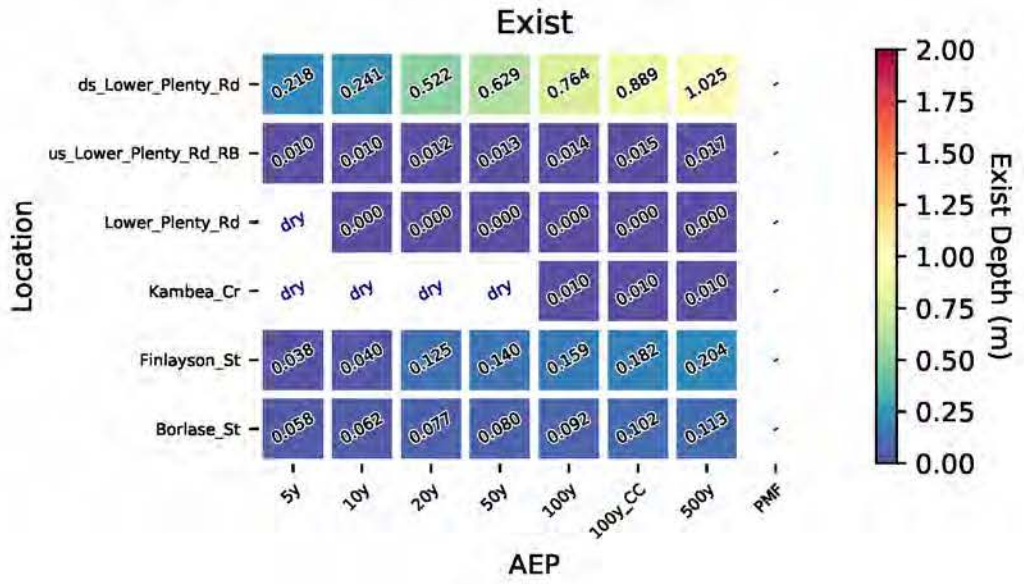
Appendix D-4

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

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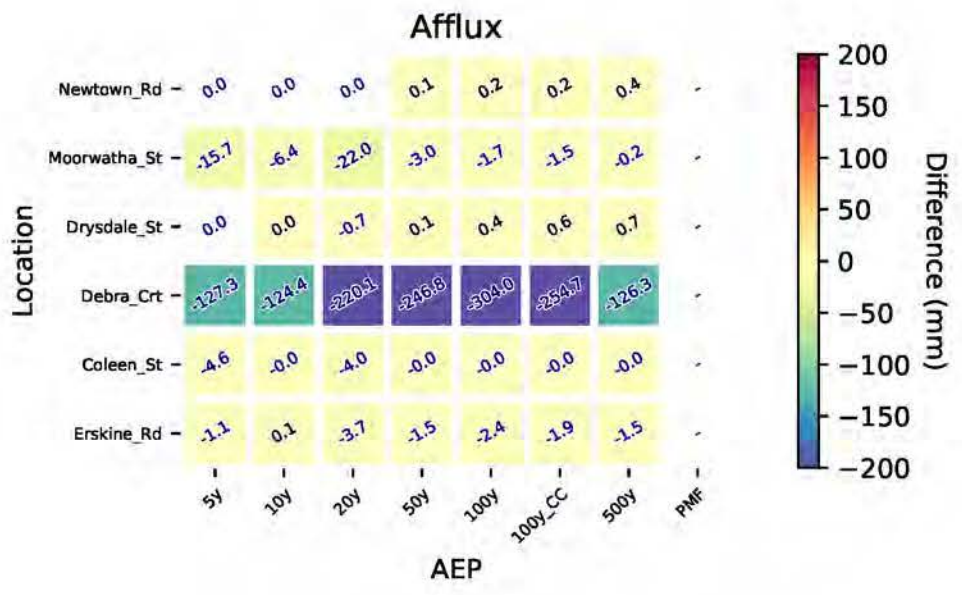
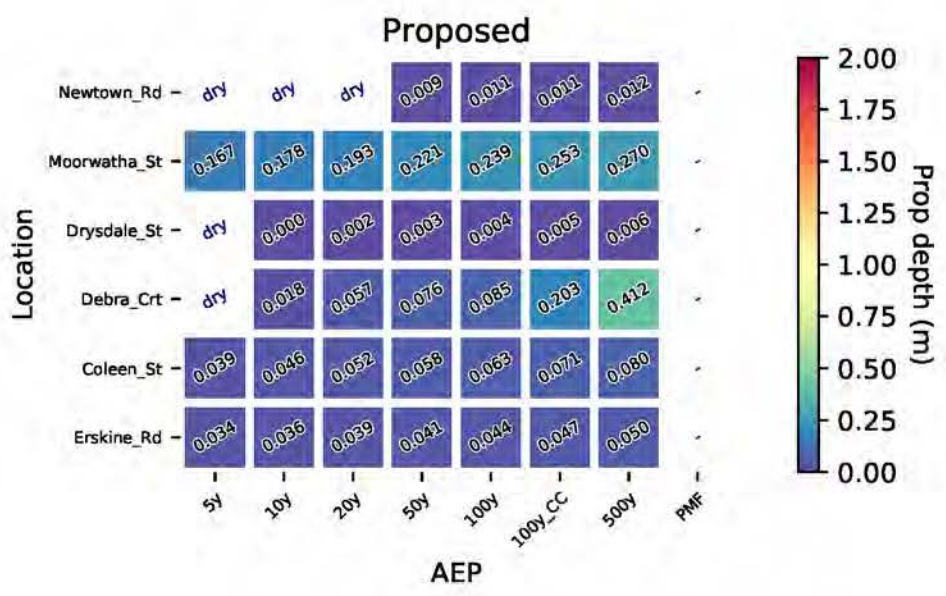
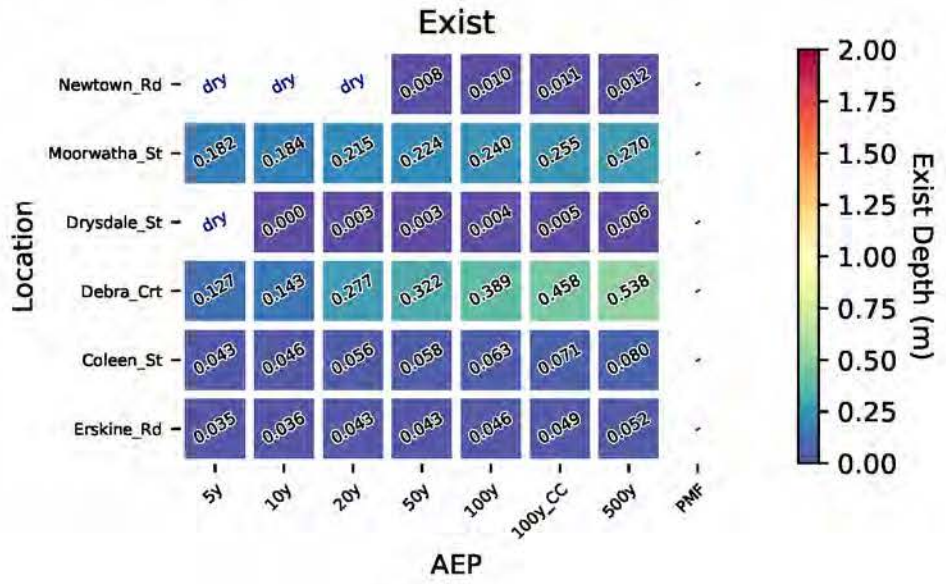


# Banyule Creek - Overview

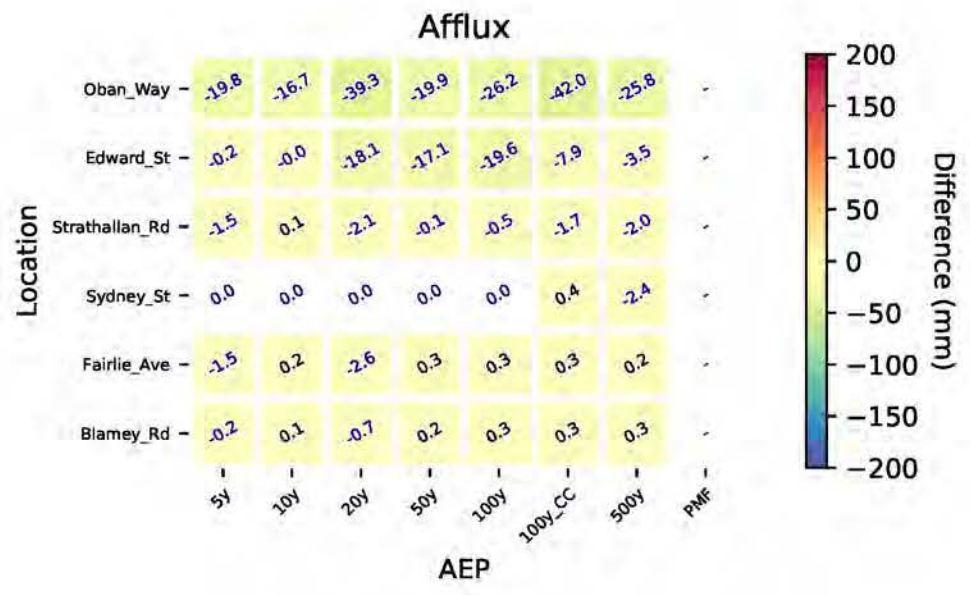
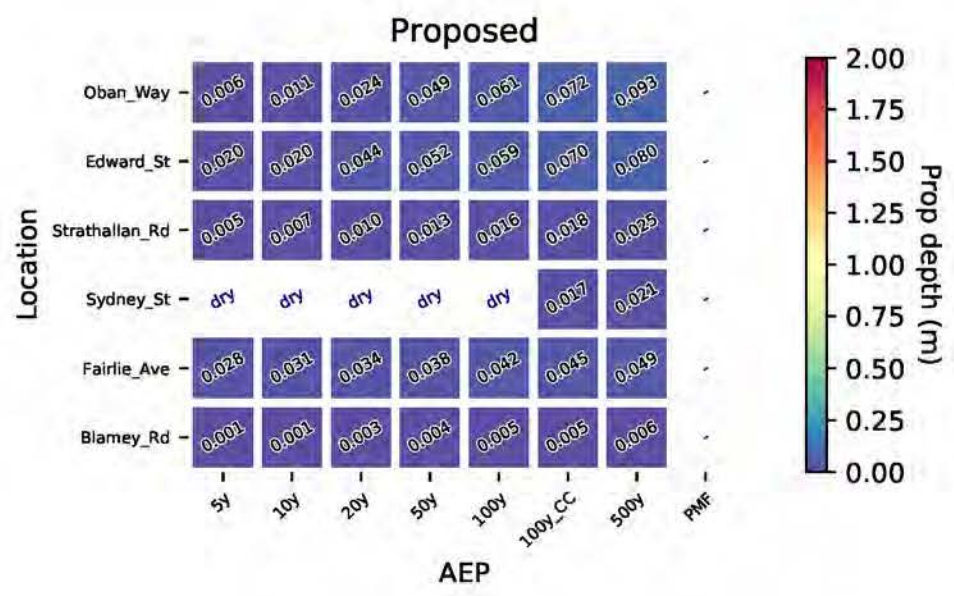
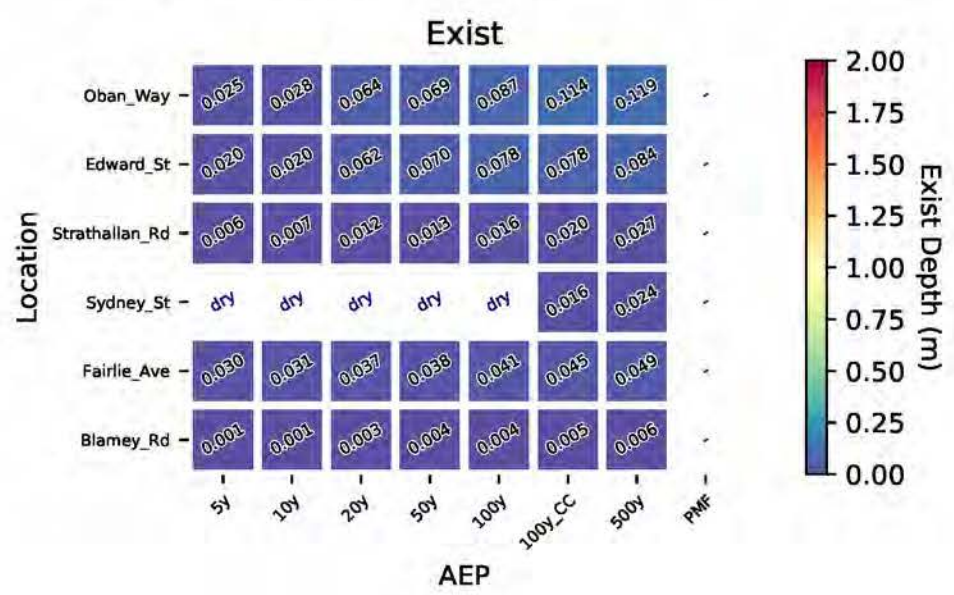




# Banyule Creek - Overview

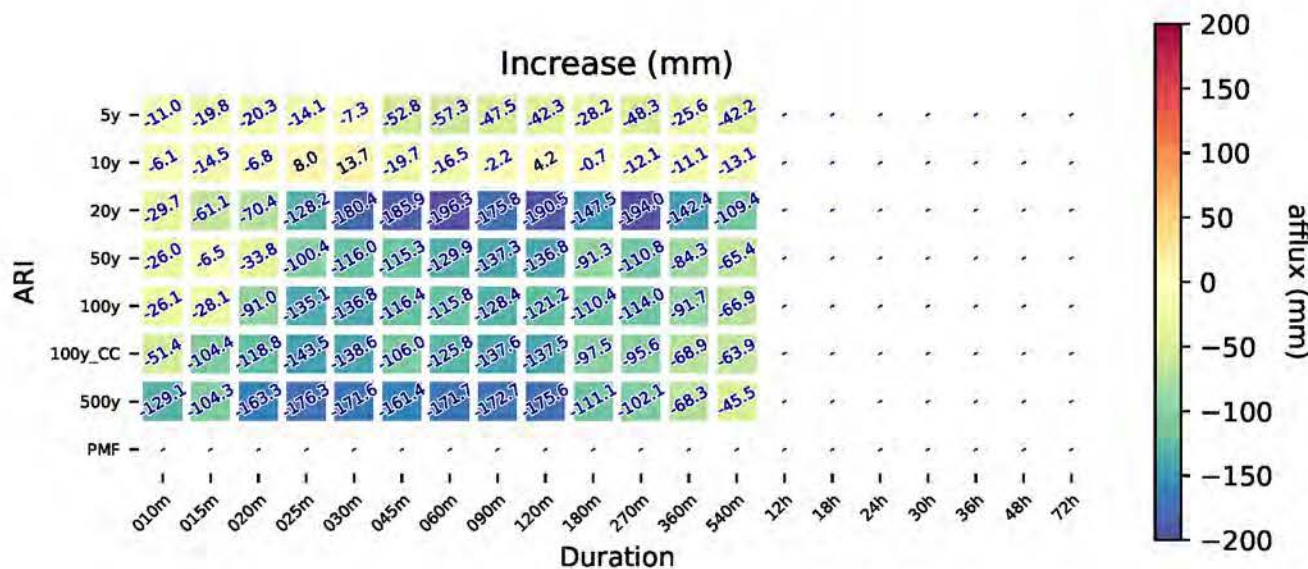
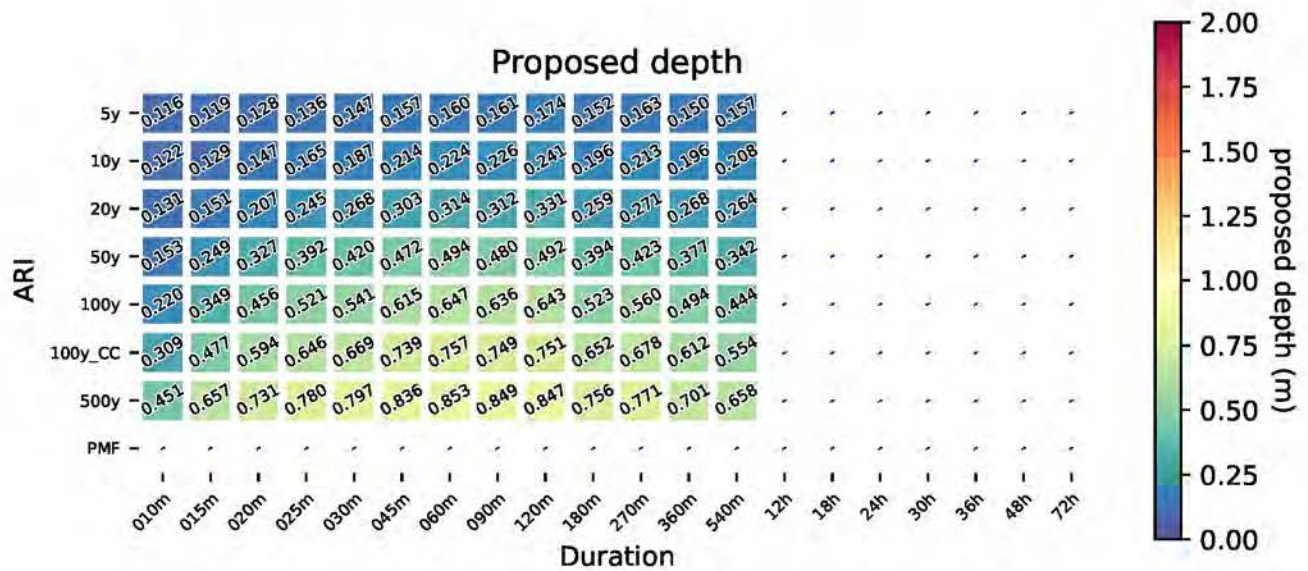
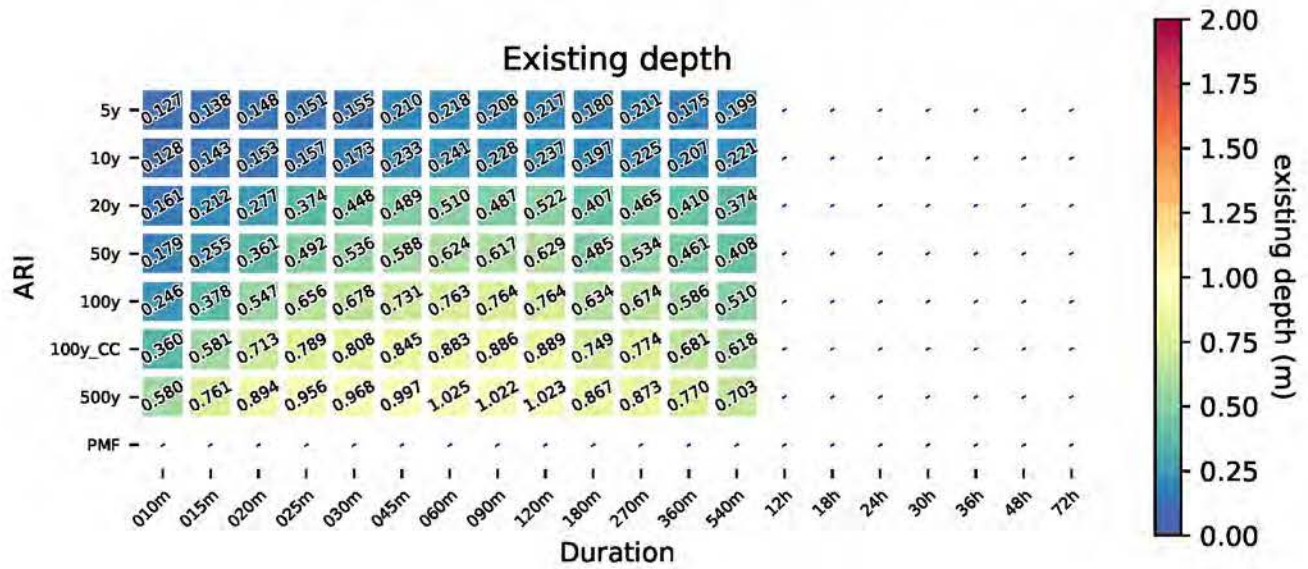


# Banyule Creek - Overview



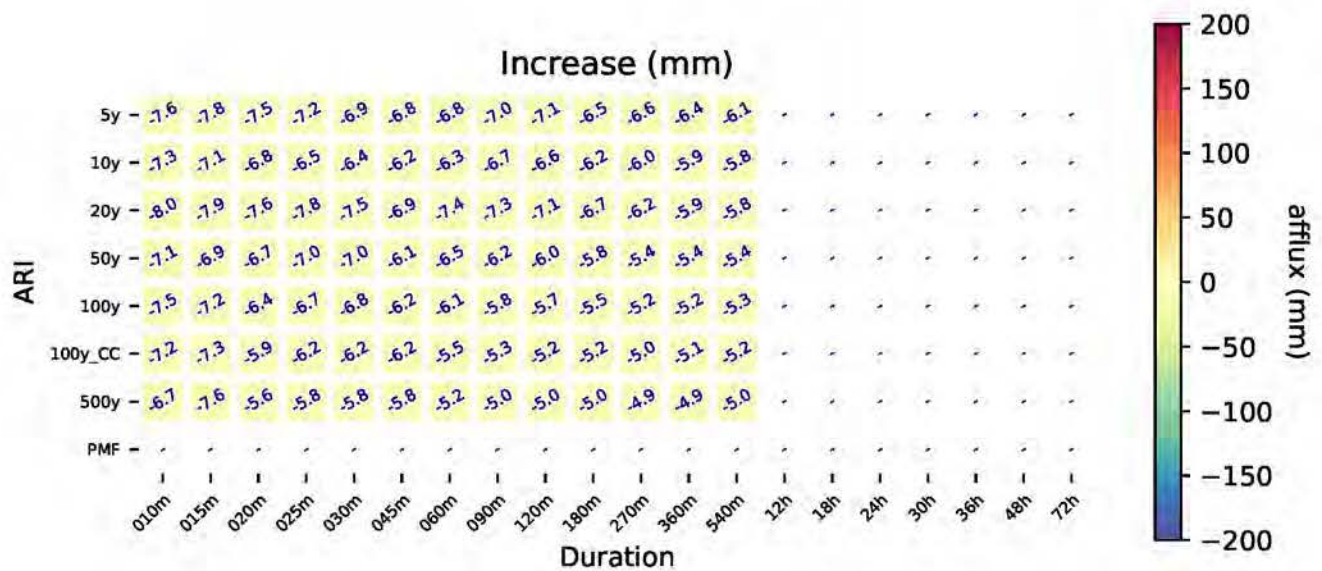
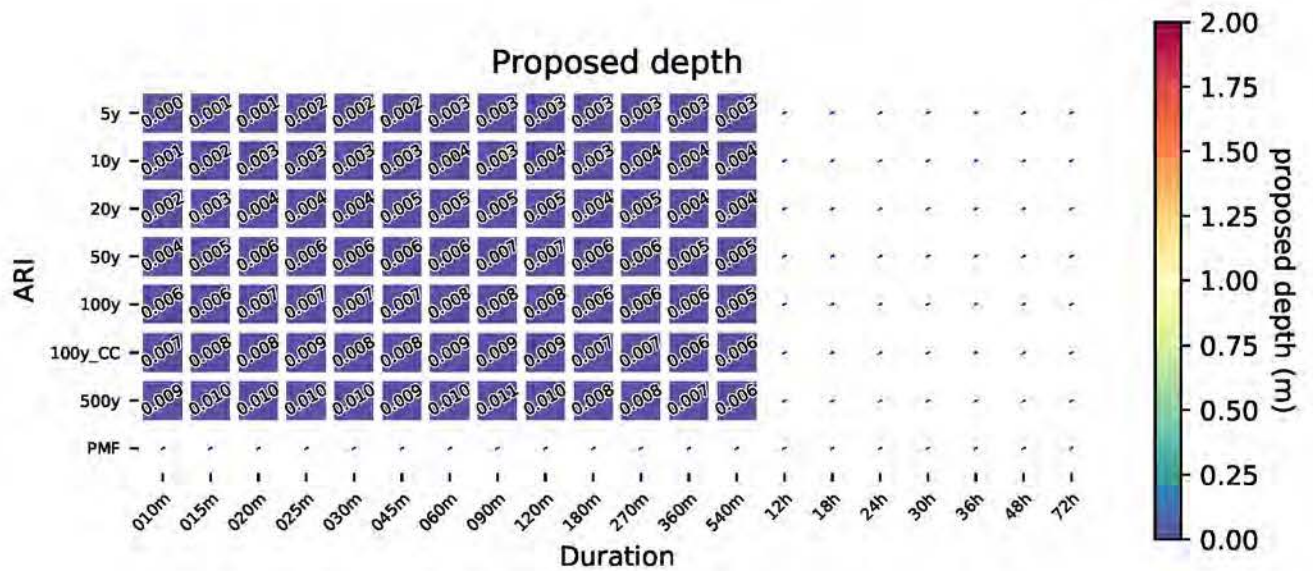
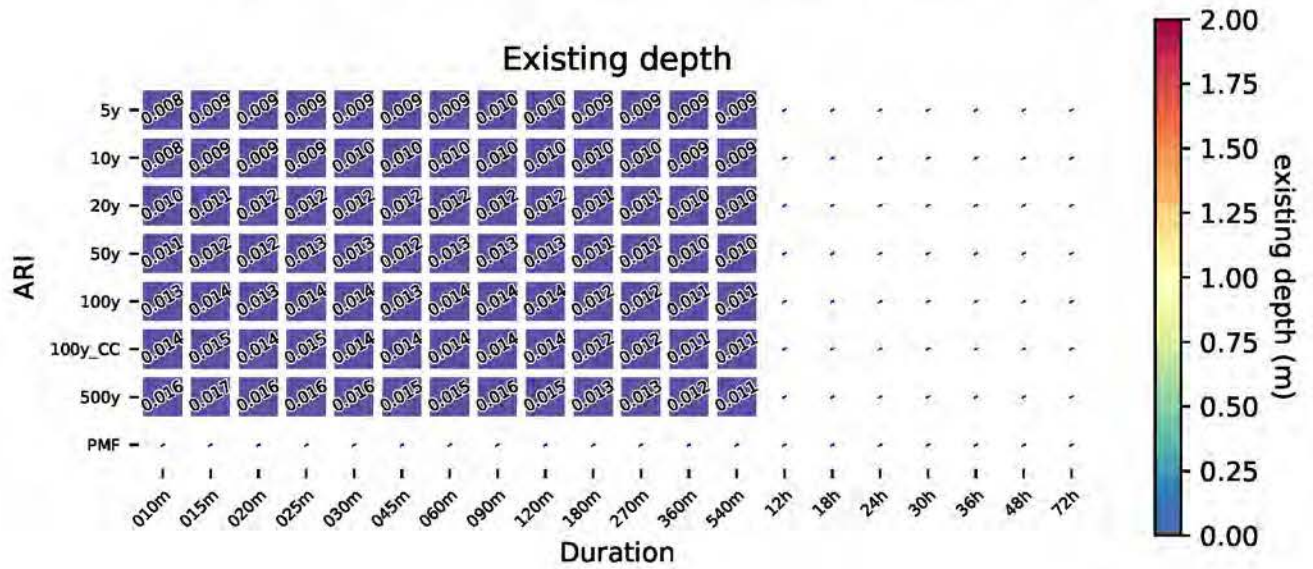


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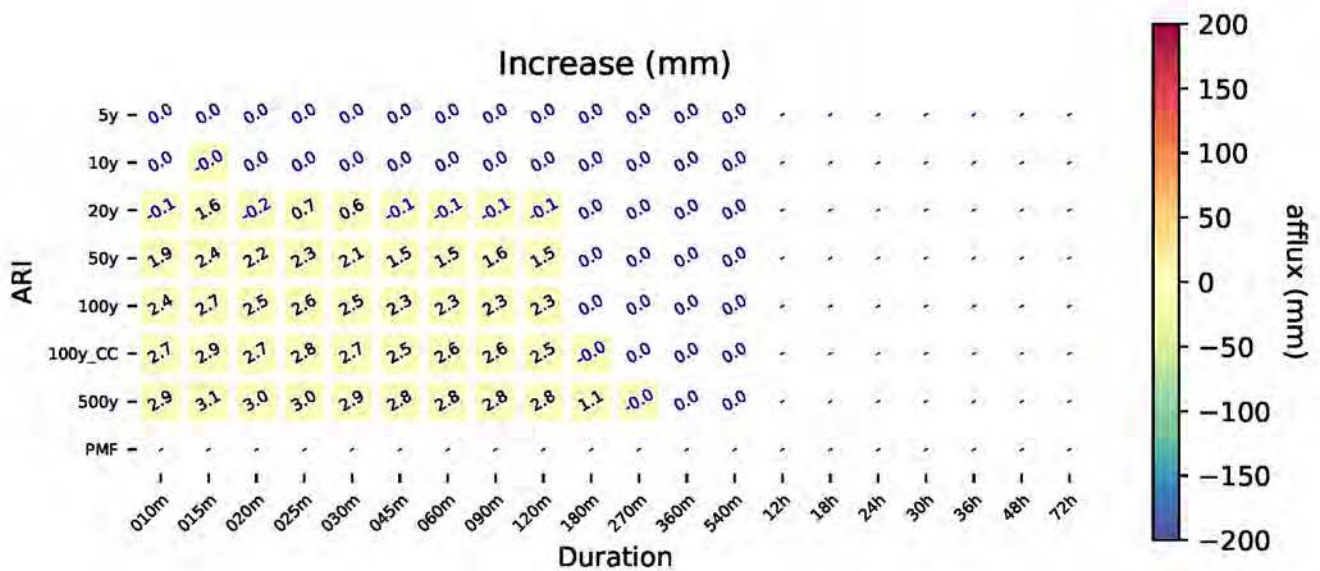
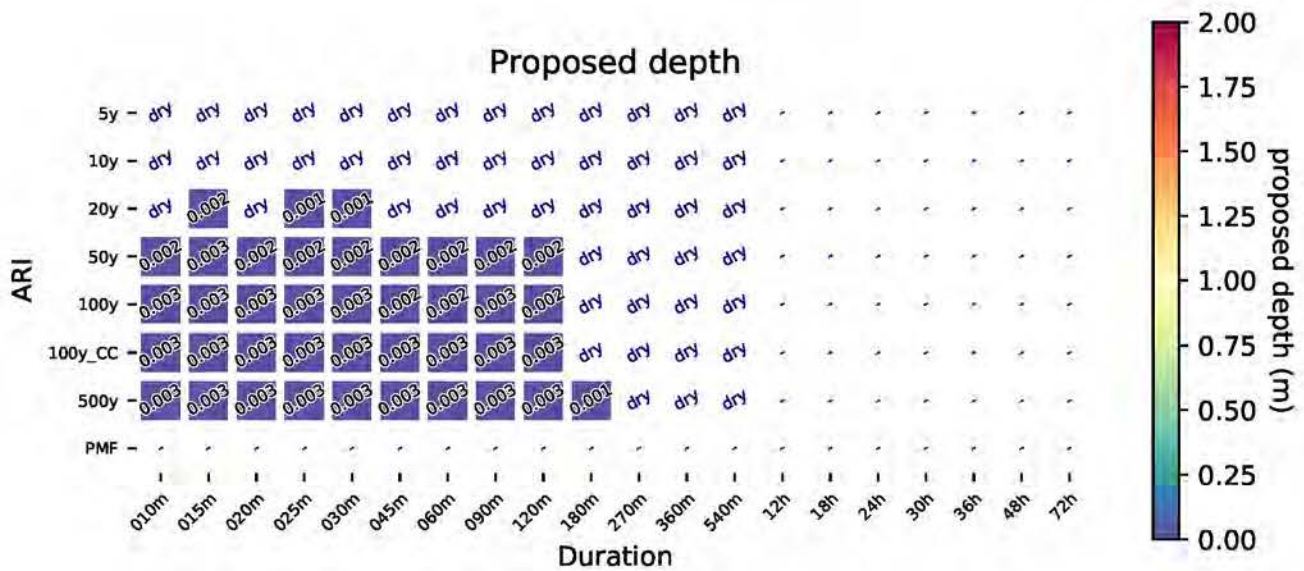
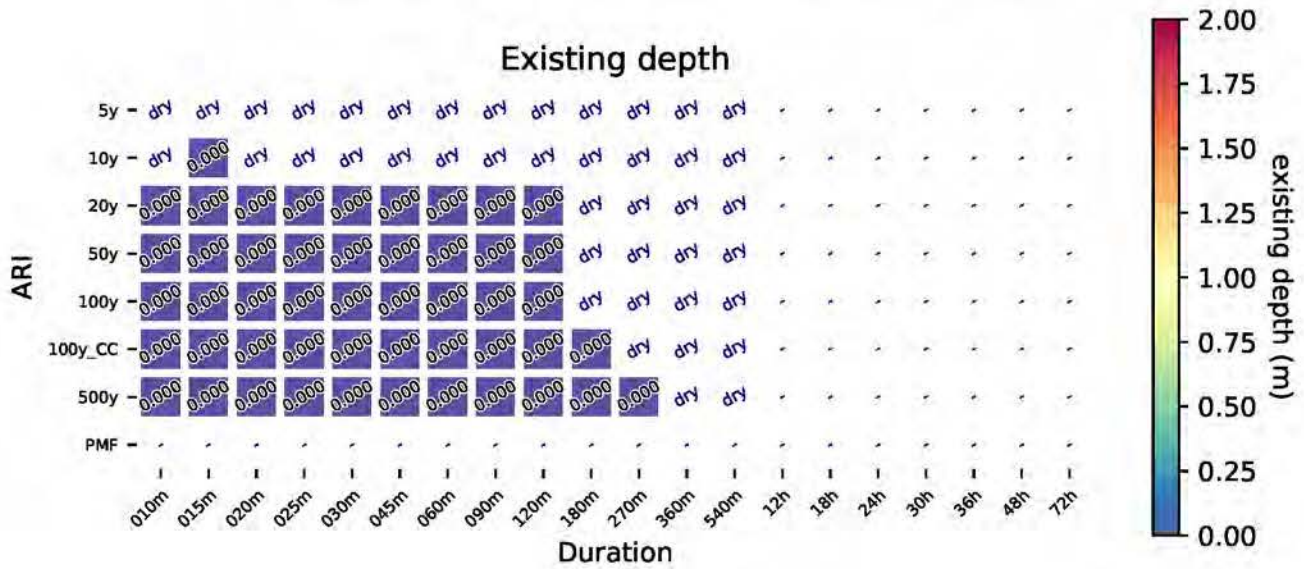




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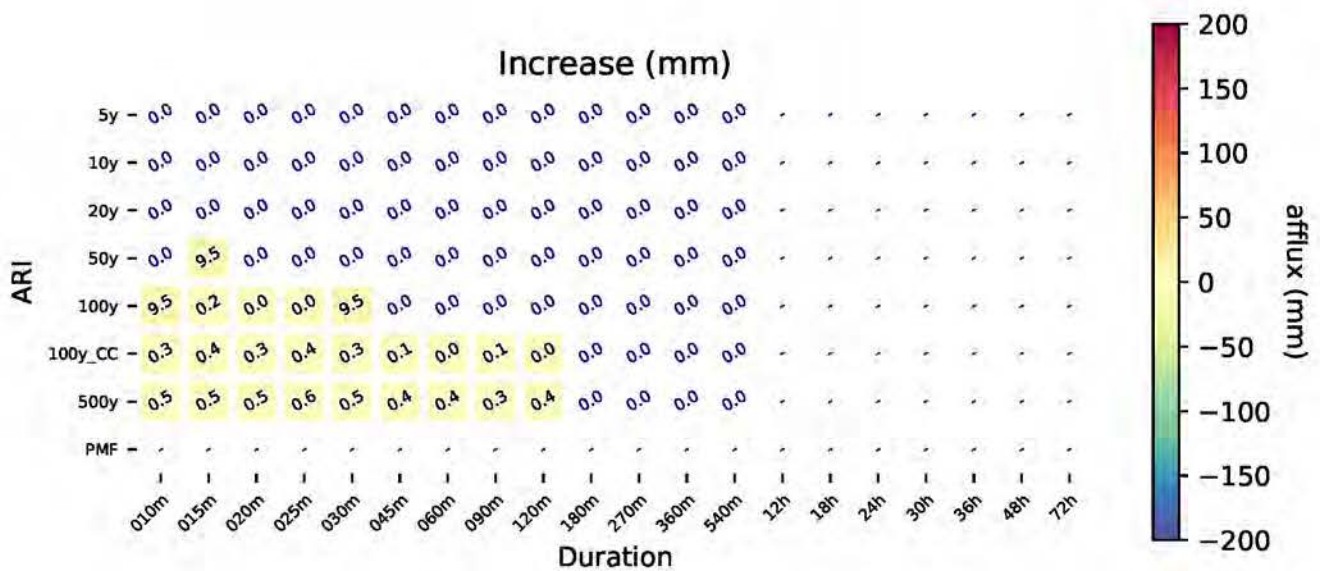
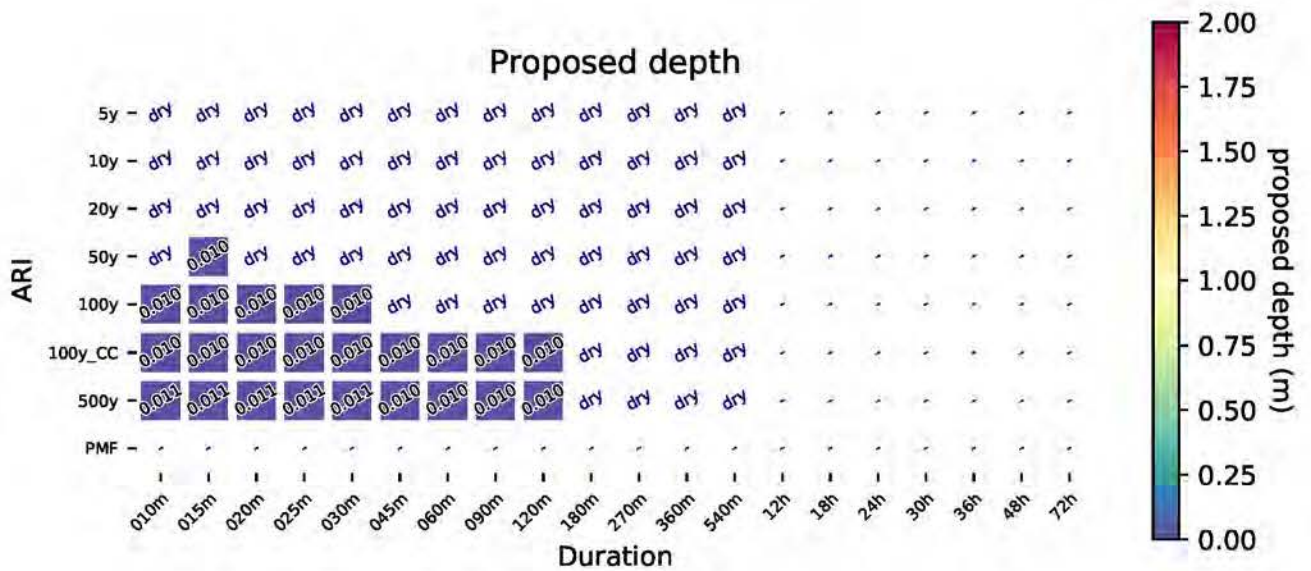
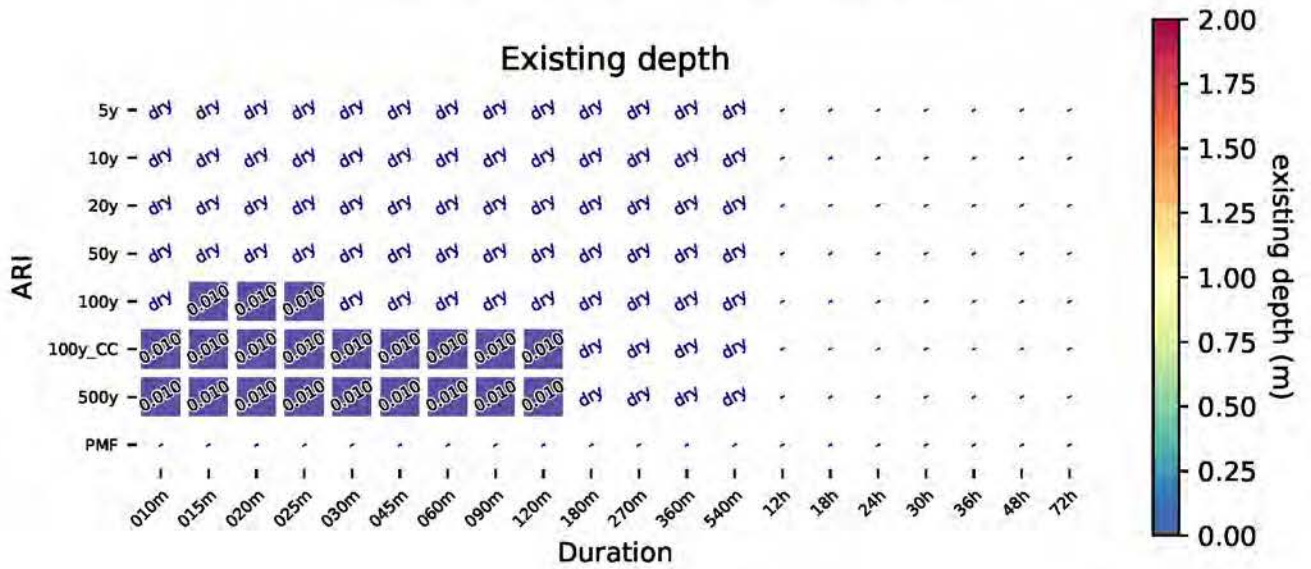


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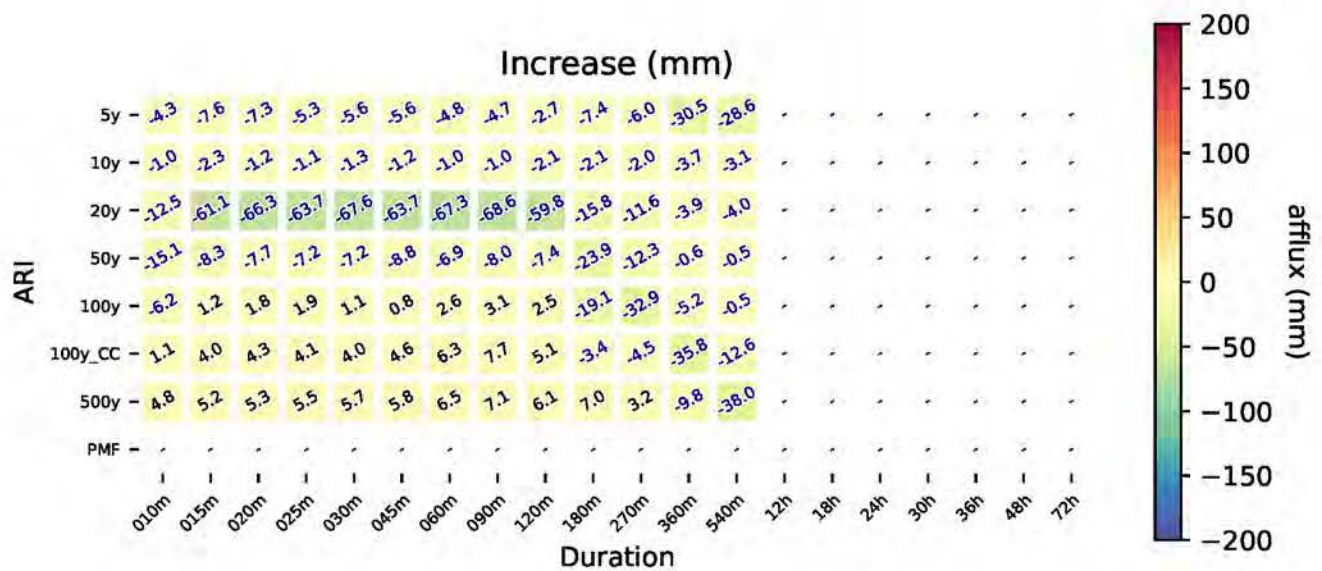
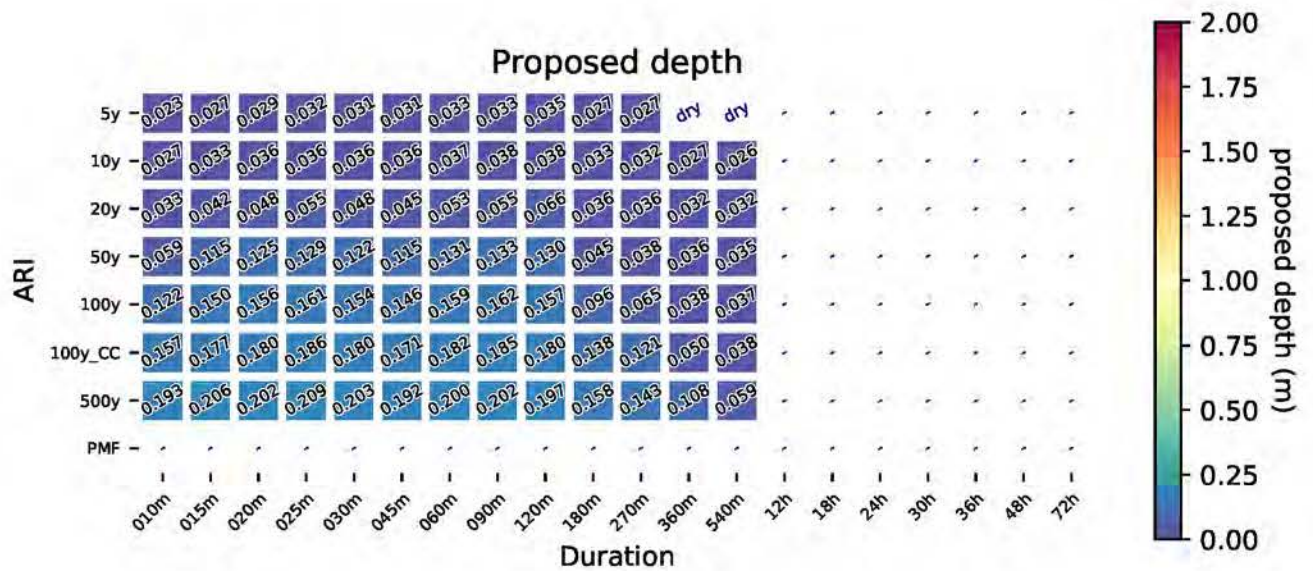
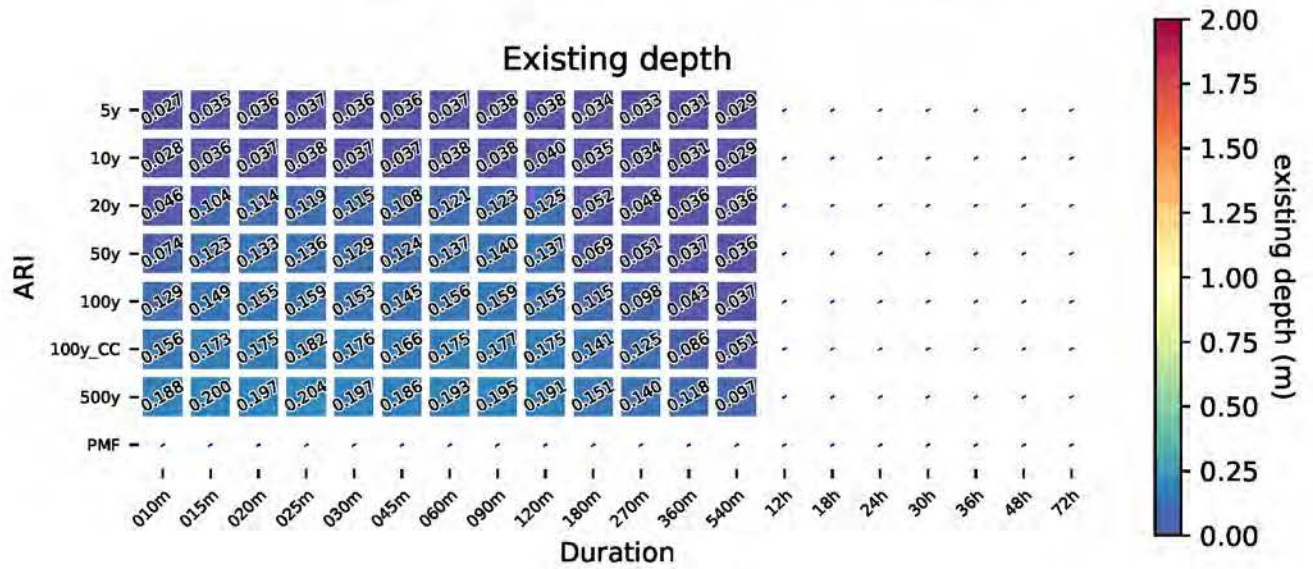




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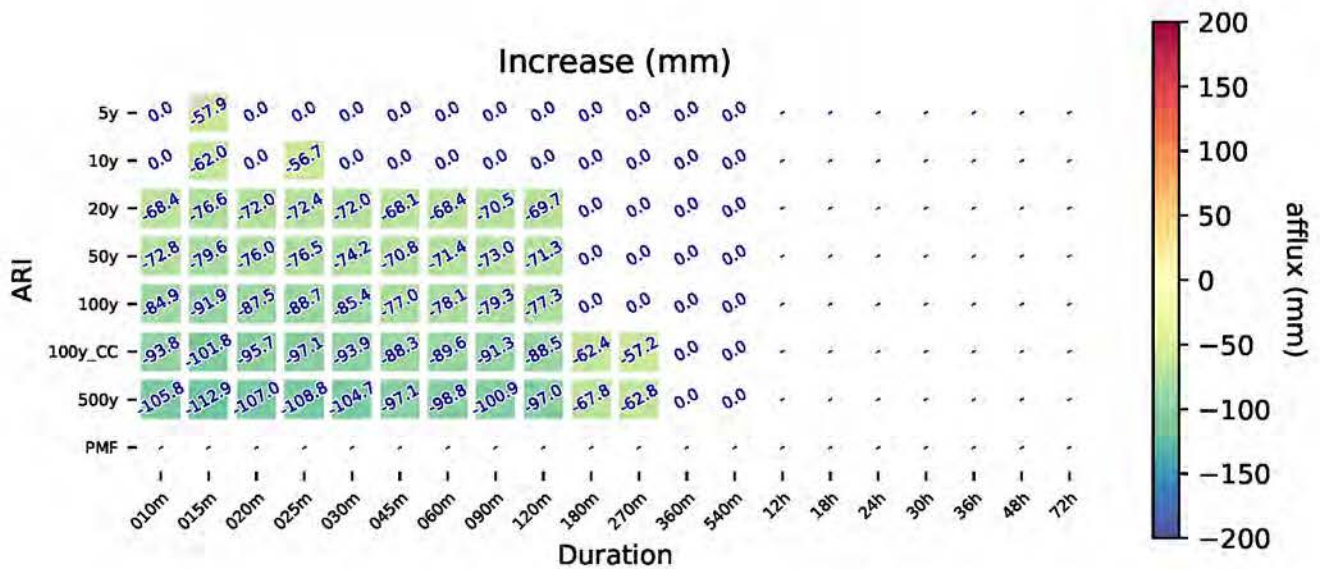
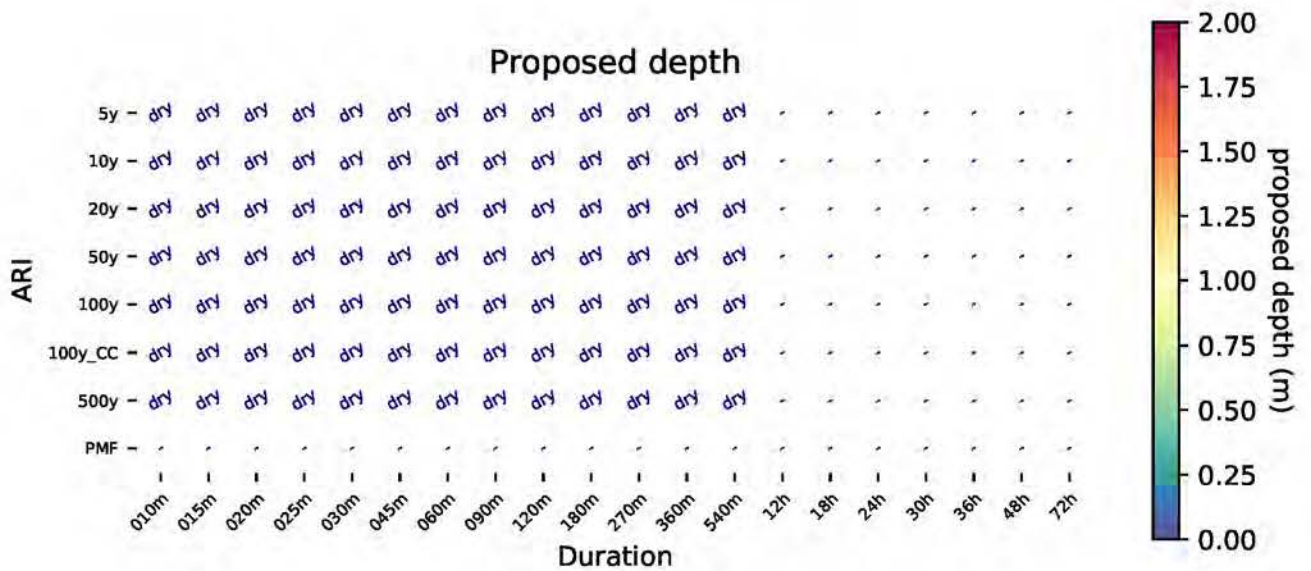
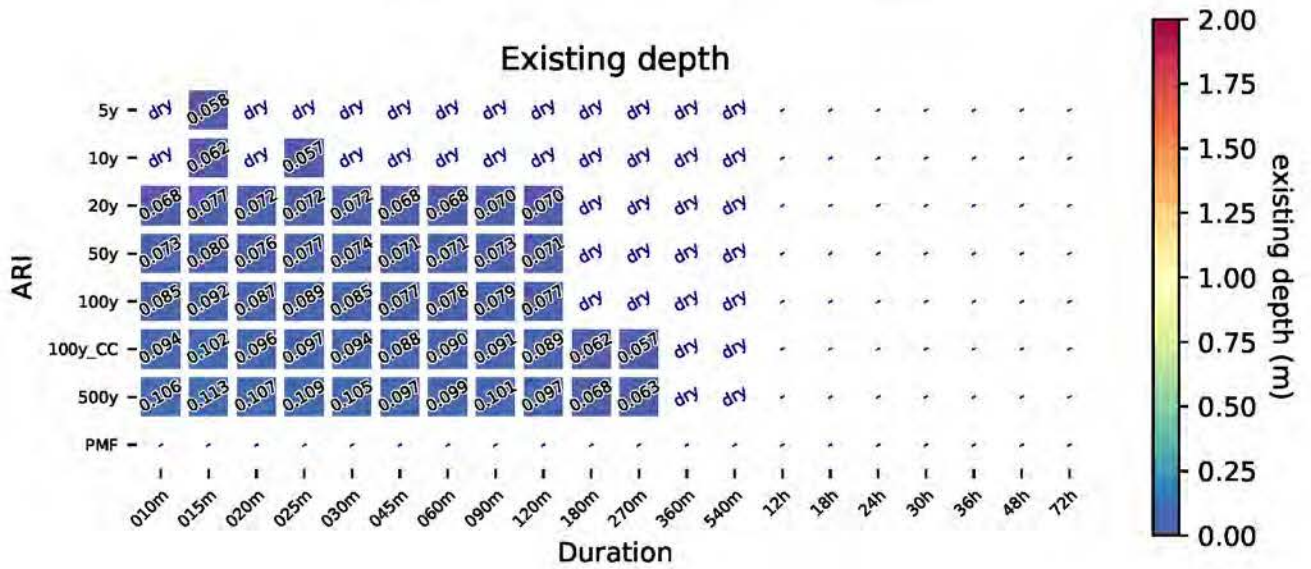


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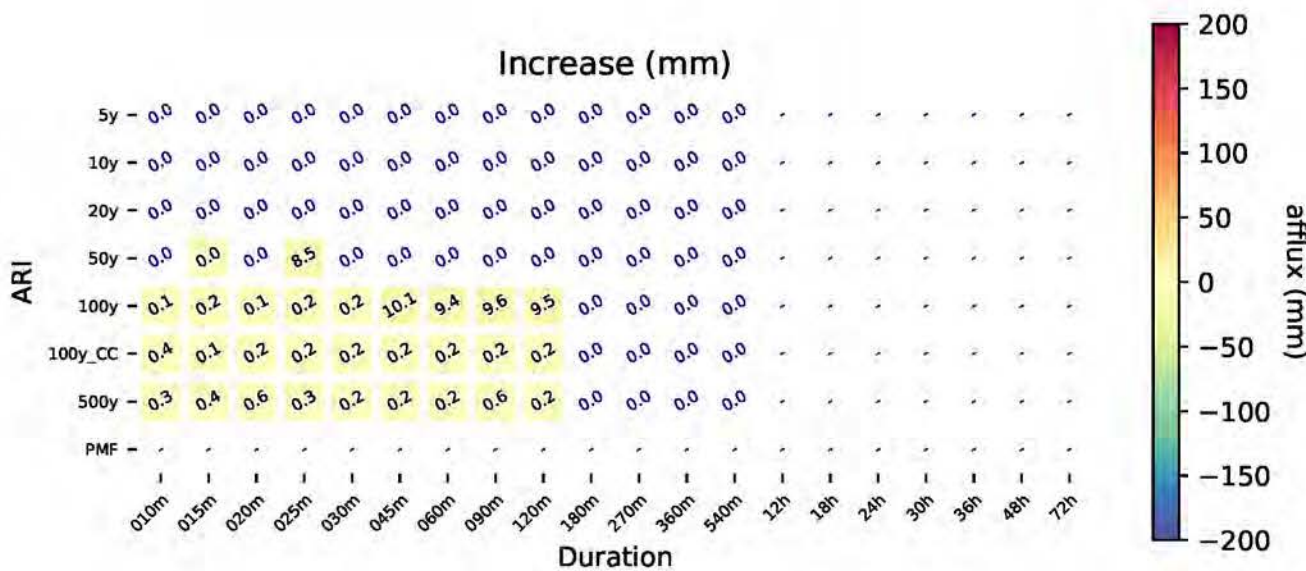
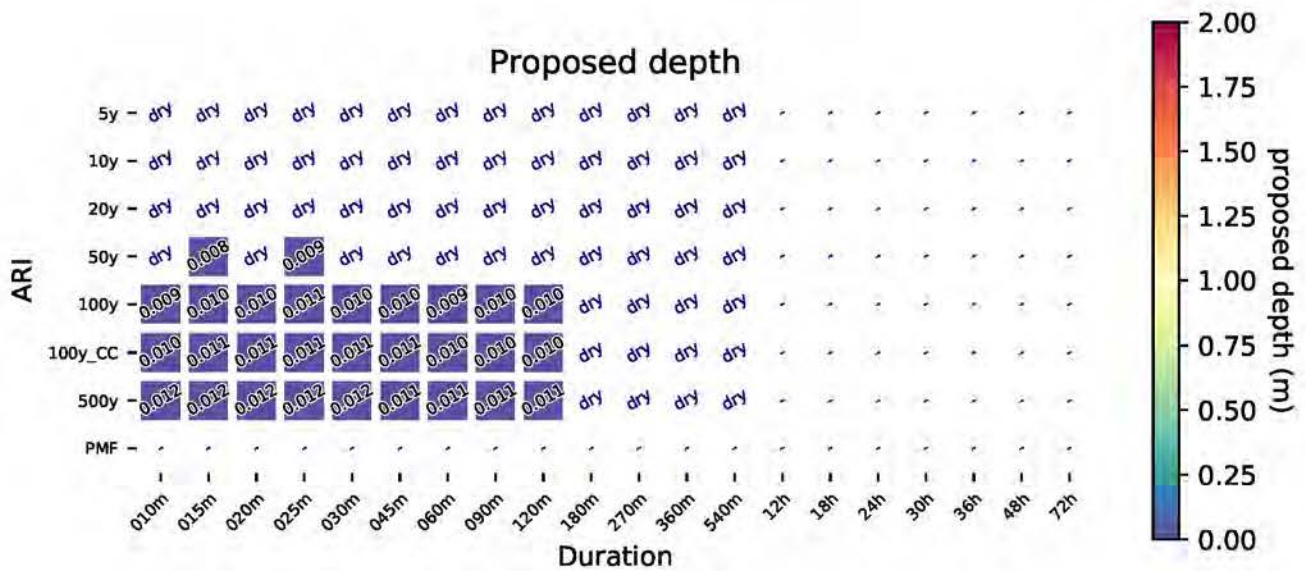
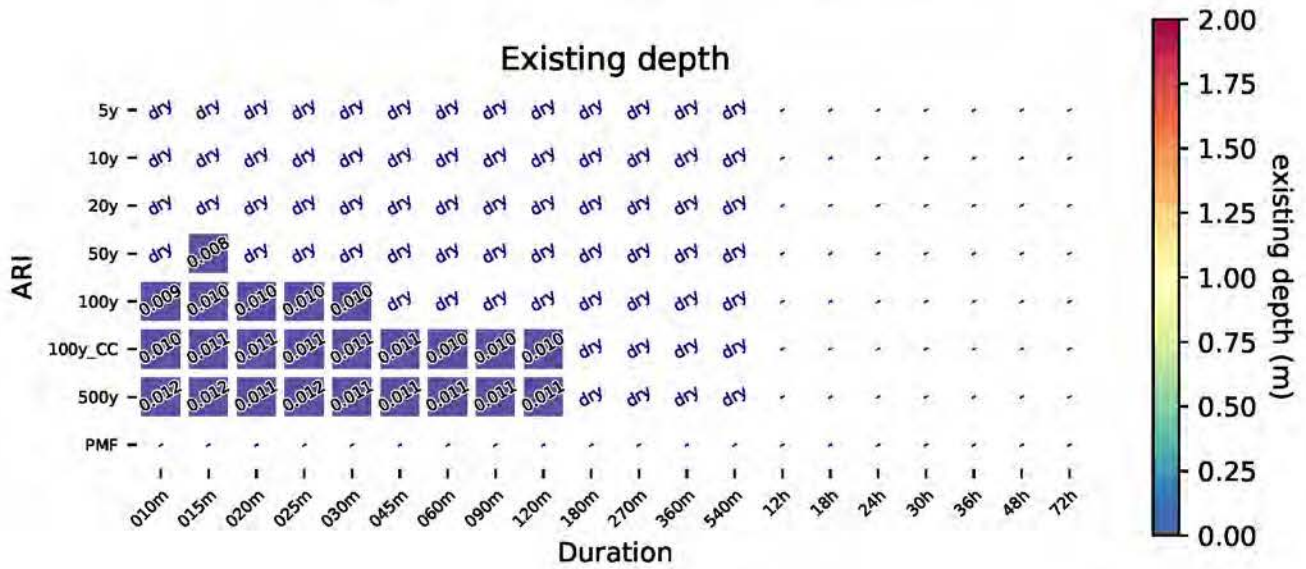




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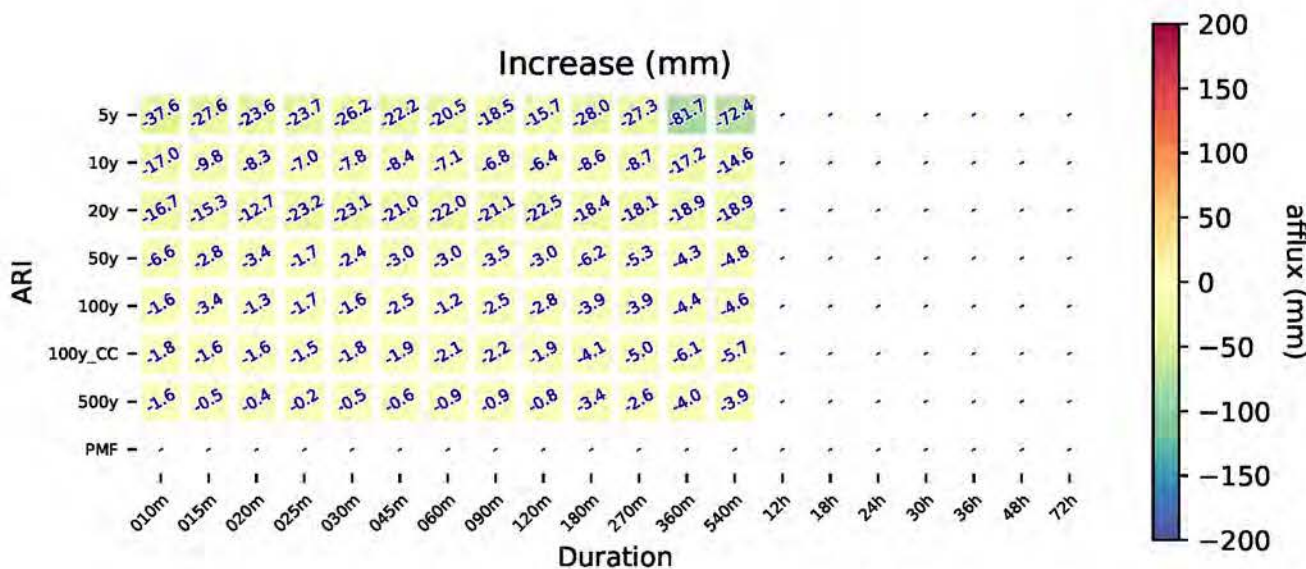
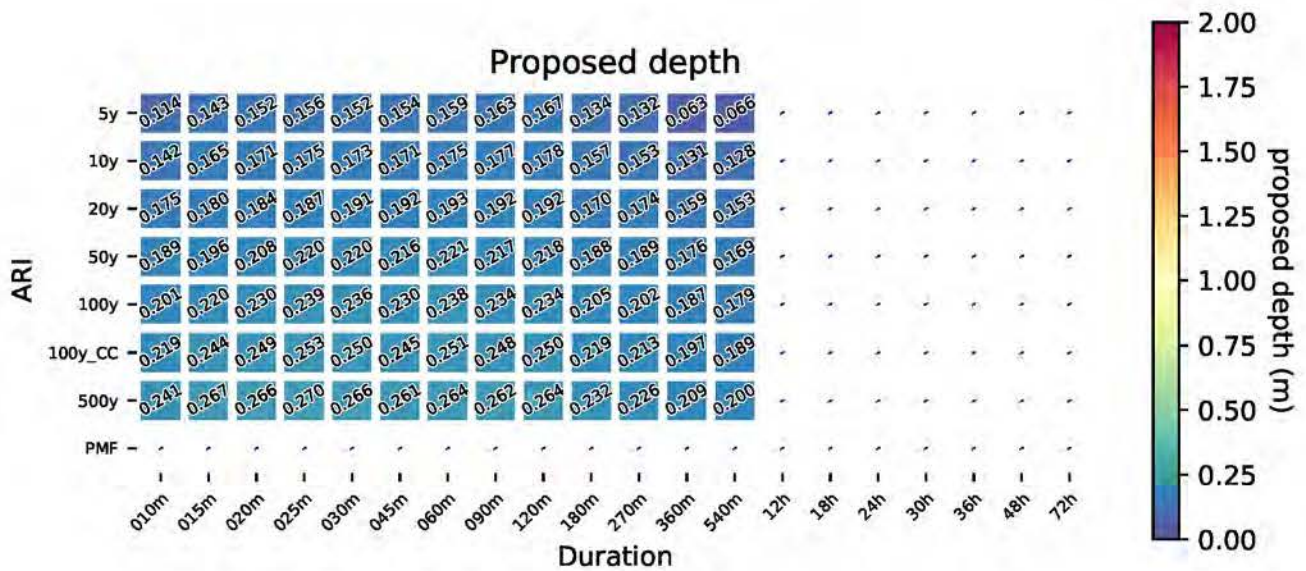
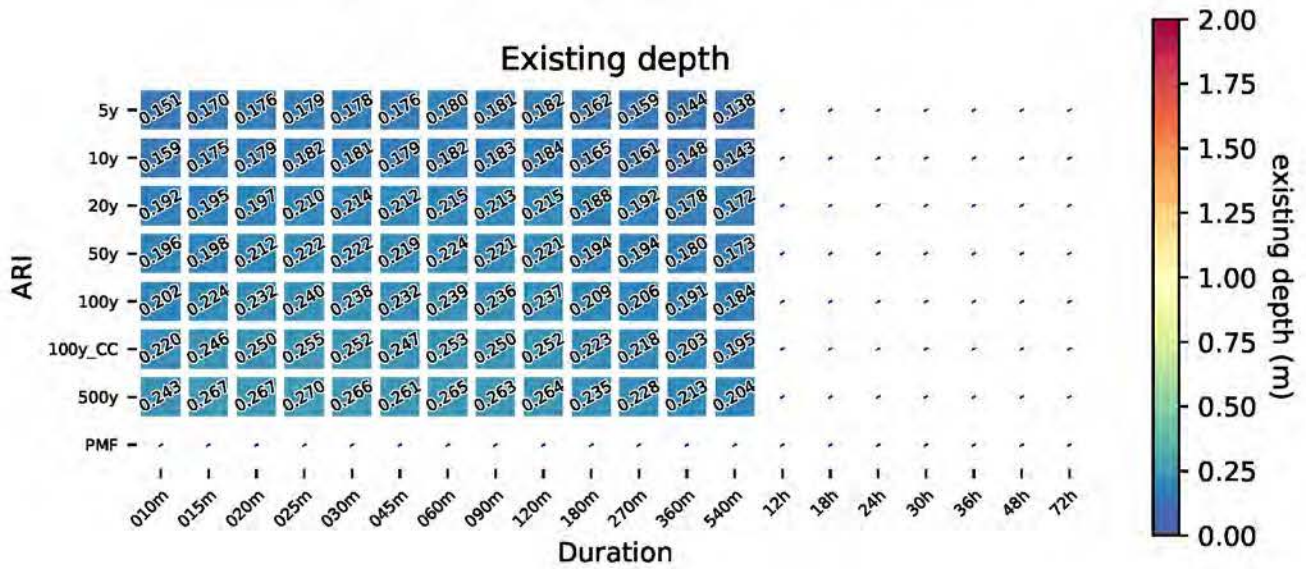


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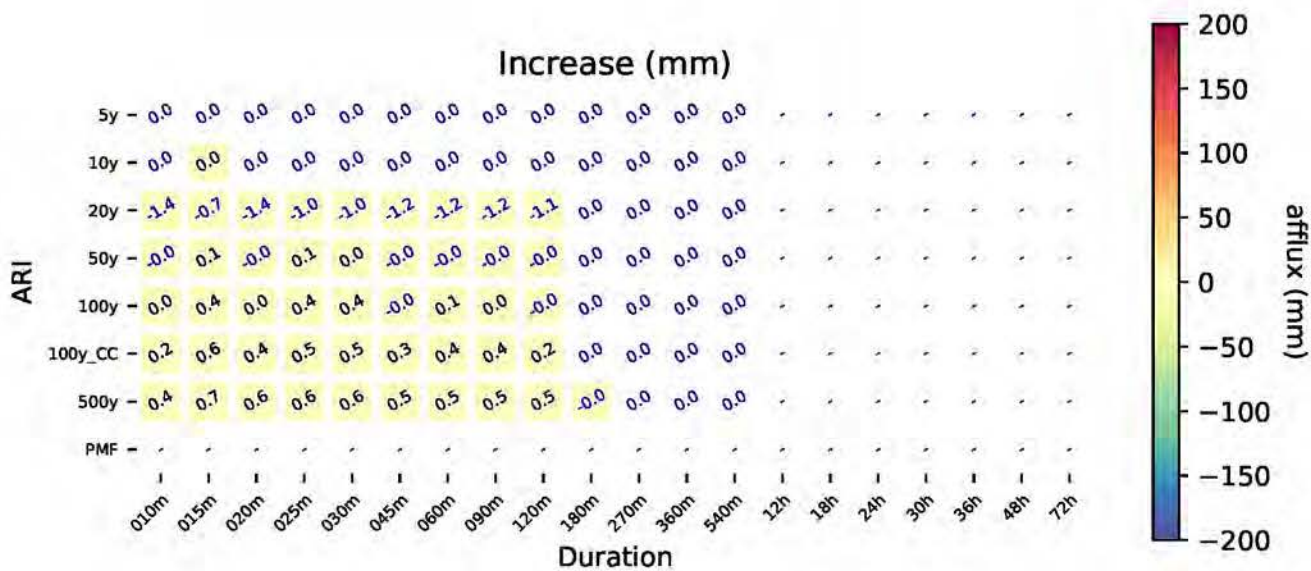
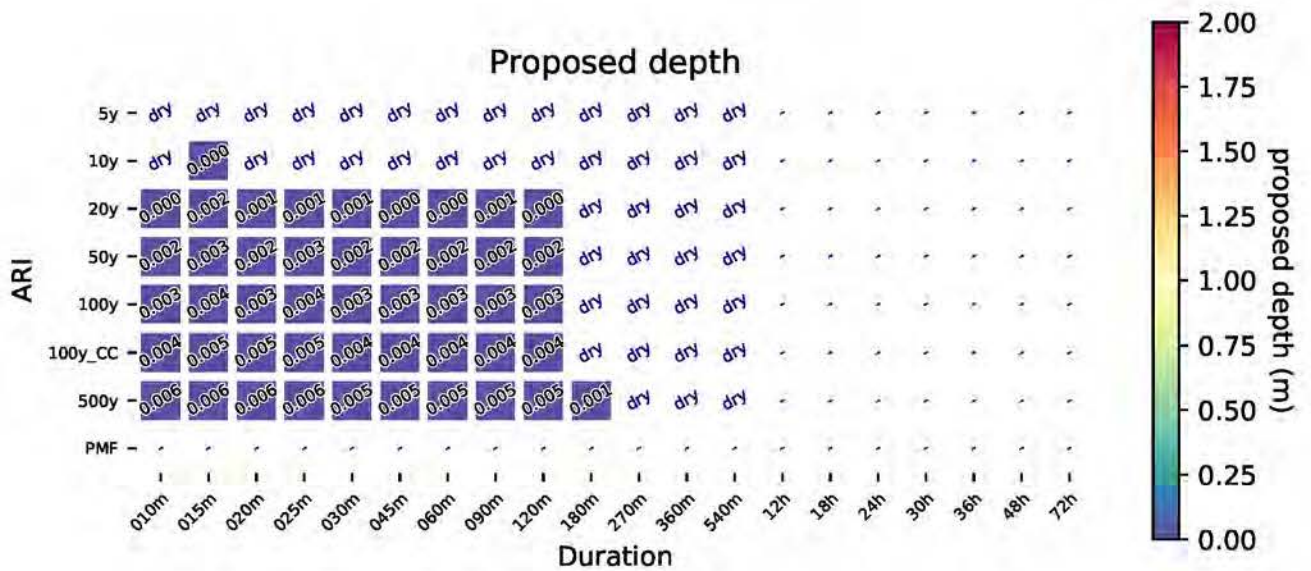
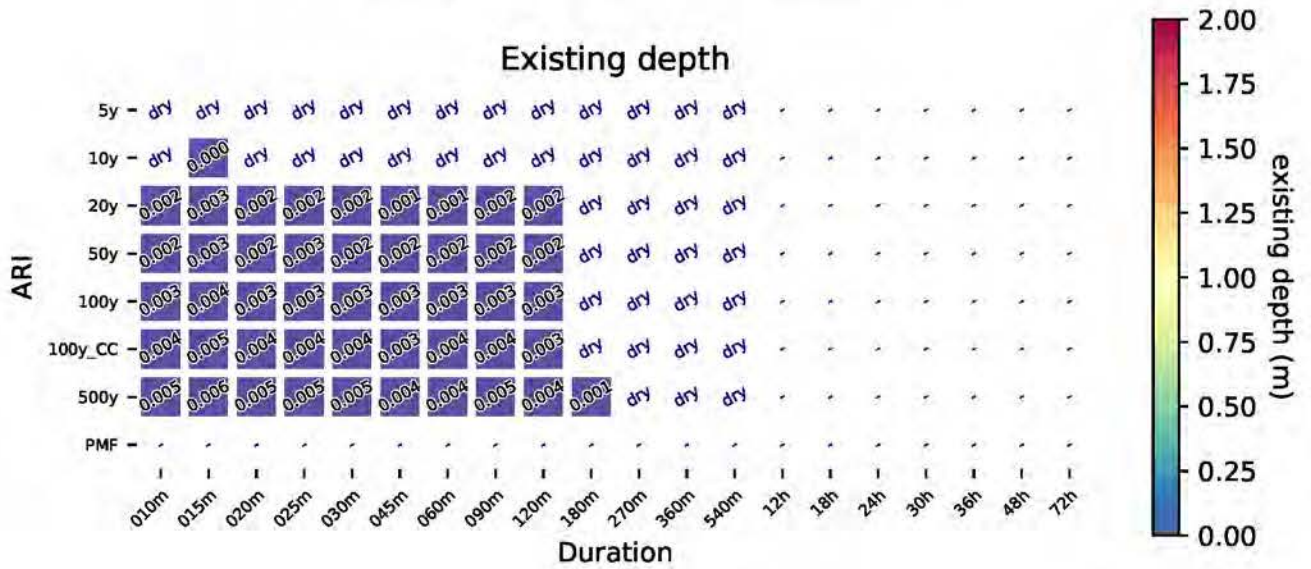




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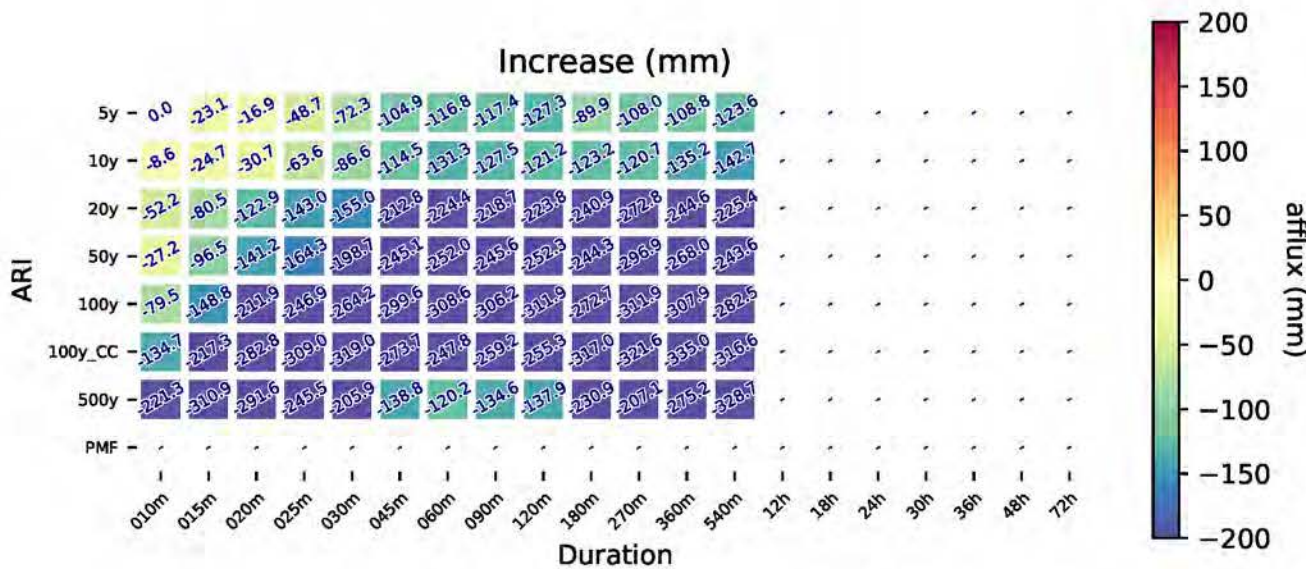
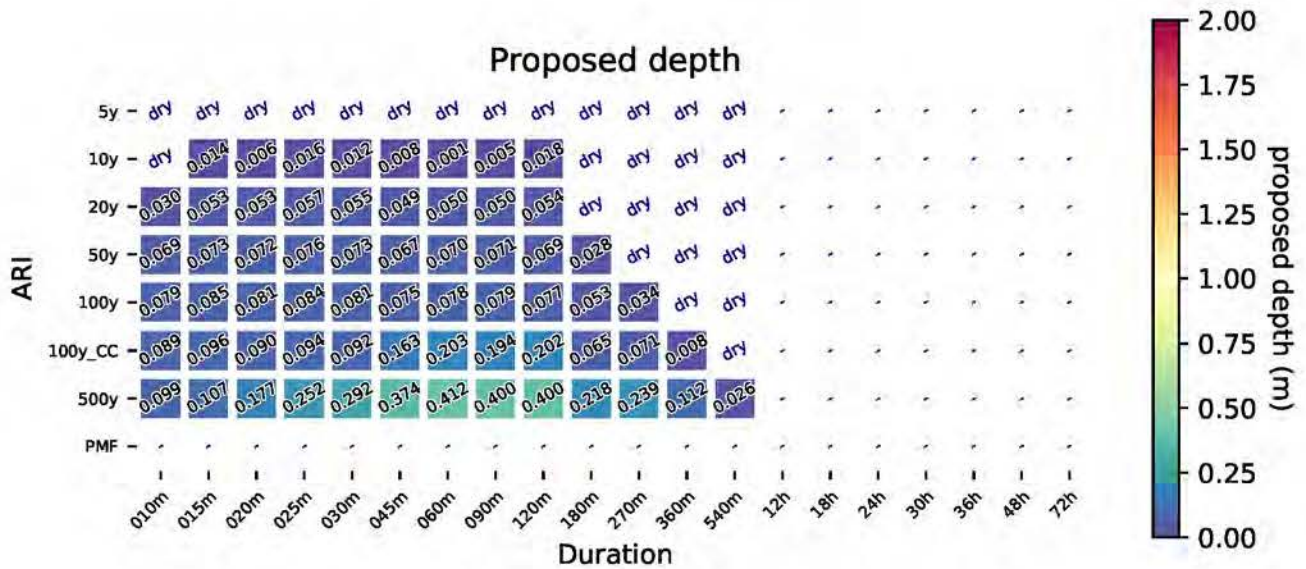
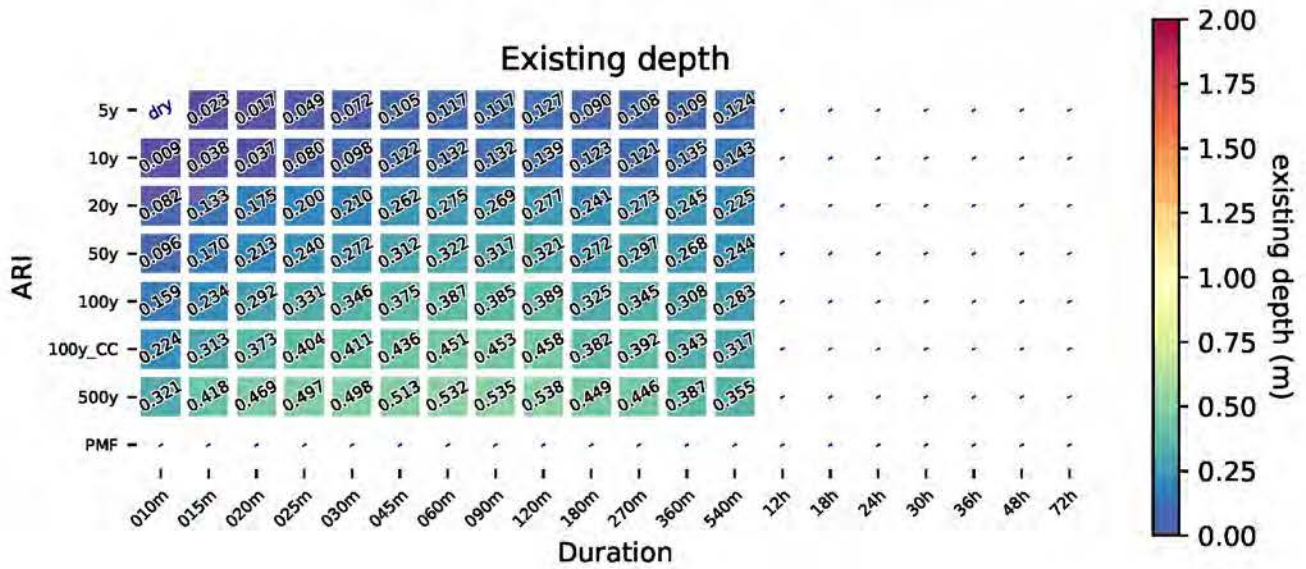


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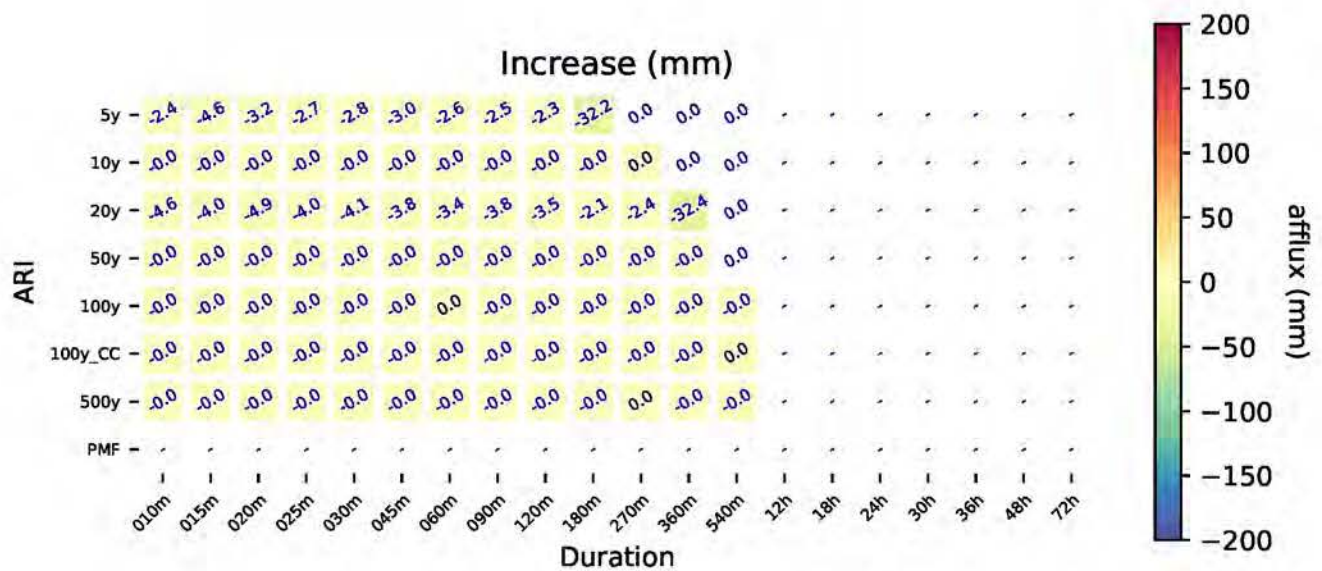
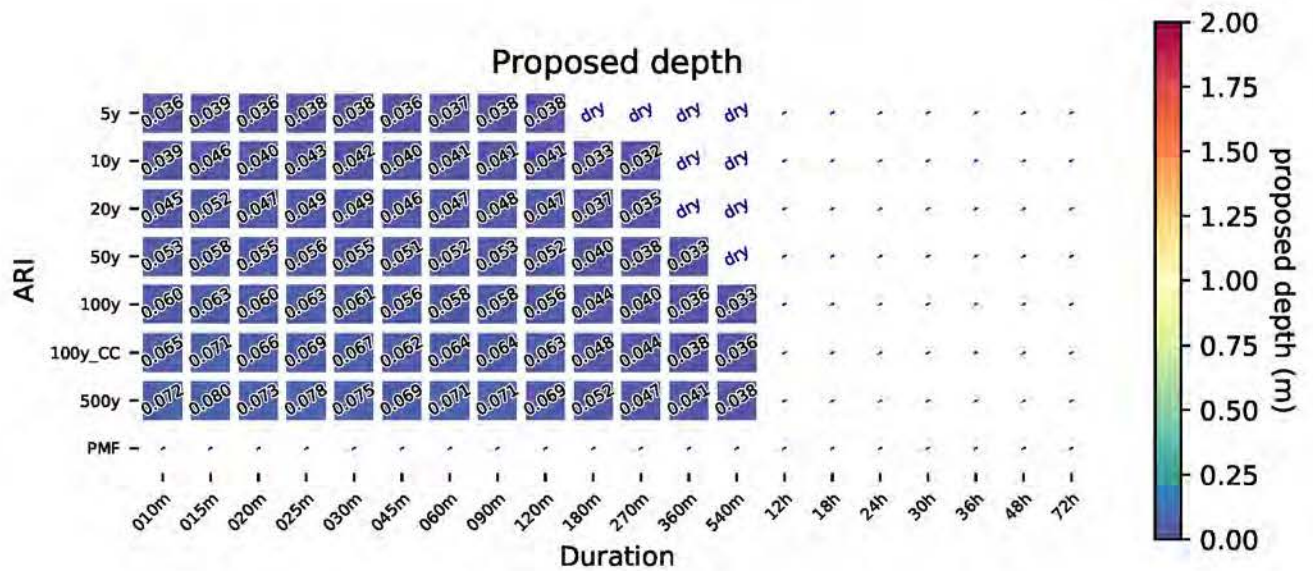
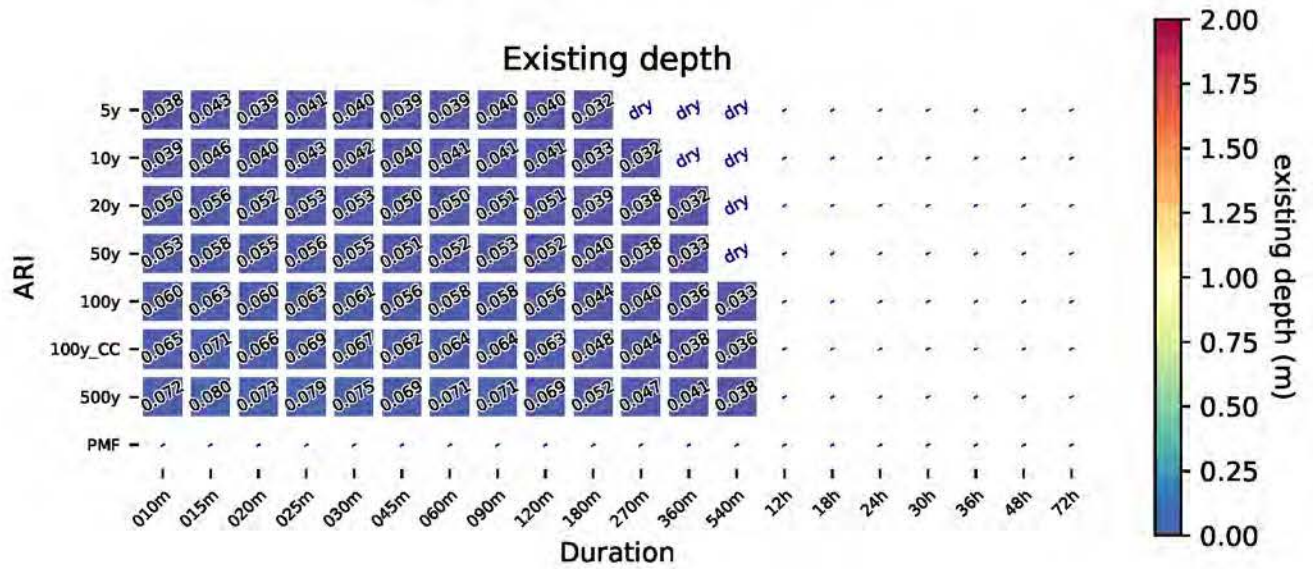


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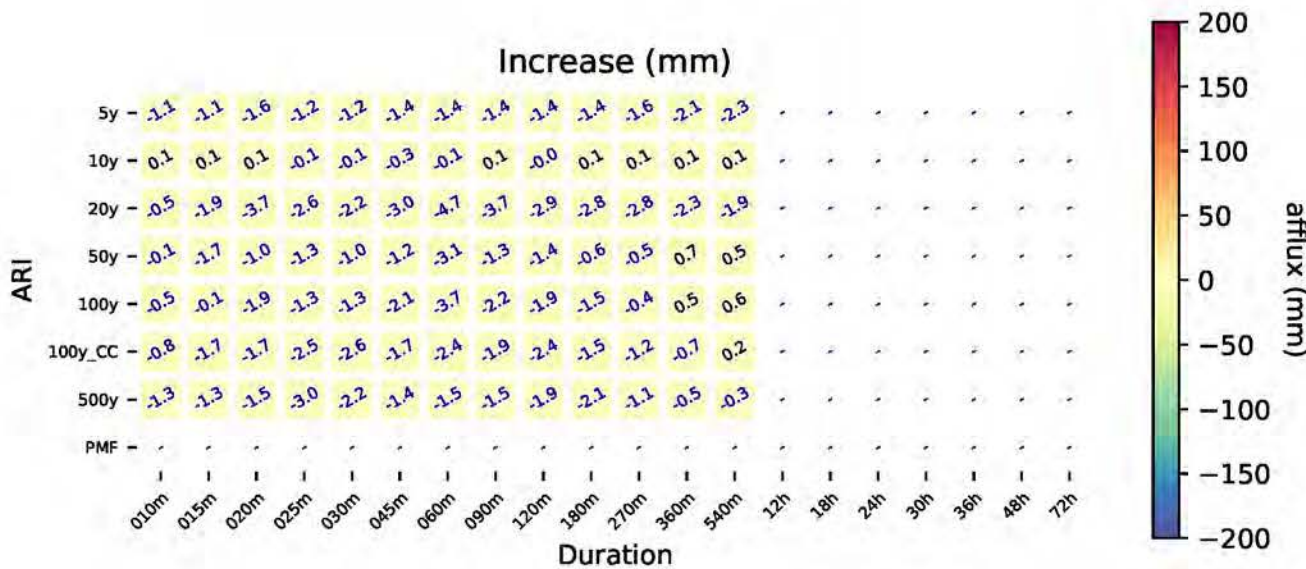
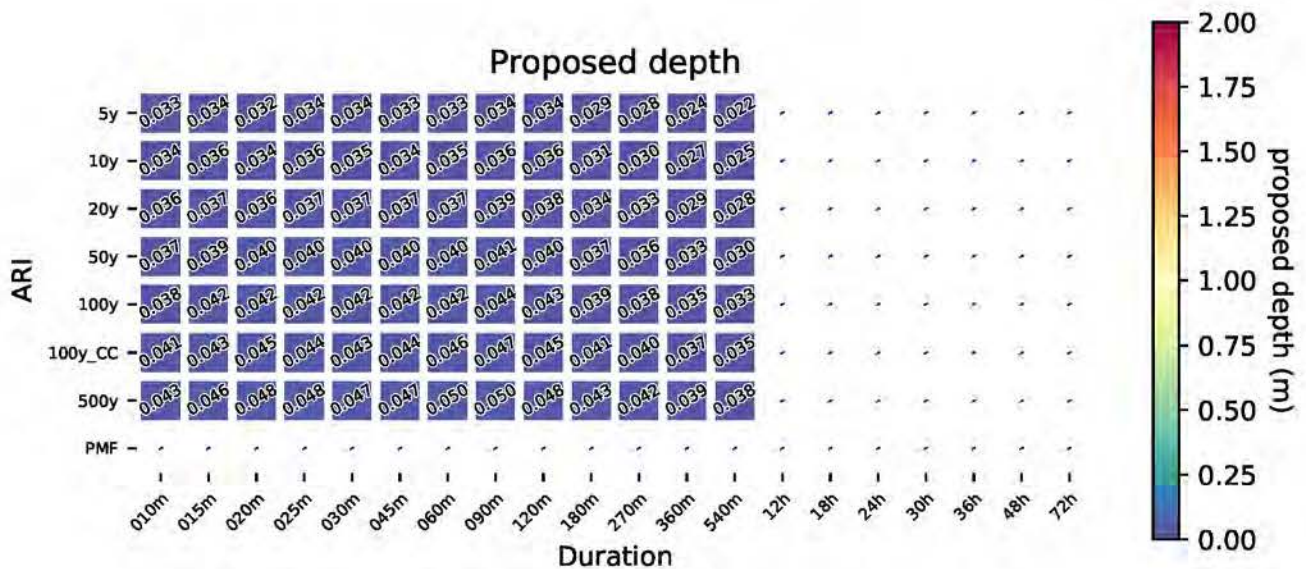
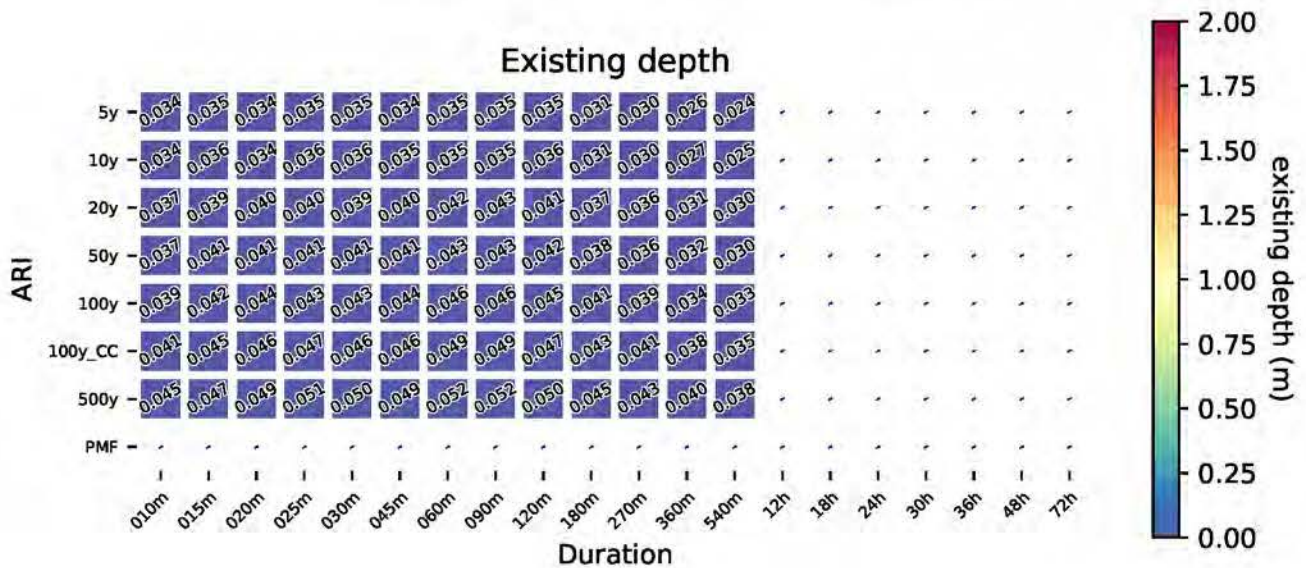


# Banyule Creek - Coleen\_St



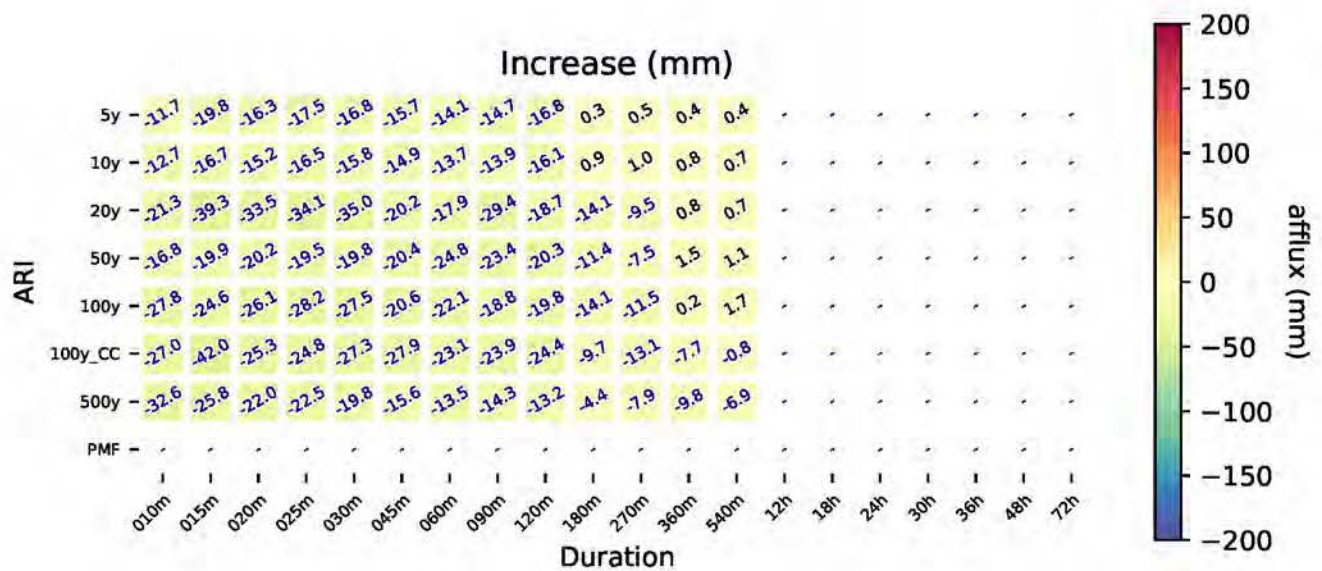
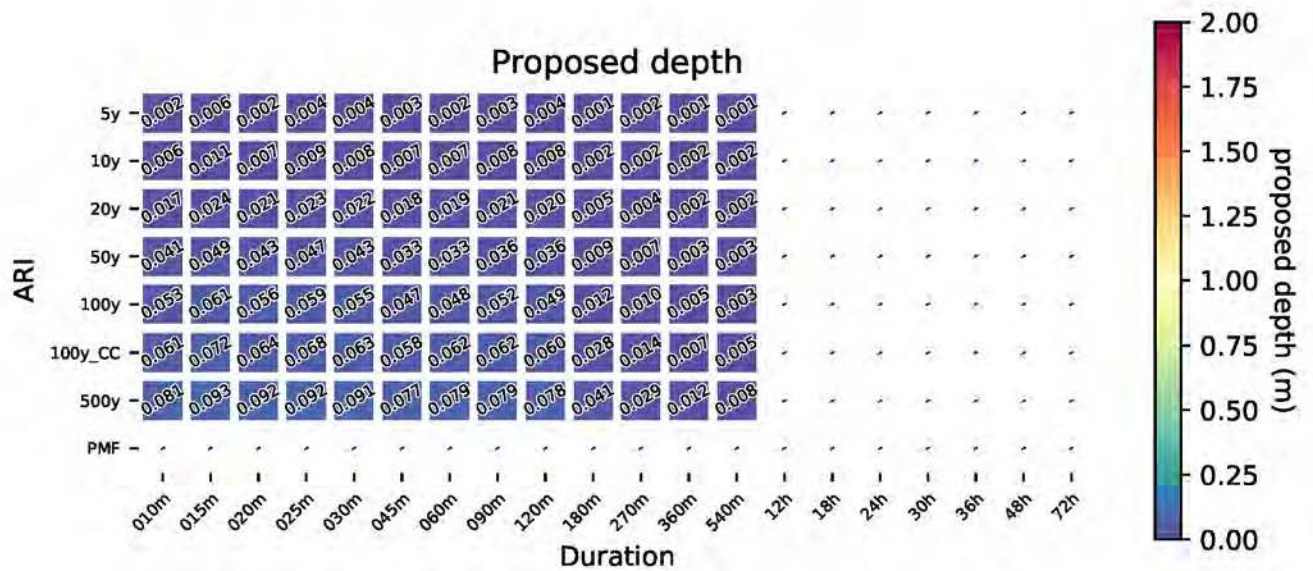
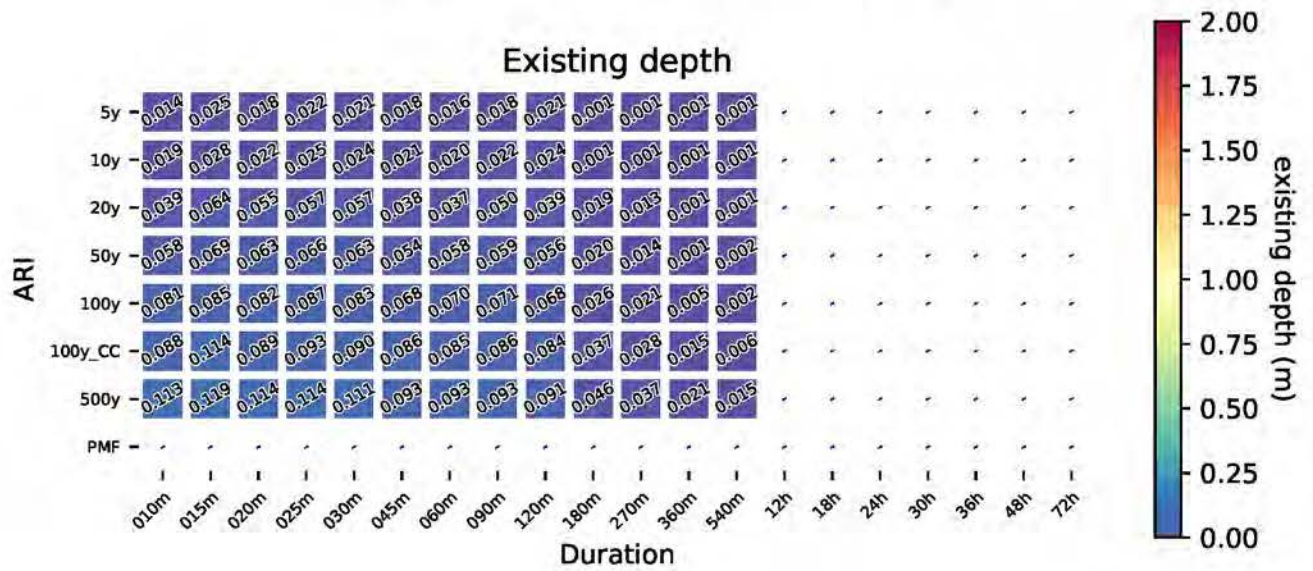


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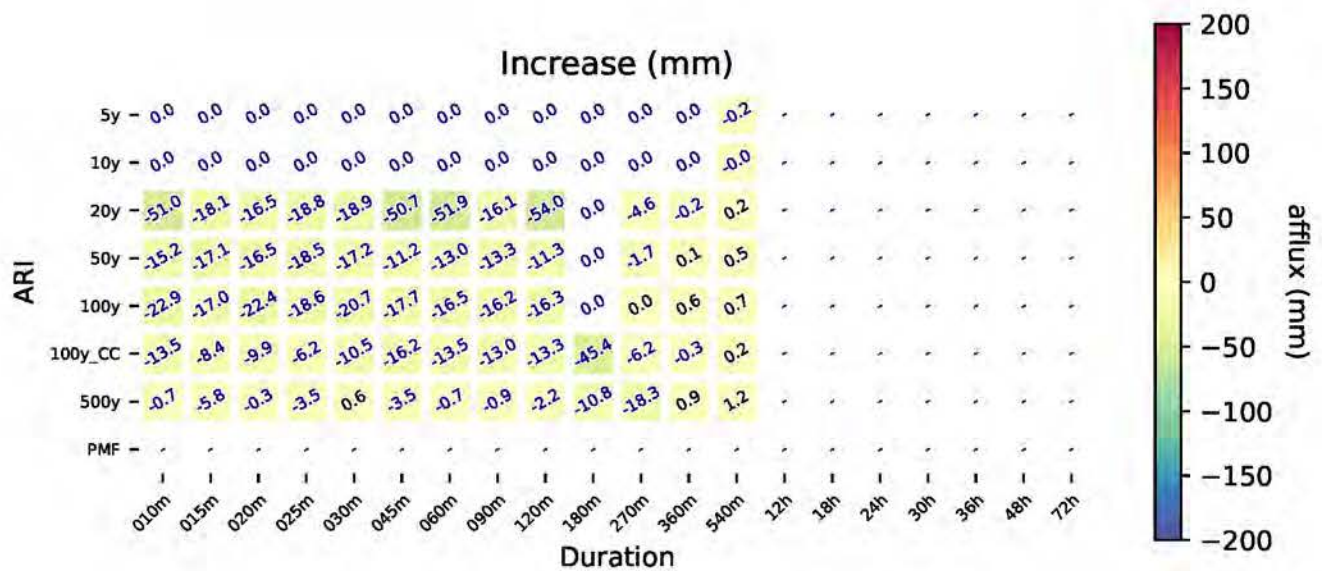
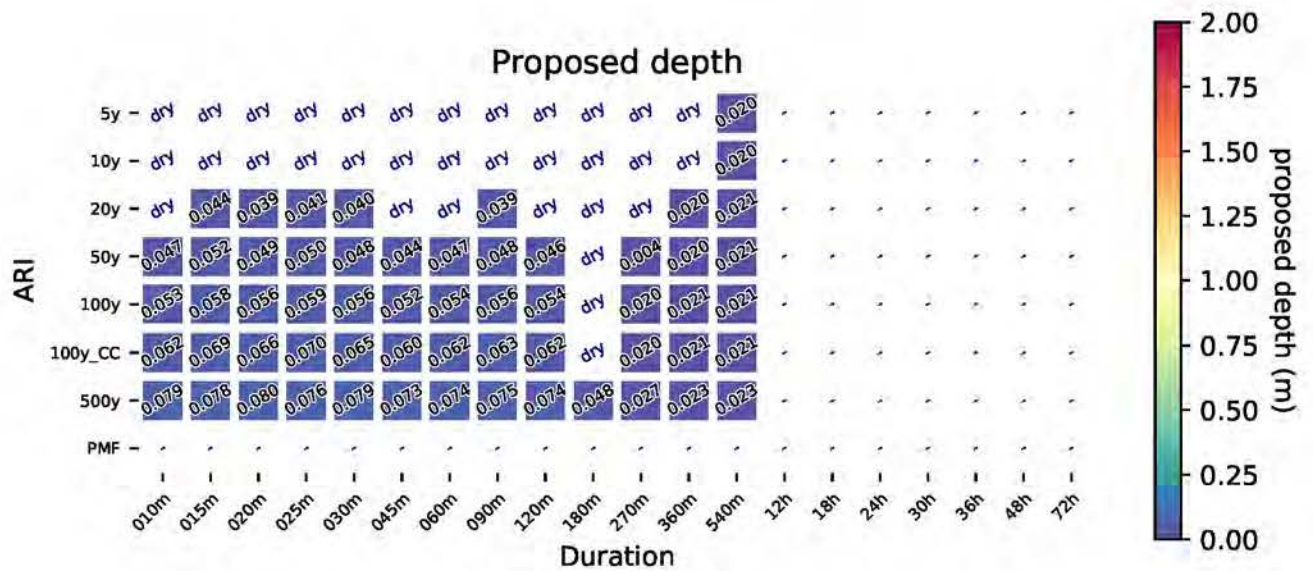
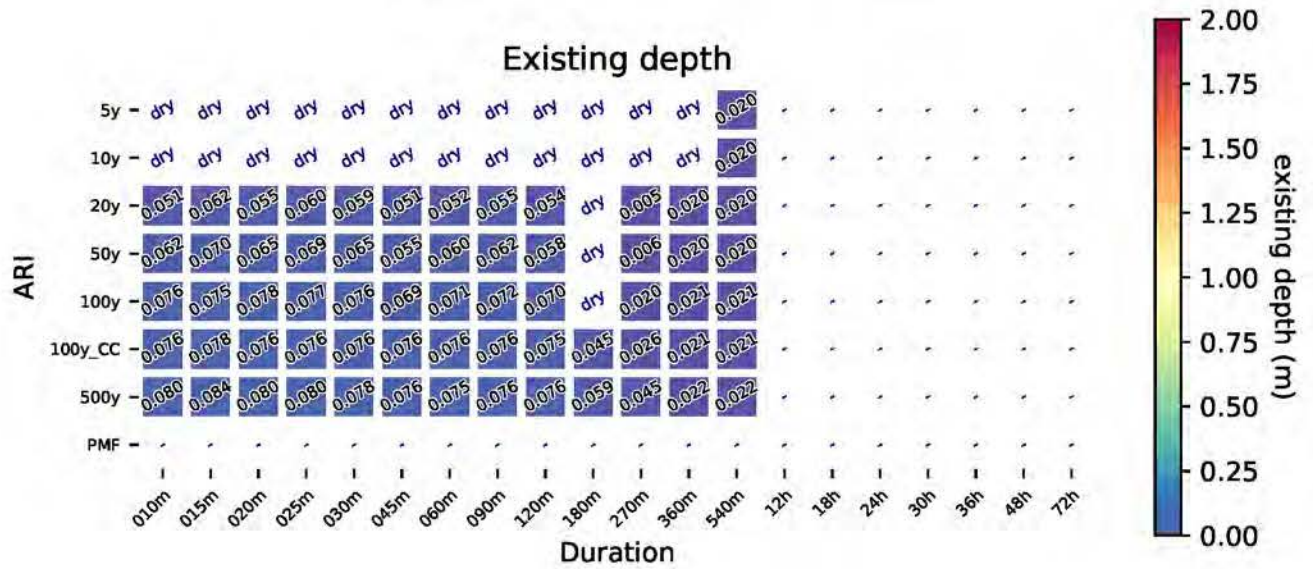


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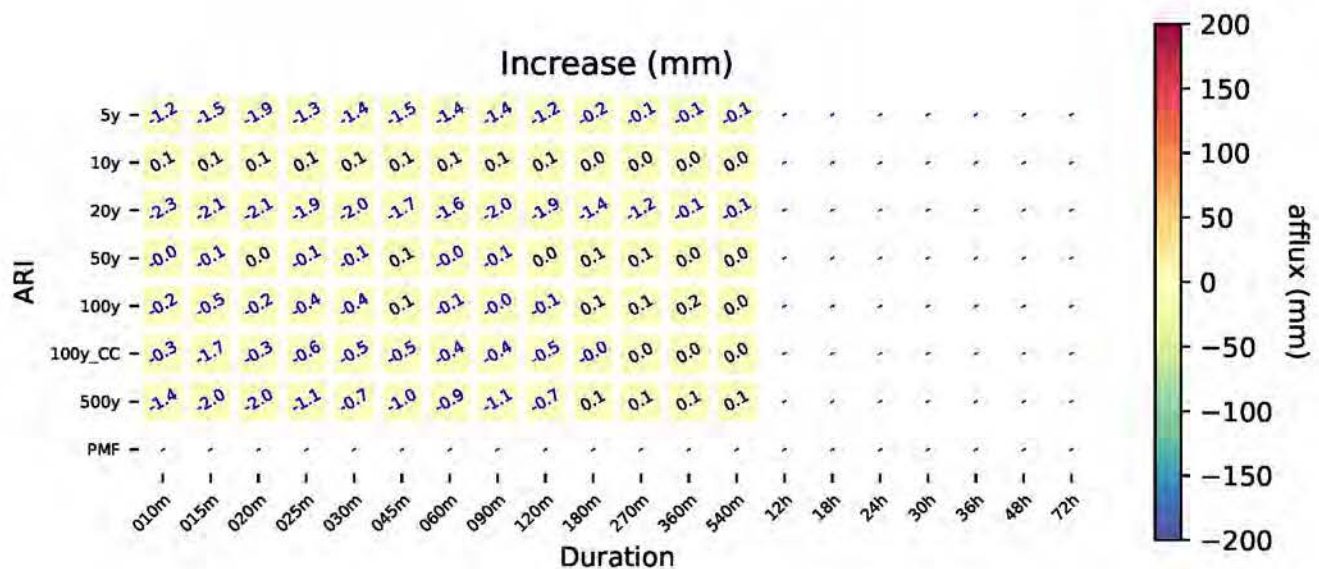
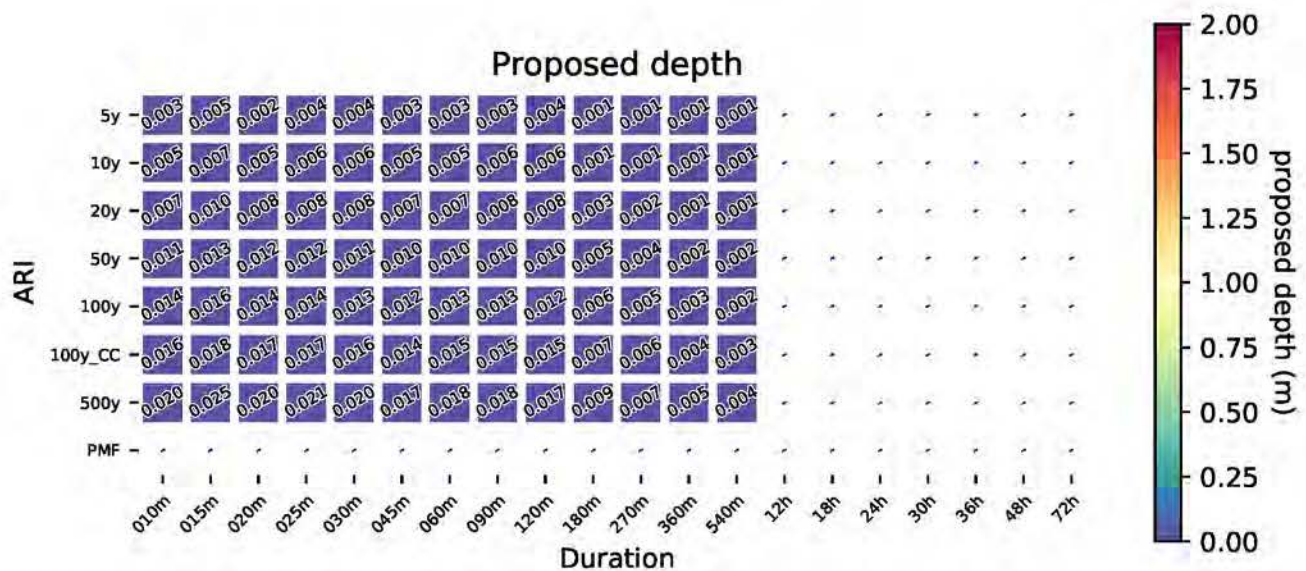
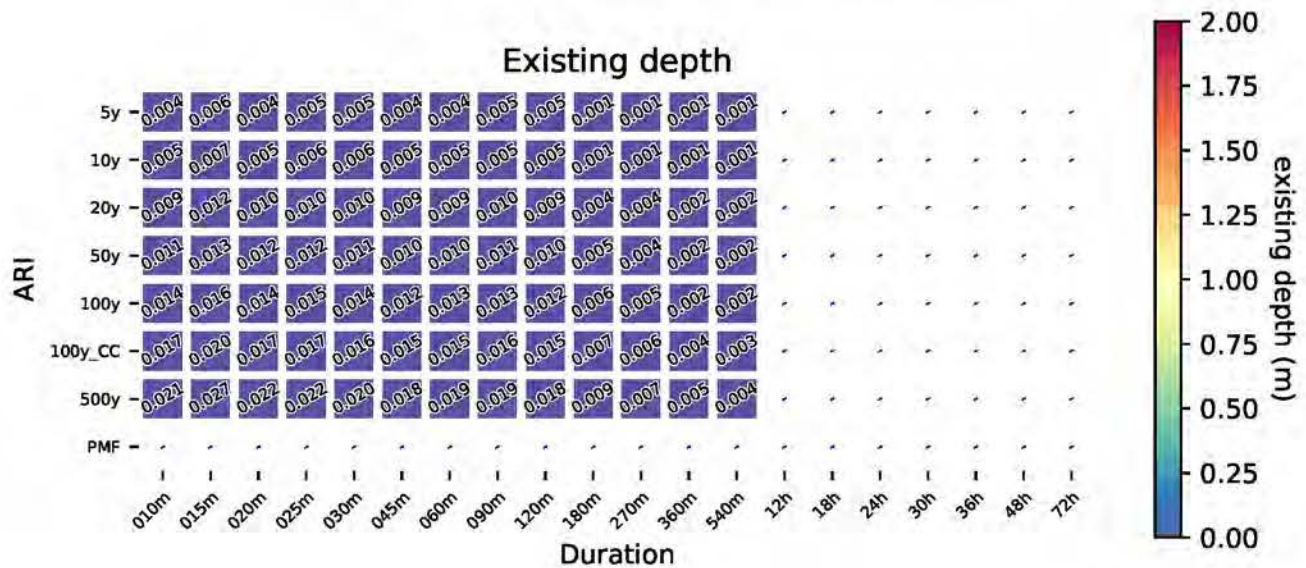


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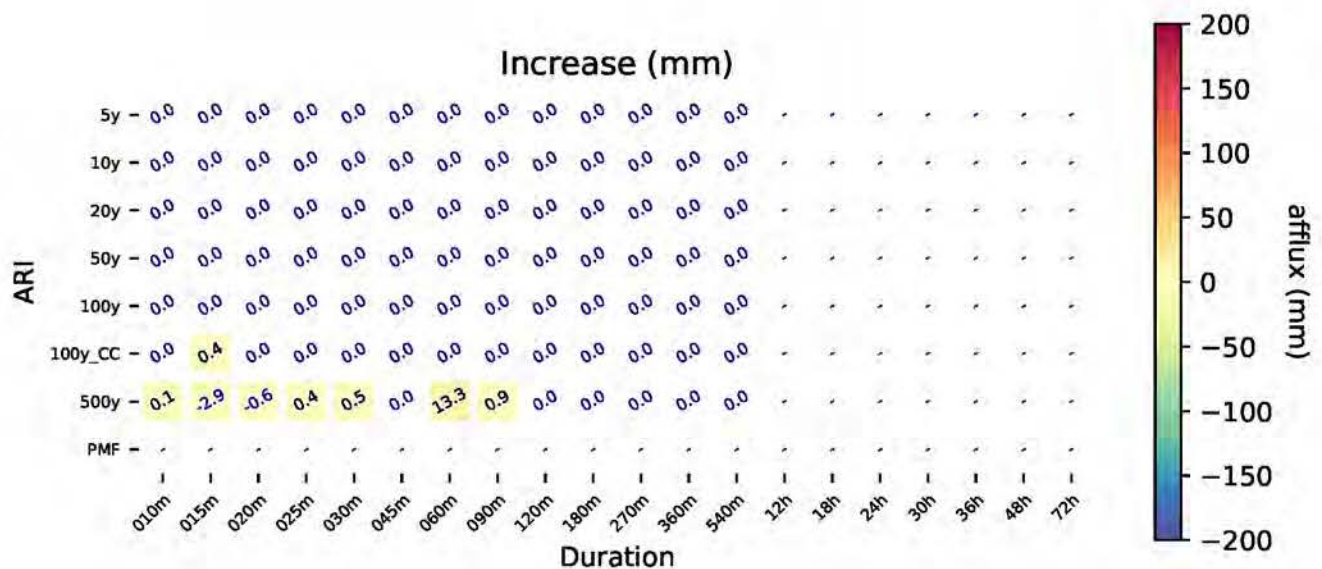
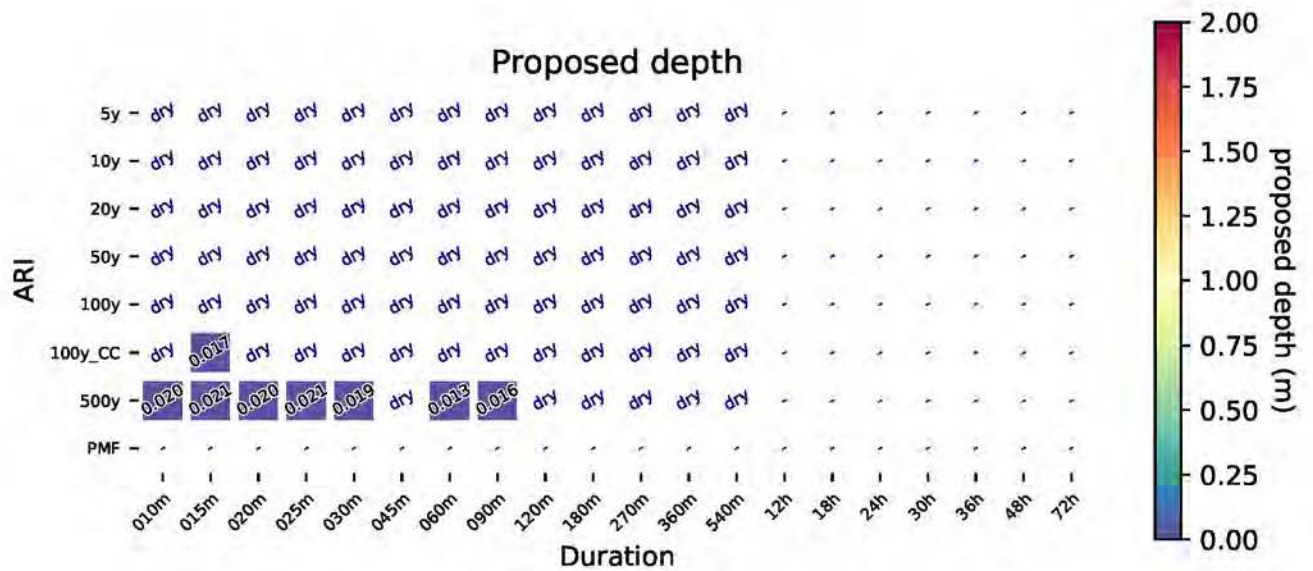
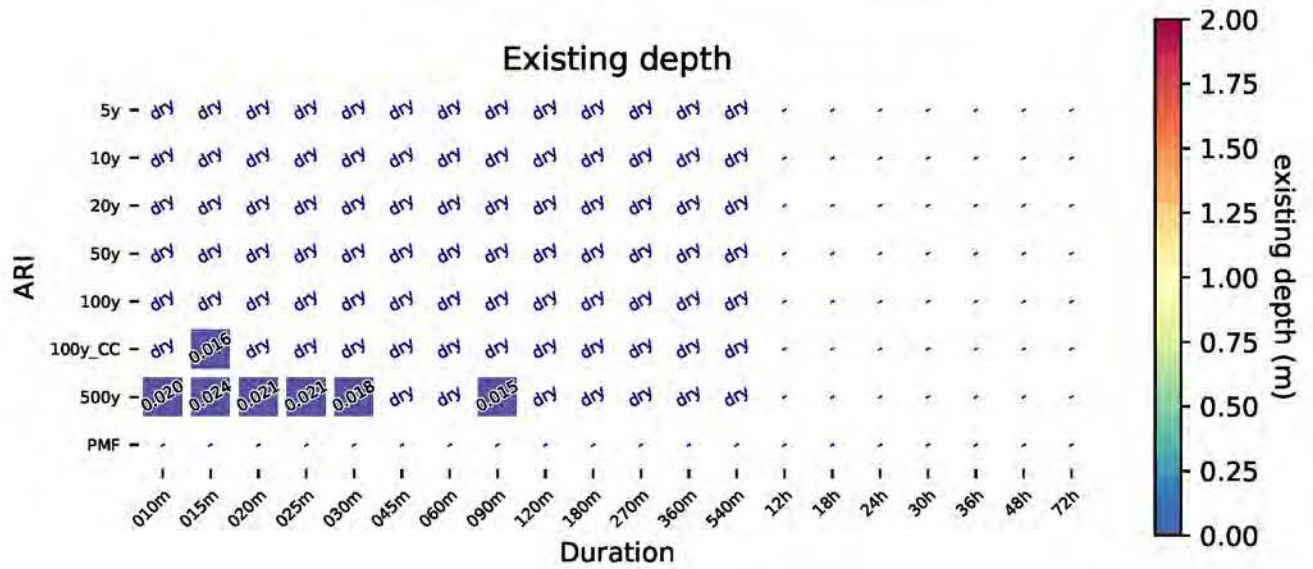


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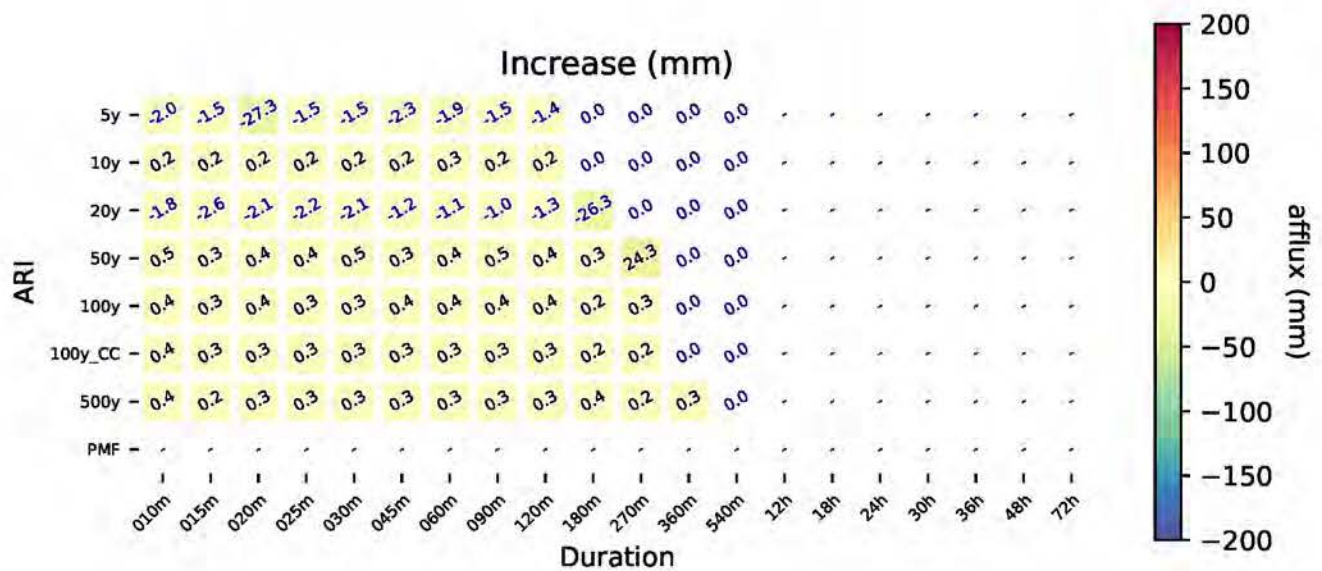
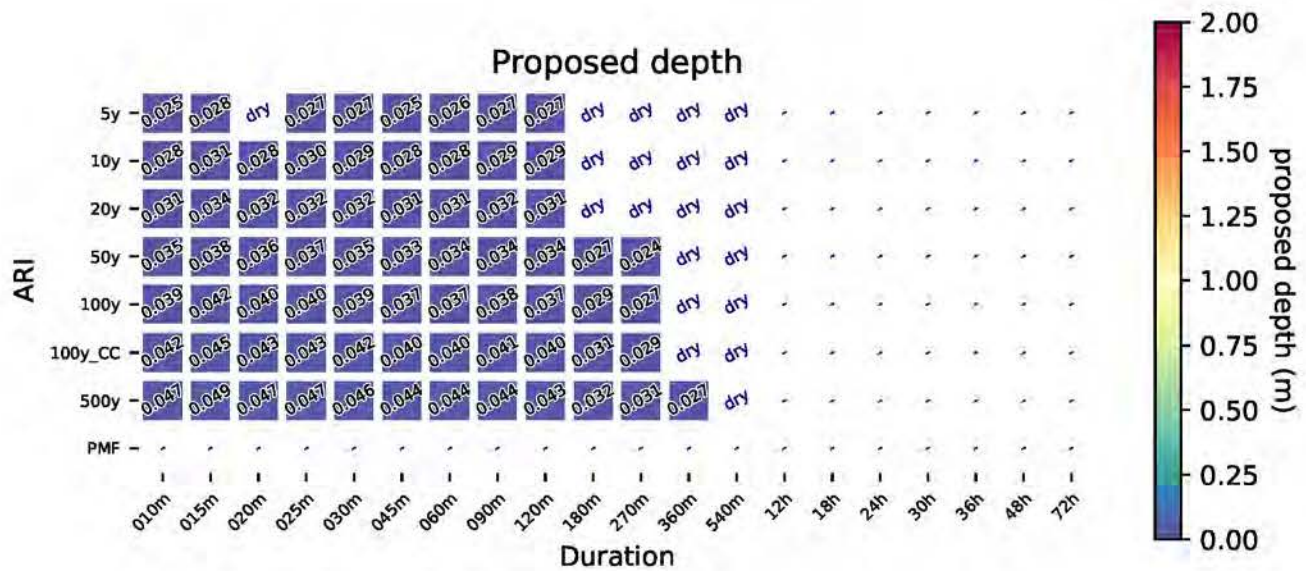
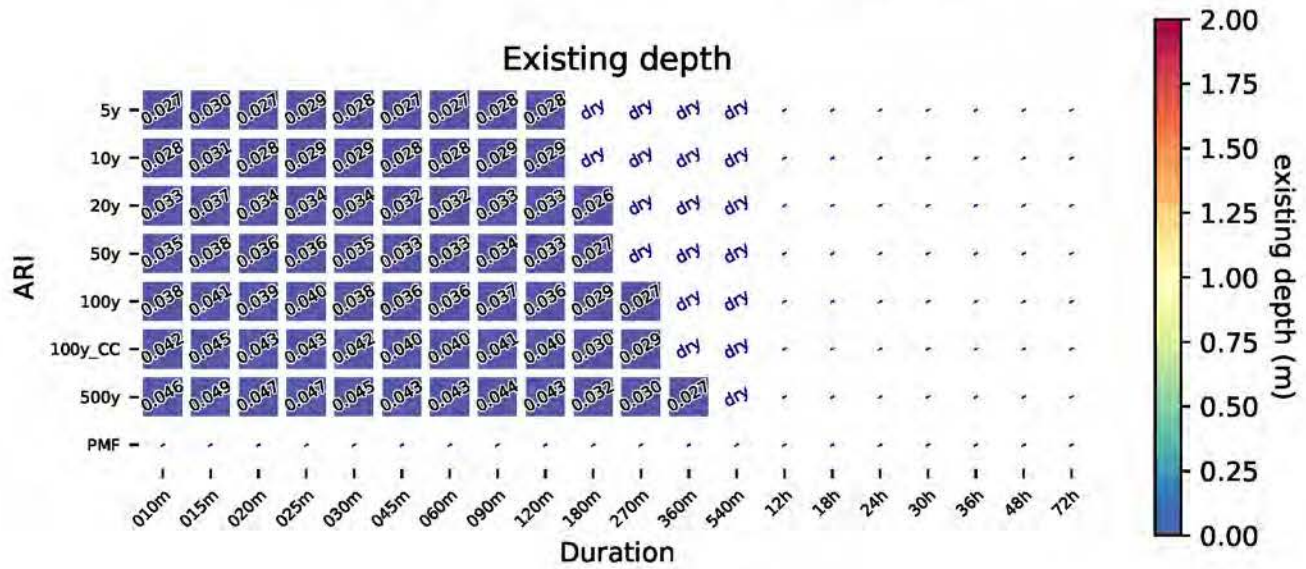




# Banyule Creek - Sydney\_St

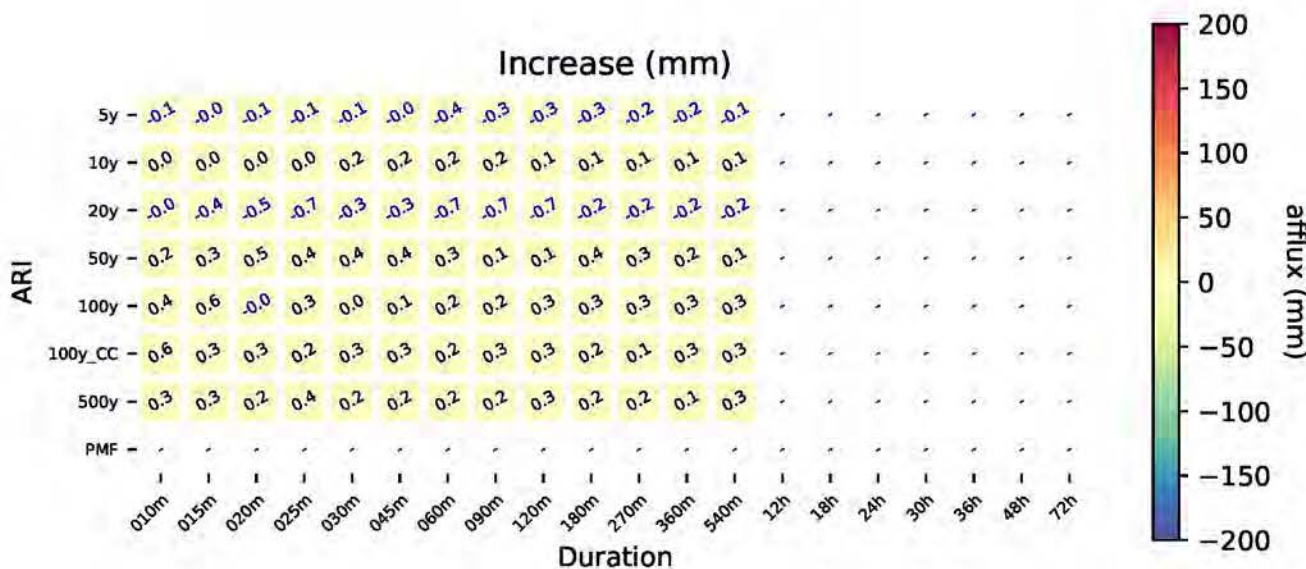
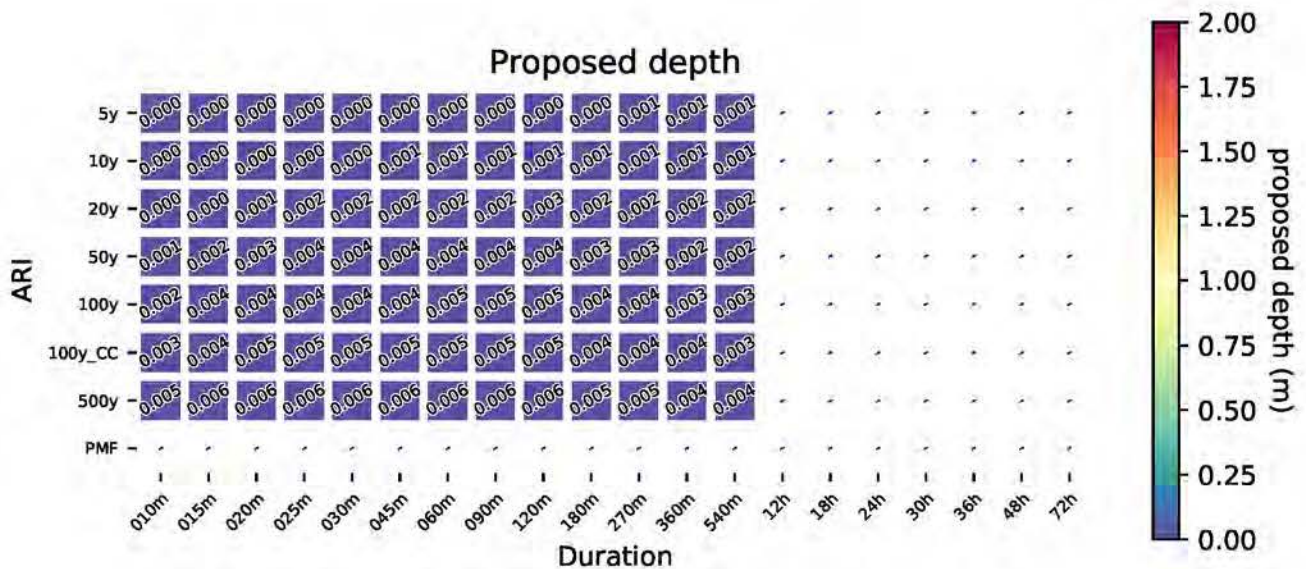
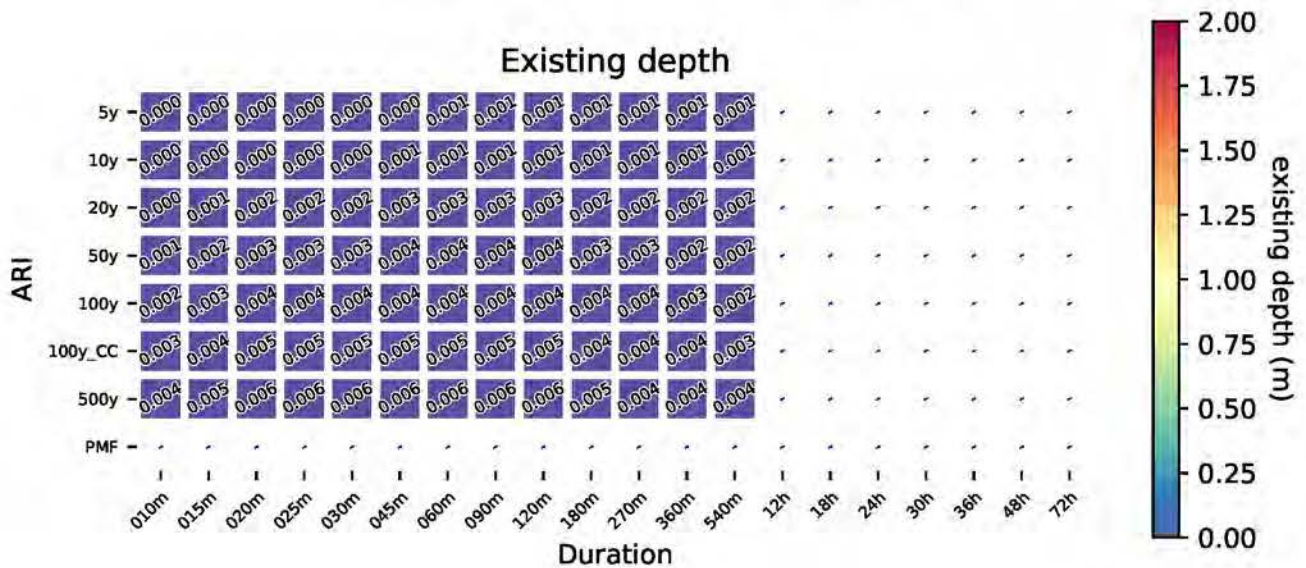


# Banyule Creek - Fairlie\_Ave





Banyule Creek - Blamey\_Rd











## LEGEND

★ Selected Locations



Paper Size A4  
0 135 270 540  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1984  
Grid: GDA 1984 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	C
Date	13/11/2018

Yarra River 2 of 3  
Comparison Locations Appendix D-5-2

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

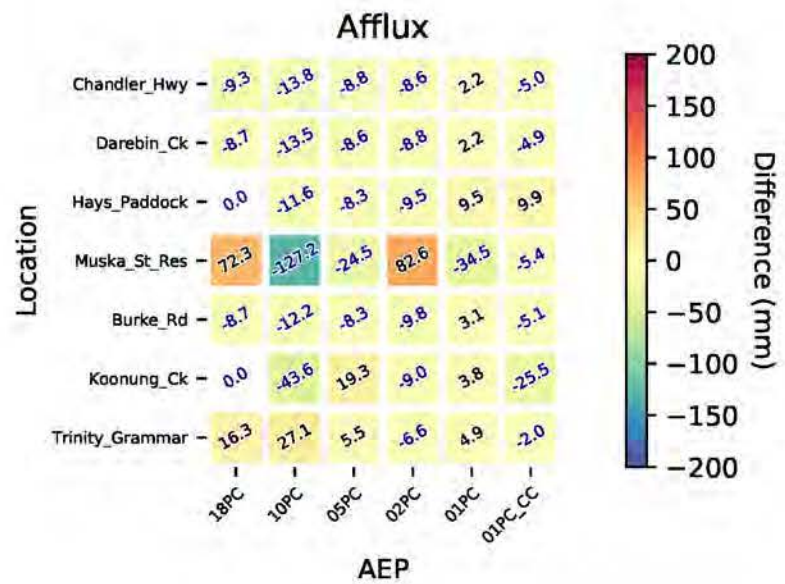
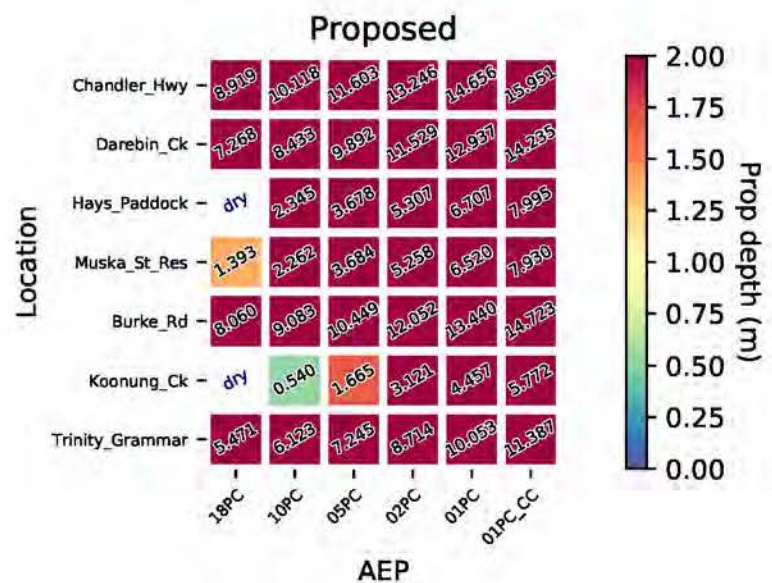
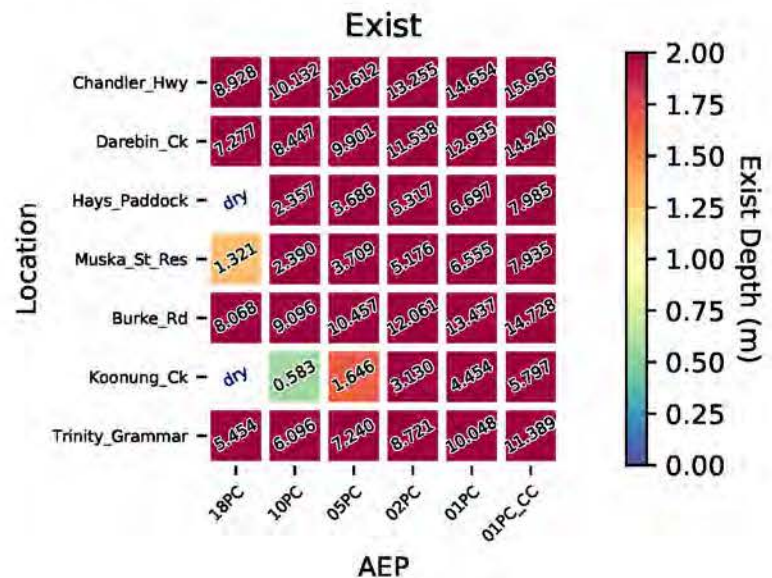
© 2018. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.



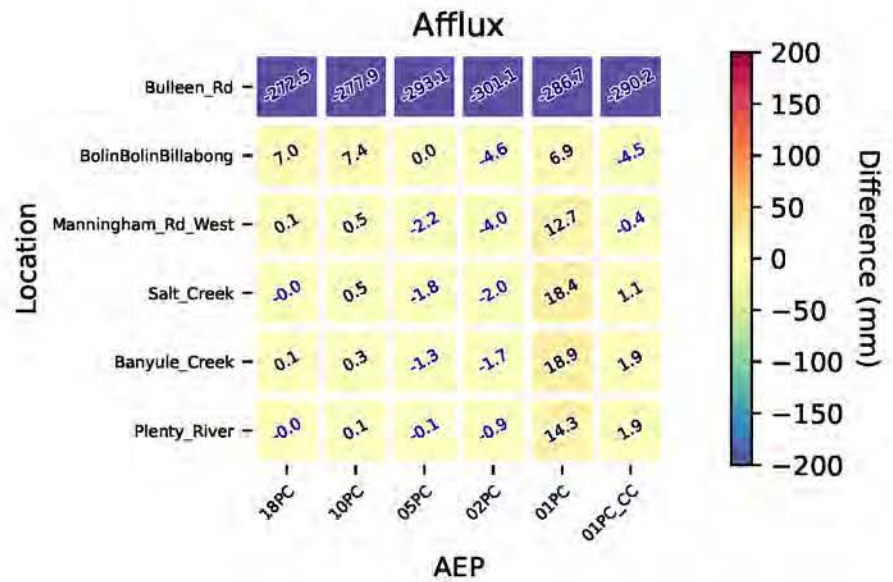
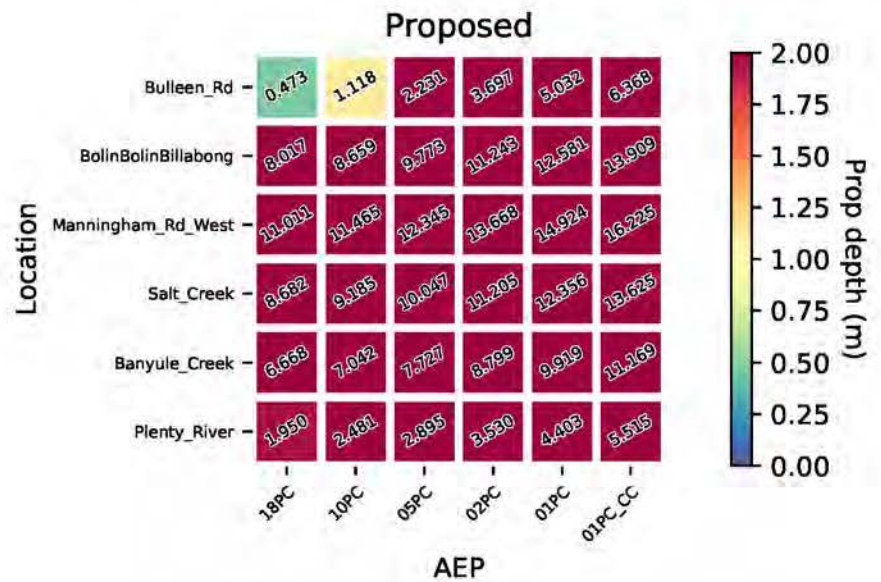
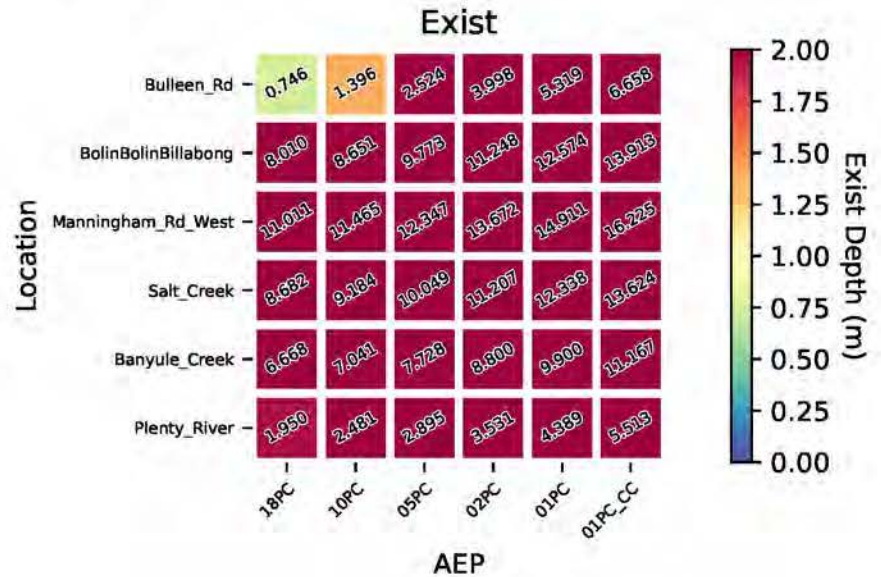




# Yarra River - Overview

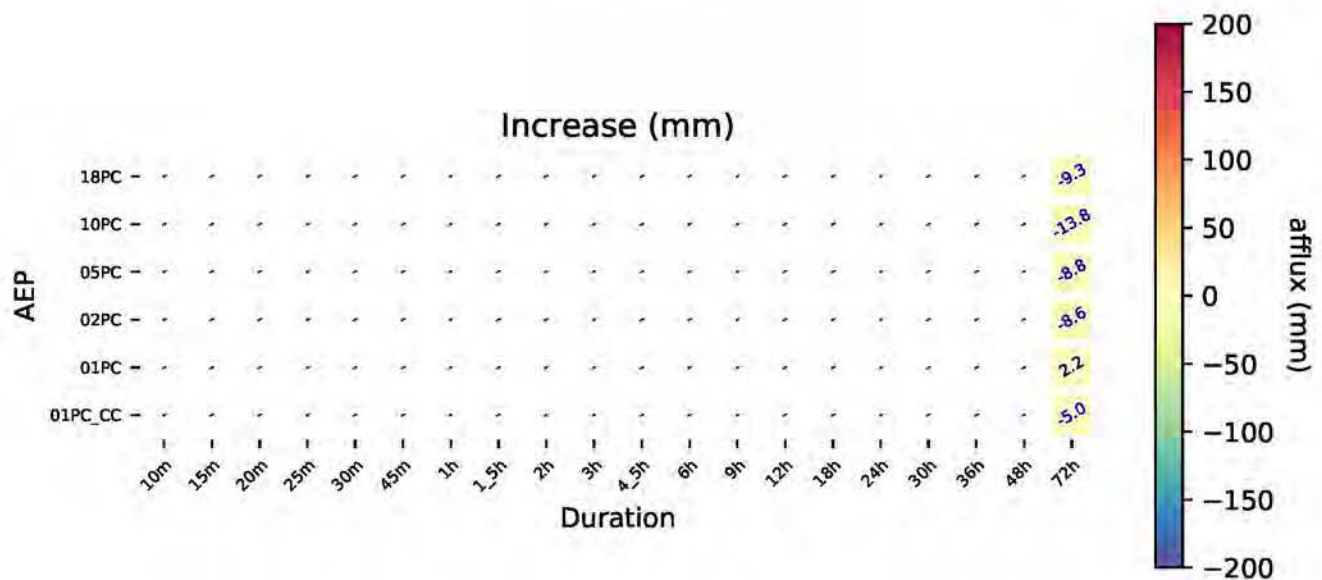
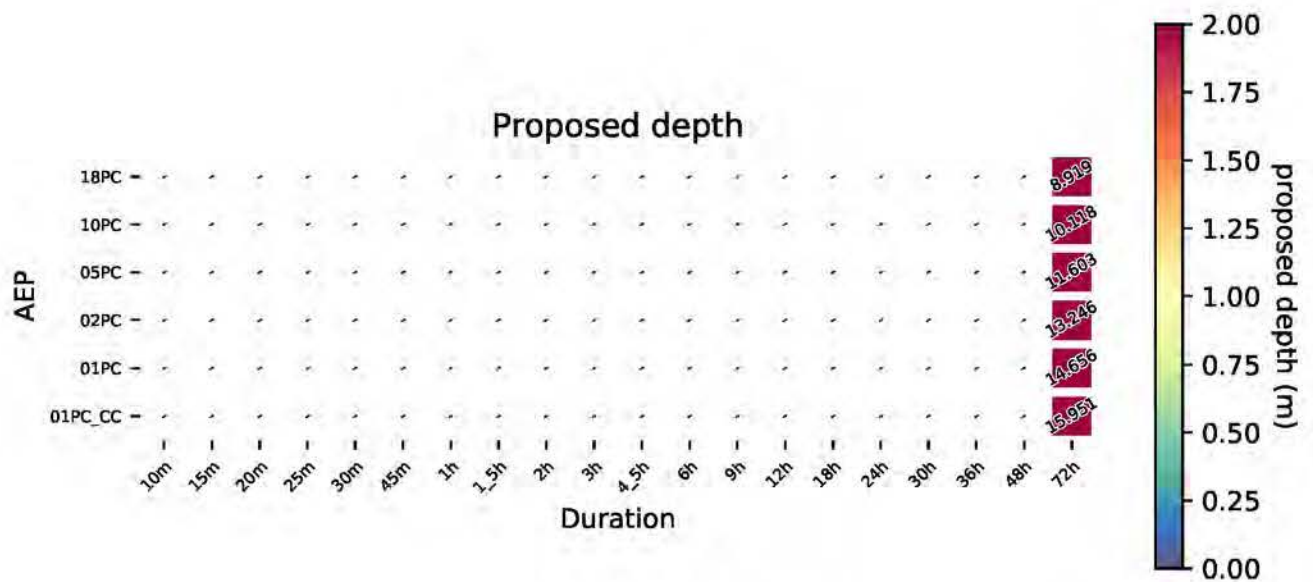
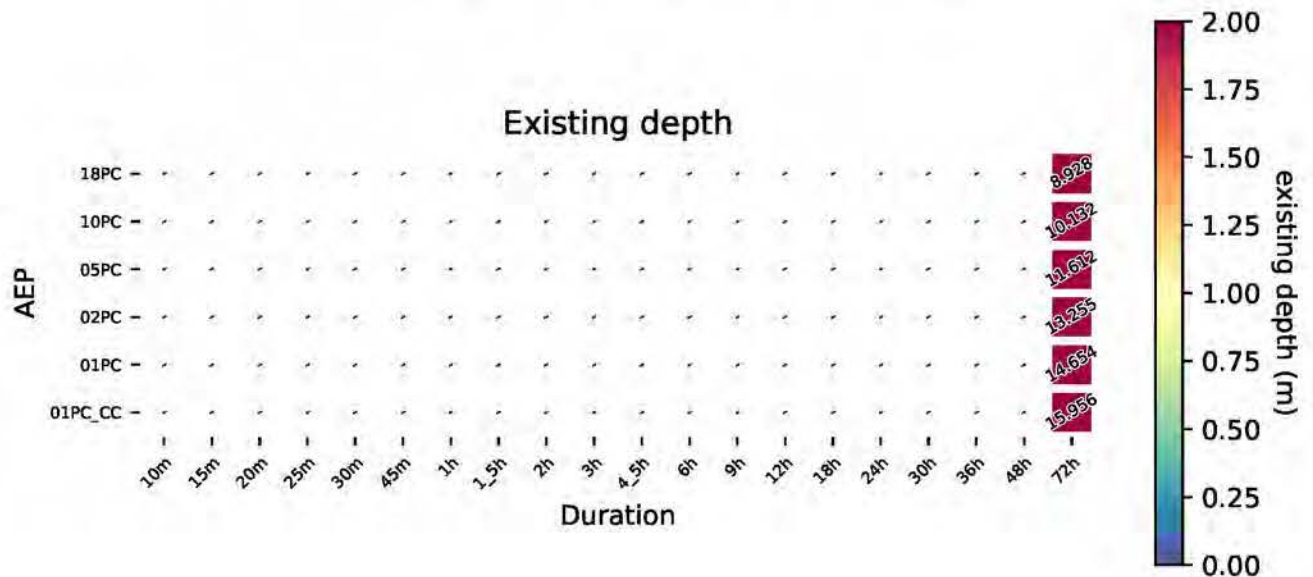


# Yarra River - Overview

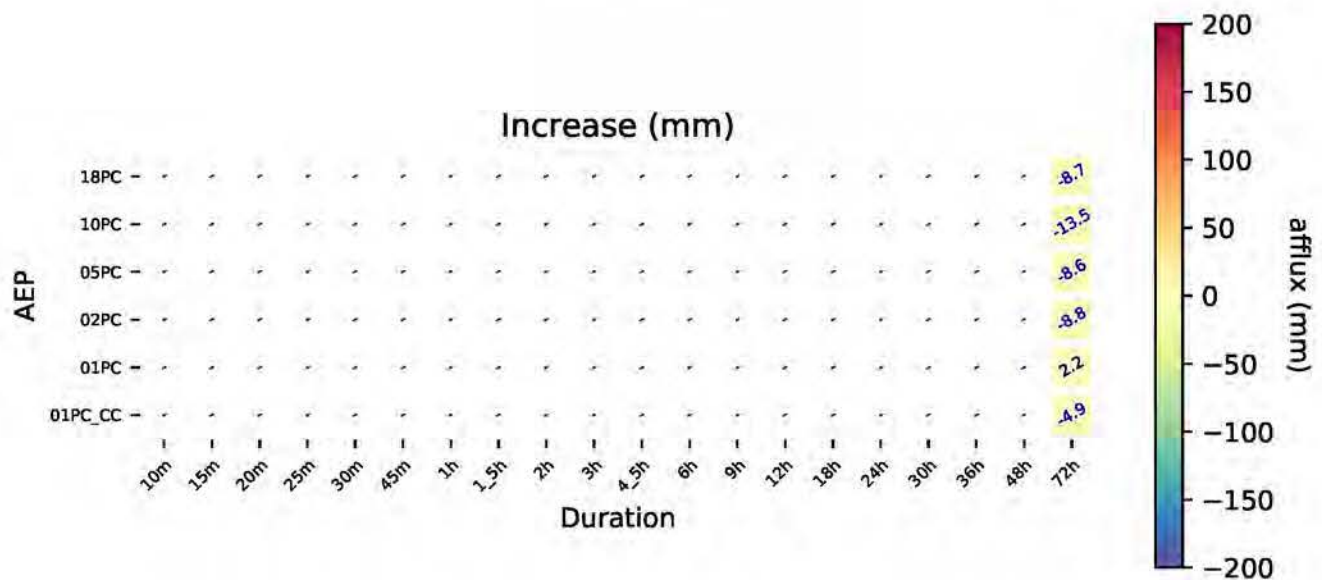
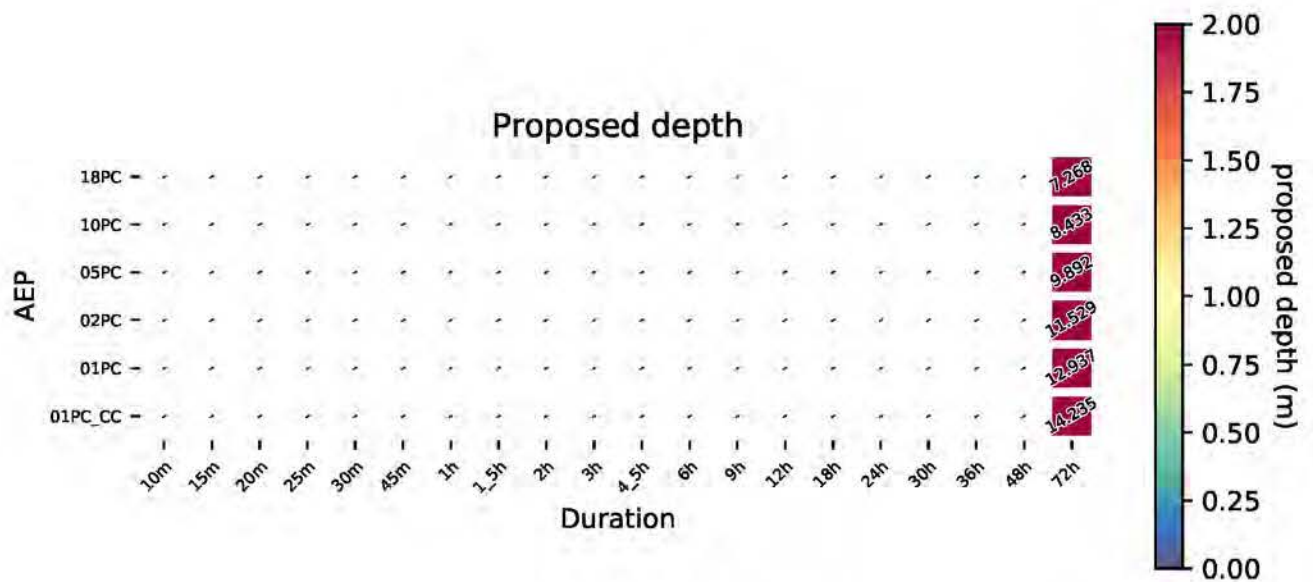
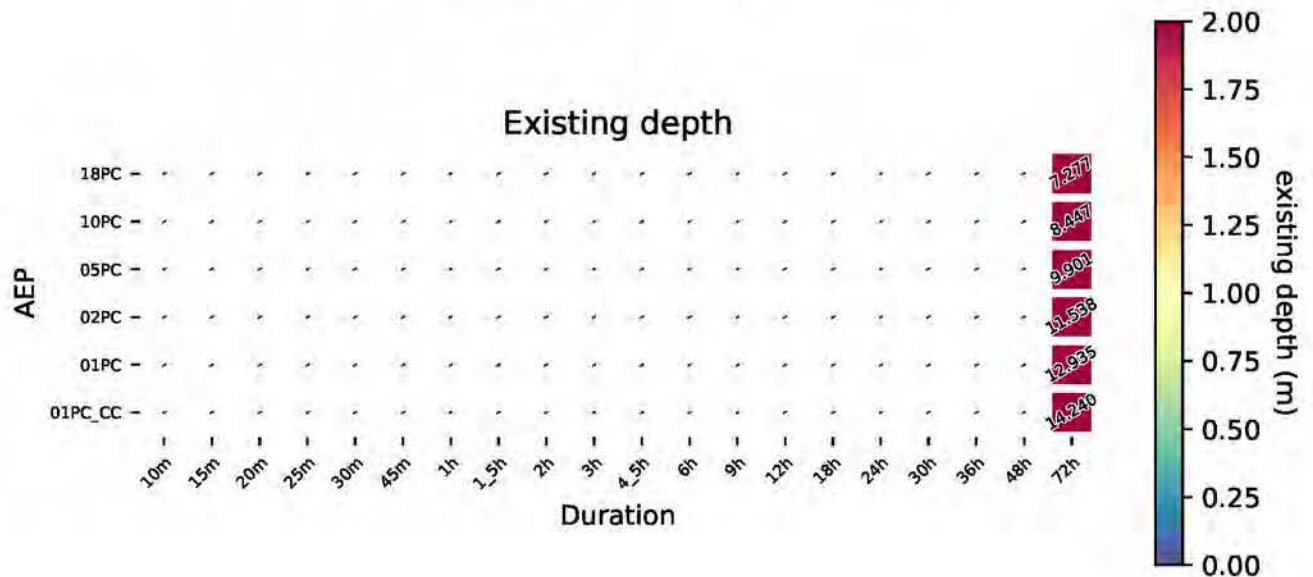




# Yarra River - Chandler\_Hwy

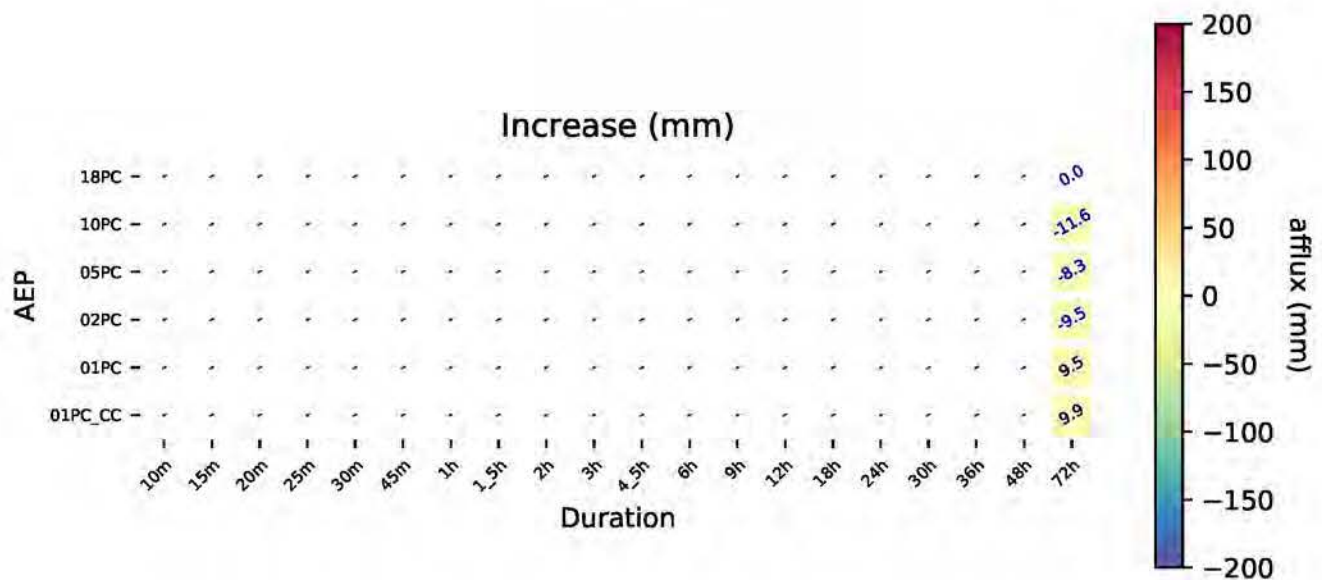
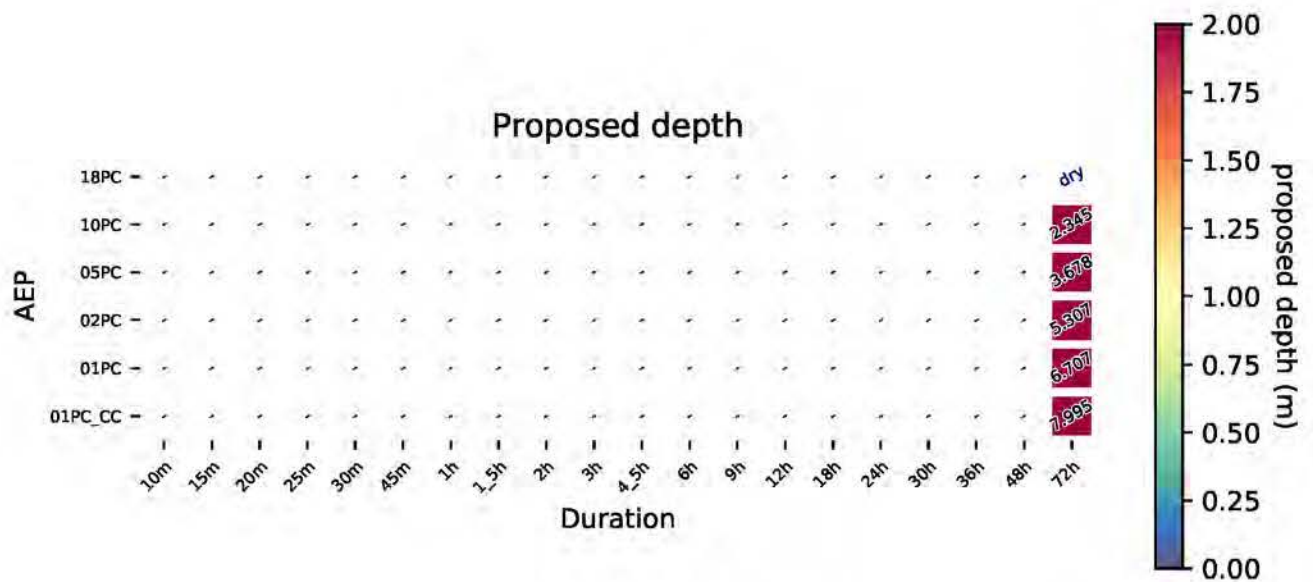
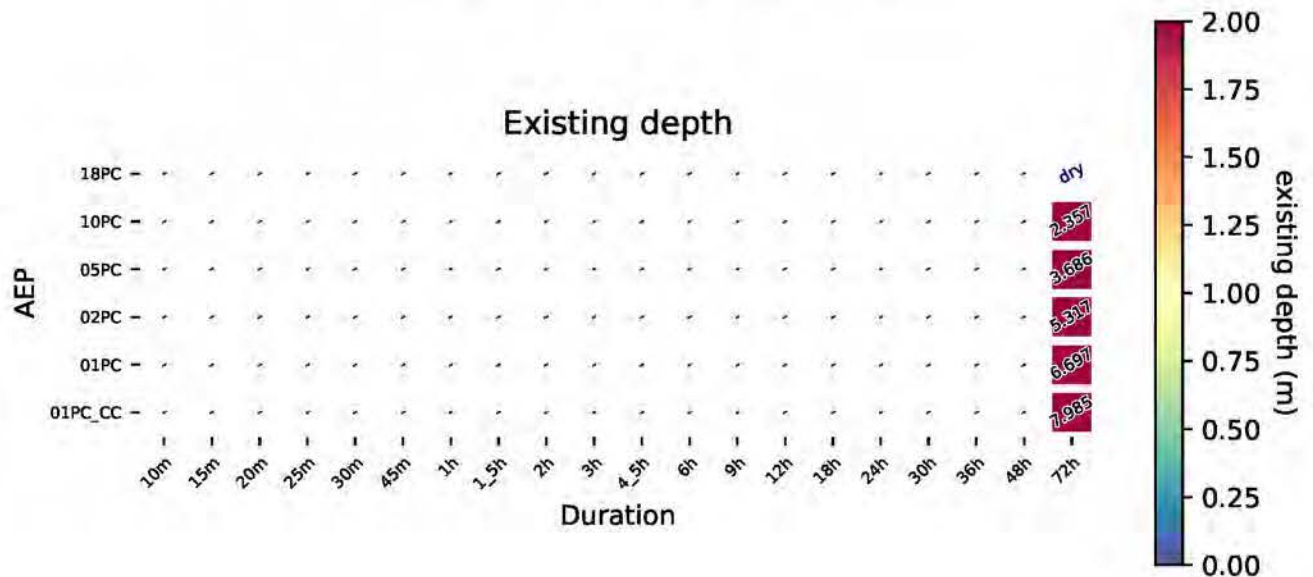


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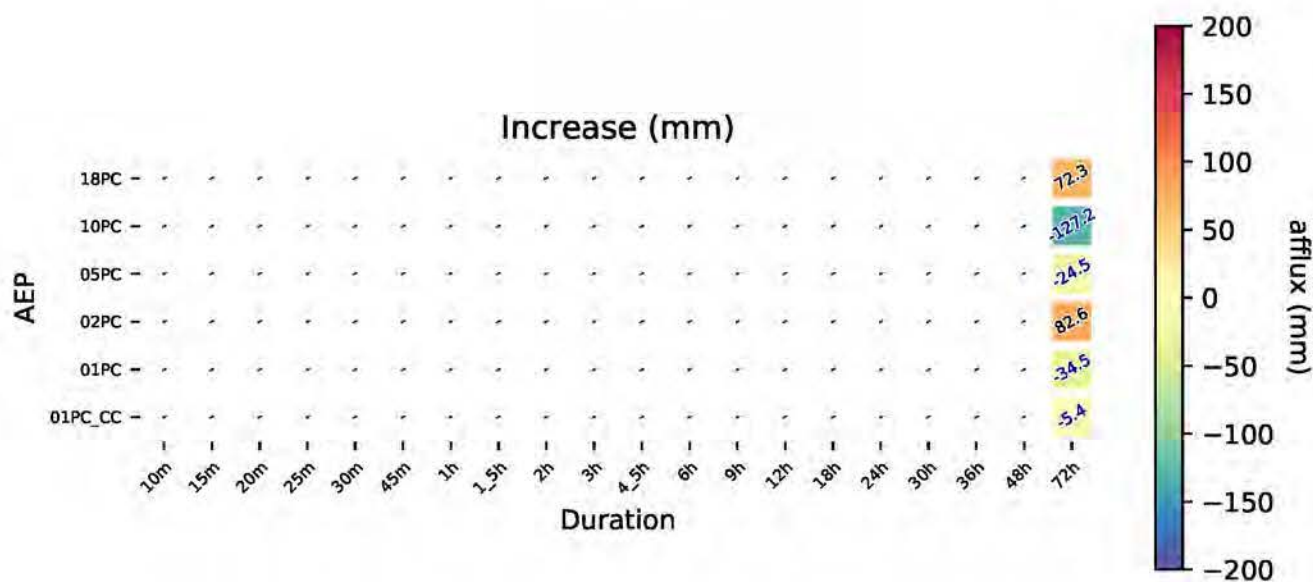
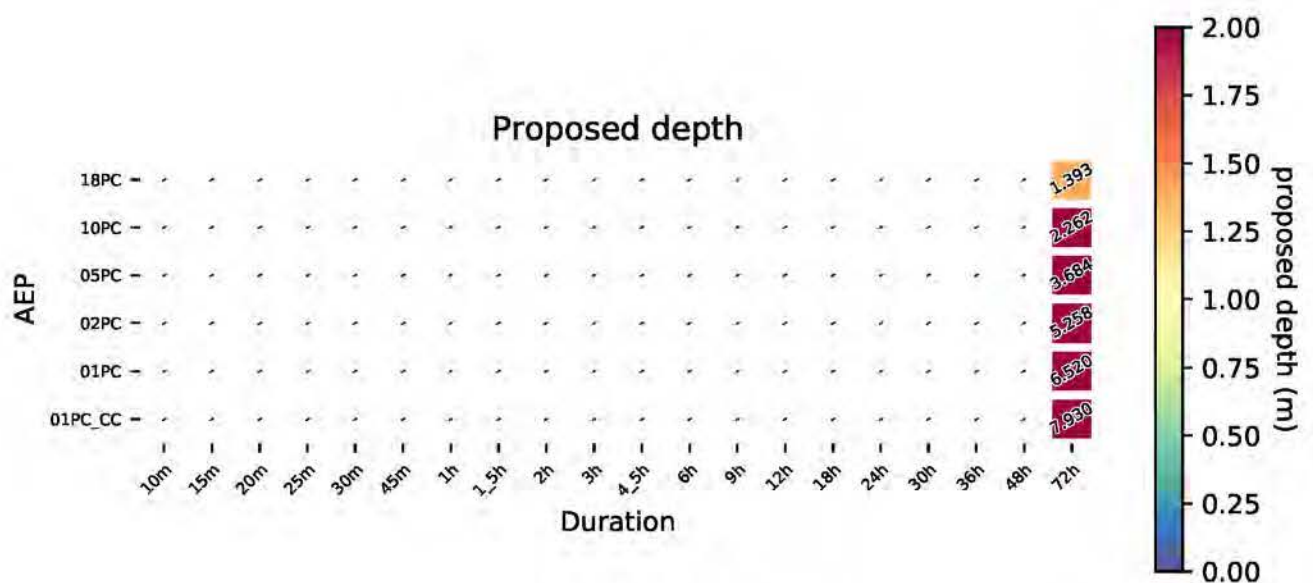
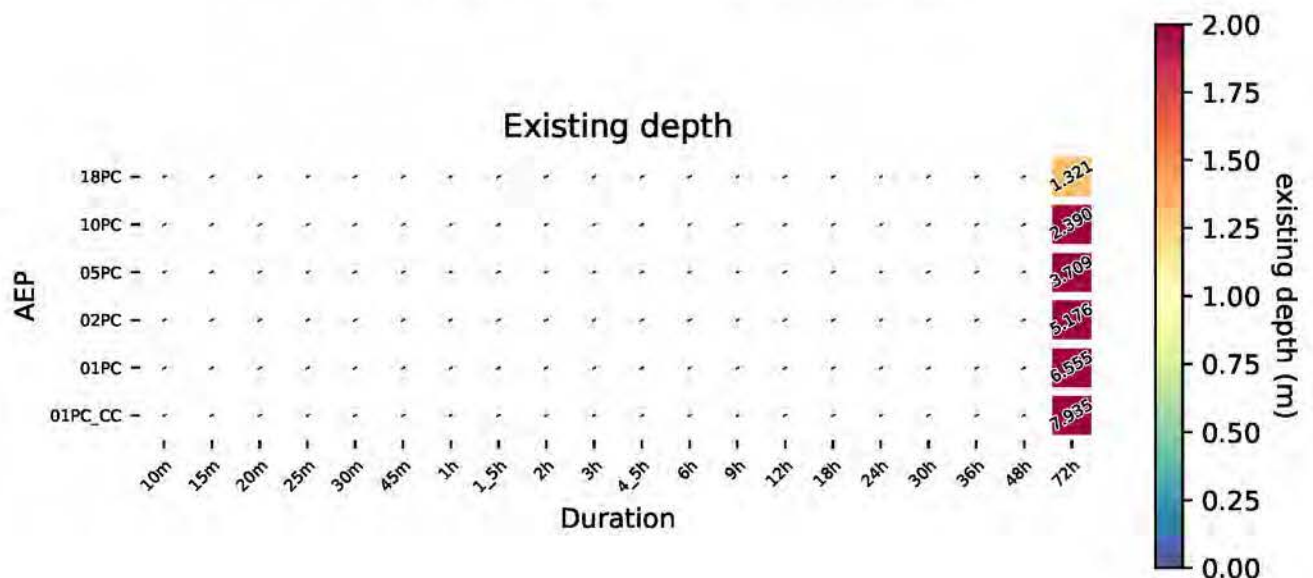




# Yarra River - Hays\_Paddock

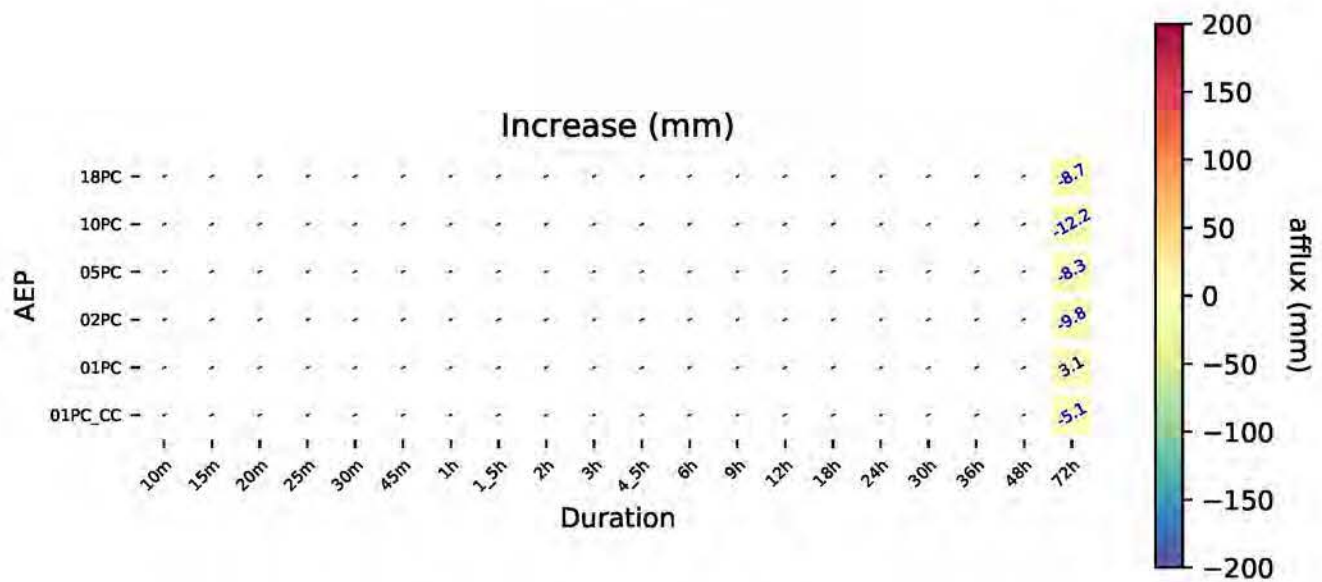
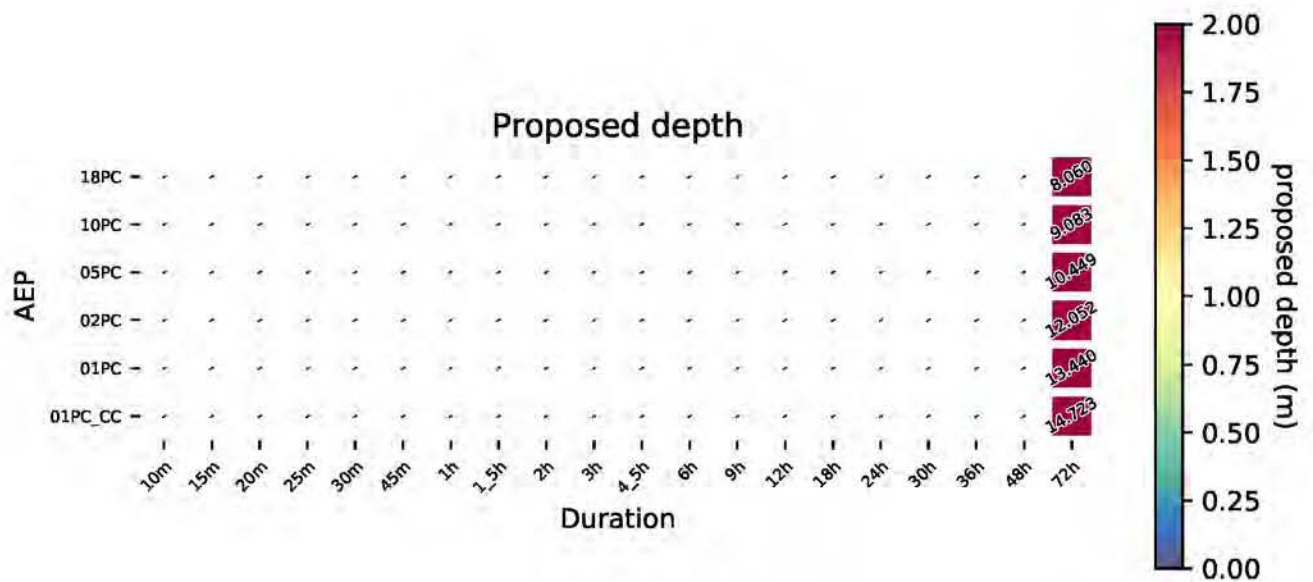
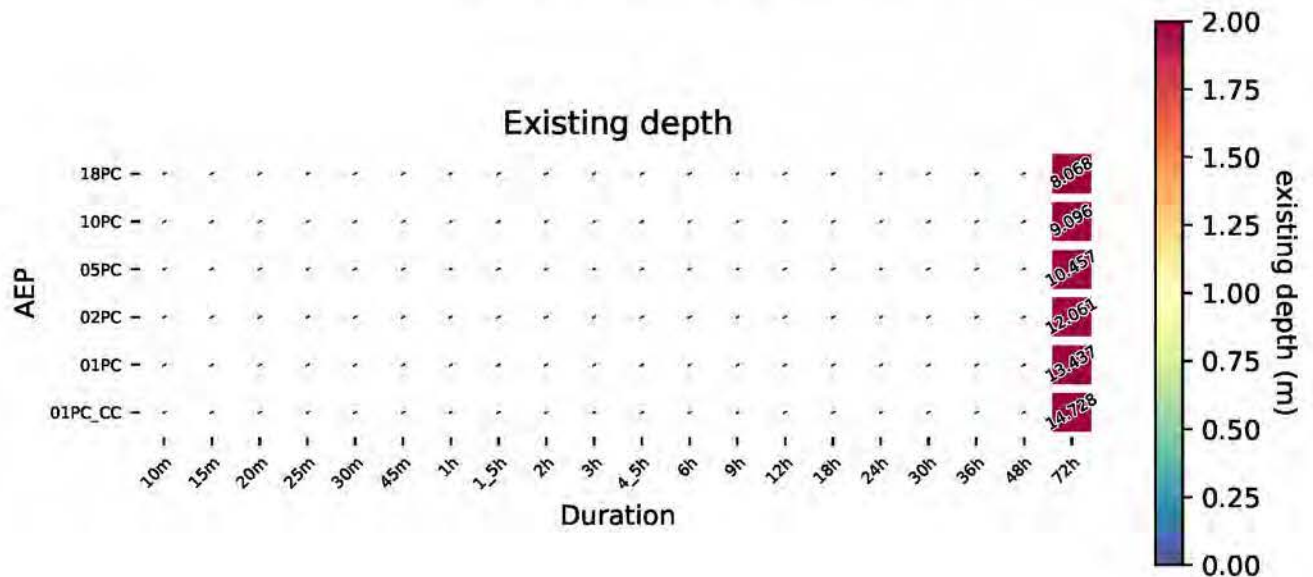


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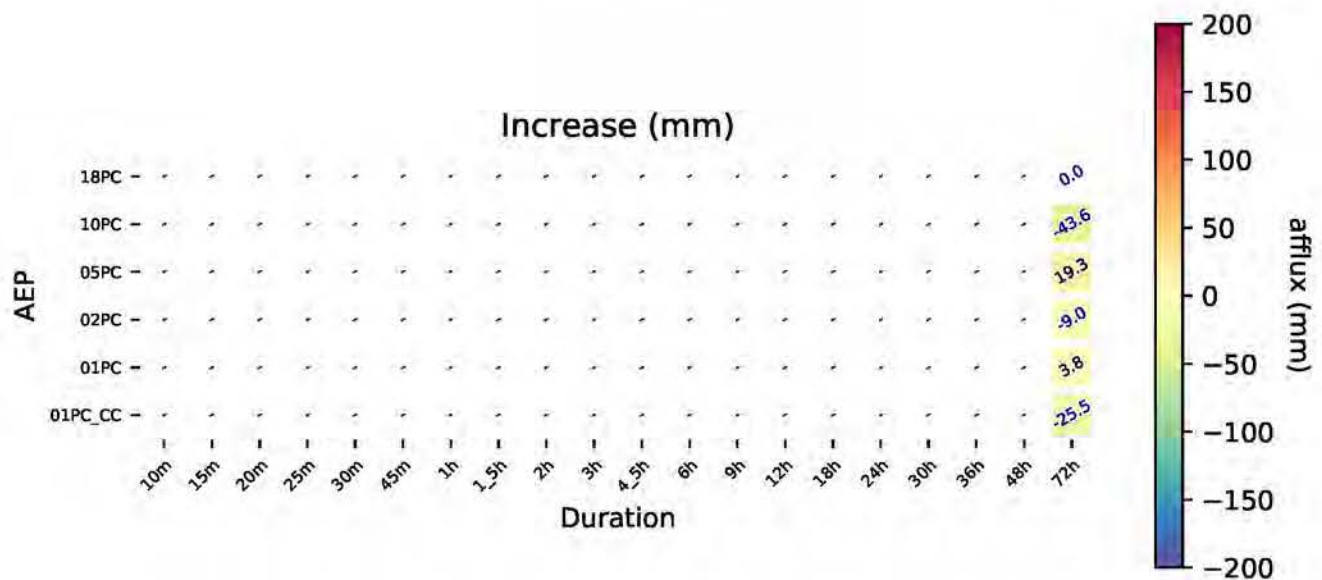
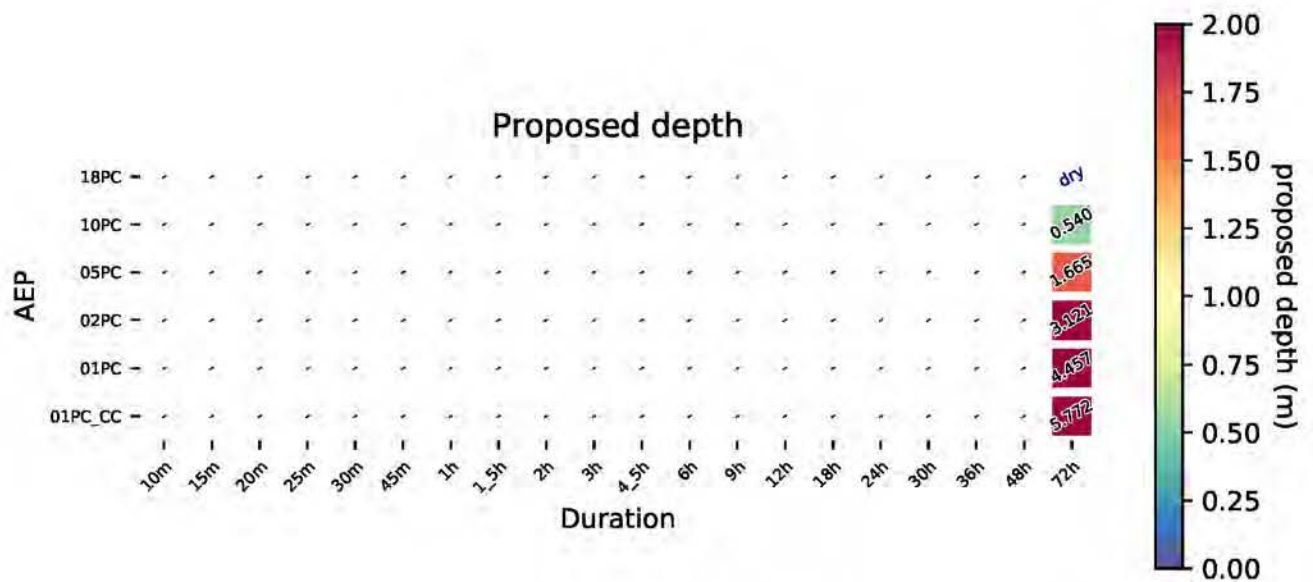
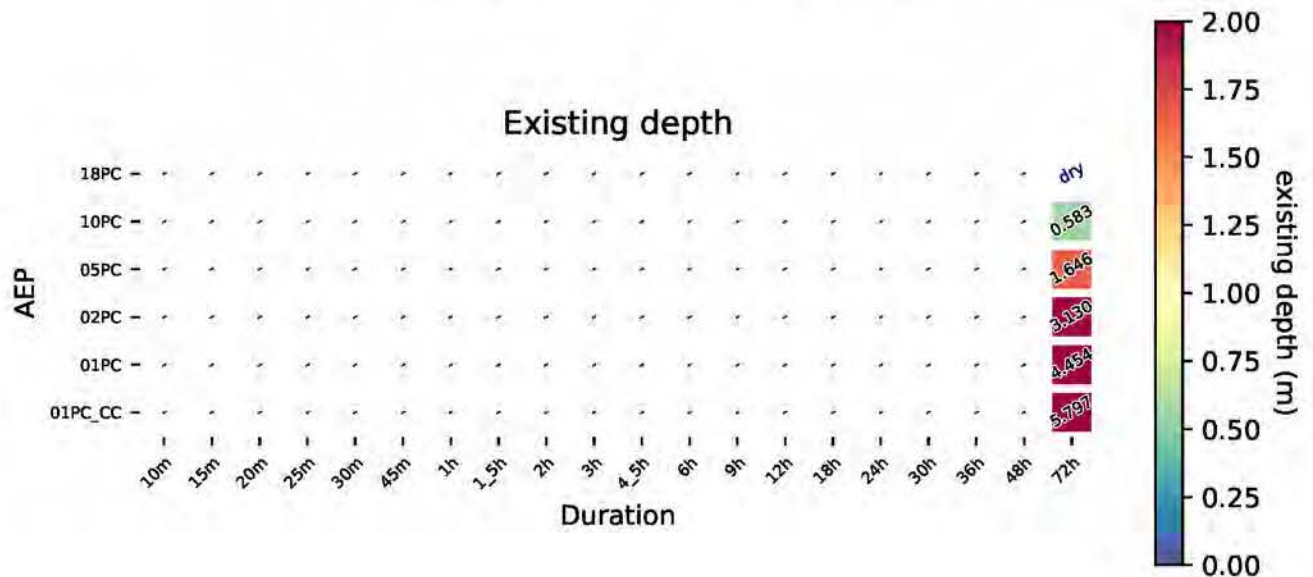




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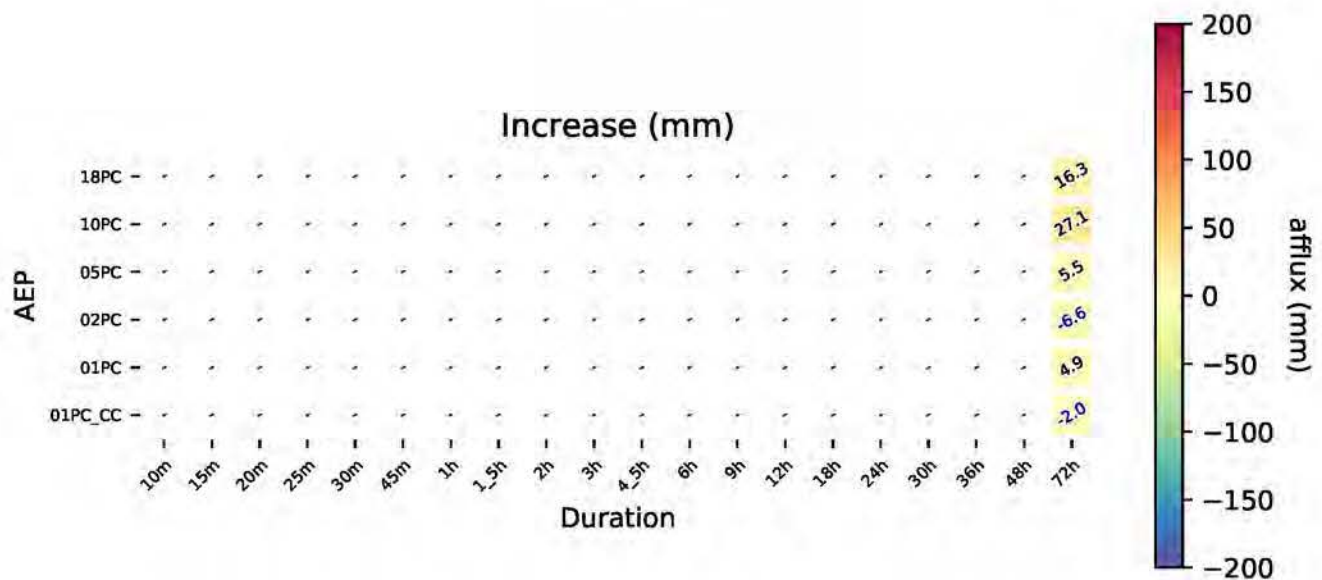
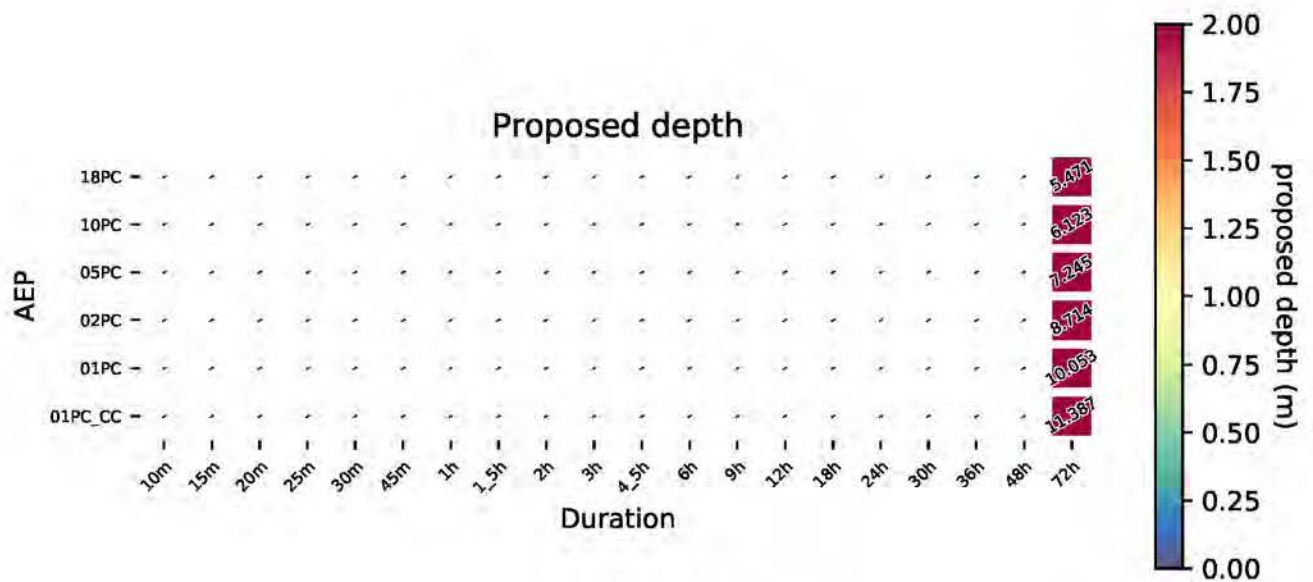
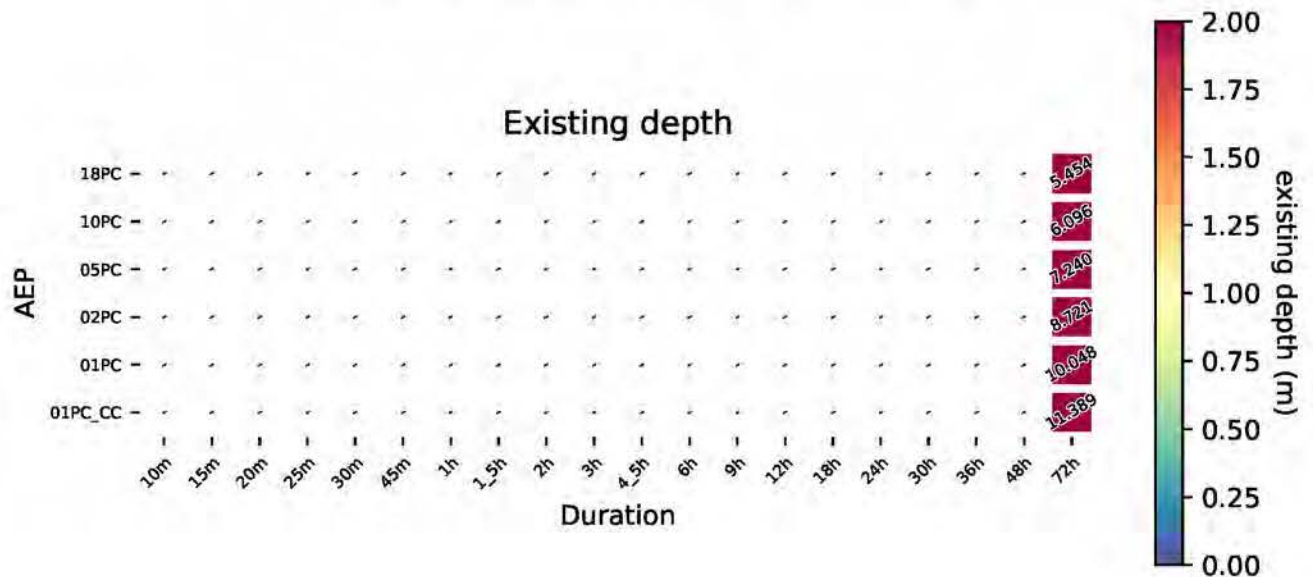


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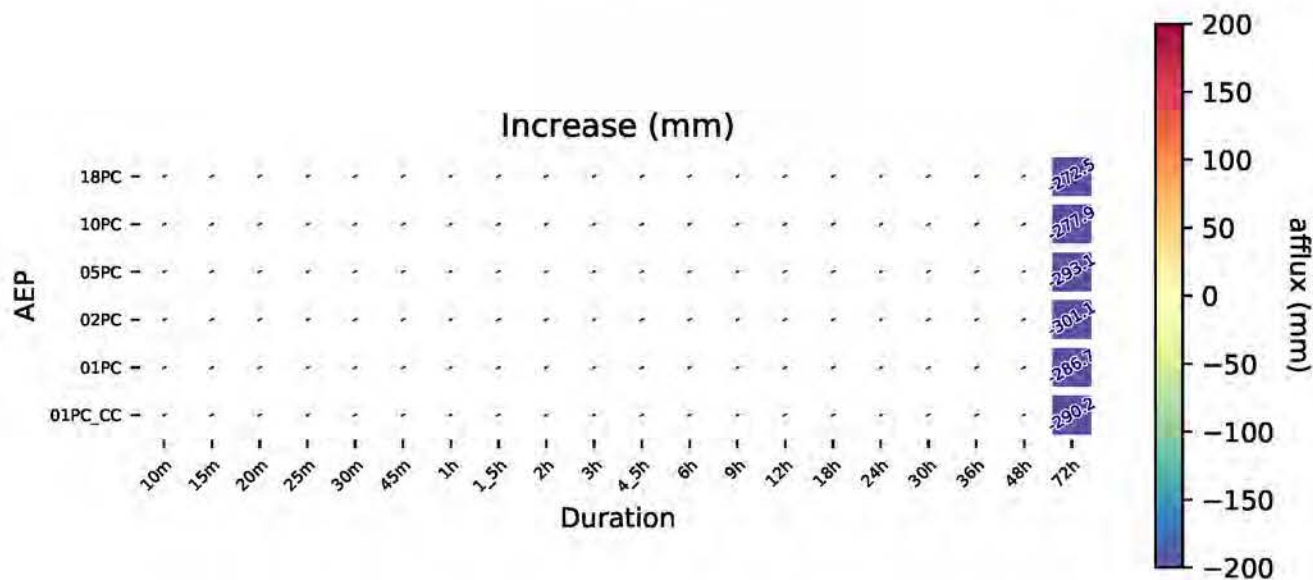
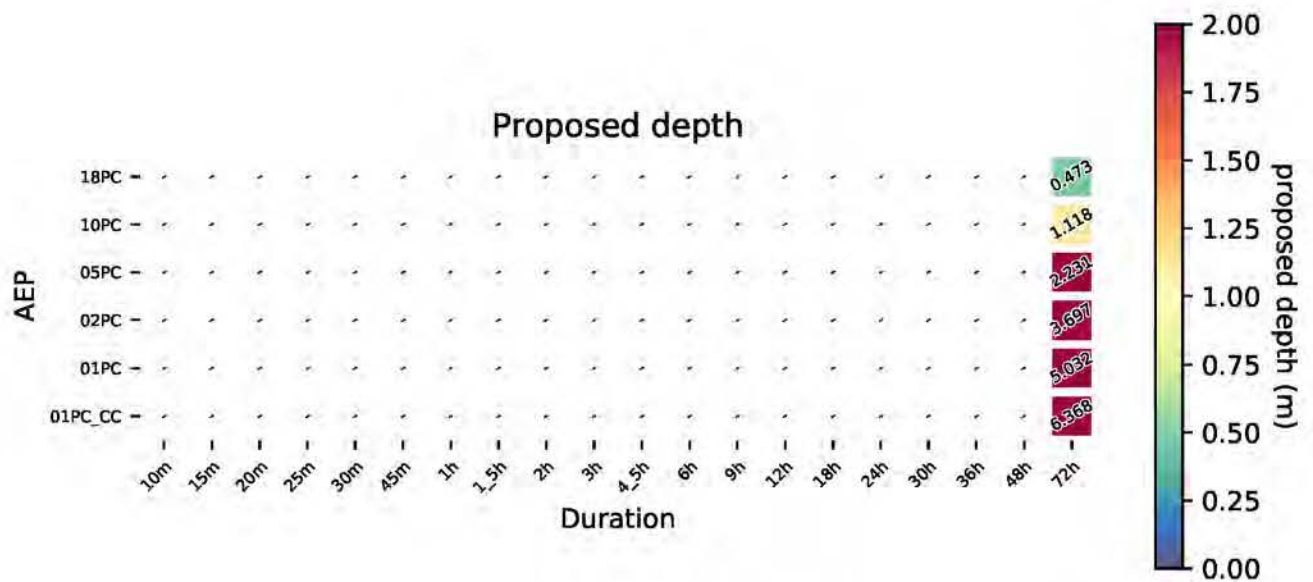
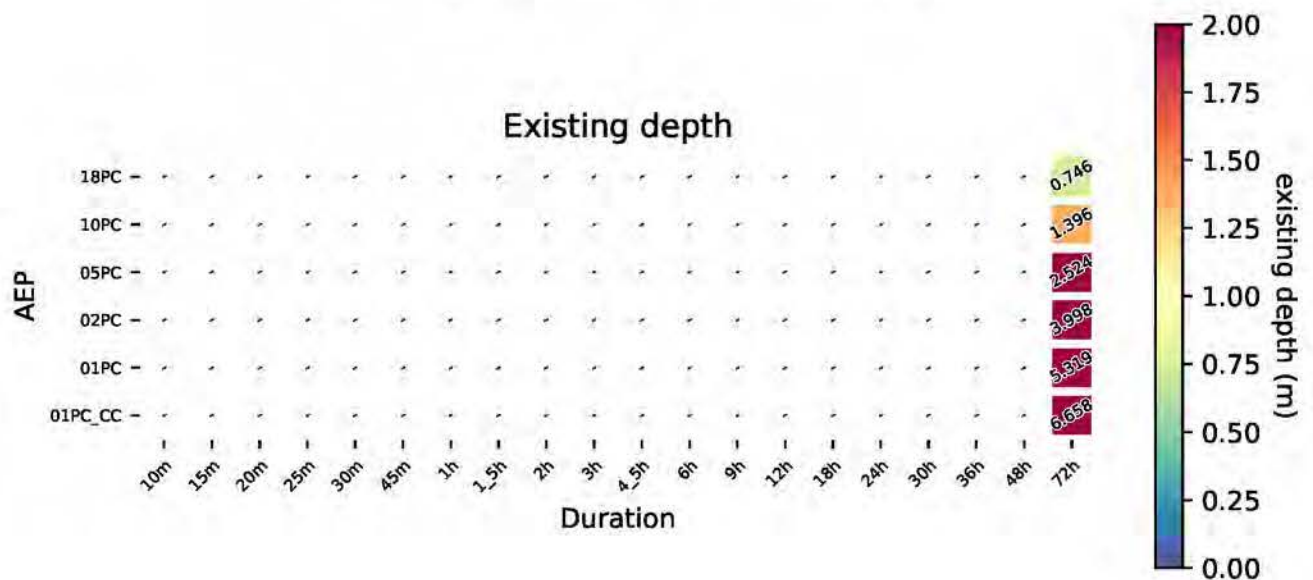




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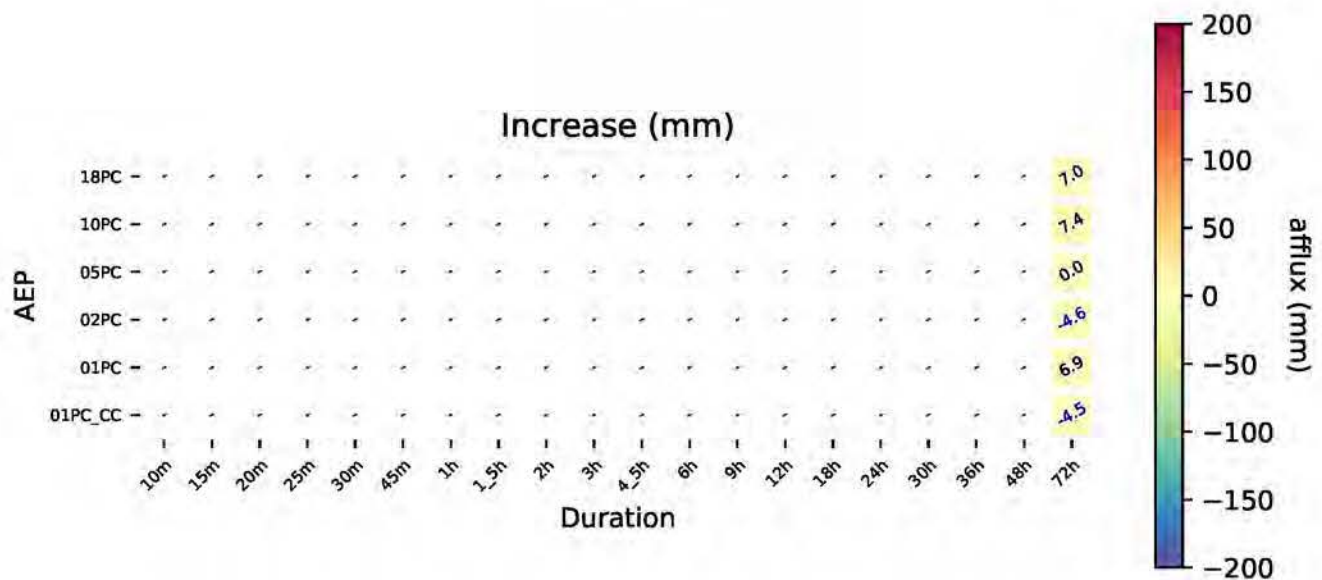
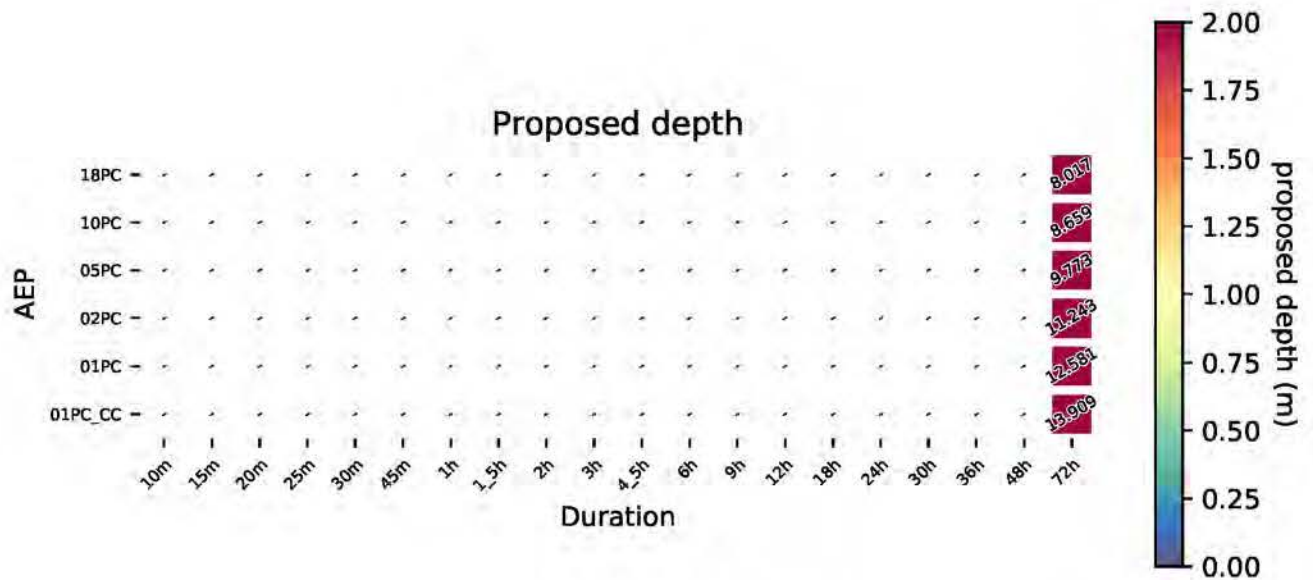
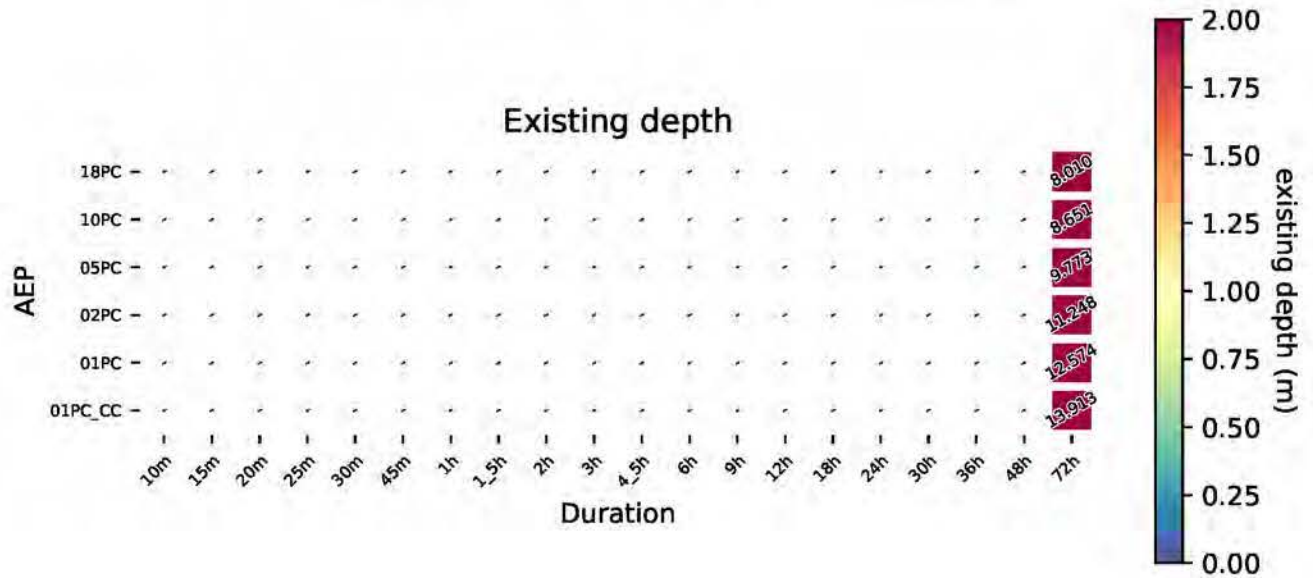


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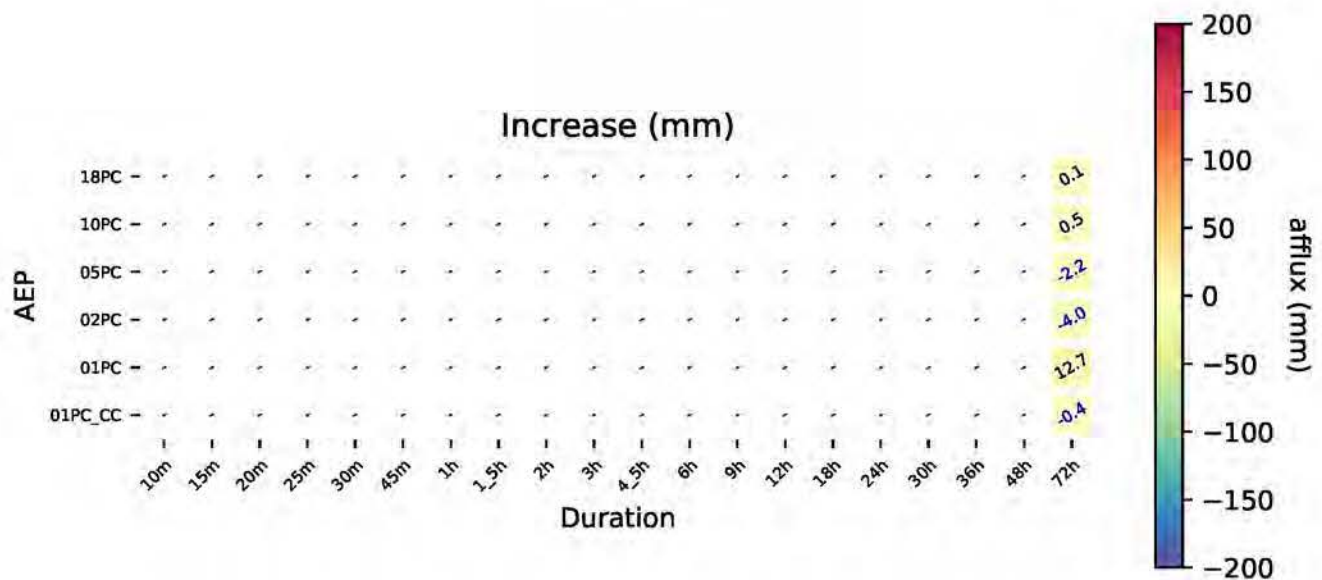
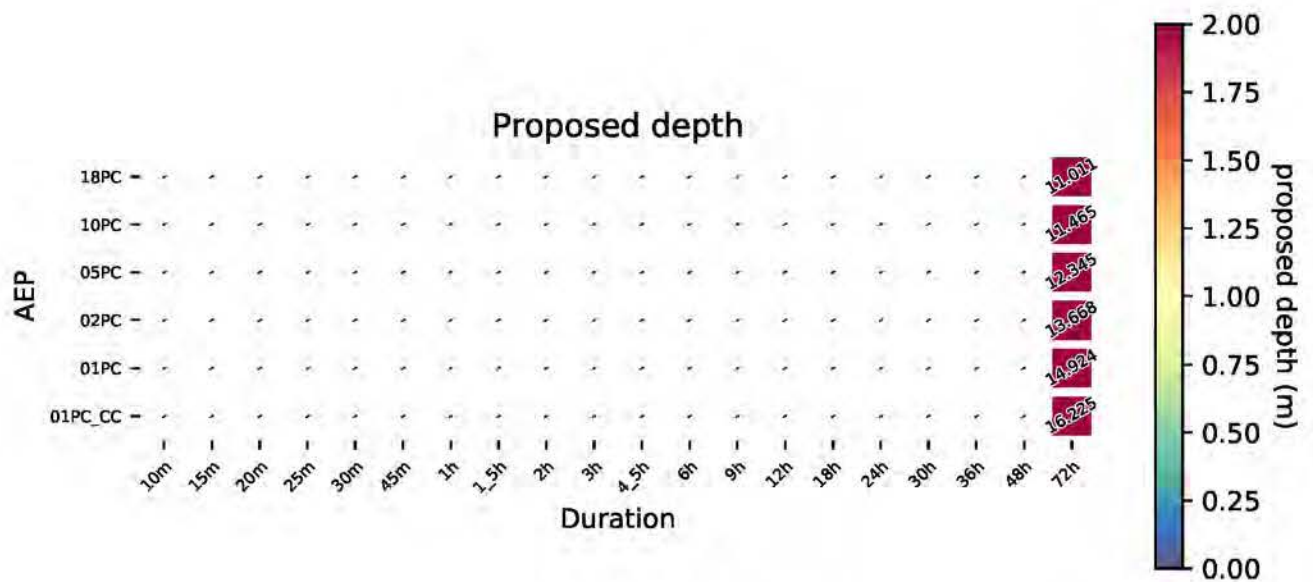
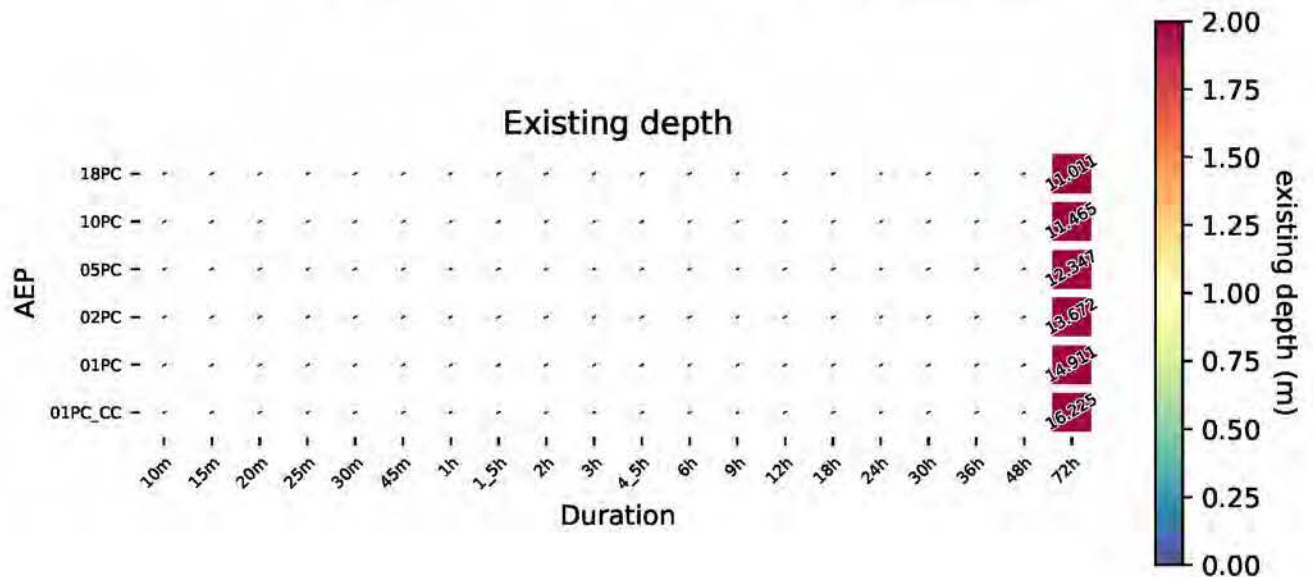




# Yarra River - BolinBolinBillabong

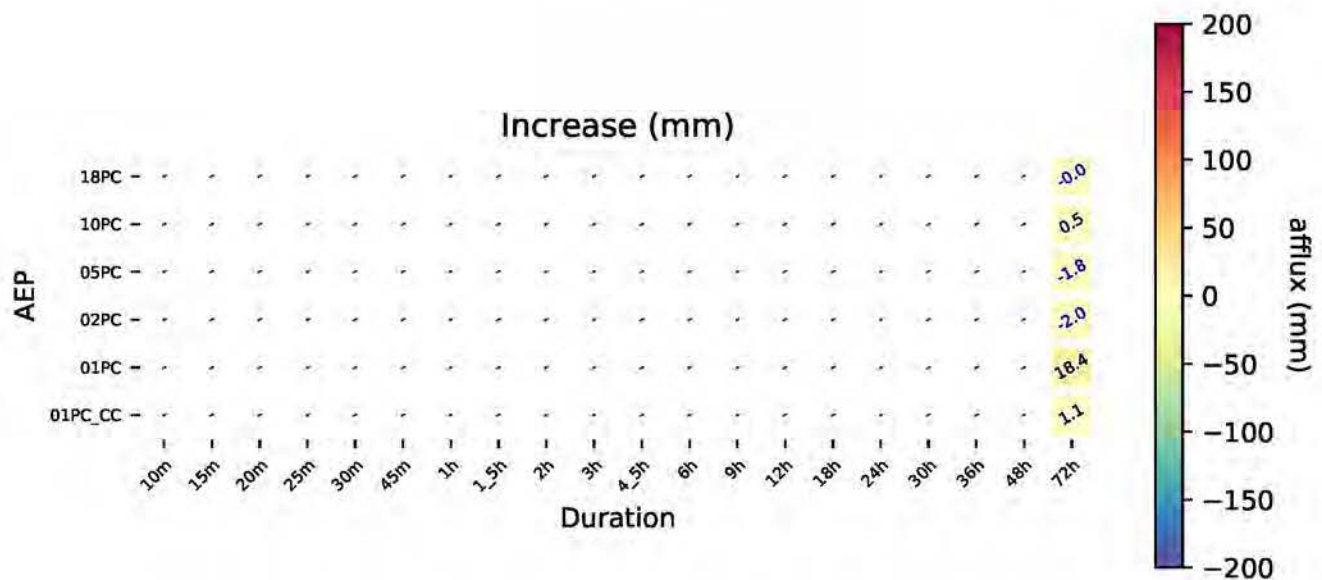
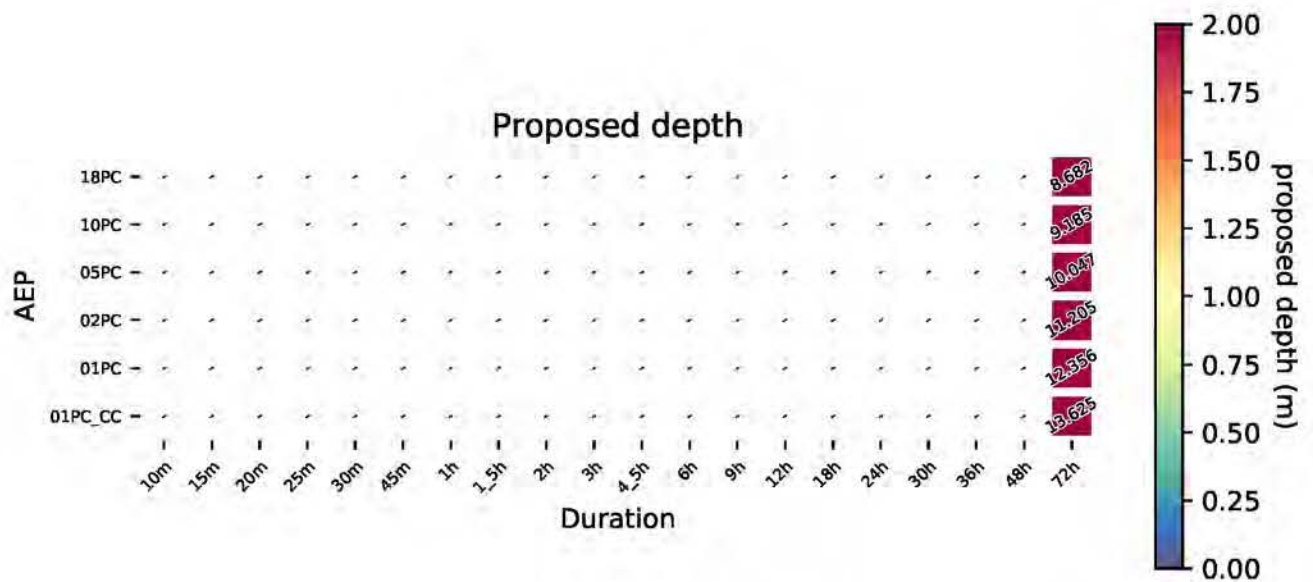
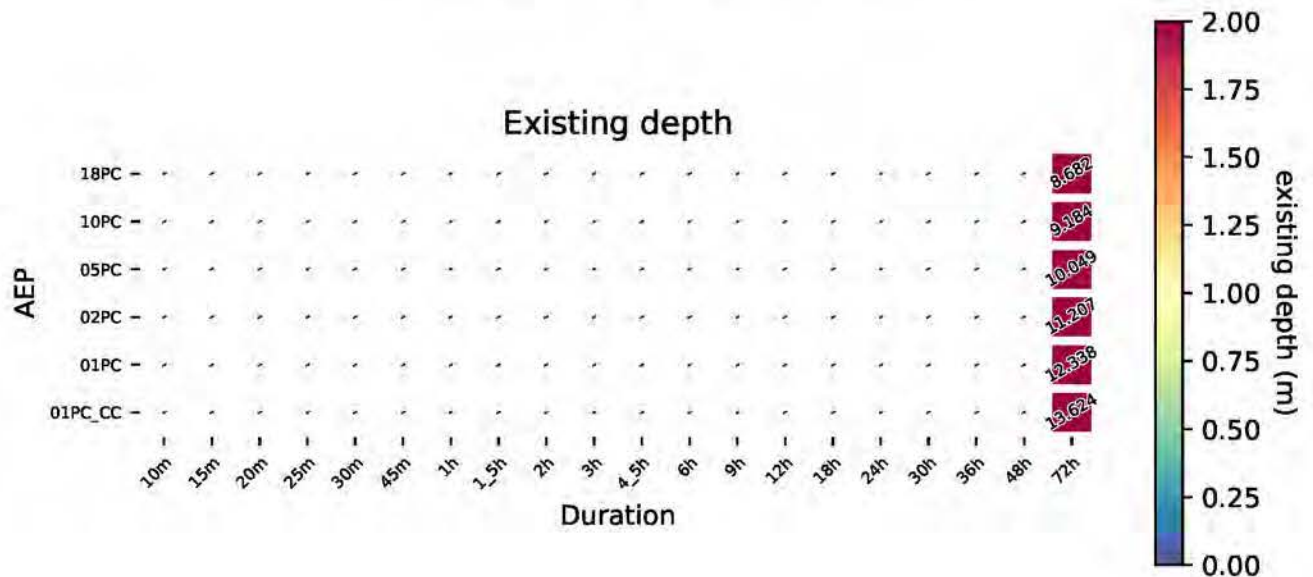


# Yarra River - Manningham\_Rd\_West

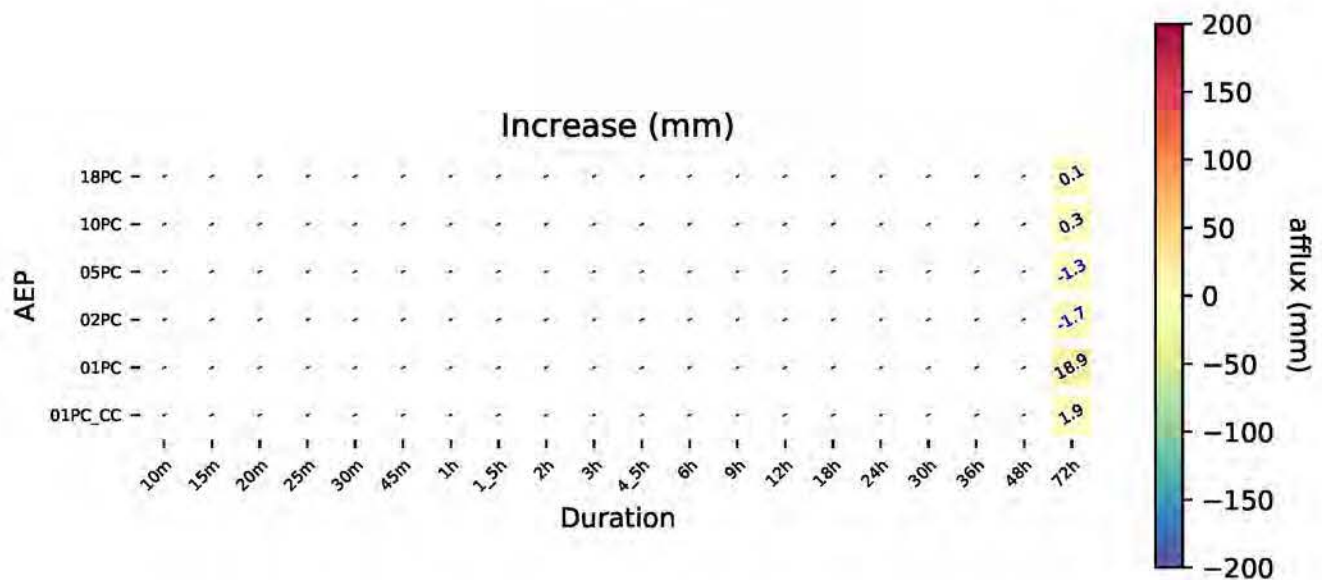
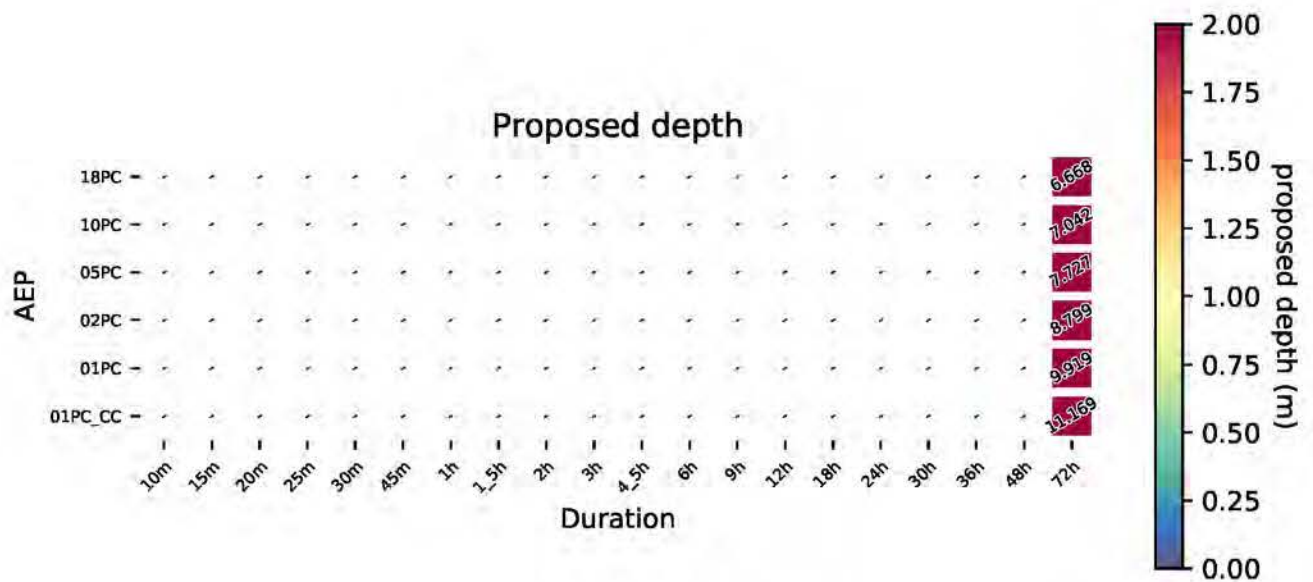
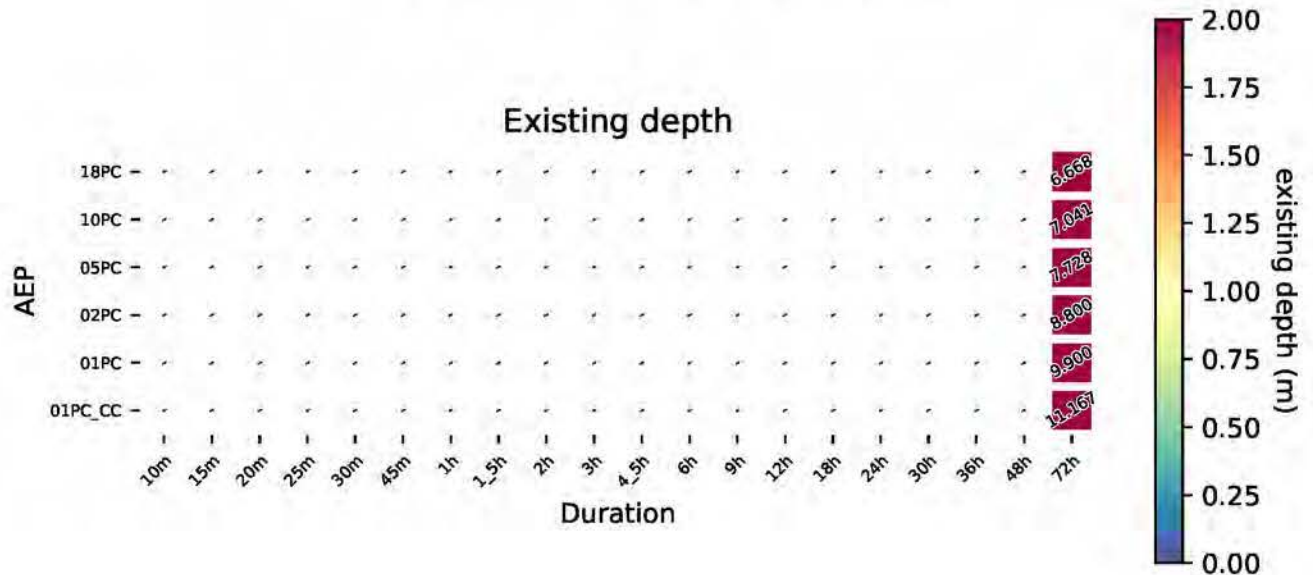




# Yarra River - Salt\_Creek

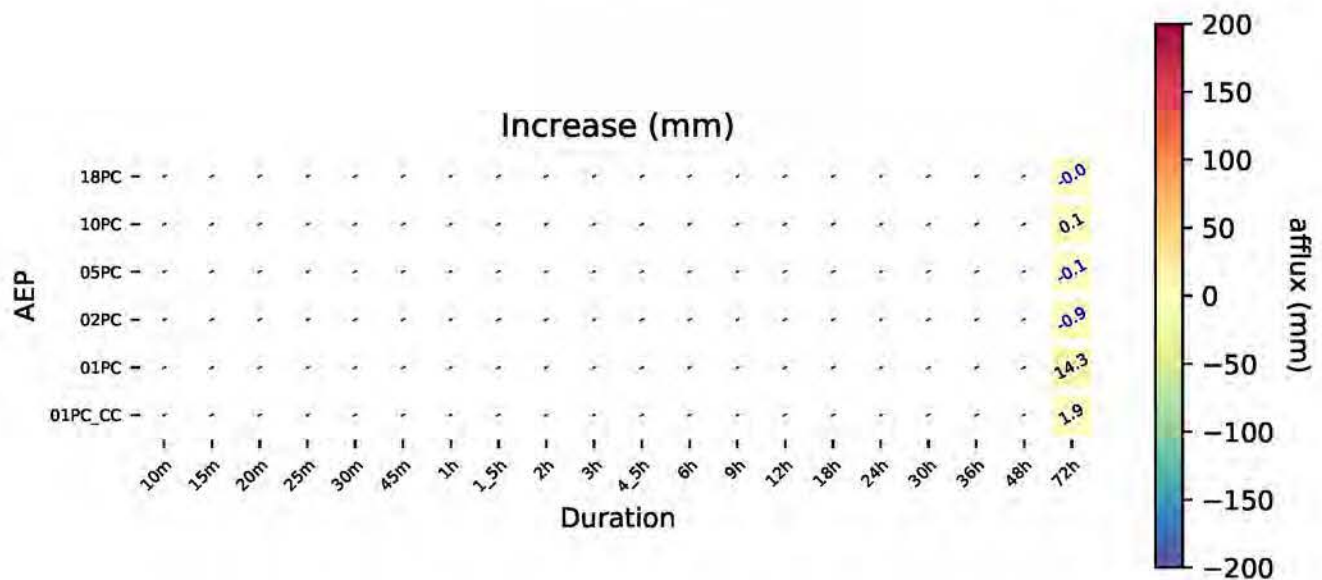
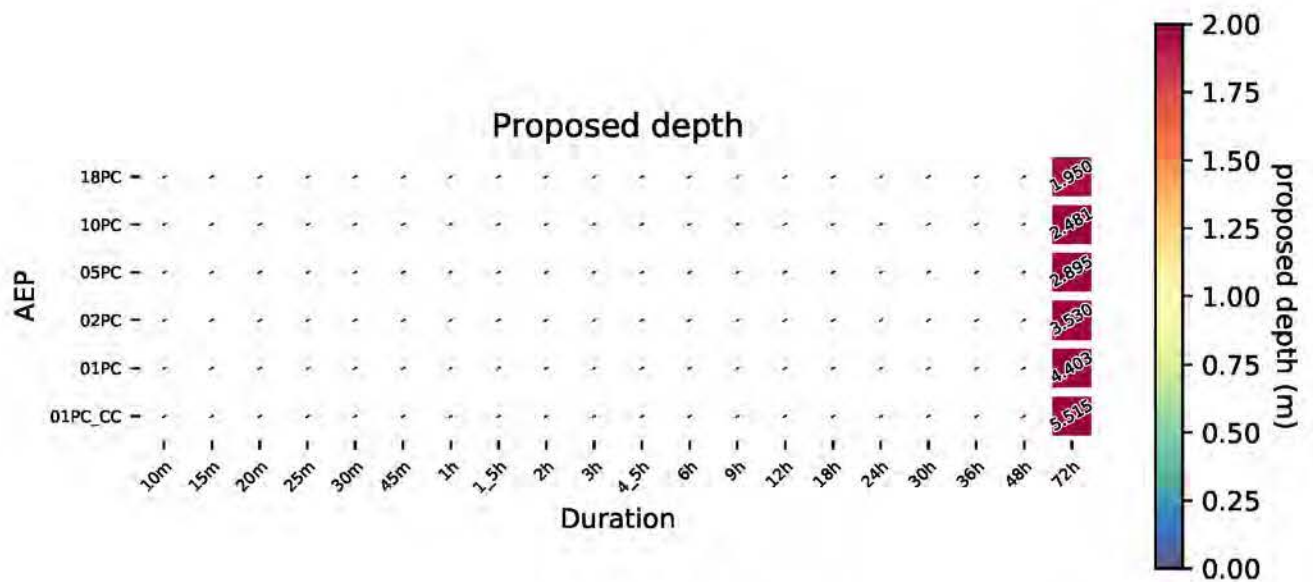
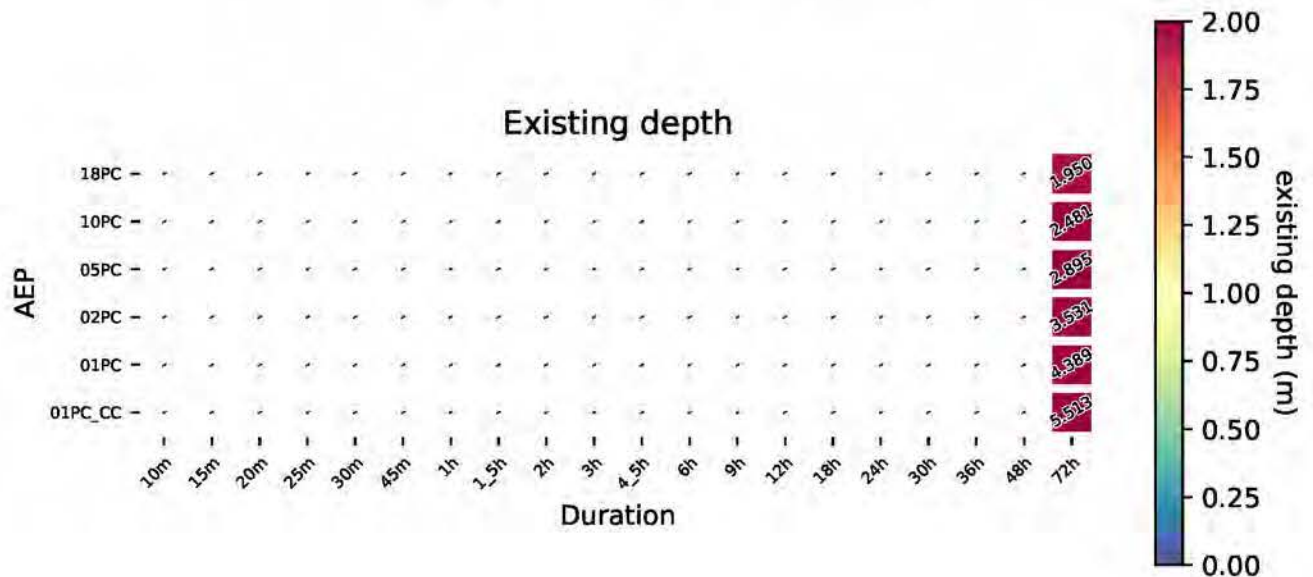


# Yarra River - Banyule\_Creek





# Yarra River - Plenty\_River







## LEGEND

★ Selected Locations



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Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	D
Date	13/11/2018

Koonung Creek 1 of 3  
Comparison Locations Appendix D-6-1

G:\3135006\GIS\Maps\Working\Specialist Submission\EE\Surface\_Water\35006\_Hydraulic\Koonung\_Creek\Koonung\_Creek\_Site\_Melbourne\_VIC\_3000\_Australia\_T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com  
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

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## LEGEND

★ Selected Locations



Paper Size A4  
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Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	D
Date	13/11/2018

Koonung Creek 2 of 3  
Comparison Locations Appendix D-6-2

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

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## LEGEND

★ Selected Locations



Paper Size A4  
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Map Projection: Transverse Mercator  
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North East Link  
North East Link Project

Job Number	31-35006
Revision	D
Date	13/11/2018

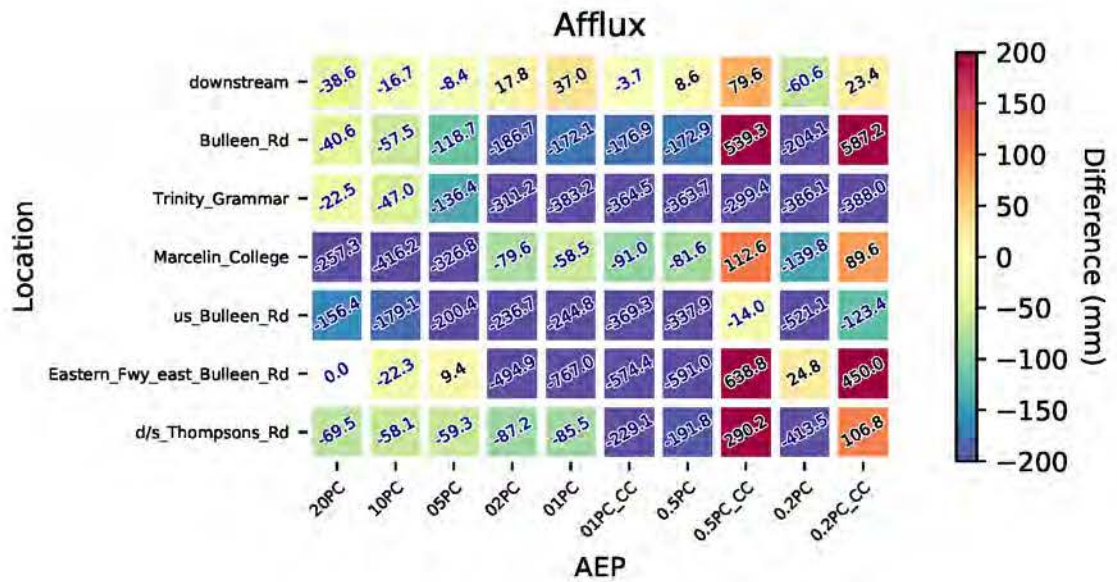
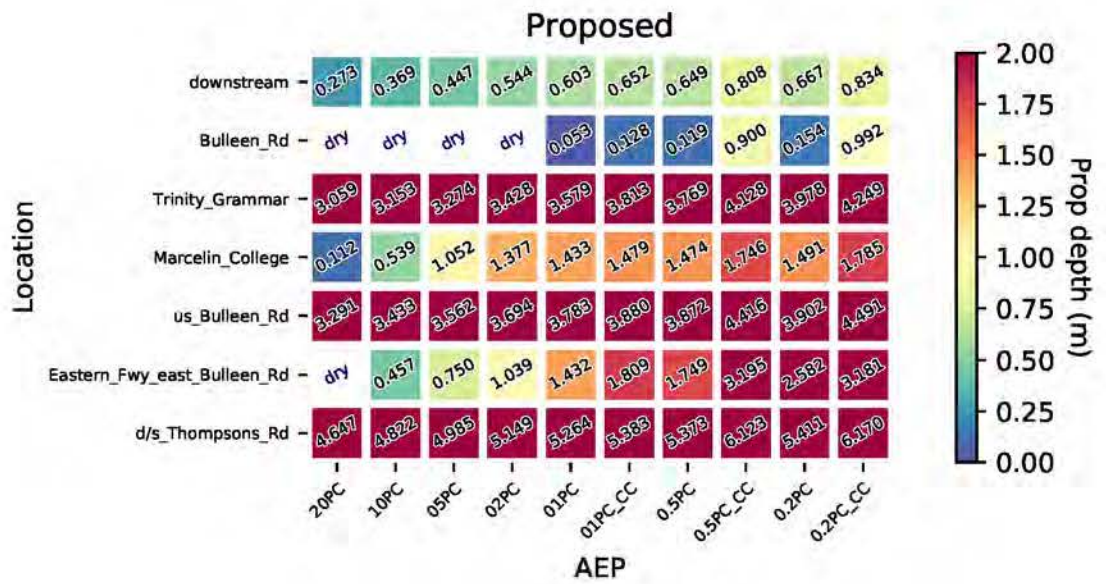
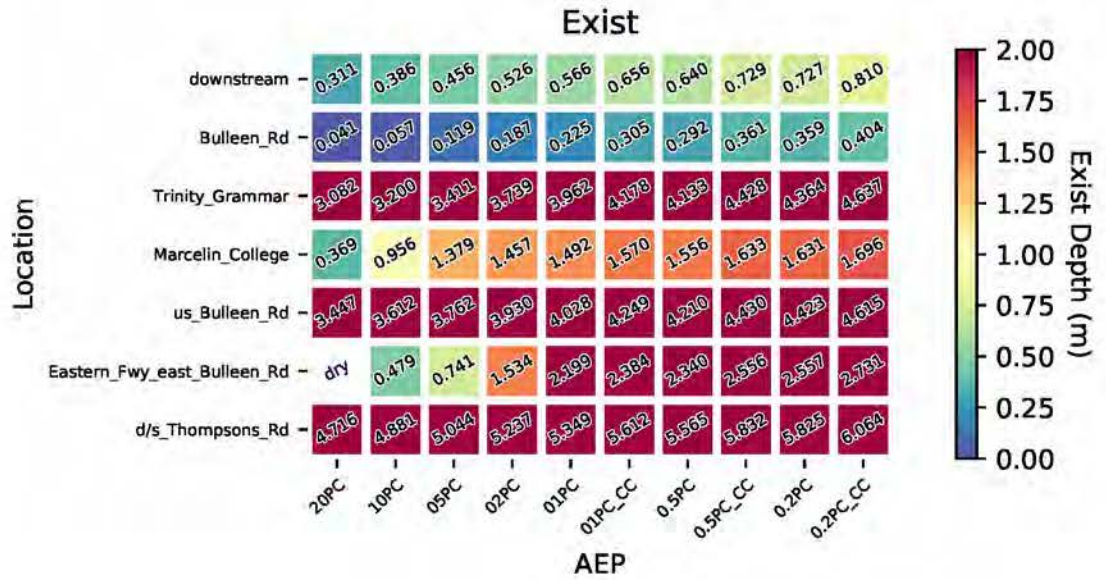
Koonung Creek 3 of 3  
Comparison Locations Appendix D-6-3

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

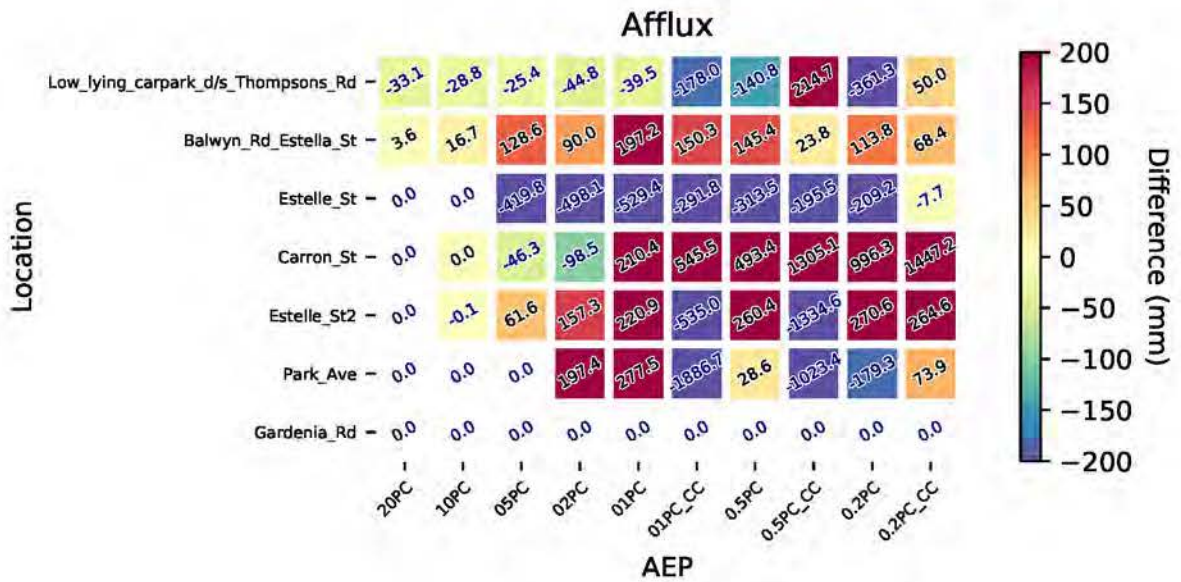
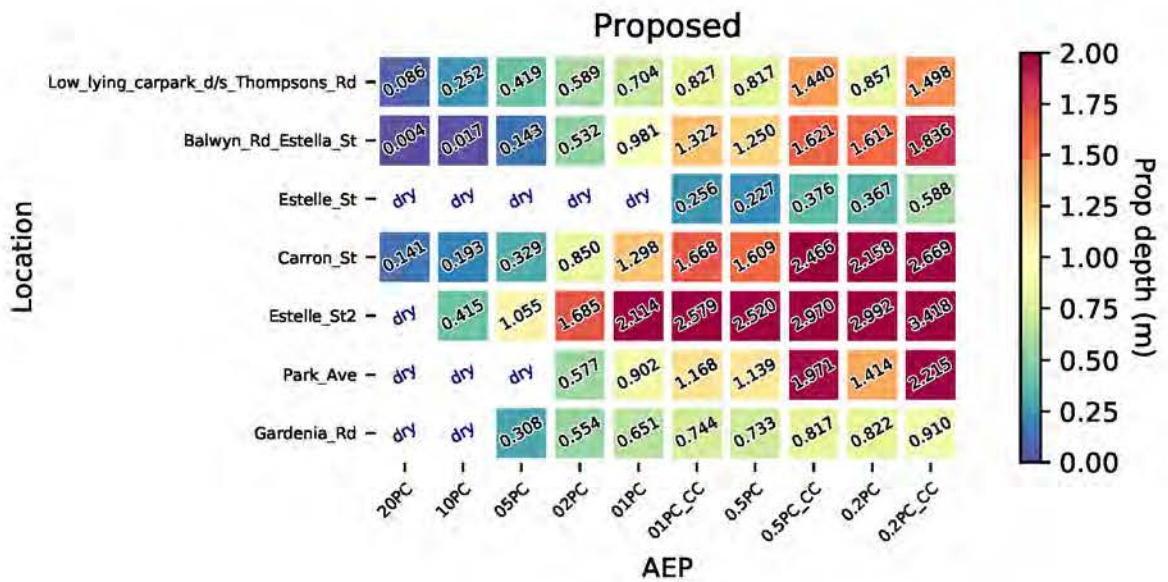
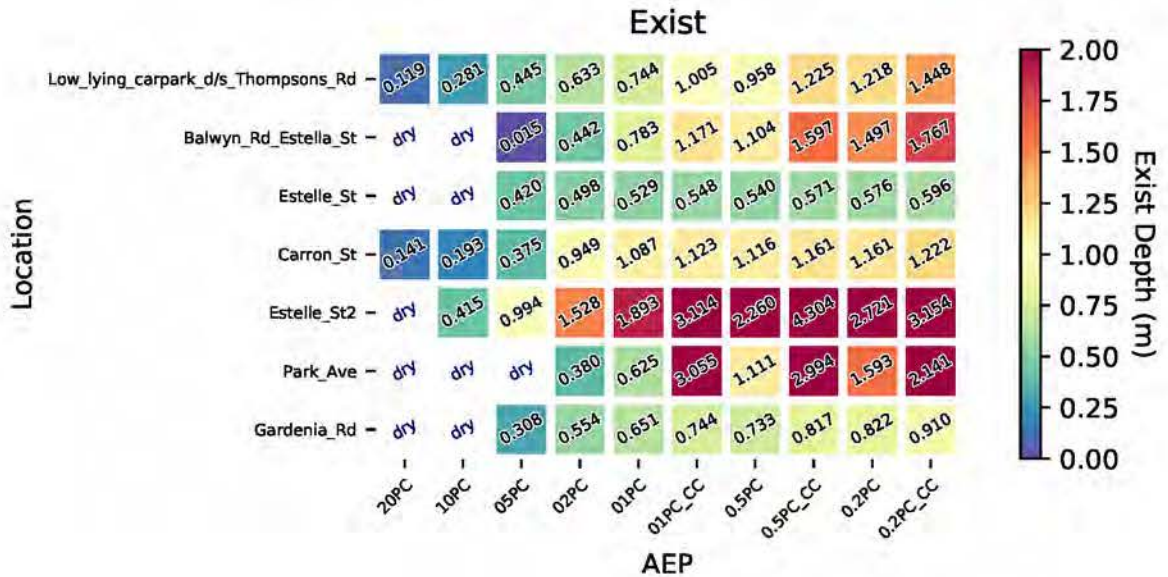
© 2018. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.



# Koonung Creek - Overview

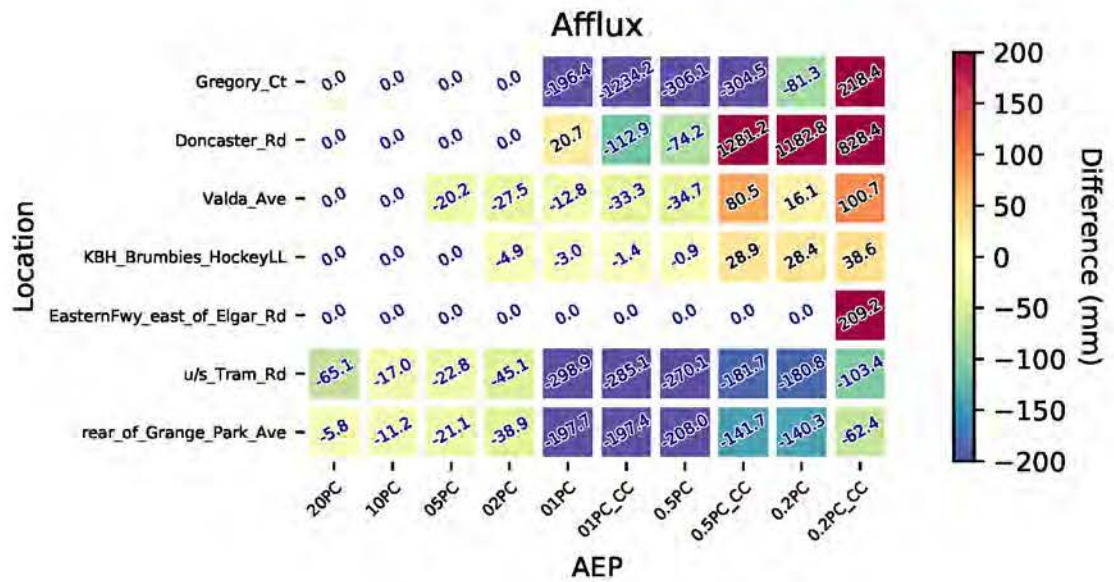
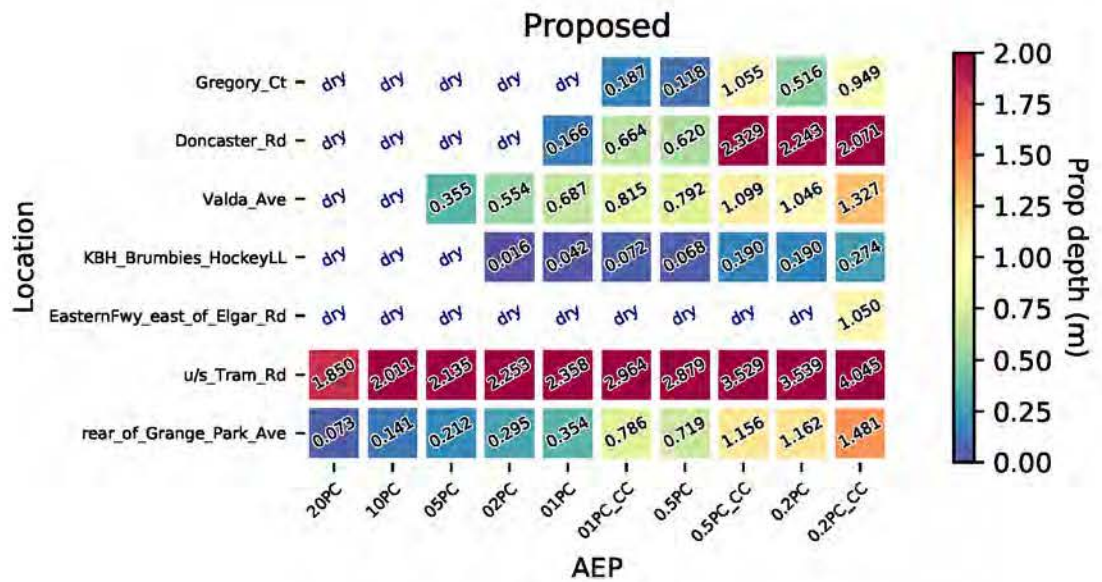
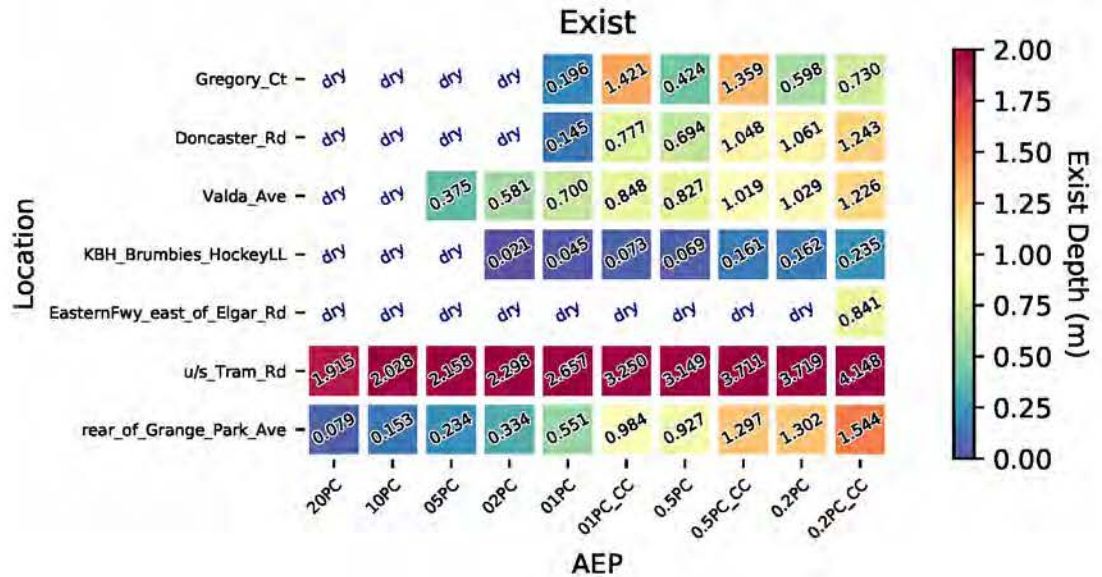


## Koonung Creek - Overview

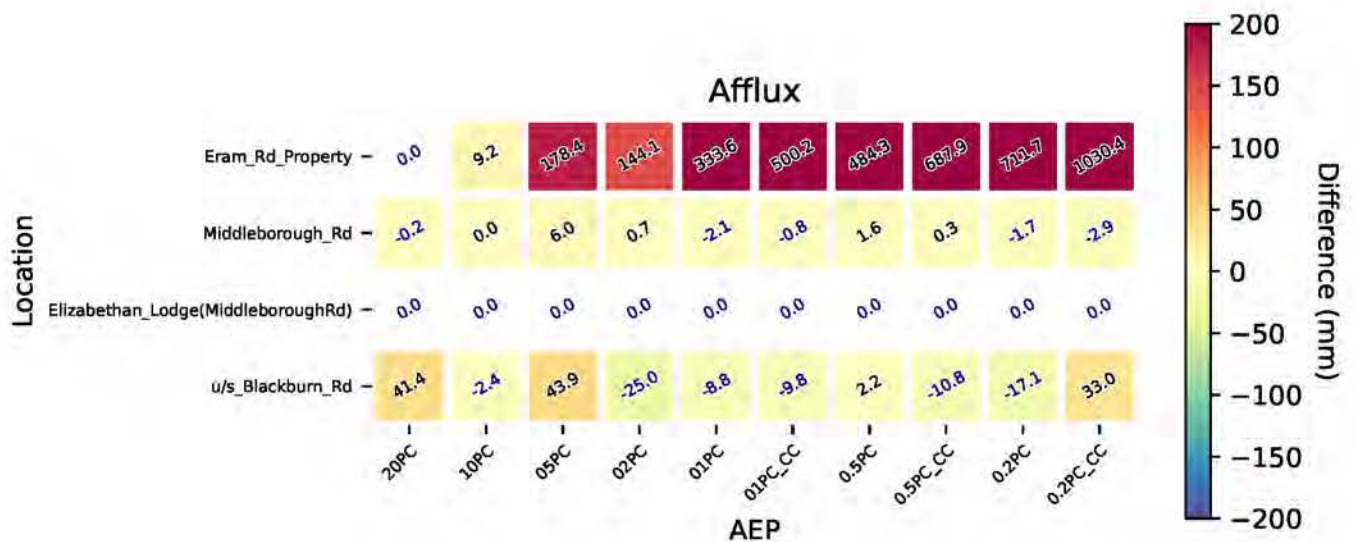
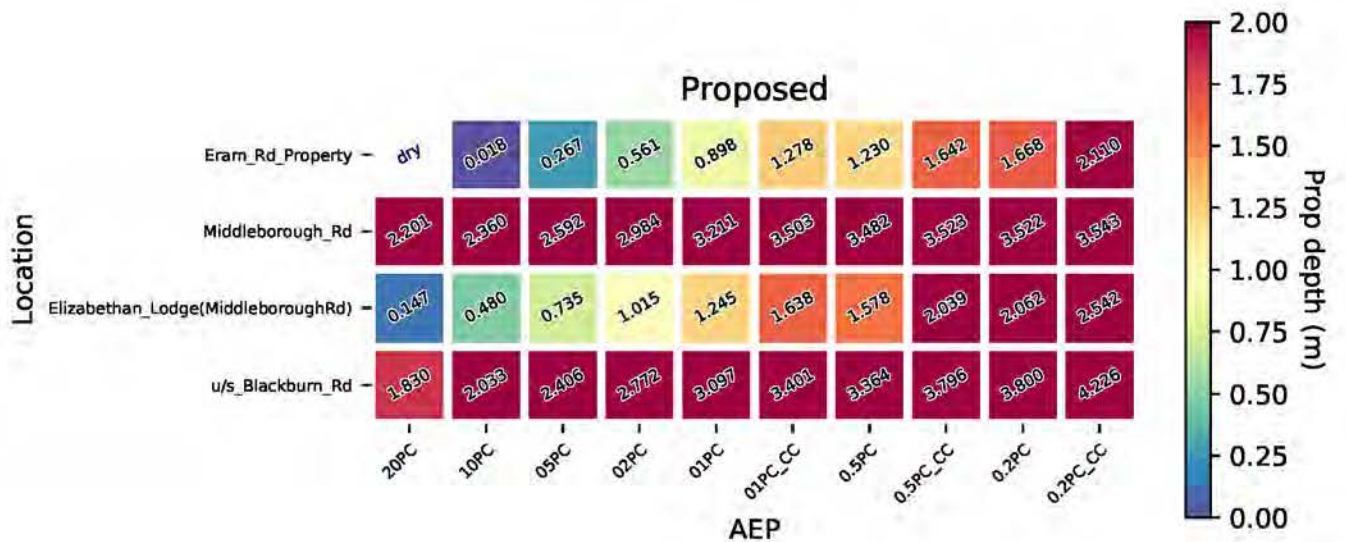
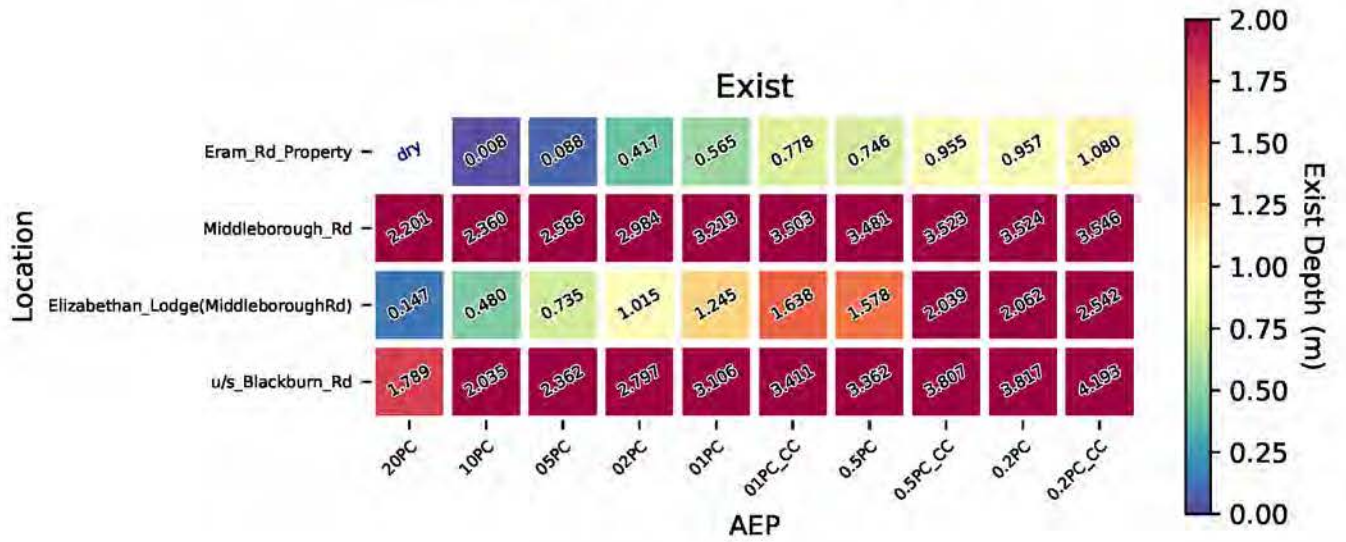




# Koonung Creek - Overview

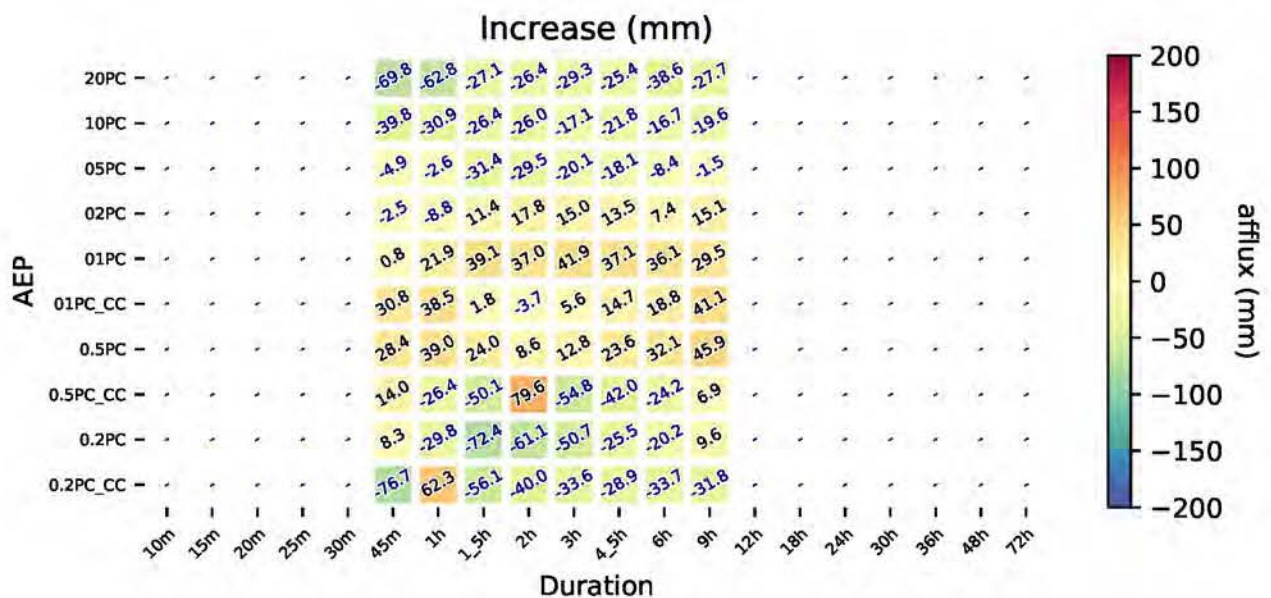
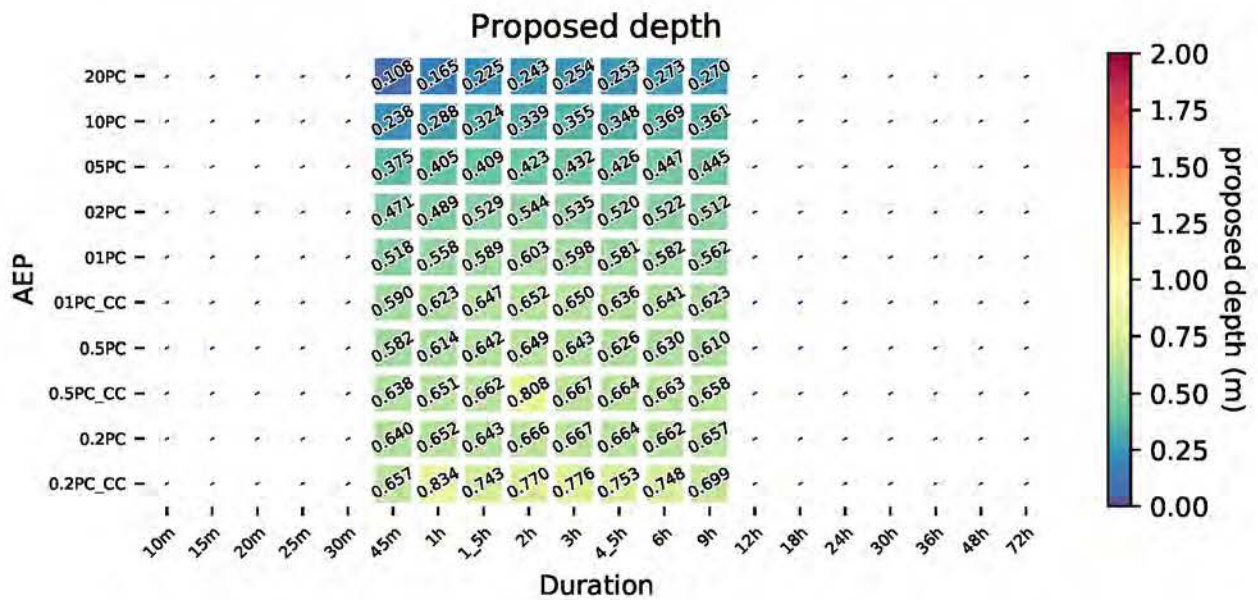
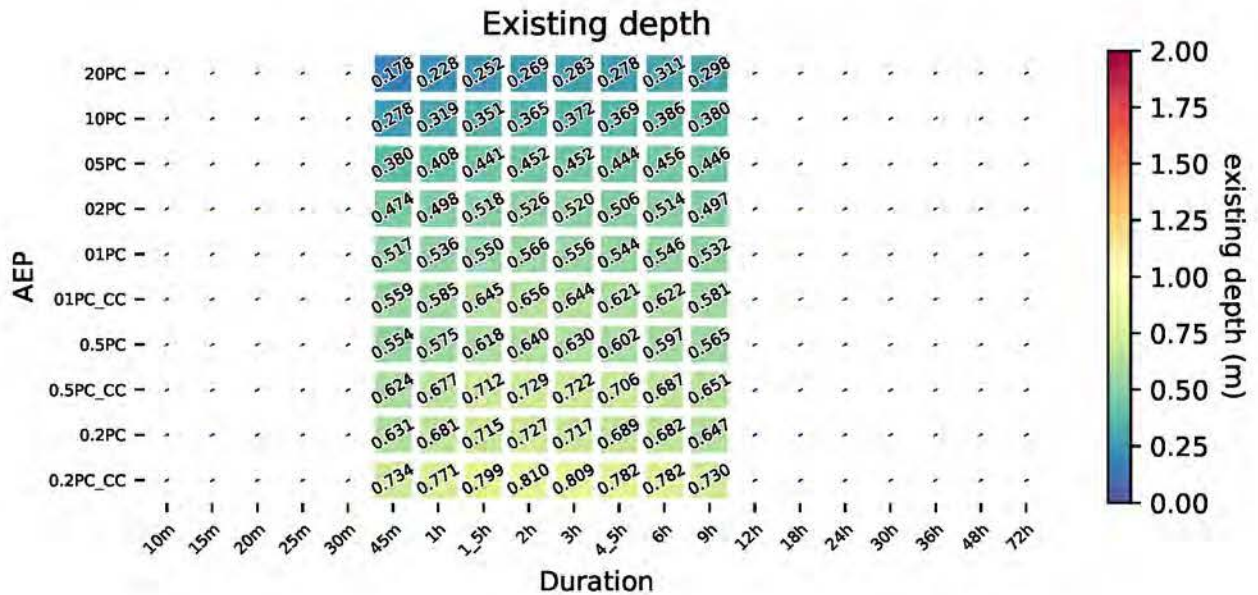


# Koonung Creek - Overview

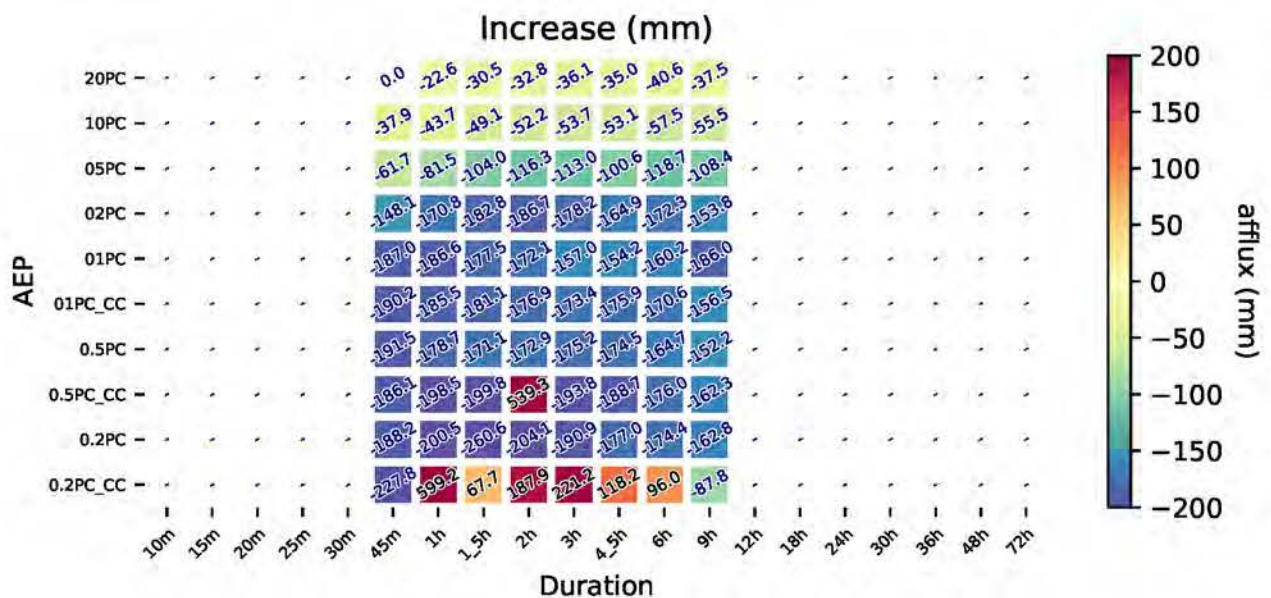
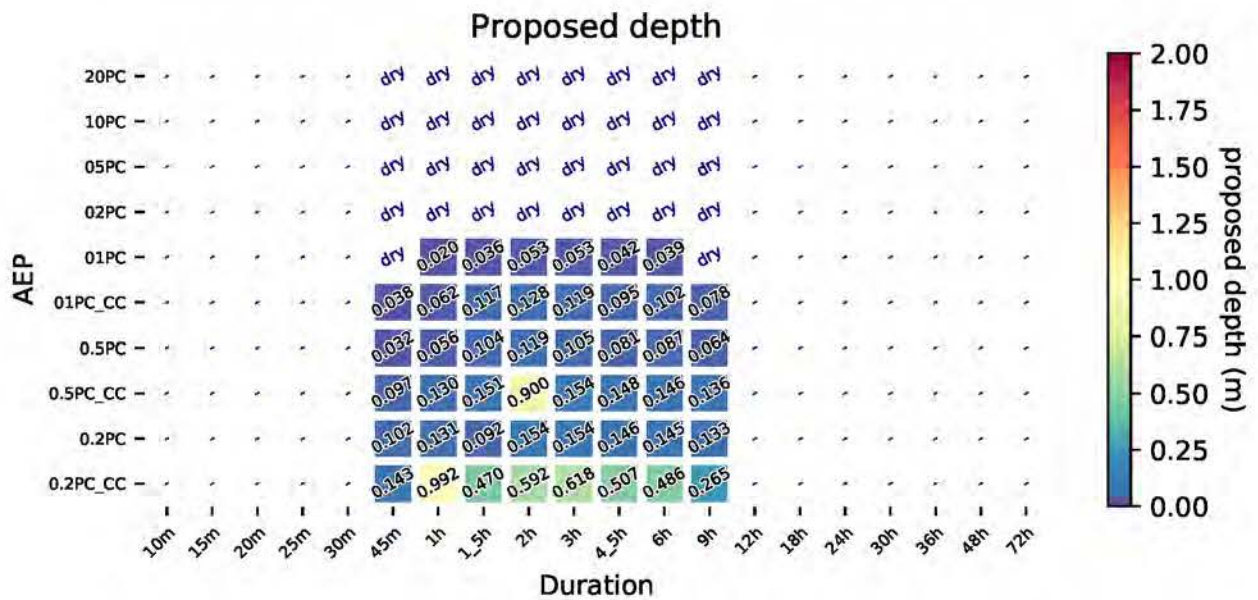
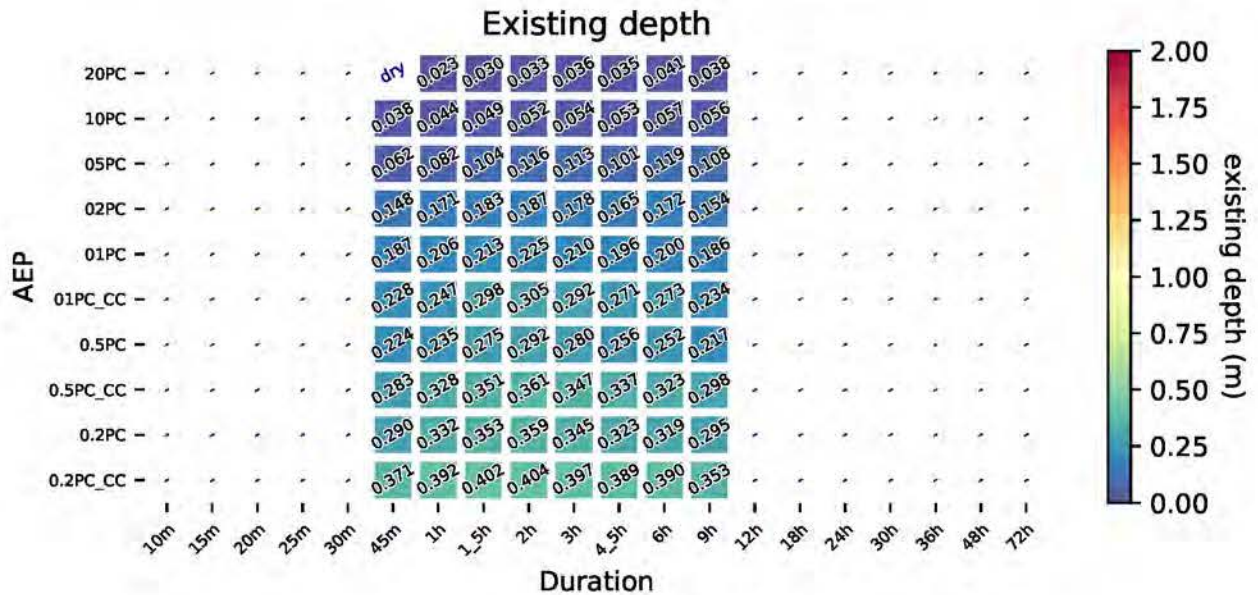




# Koonung Creek - downstream

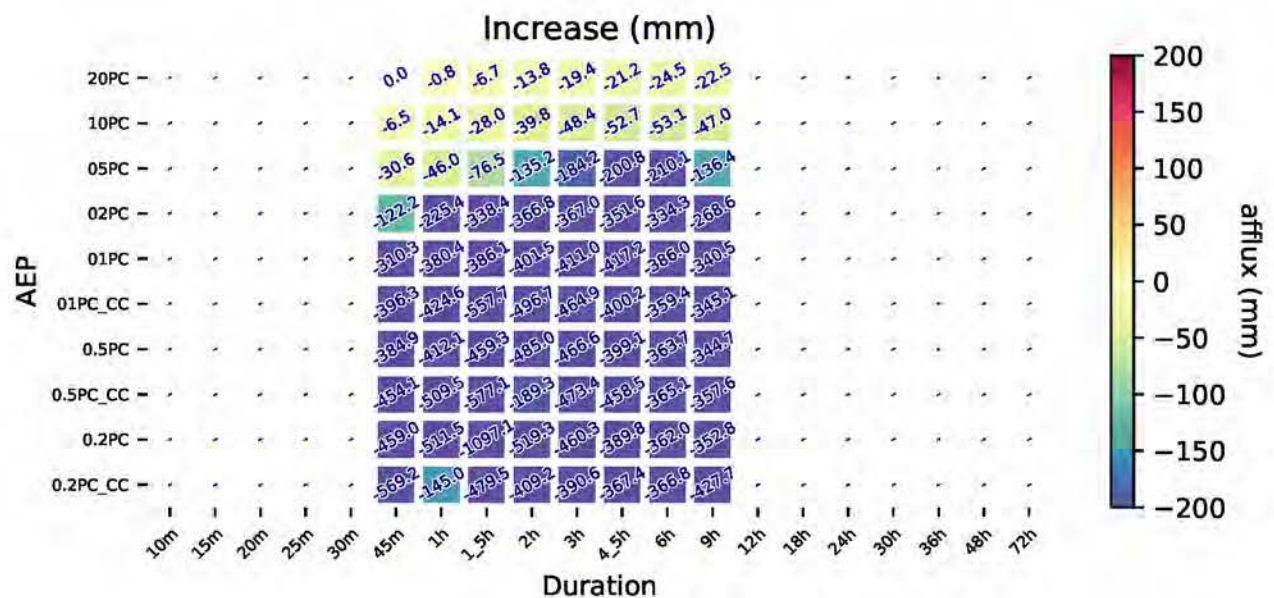
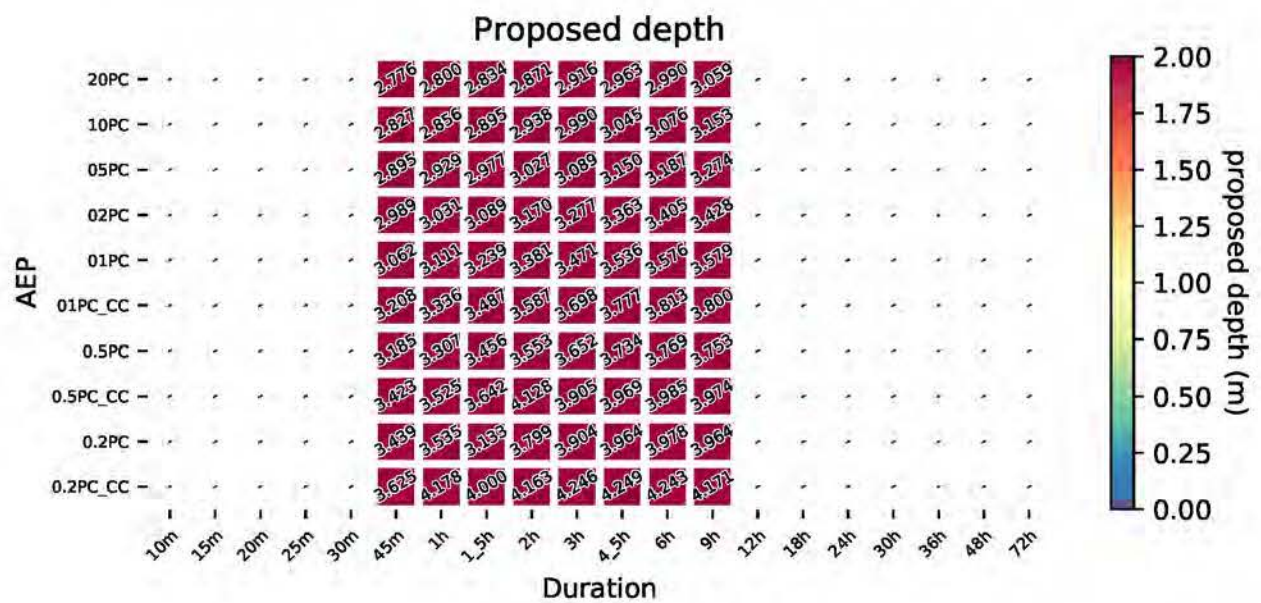
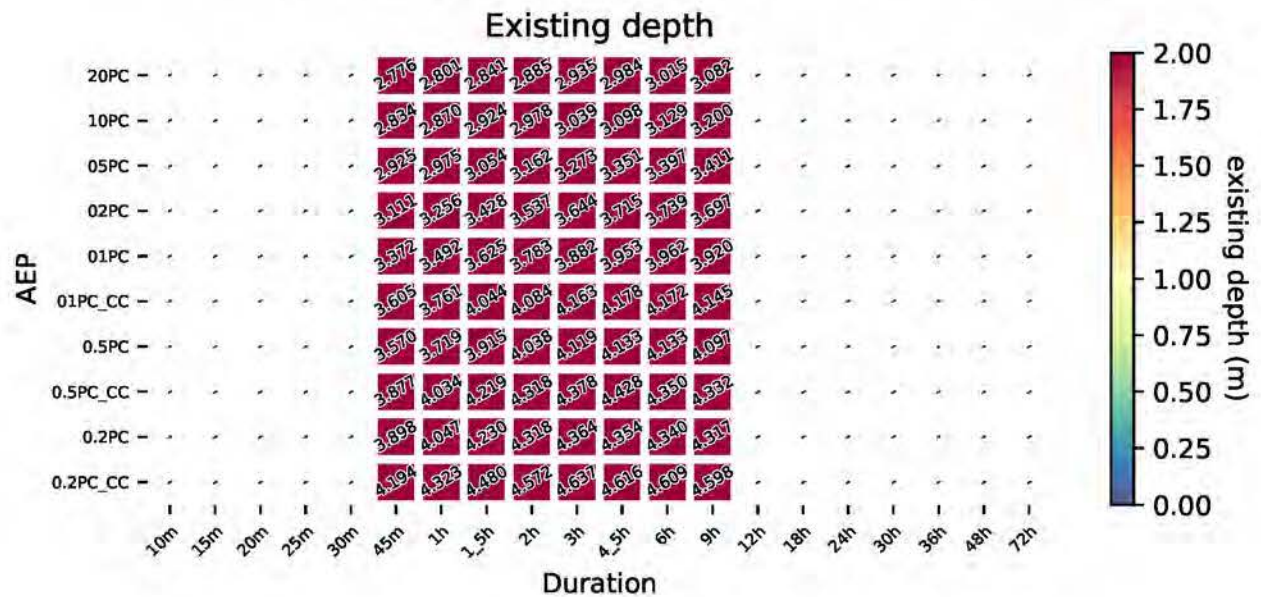


# Koonung Creek - Bulleen\_Rd



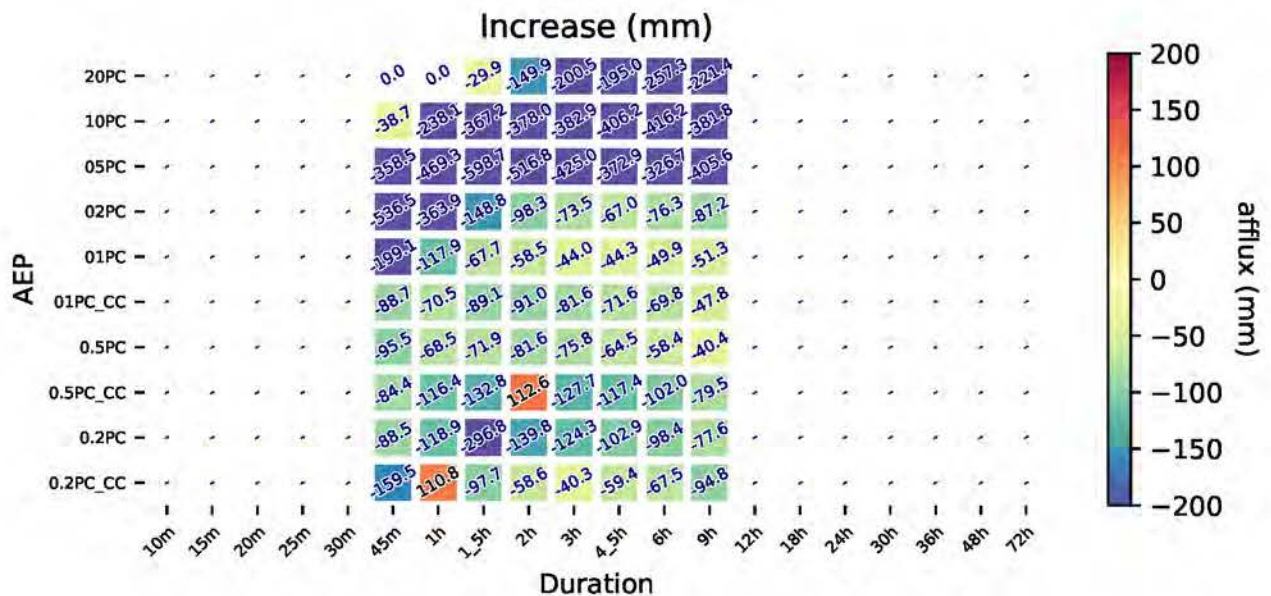
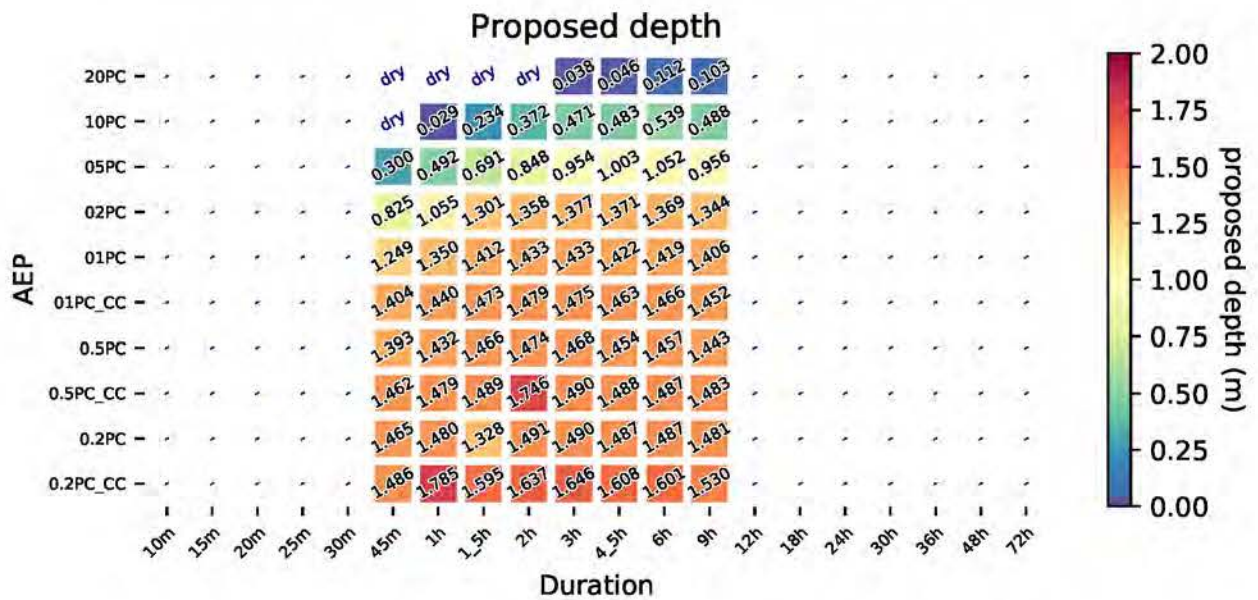
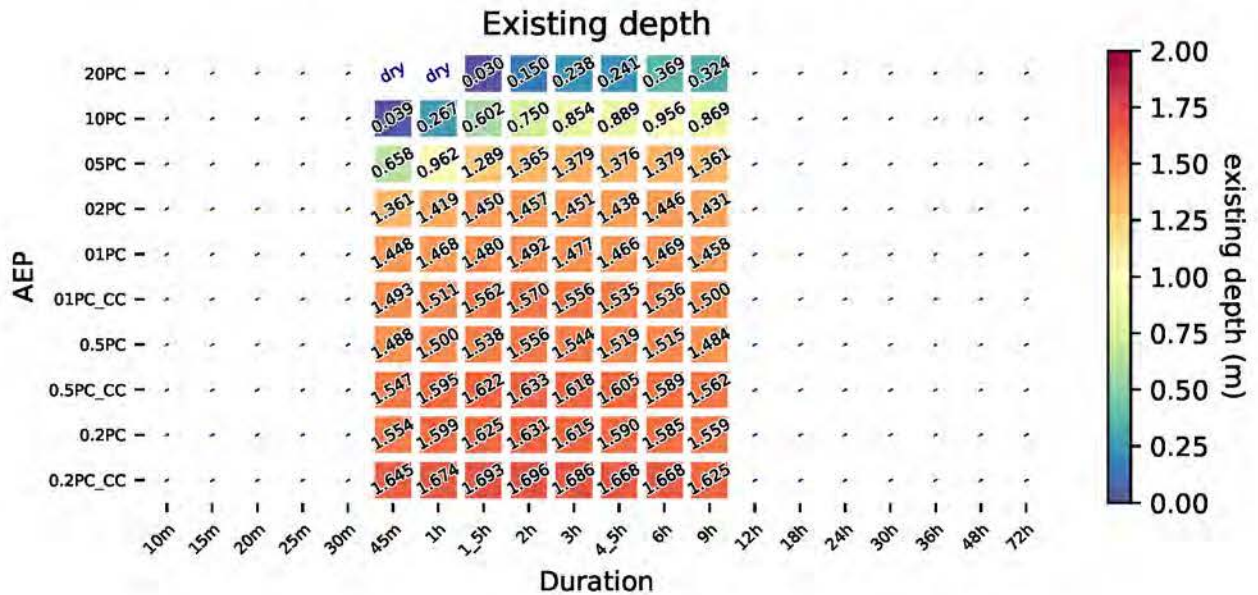


# Koonung Creek - Trinity\_Grammar



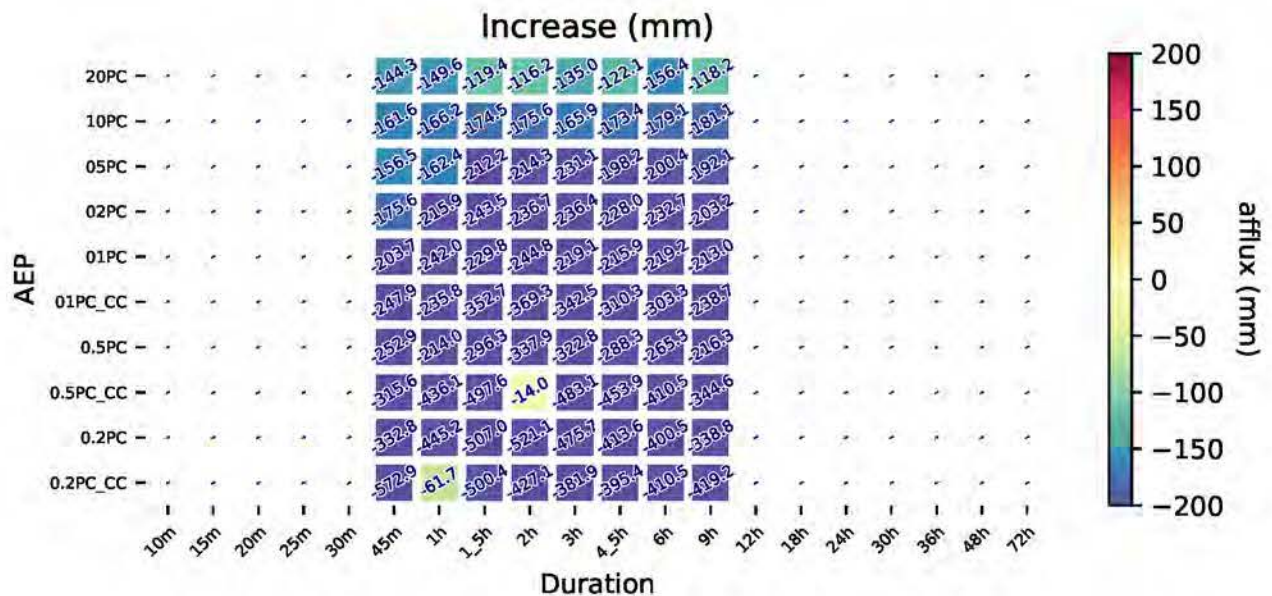
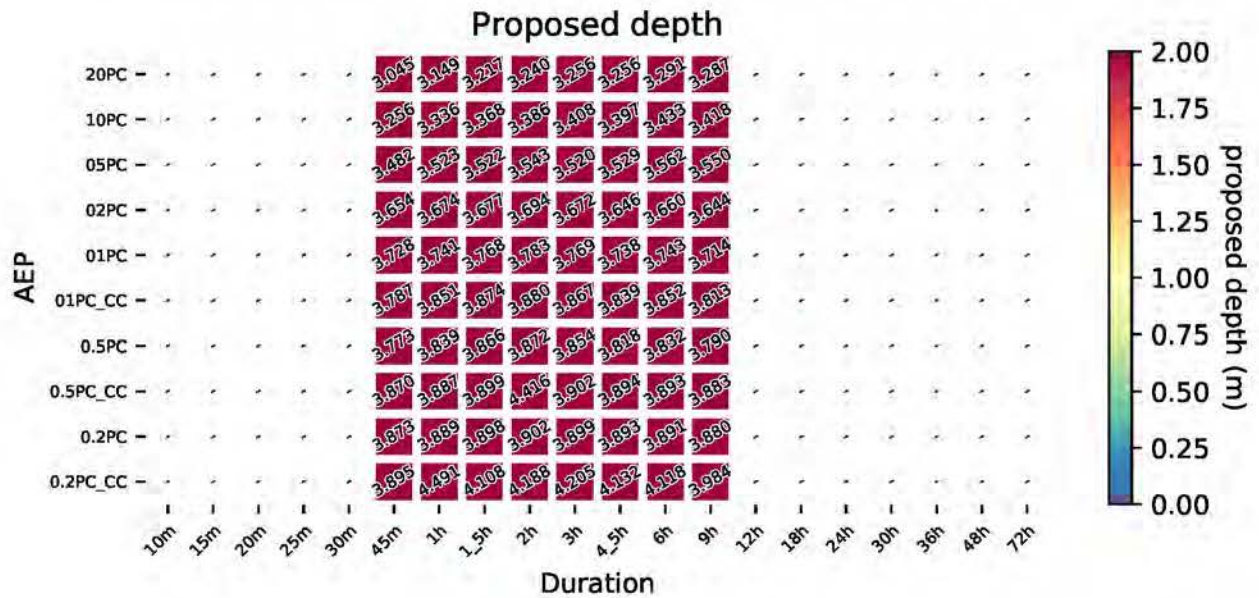
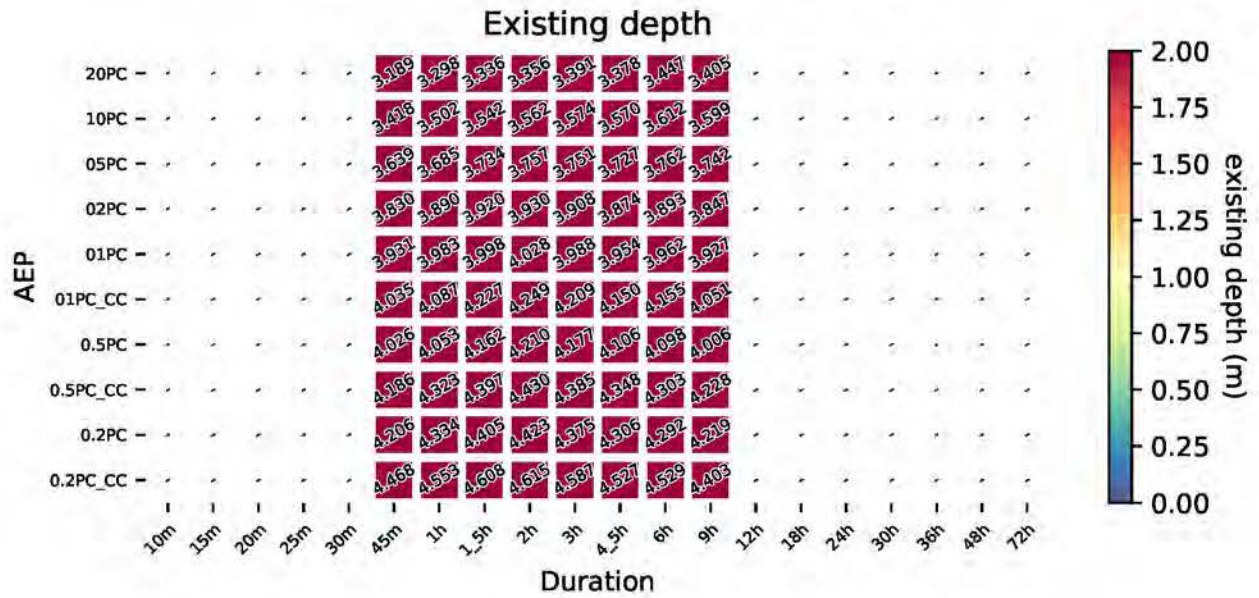


# Koonung Creek - Marcelin\_College



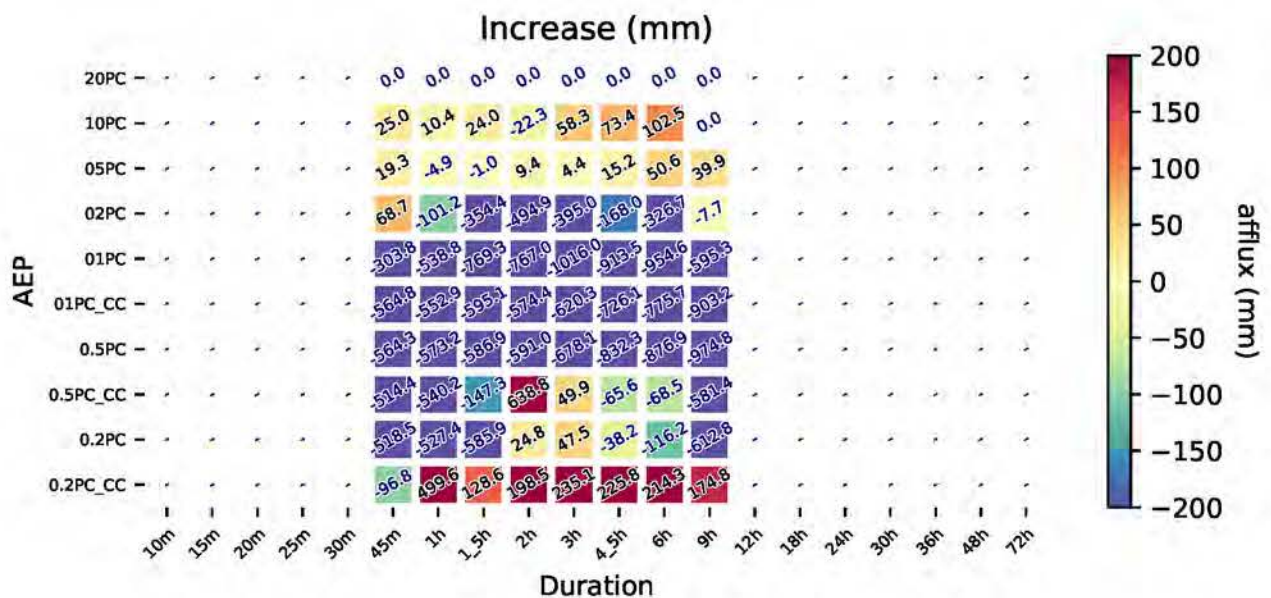
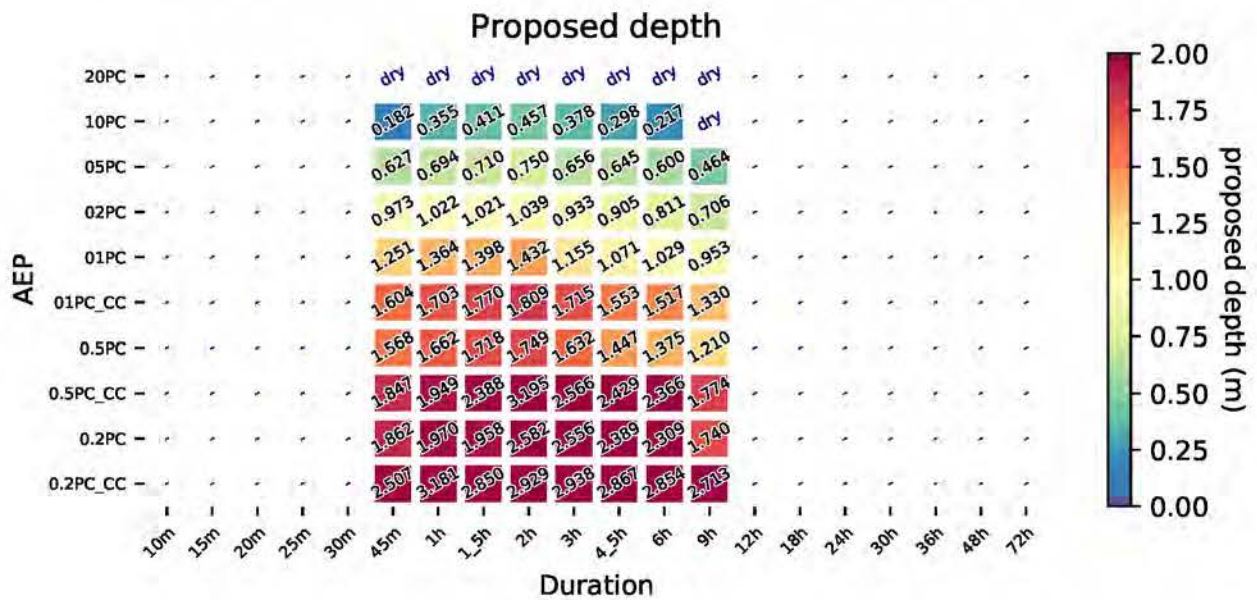
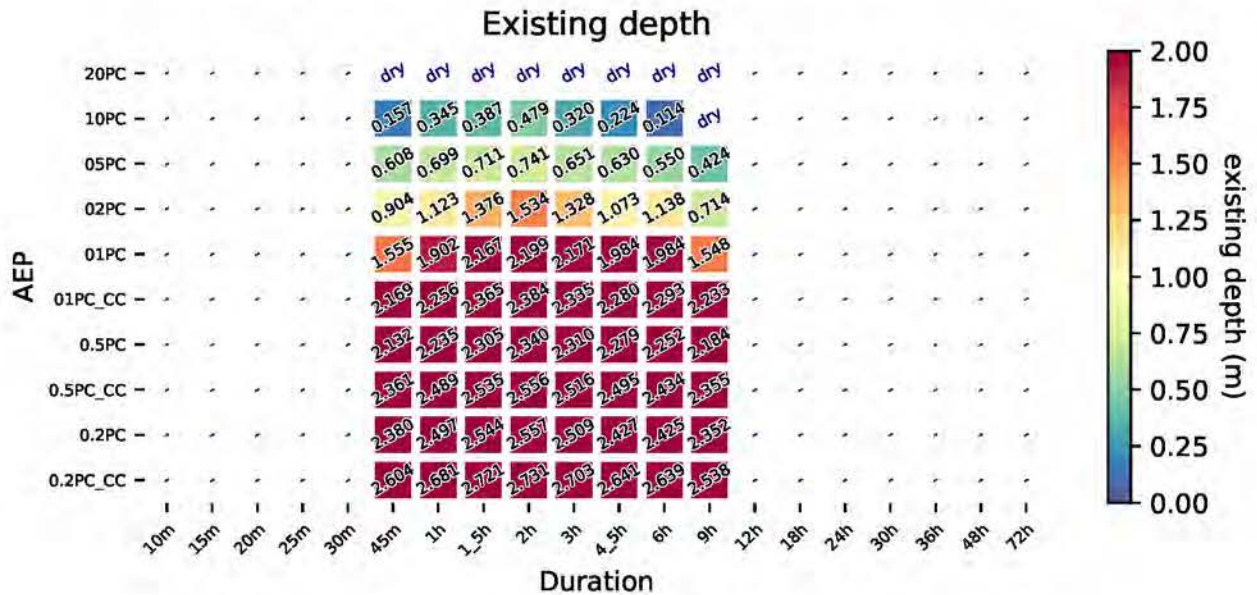


# Koonung Creek - us\_Bulleen\_Rd



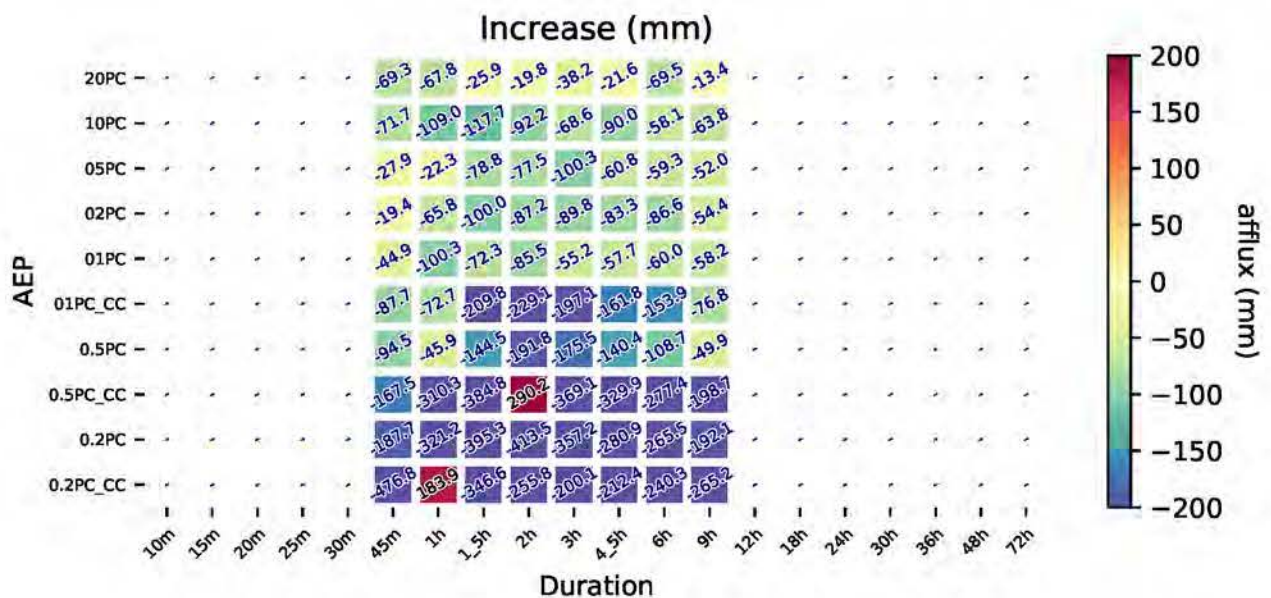
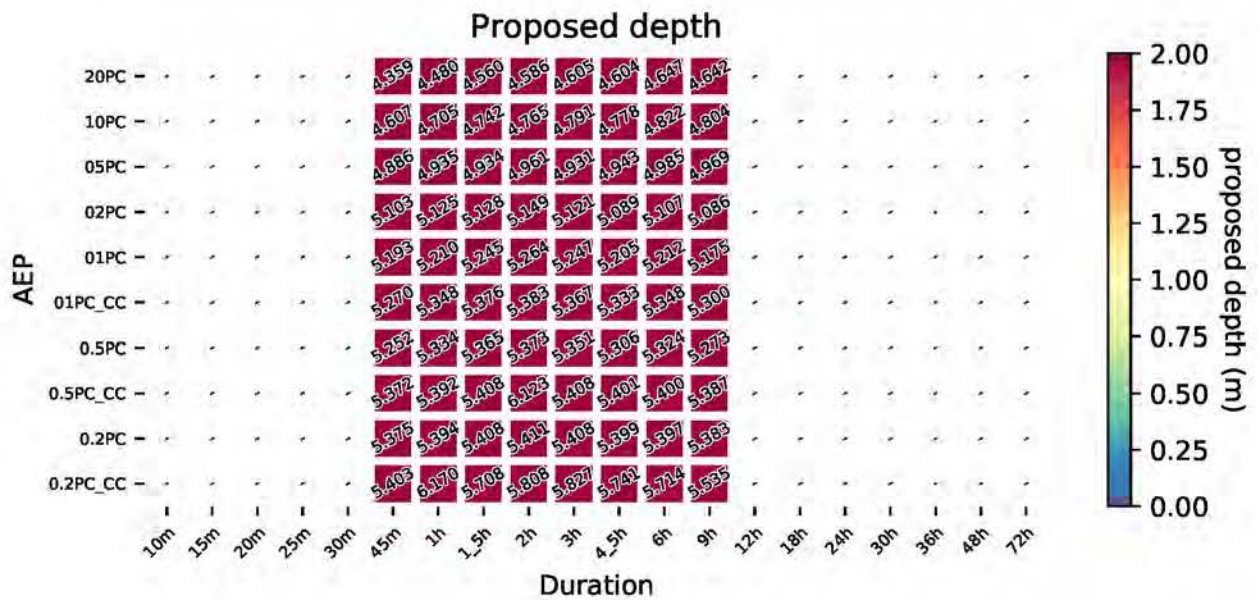
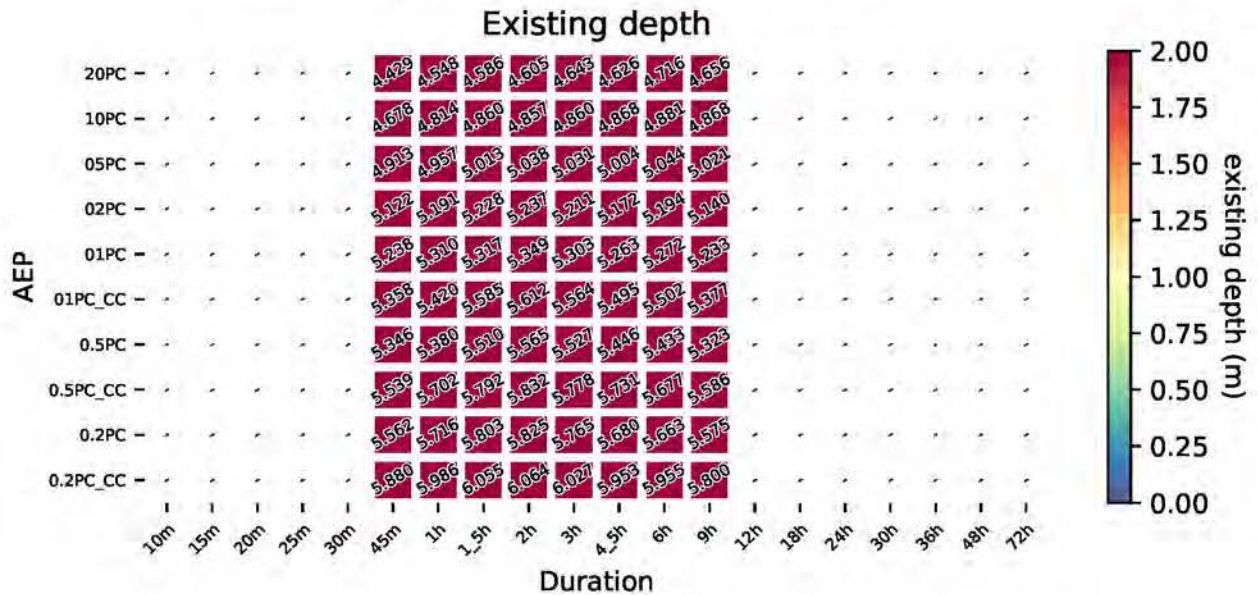


# Koonung Creek - Eastern\_Fwy\_east\_Bulleen\_Rd



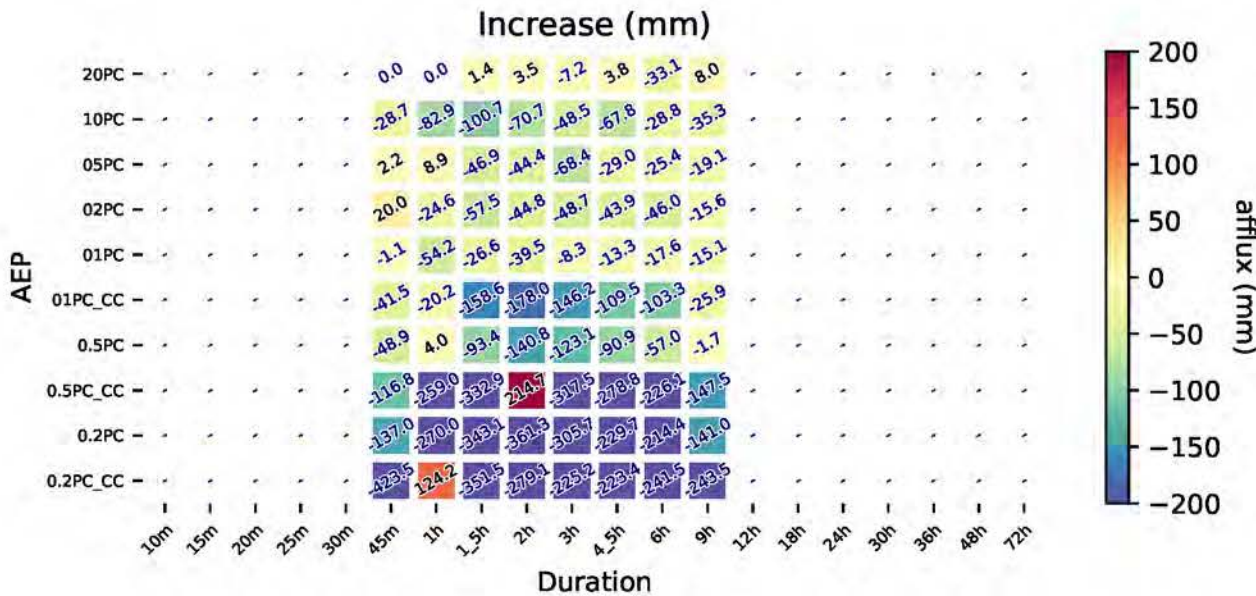
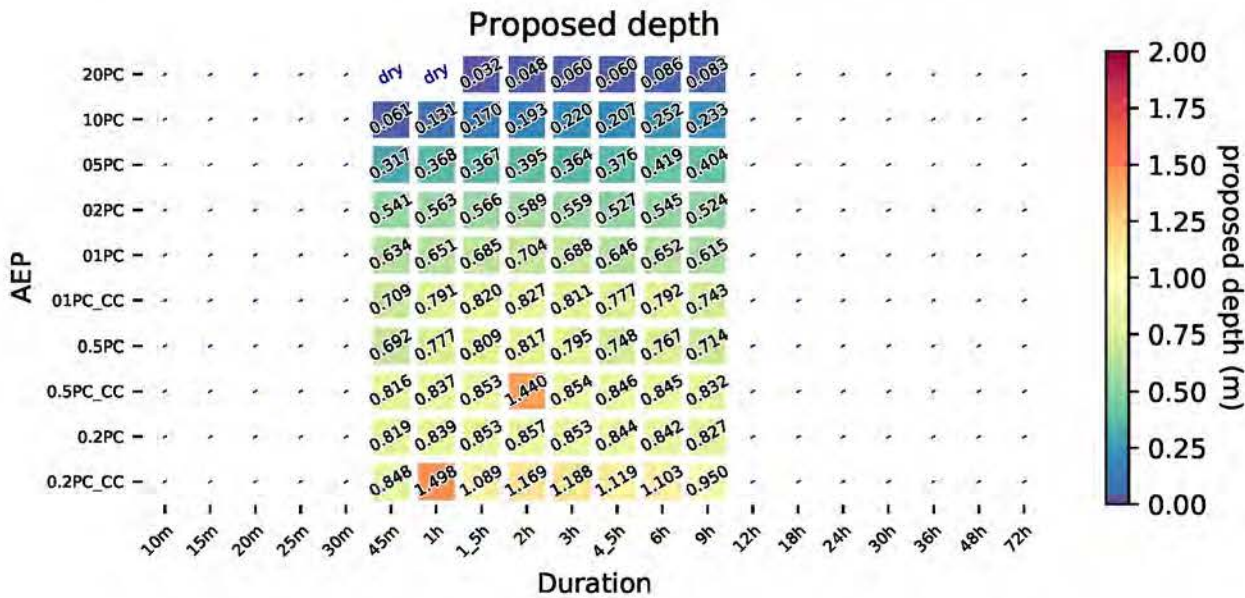
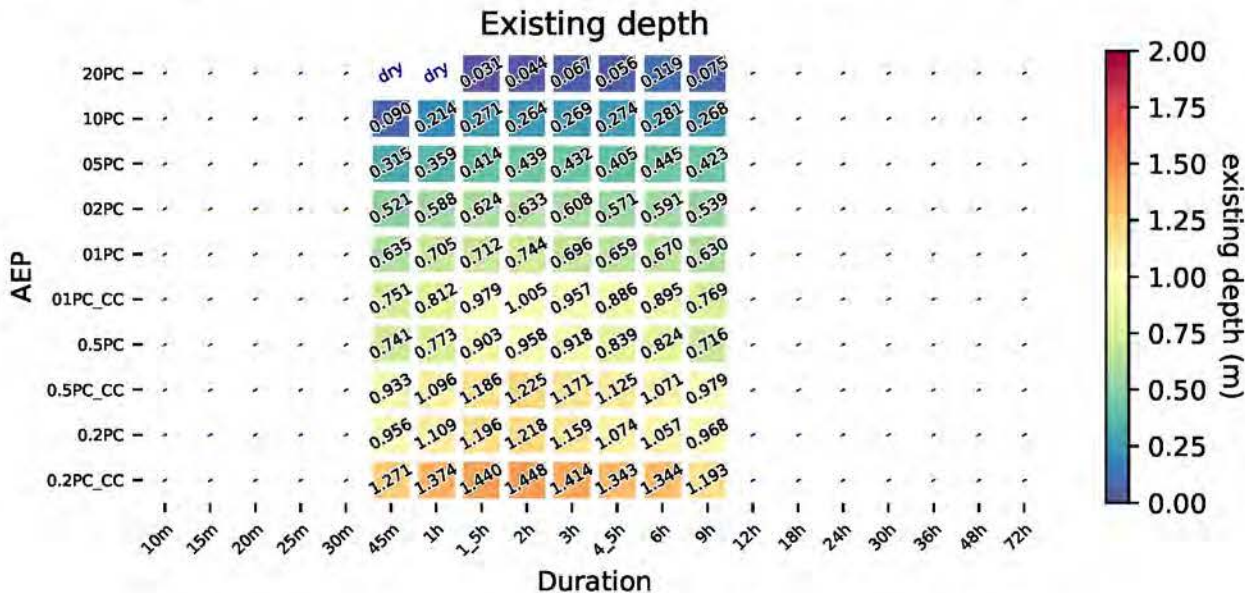


# Koonung Creek - d/s\_Thompsons\_Rd



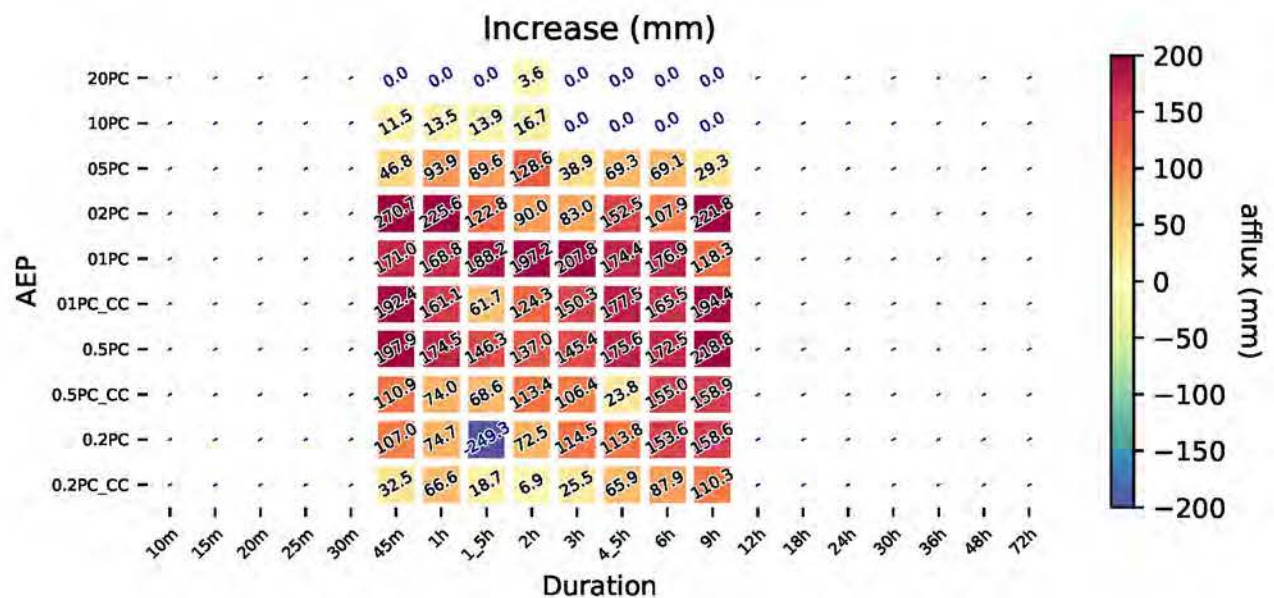
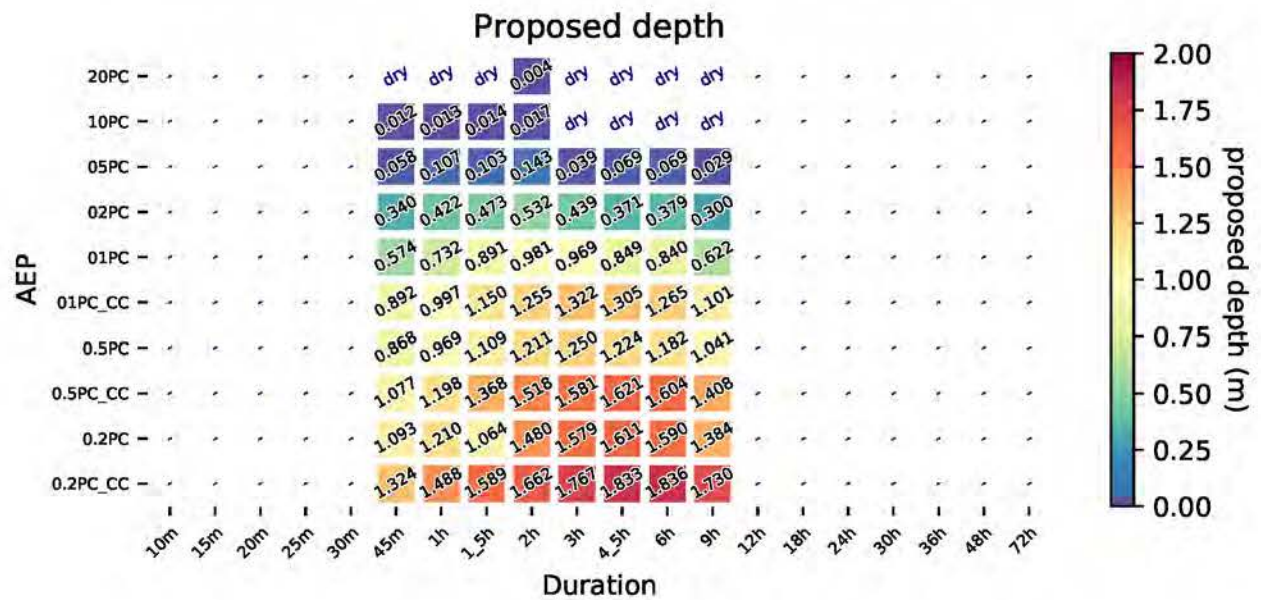
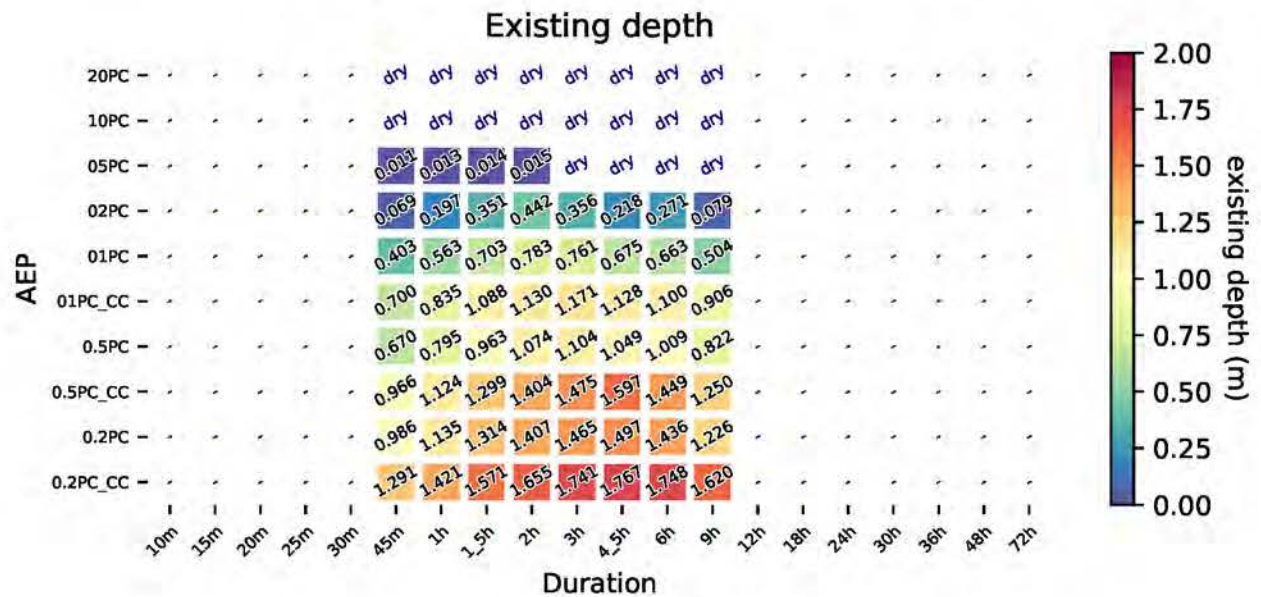


Koonung Creek - Low\_lying\_carpark\_d/s\_Thompsons\_Rd

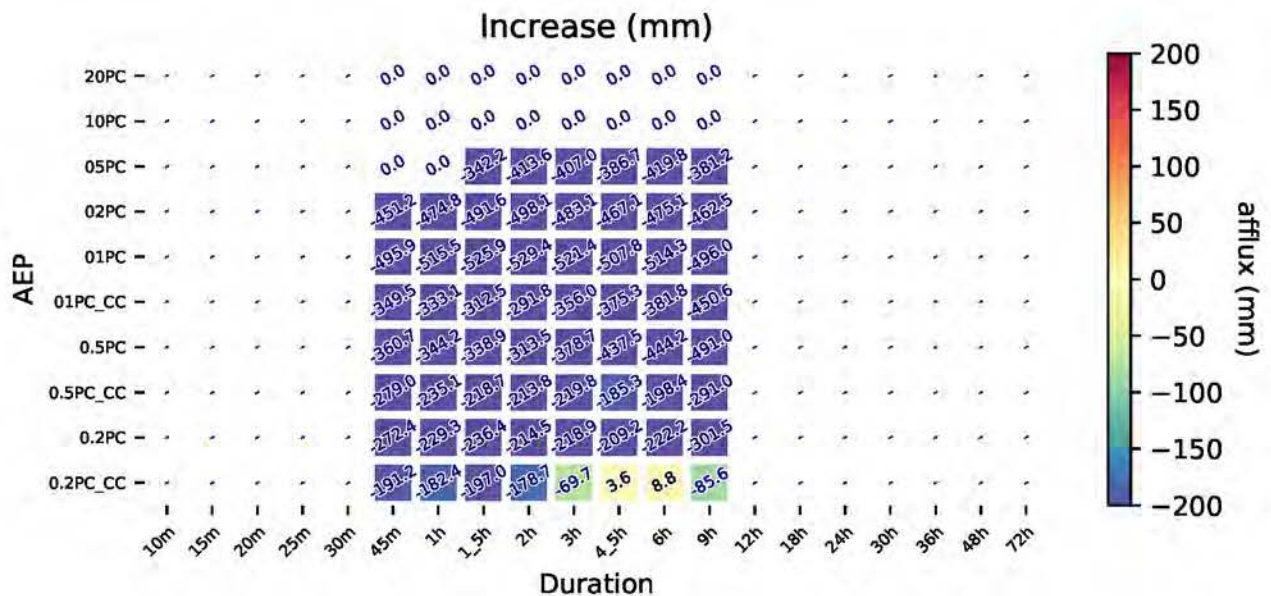
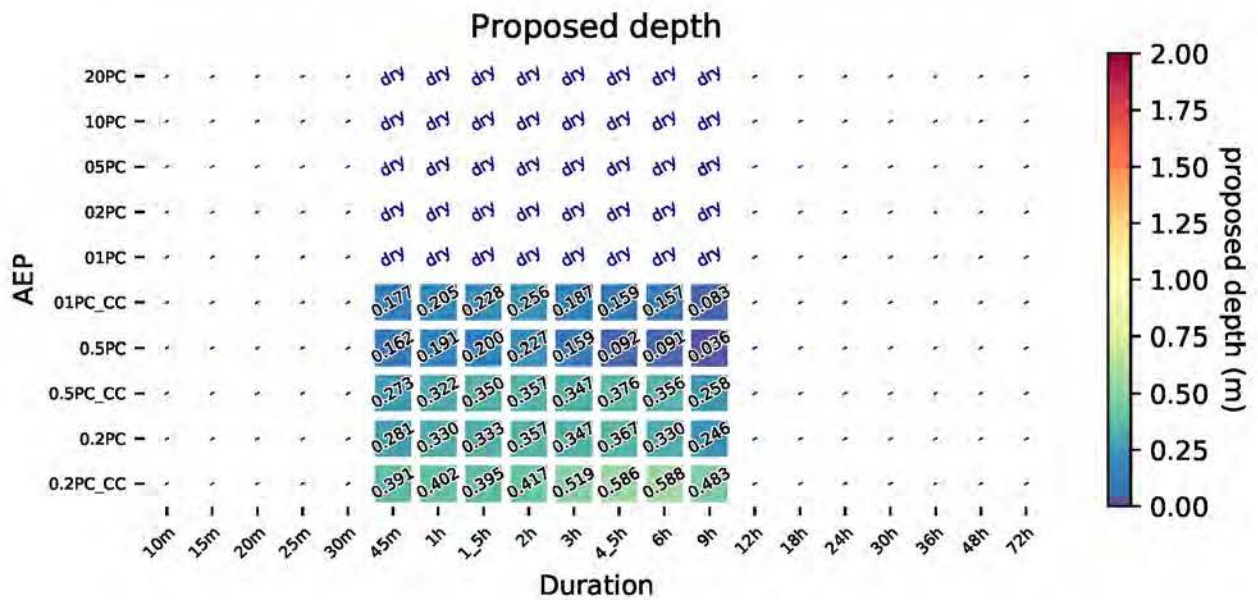
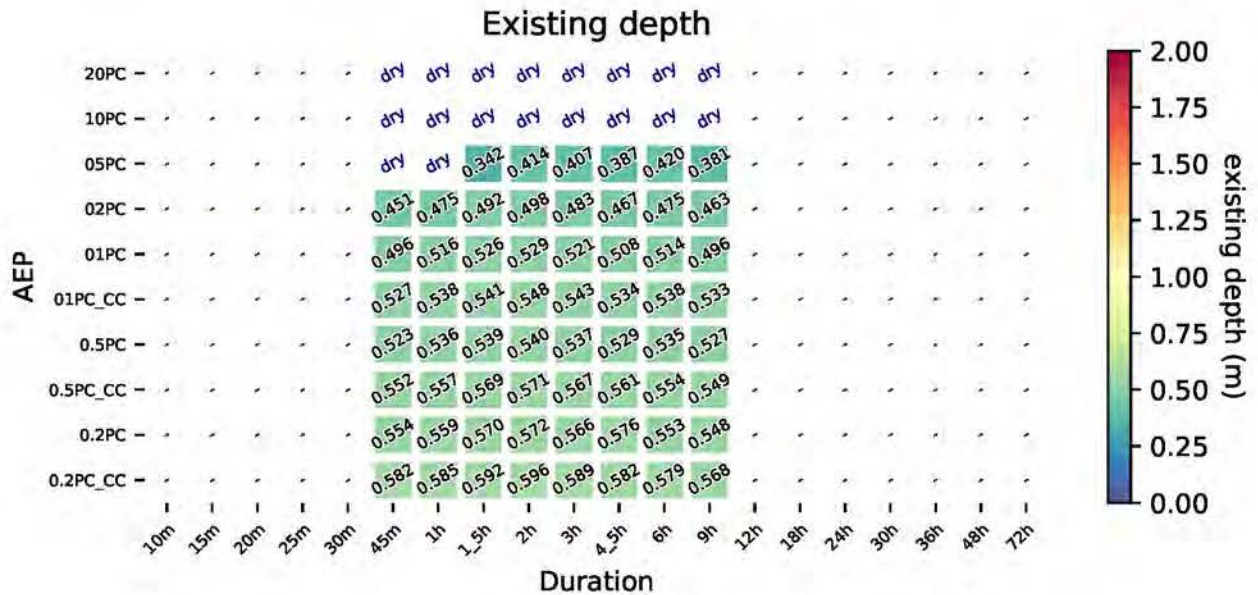




# Koonung Creek - Balwyn\_Rd\_Estella\_St

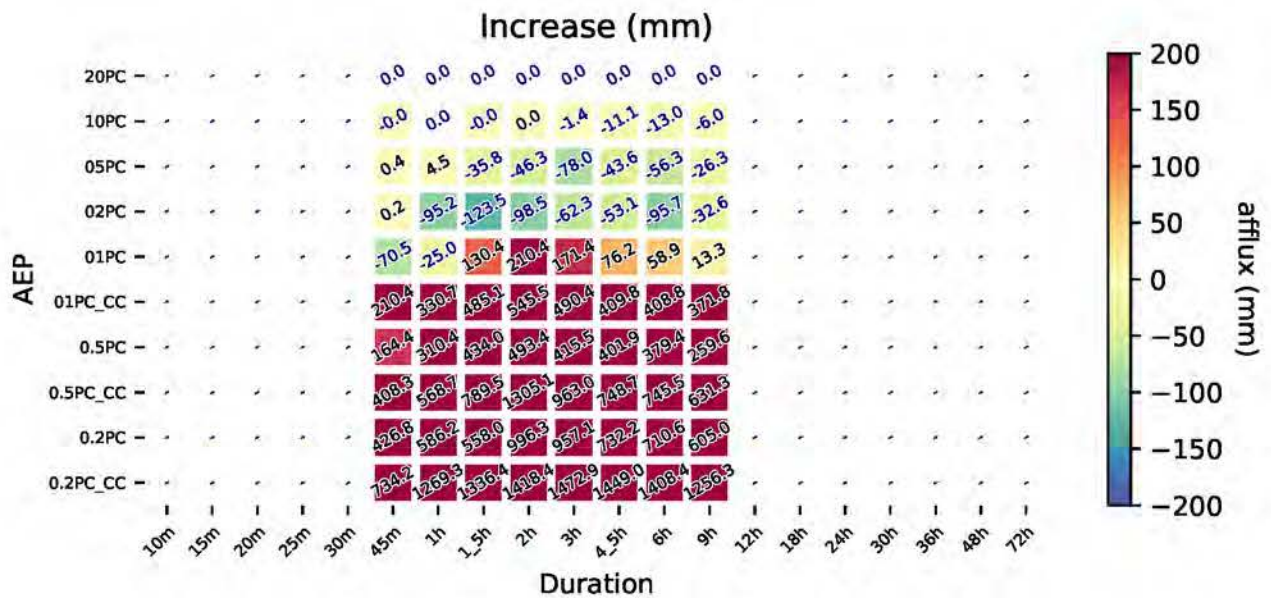
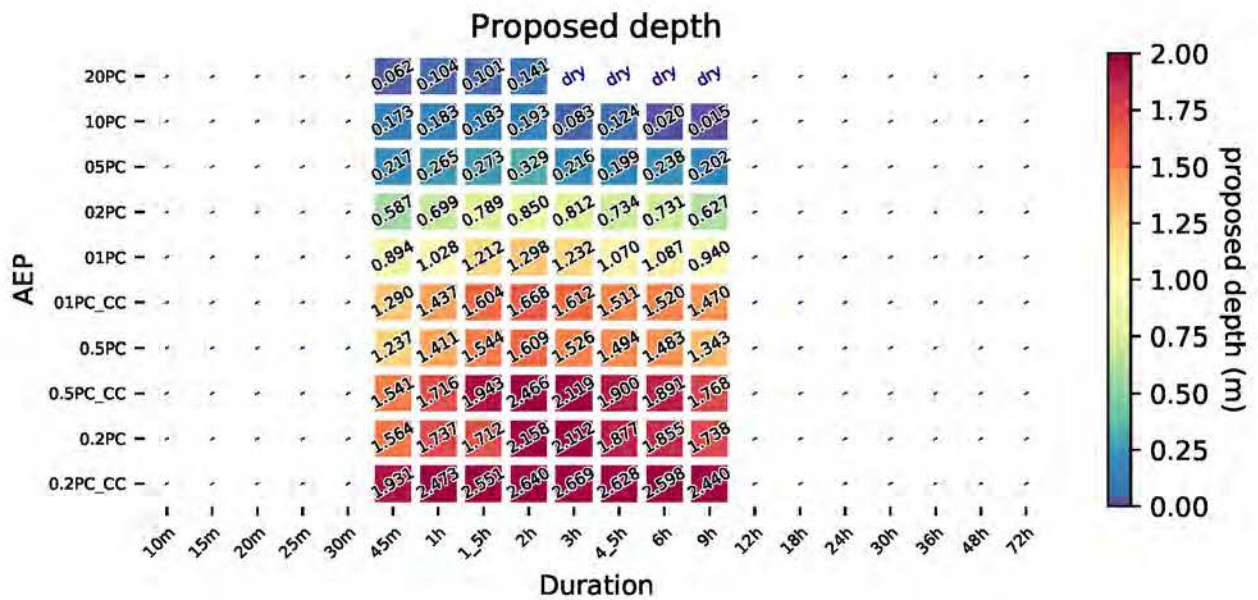
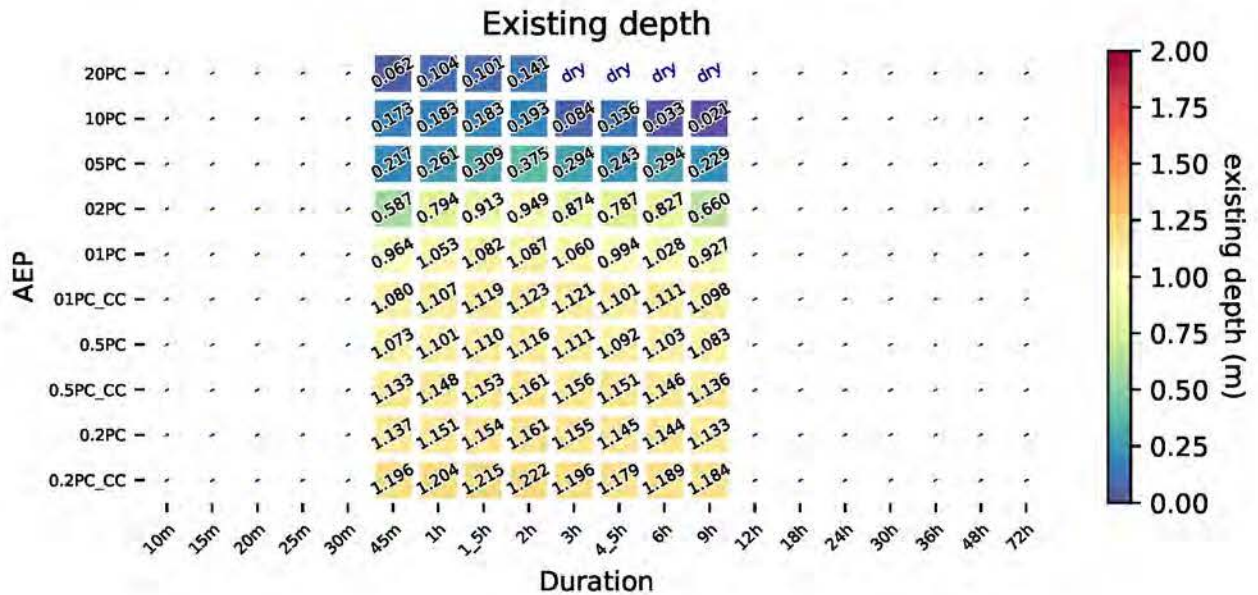


# Koonung Creek - Estelle\_St

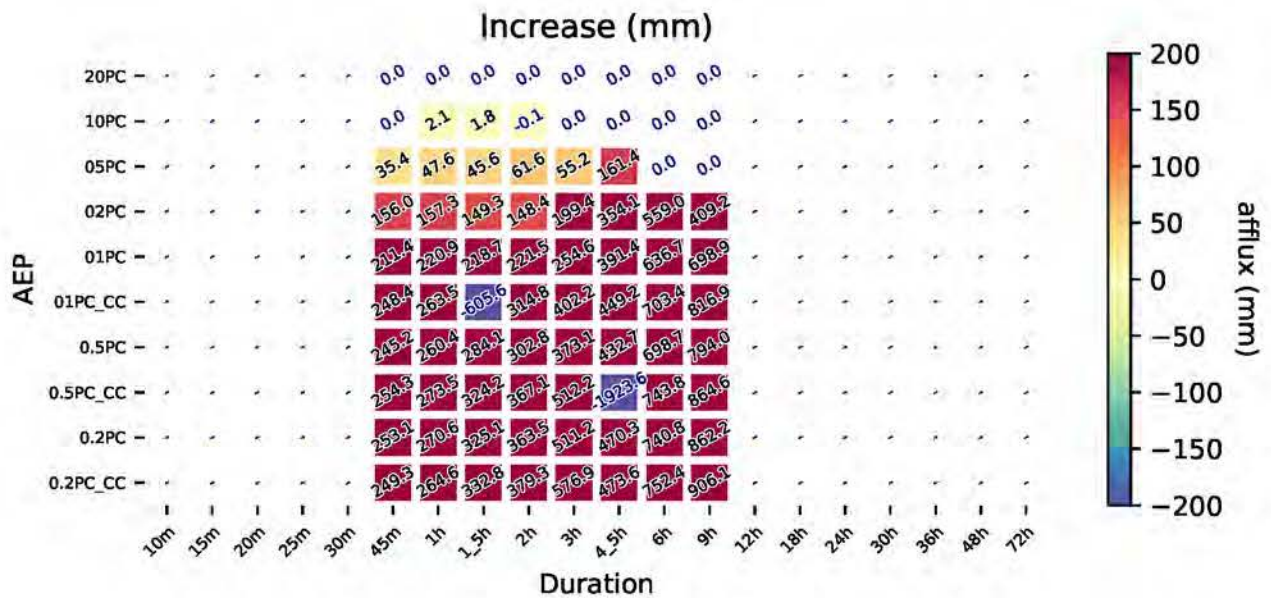
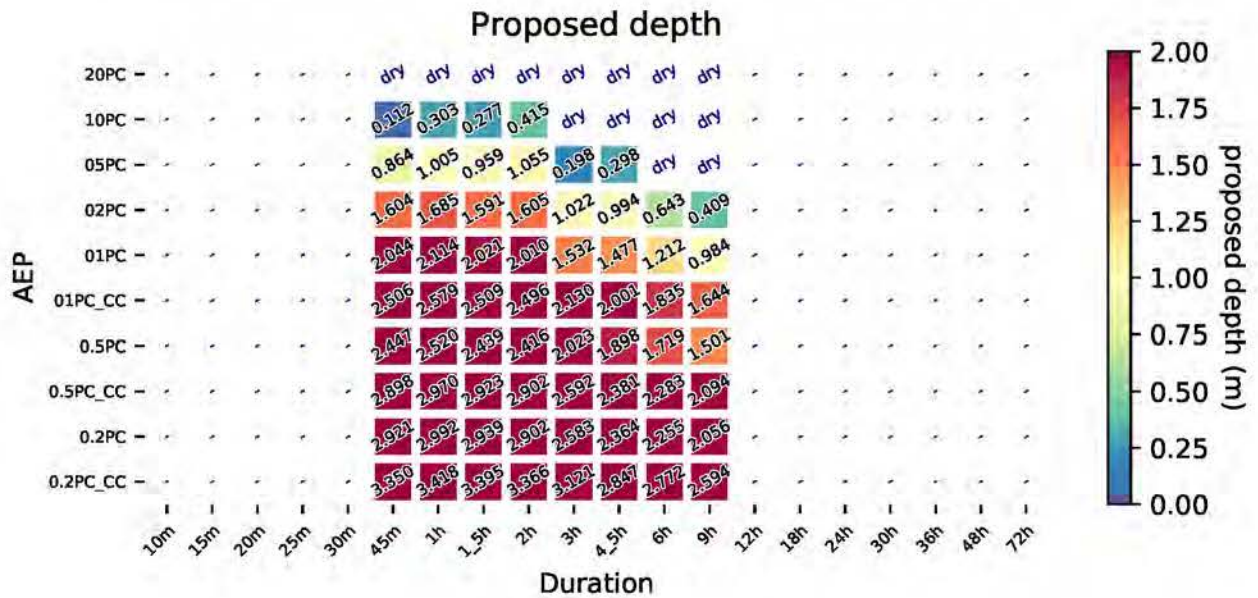
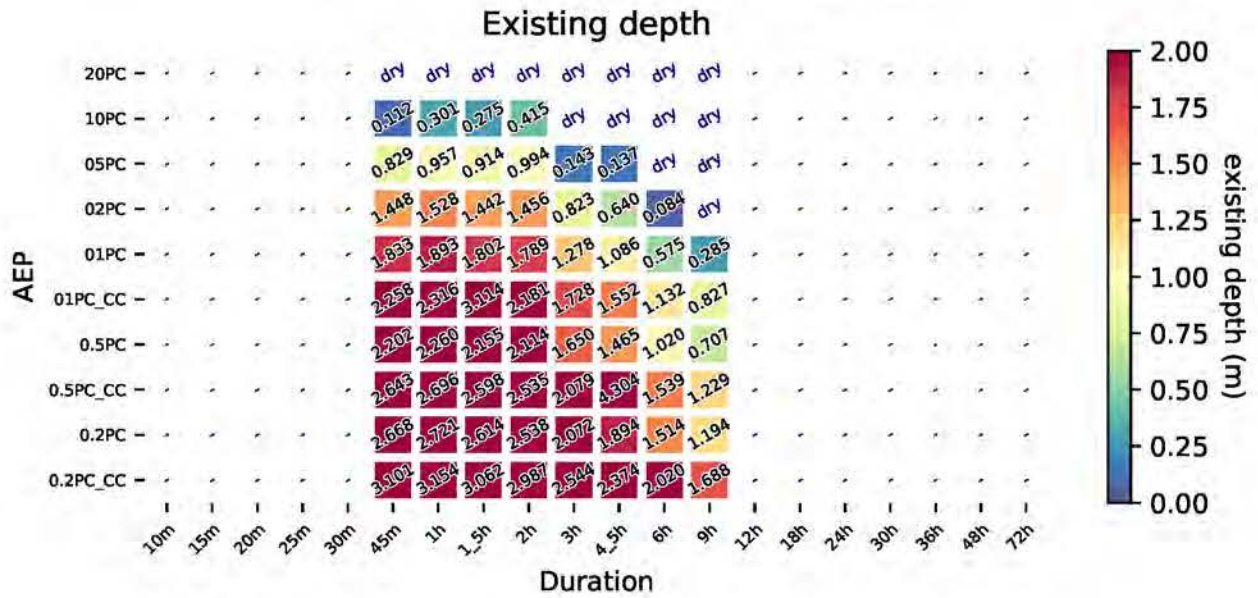




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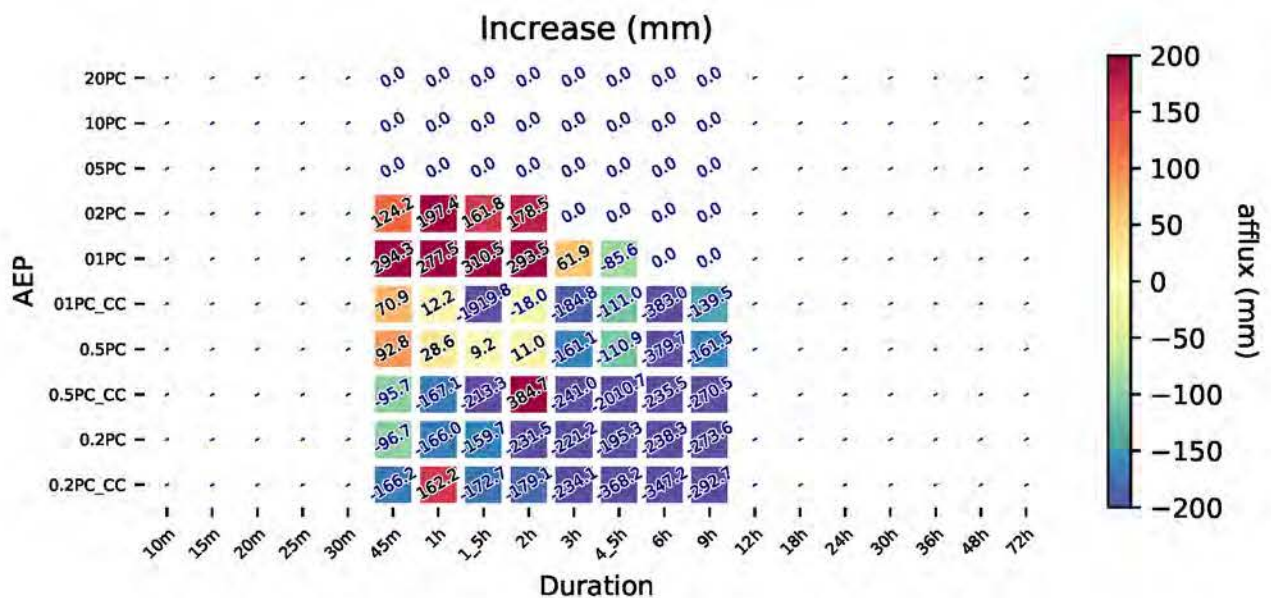
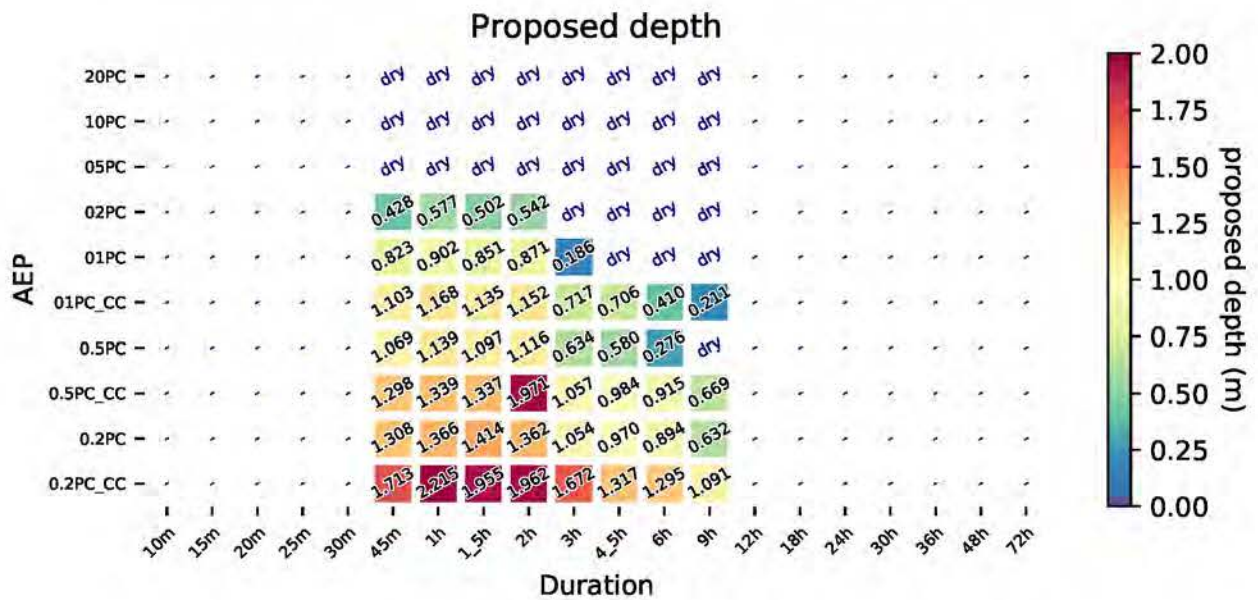
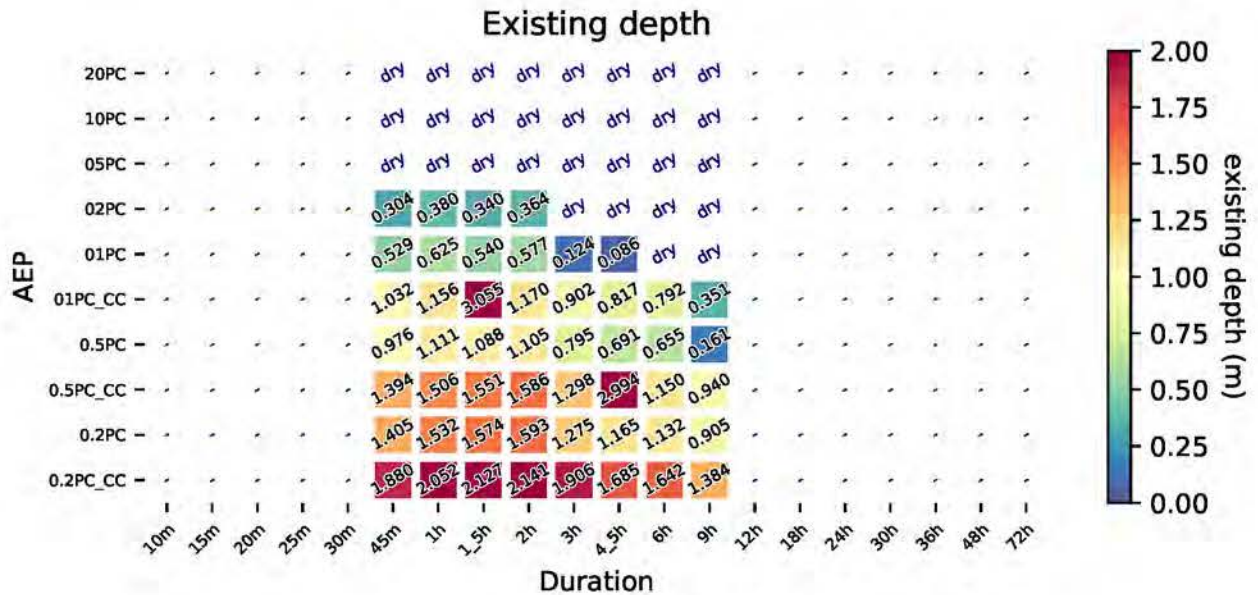


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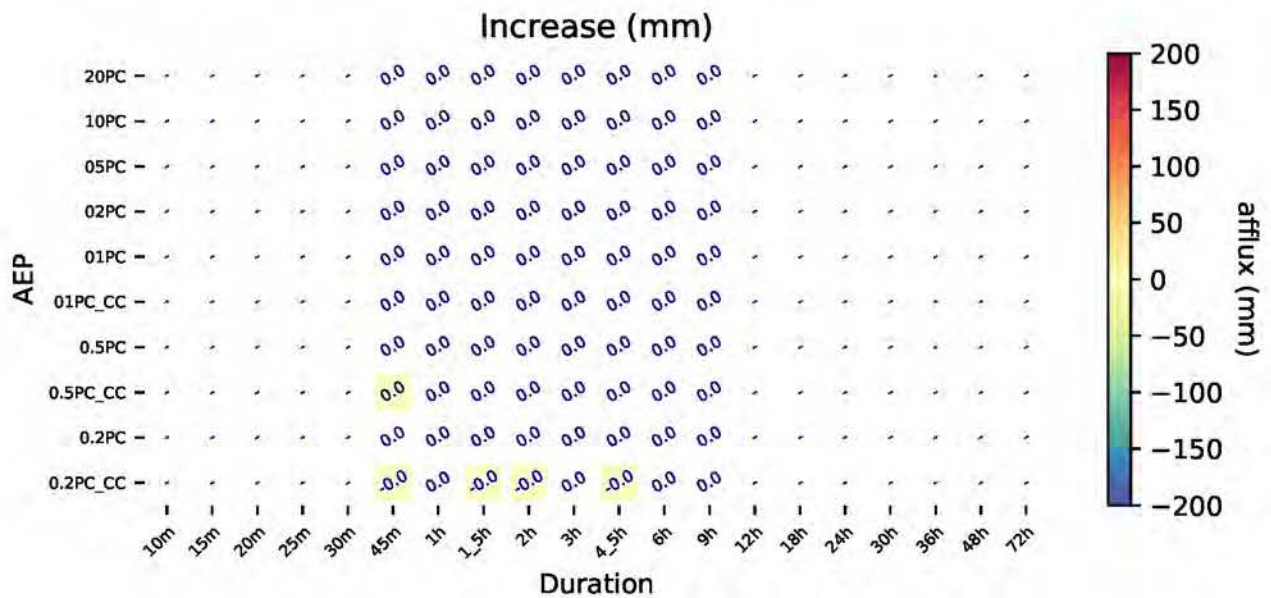
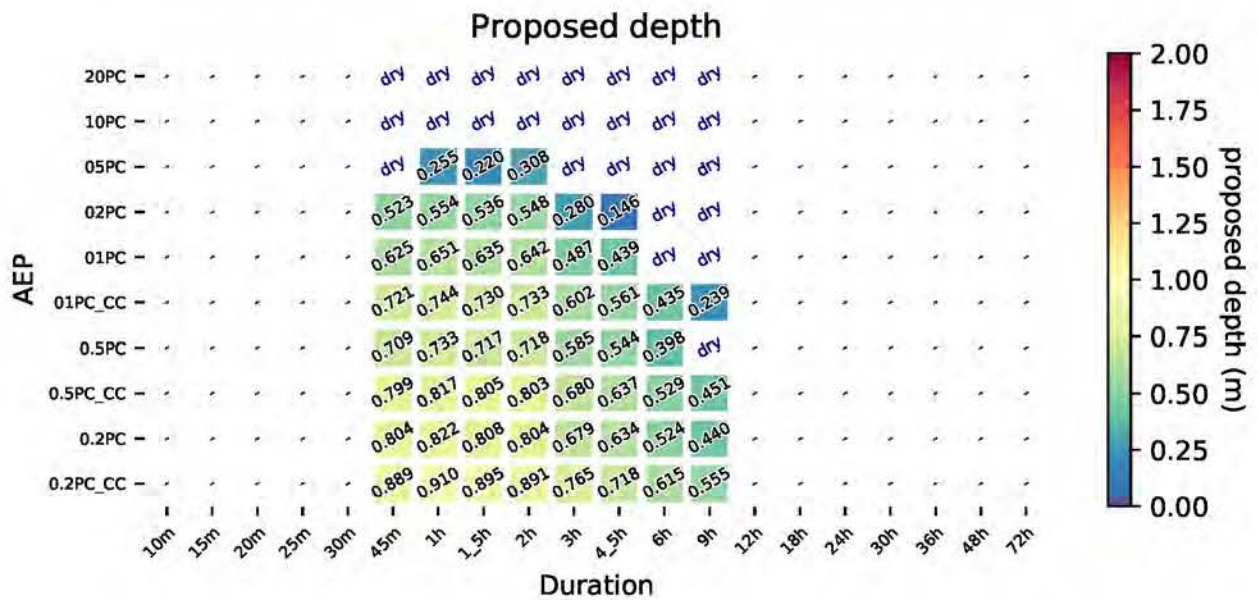
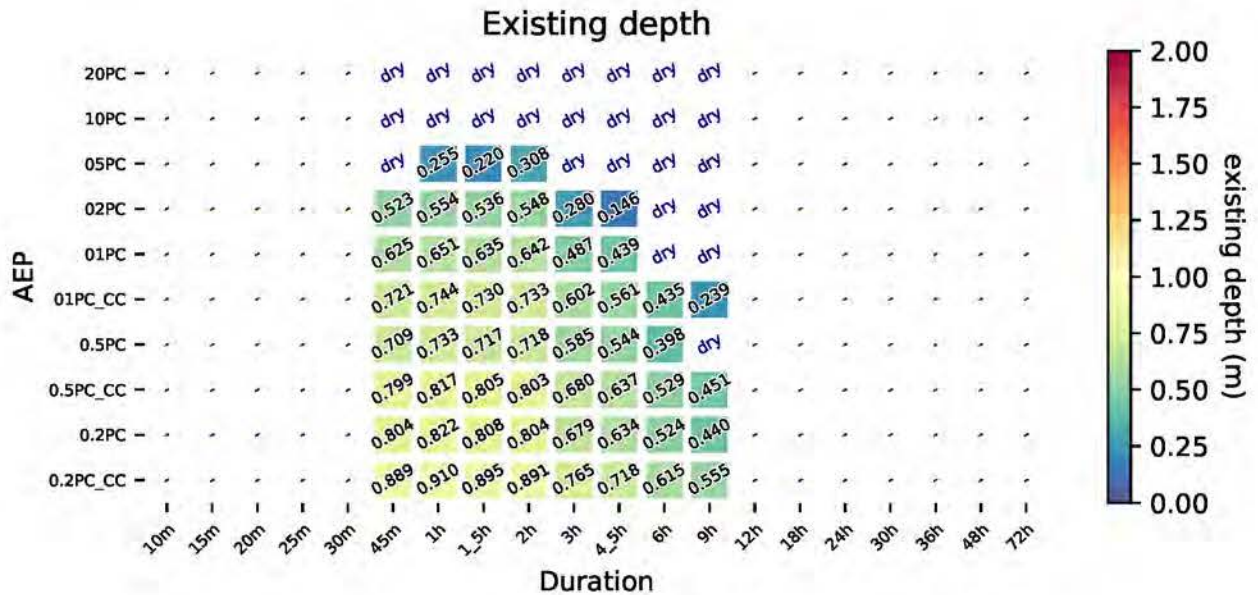




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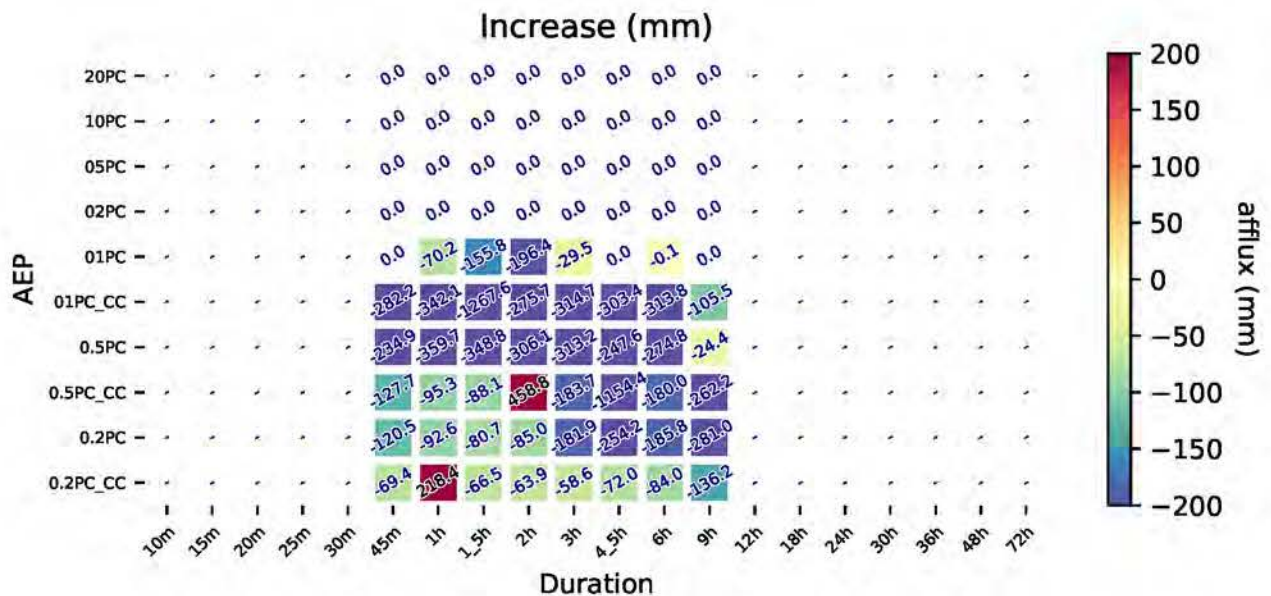
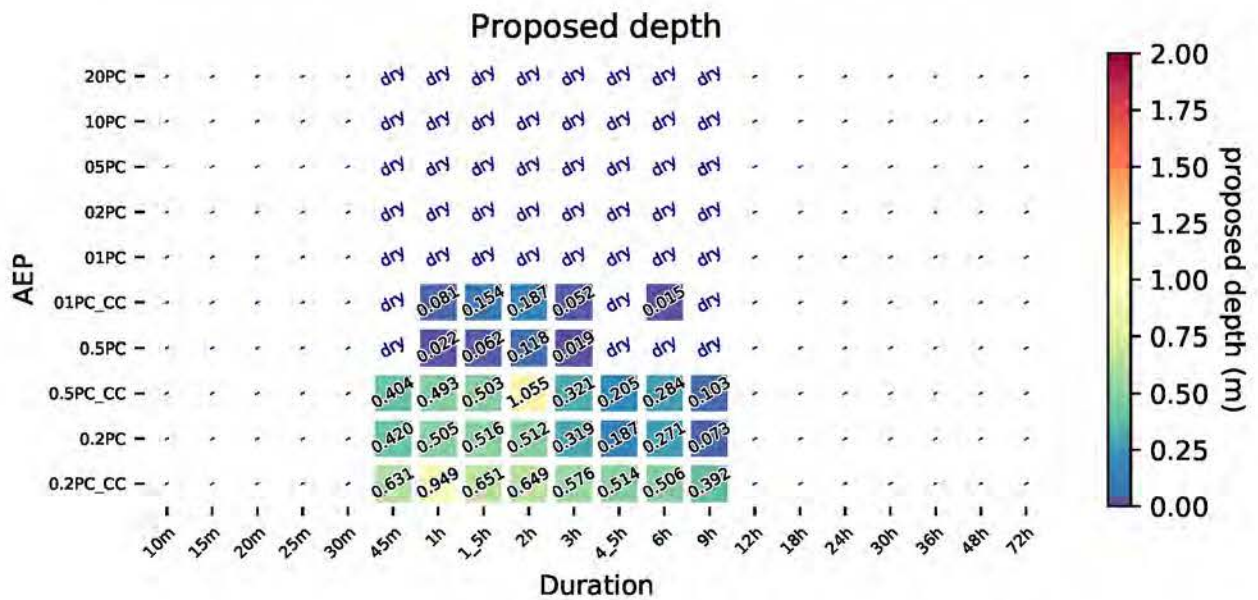
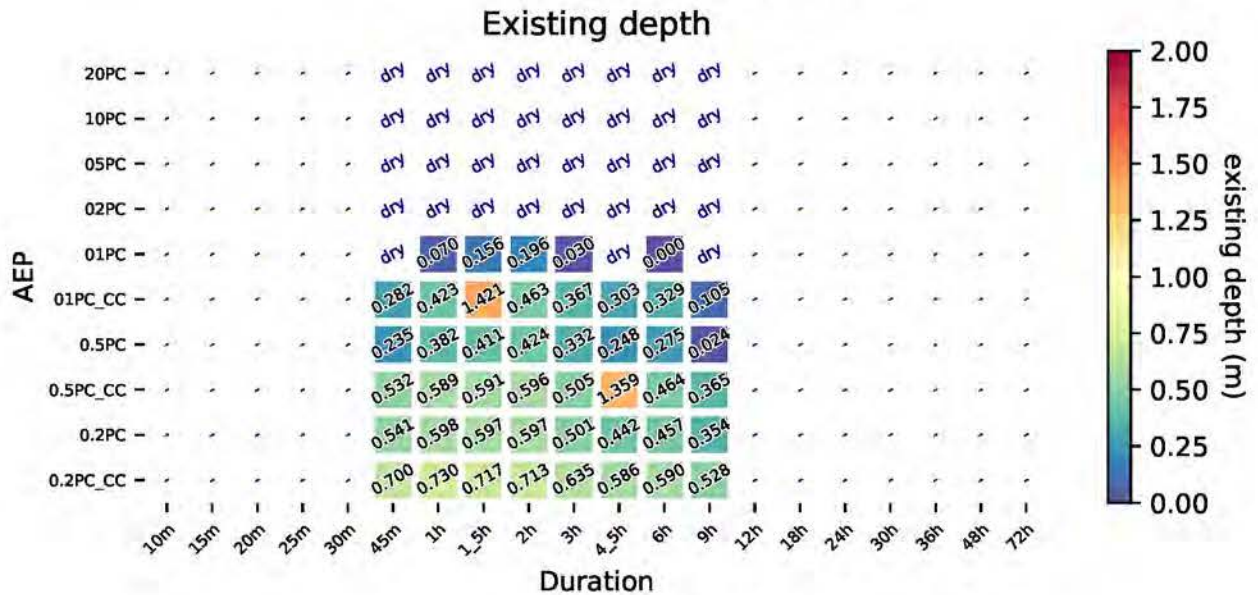


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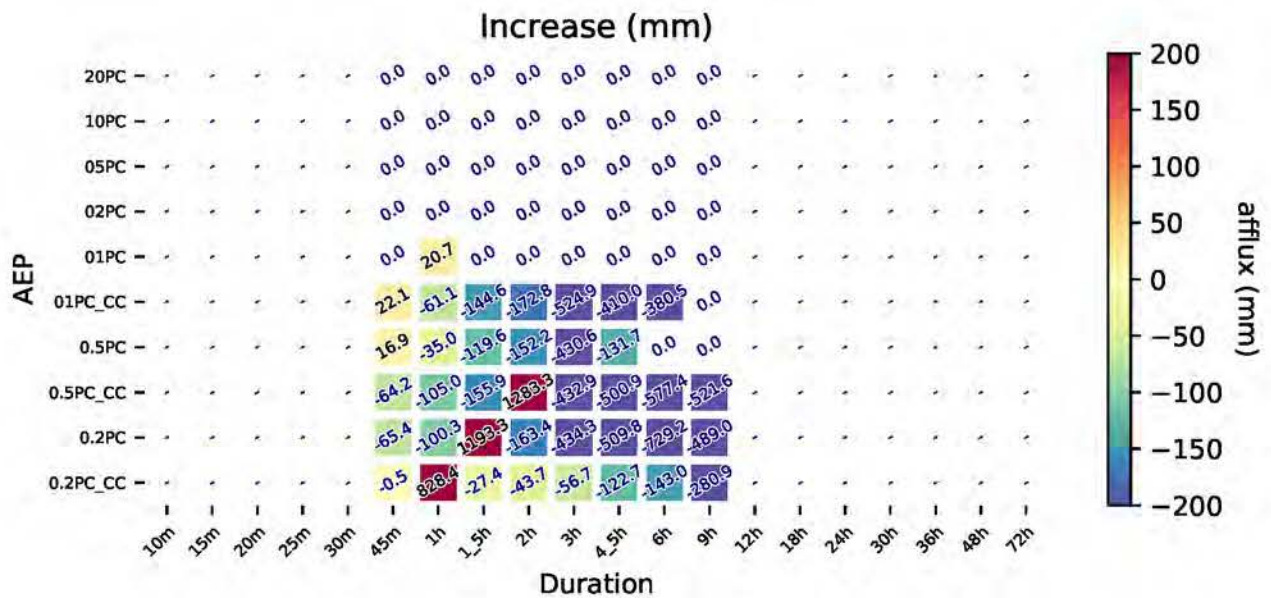
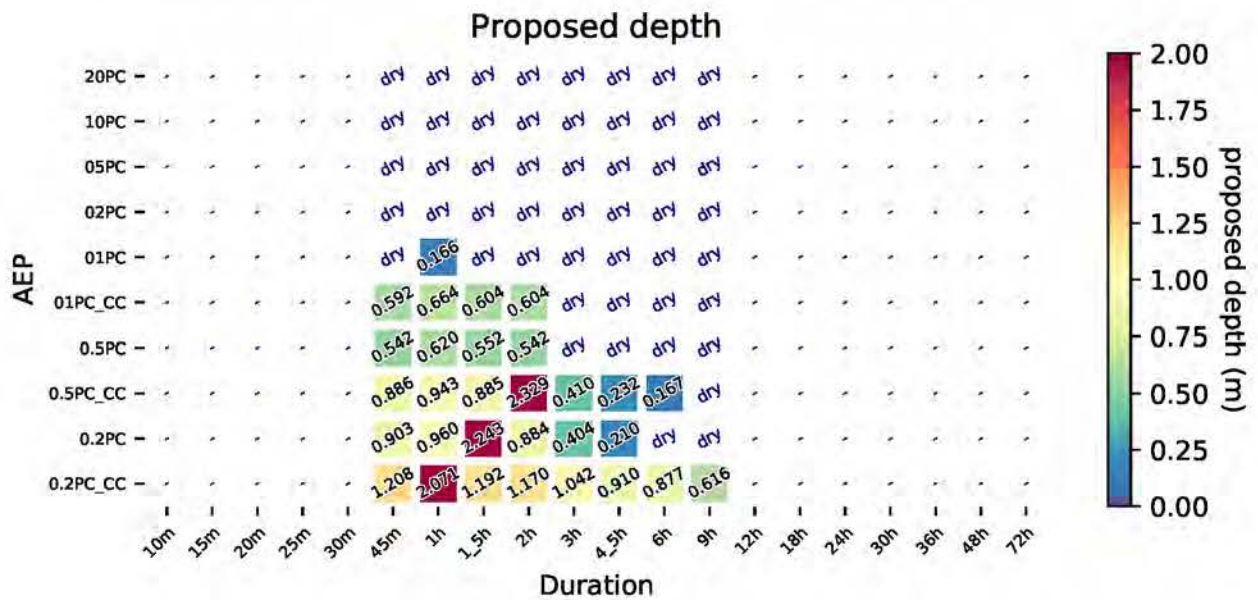
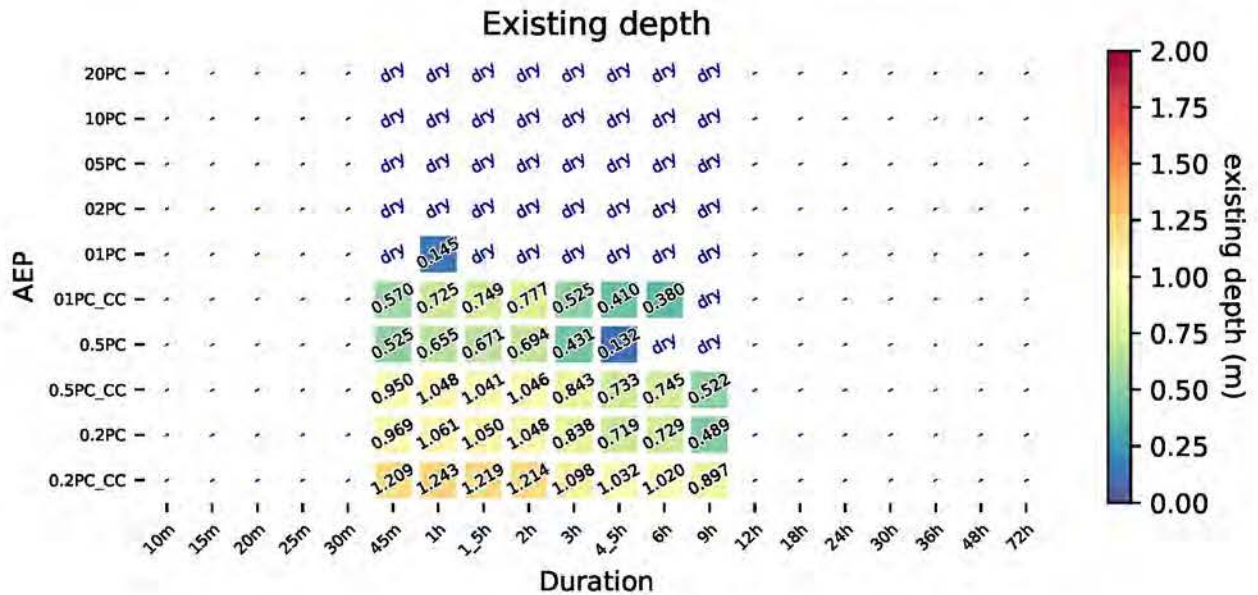




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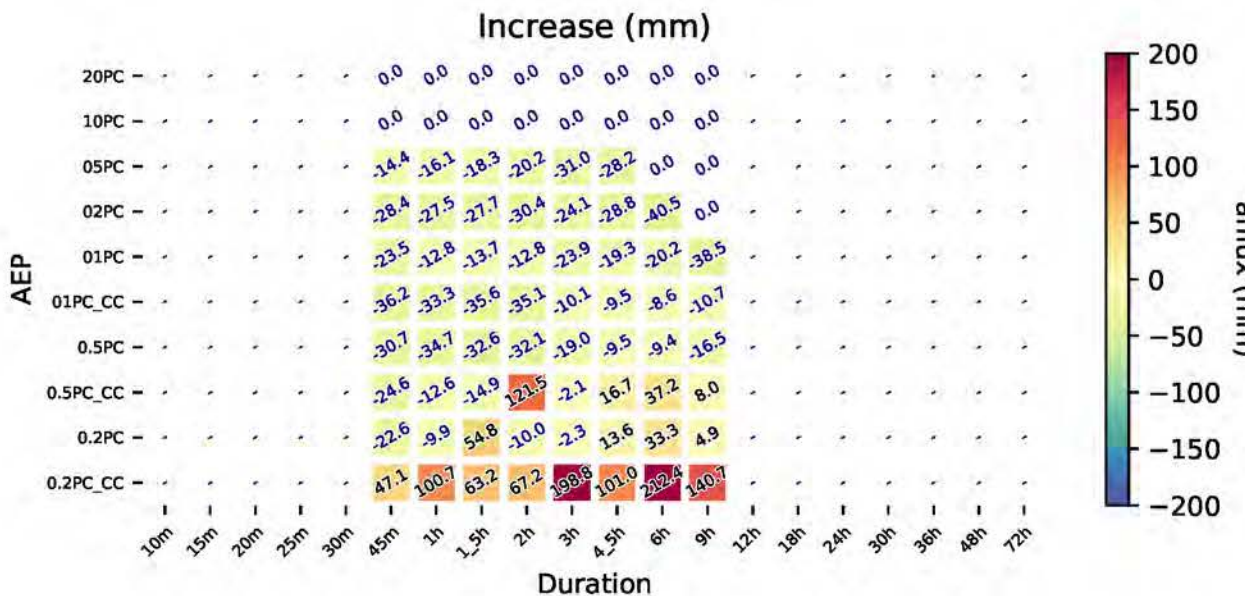
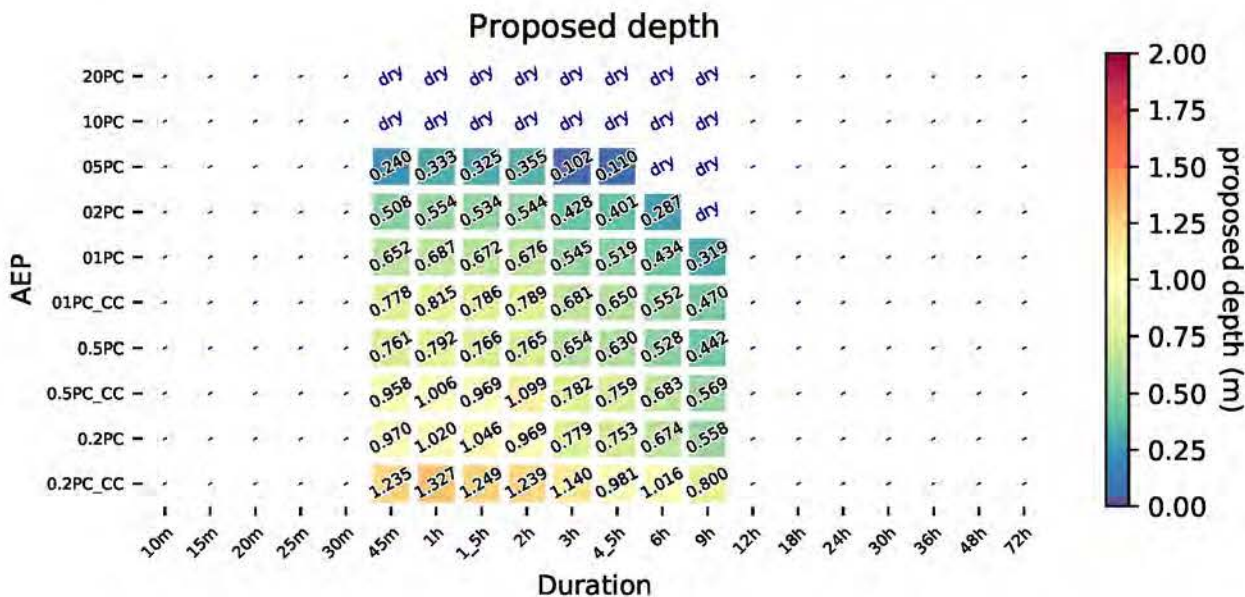
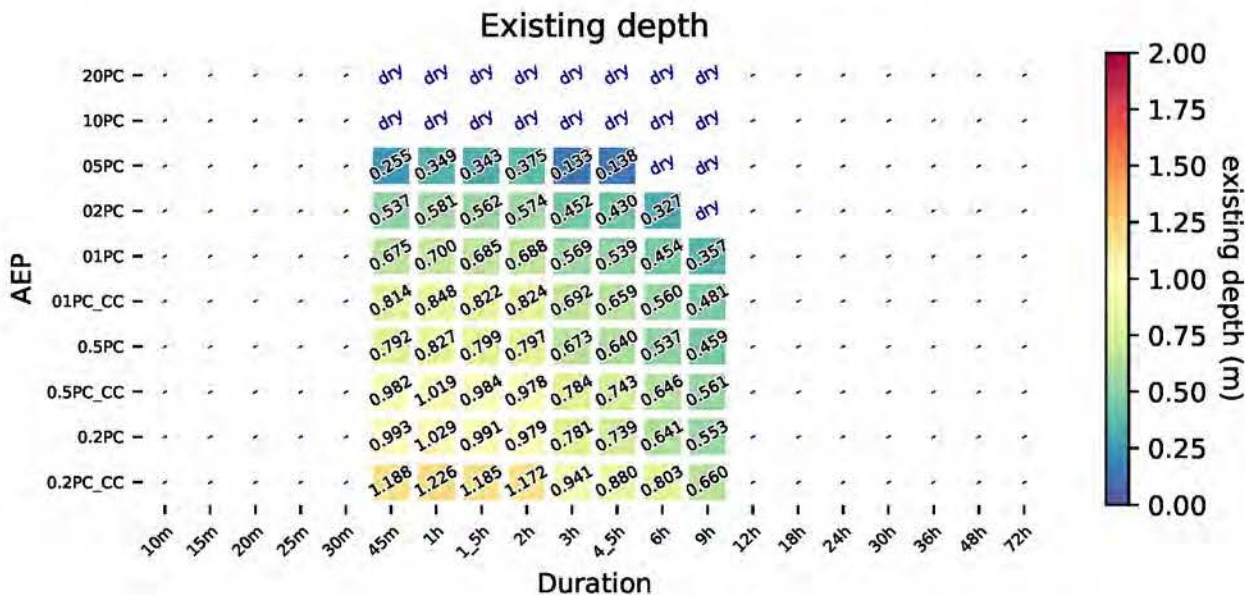


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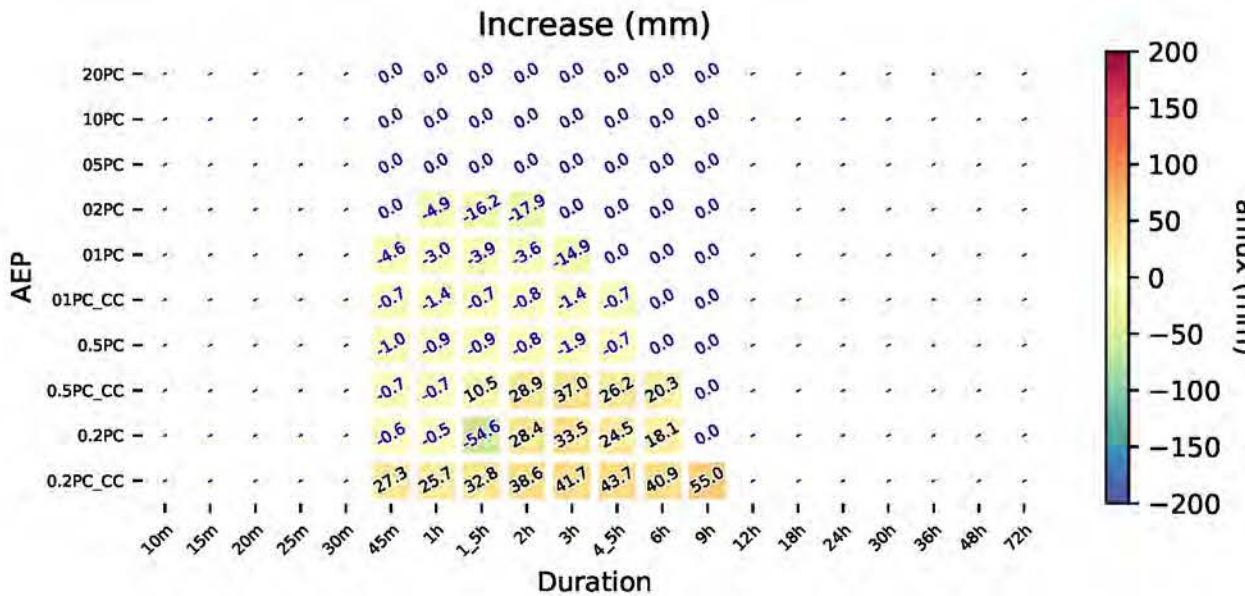
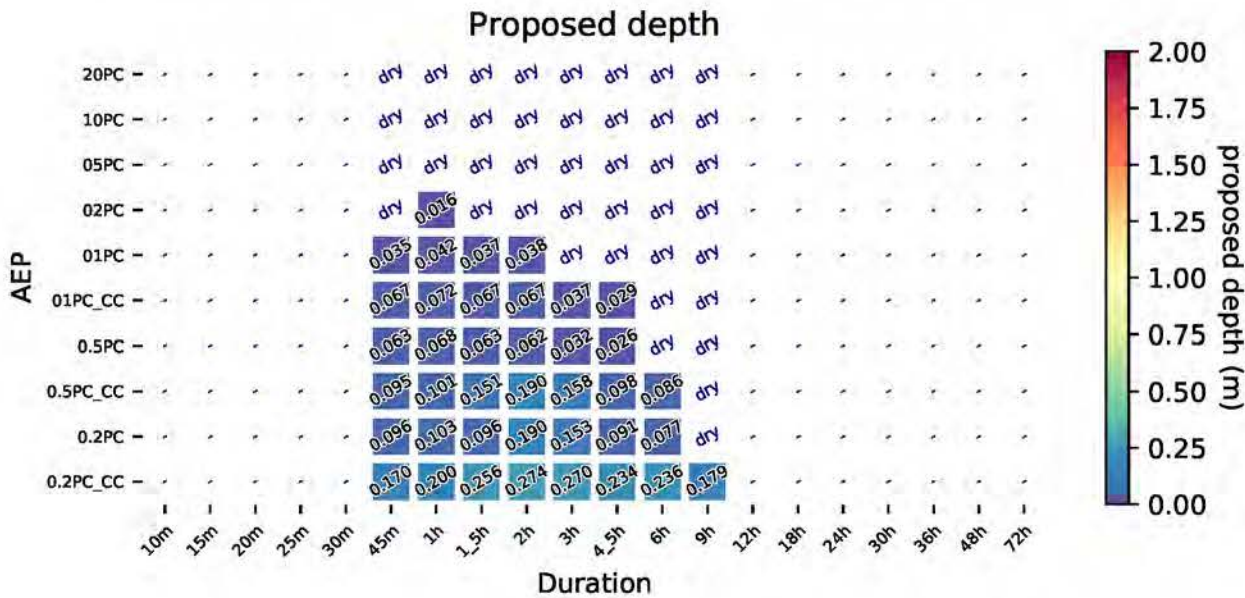
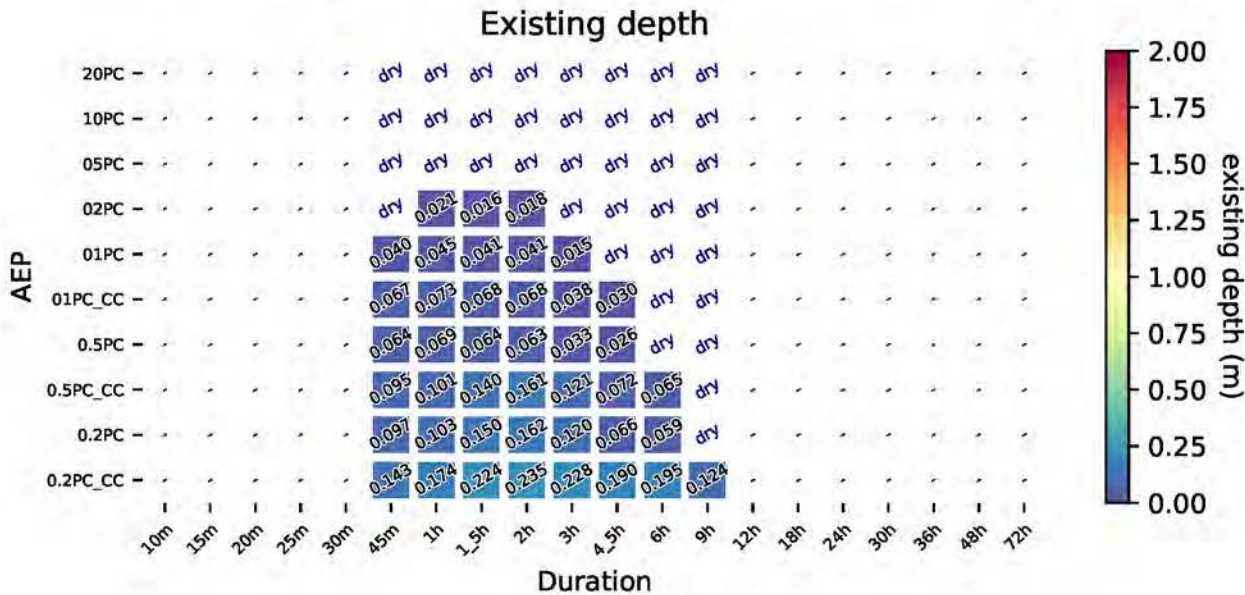




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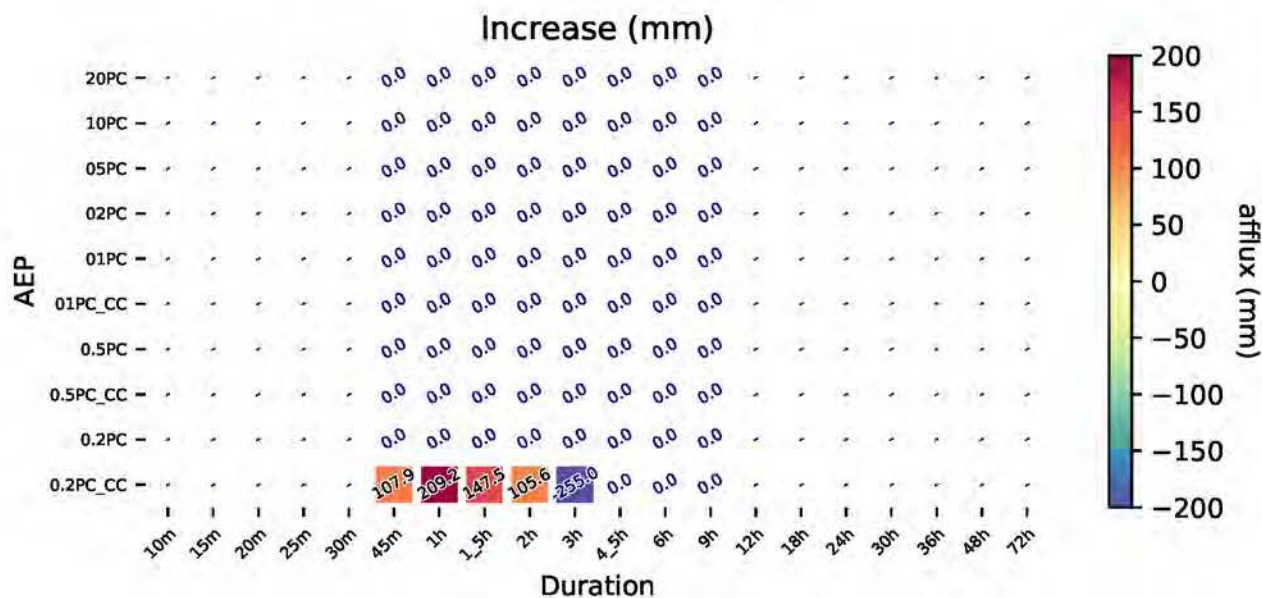
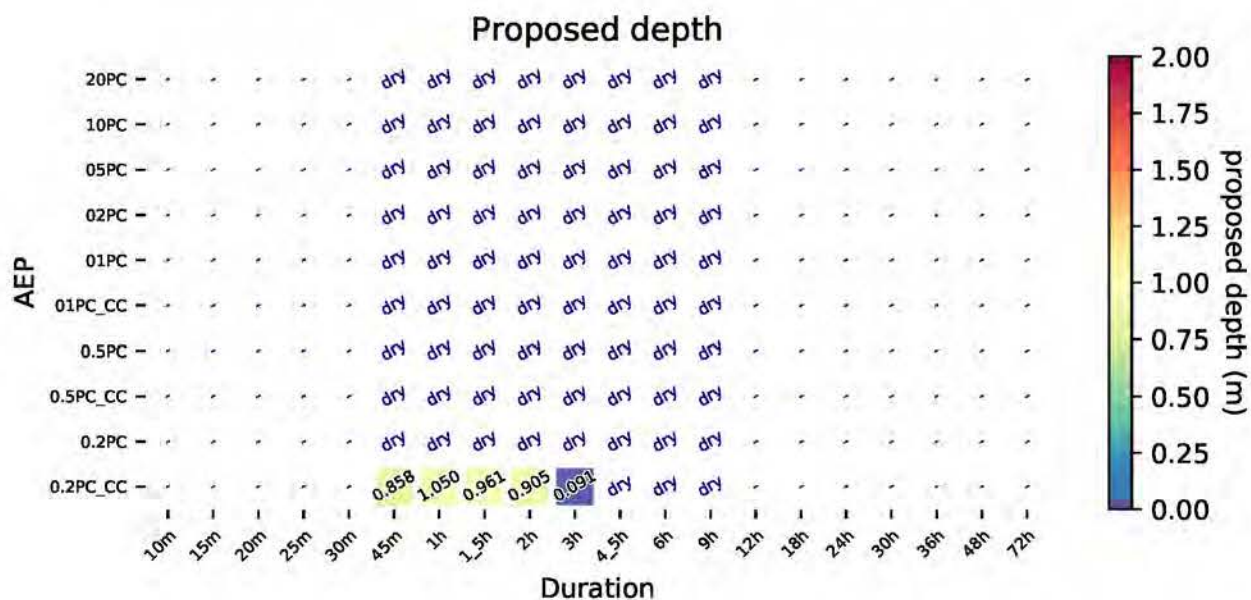
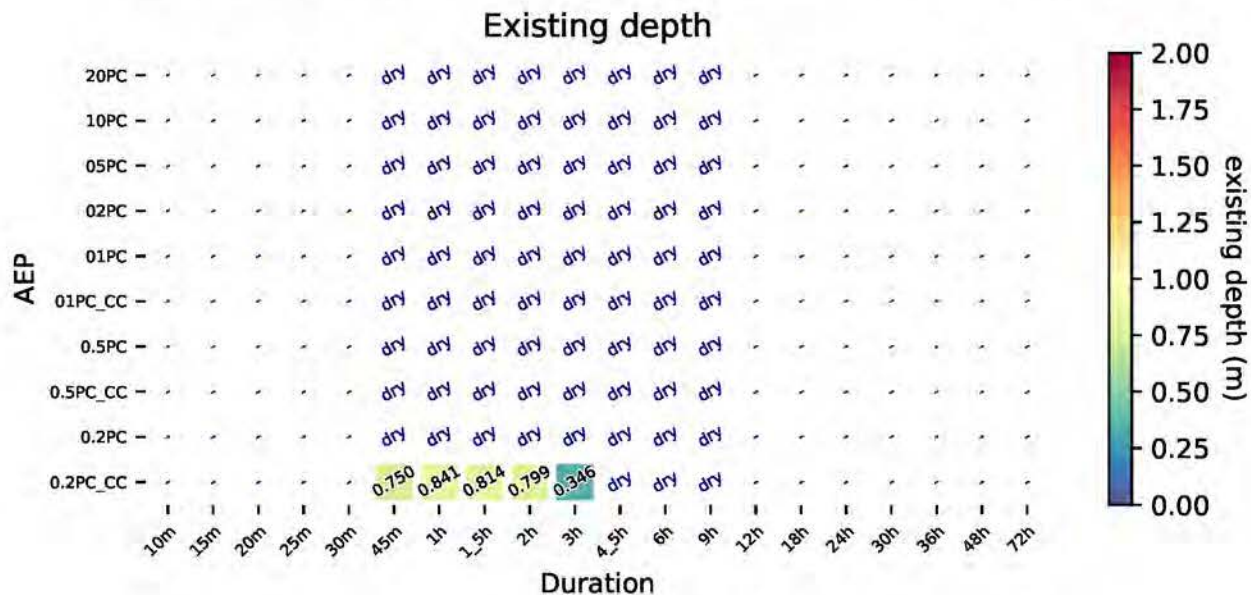


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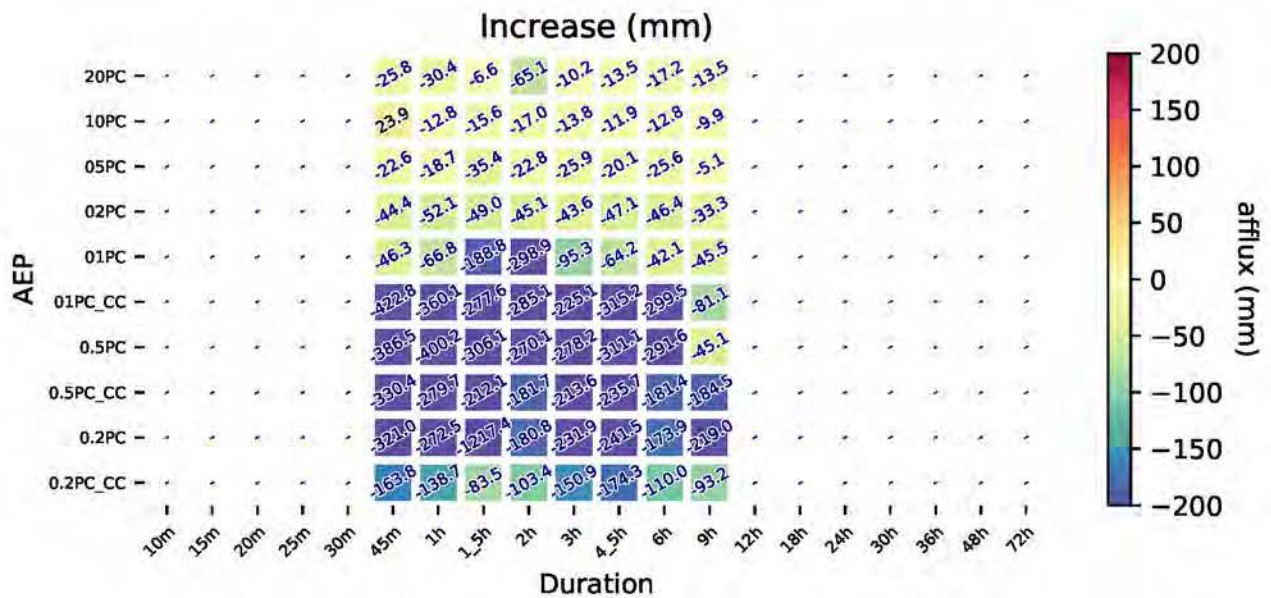
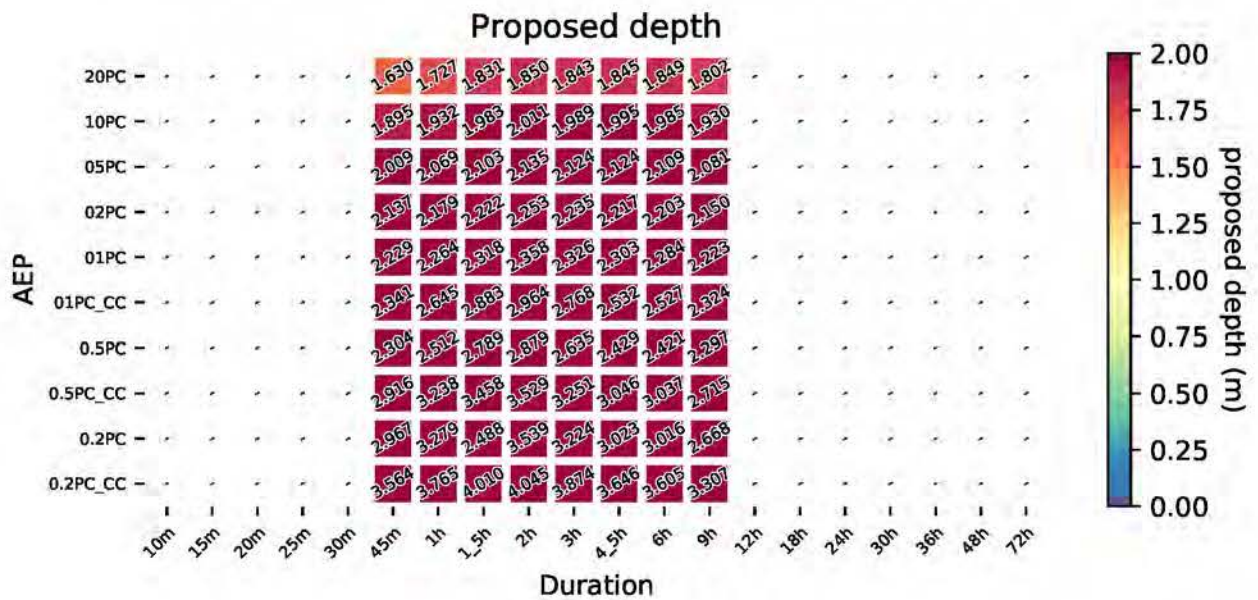
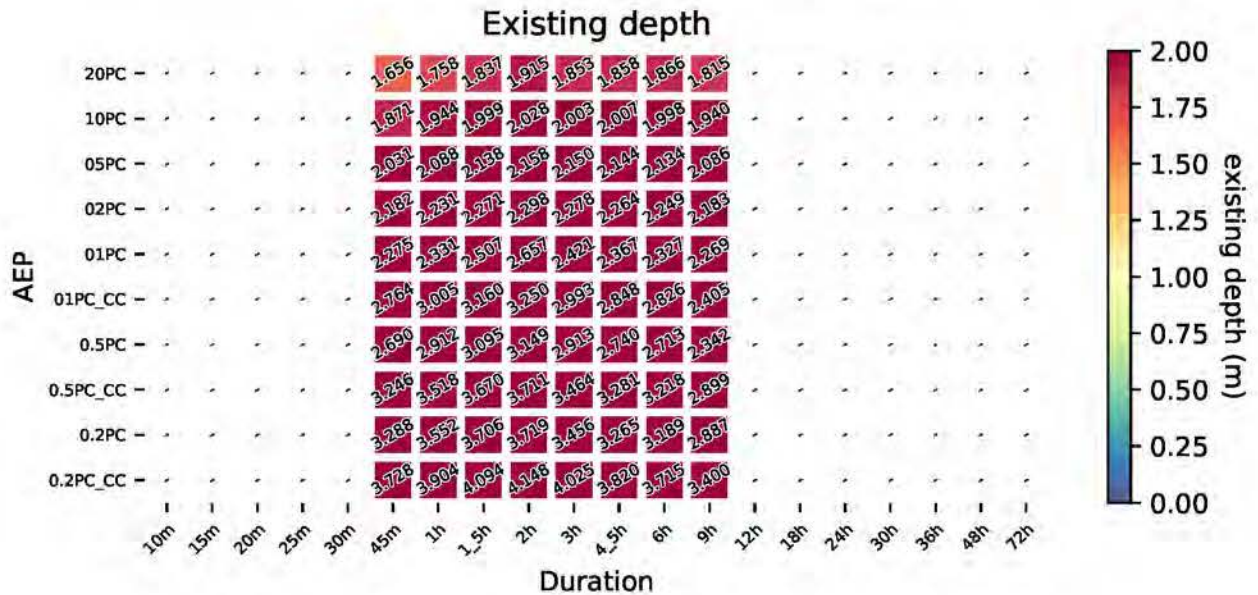




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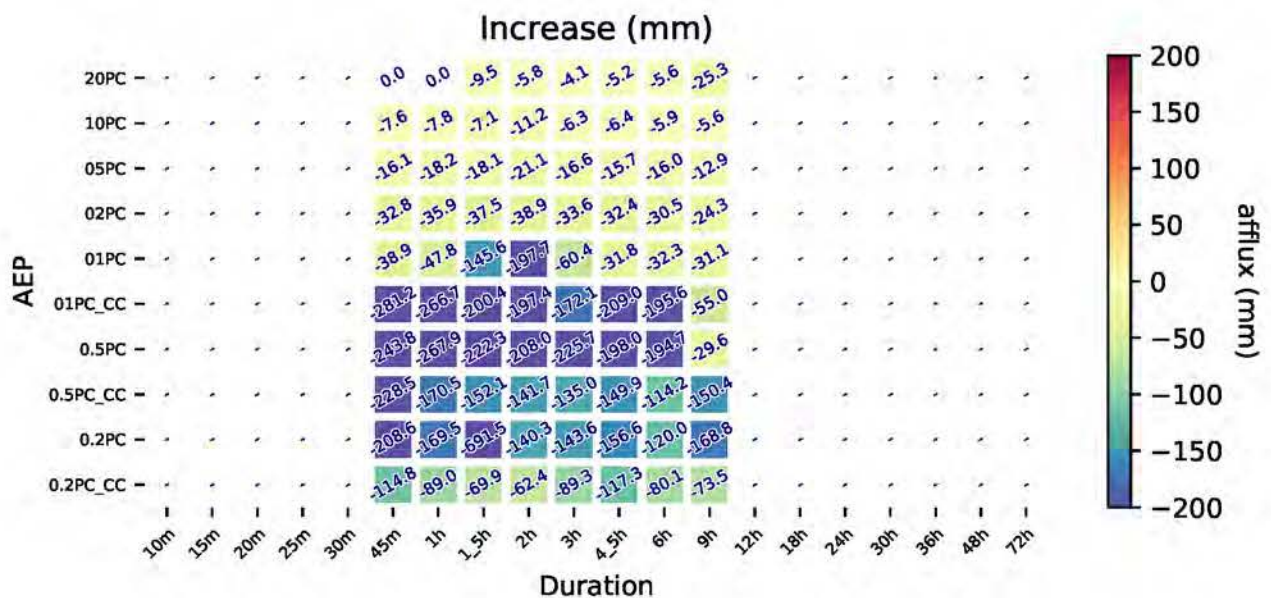
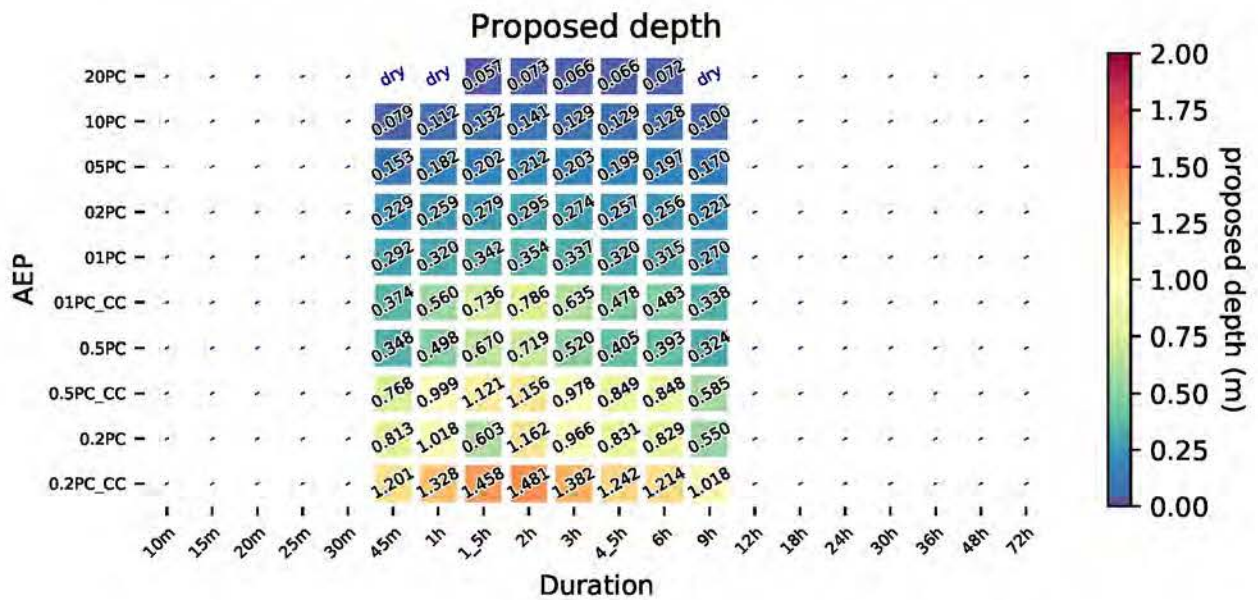
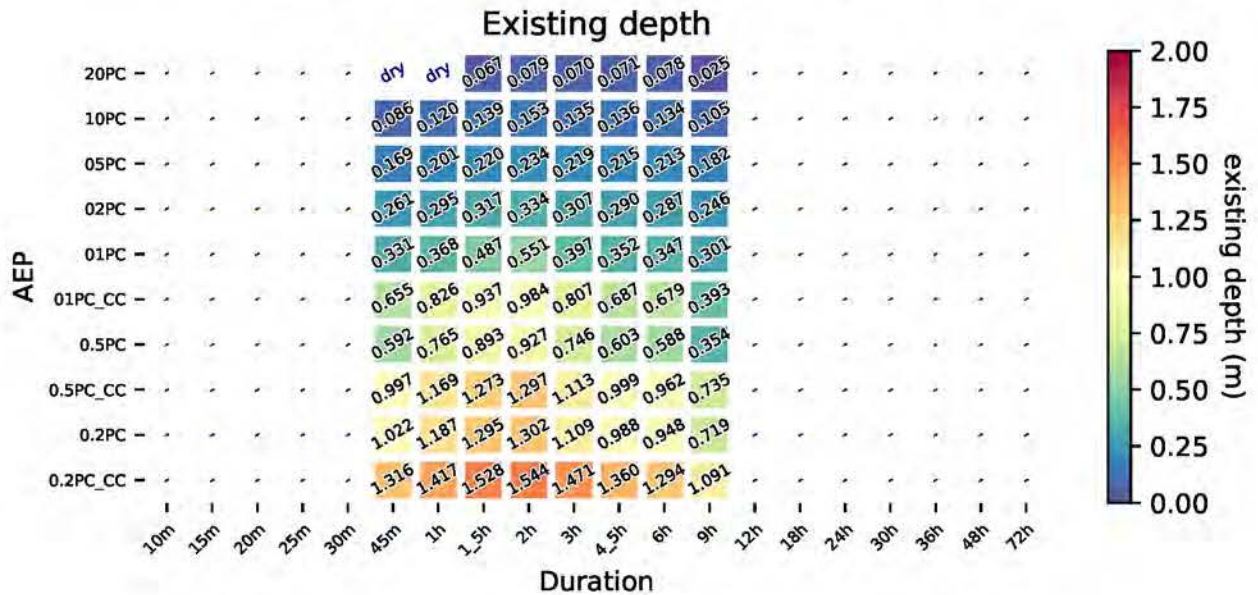


# Koonung Creek - u/s\_Tram\_Rd

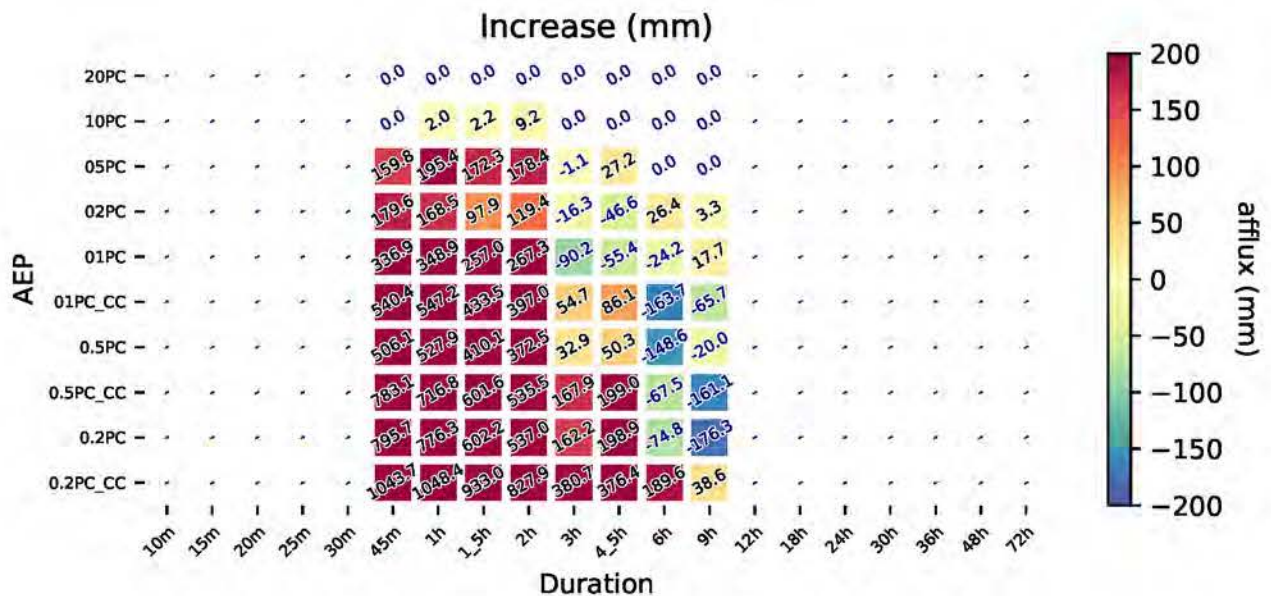
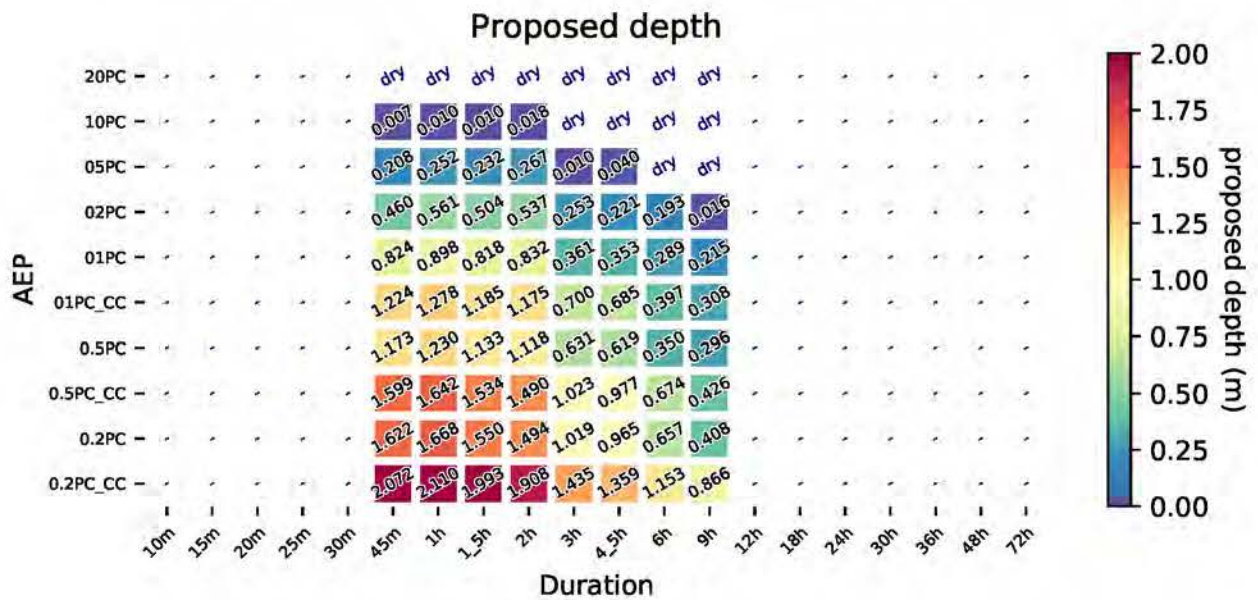
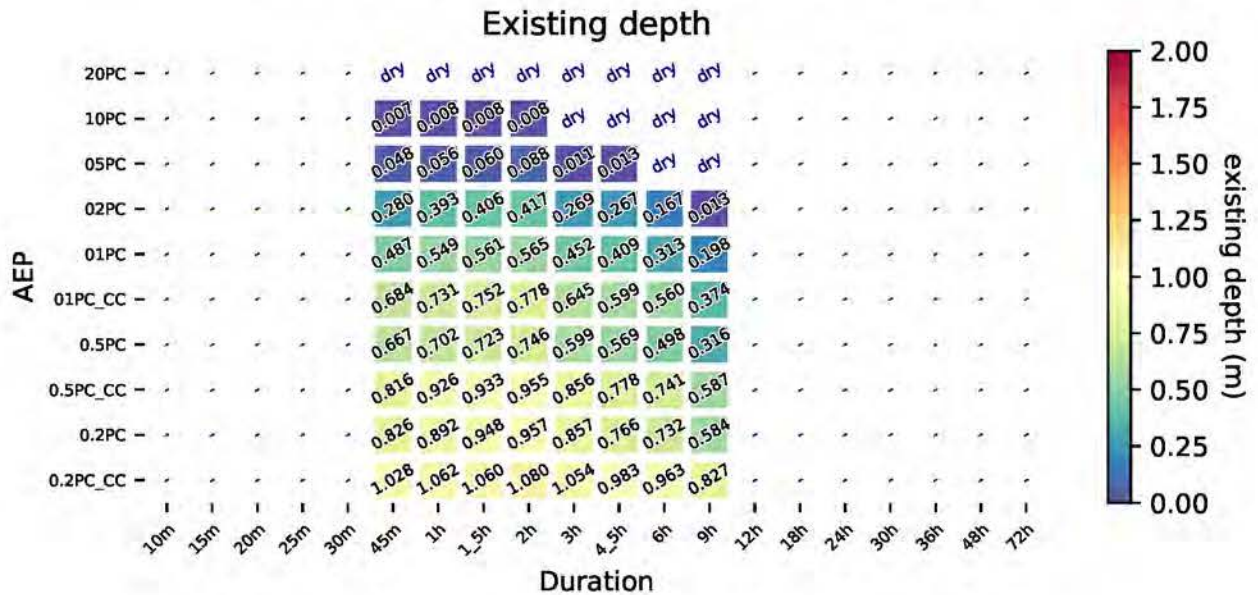




# Koonung Creek - rear\_of\_Grange\_Park\_Ave

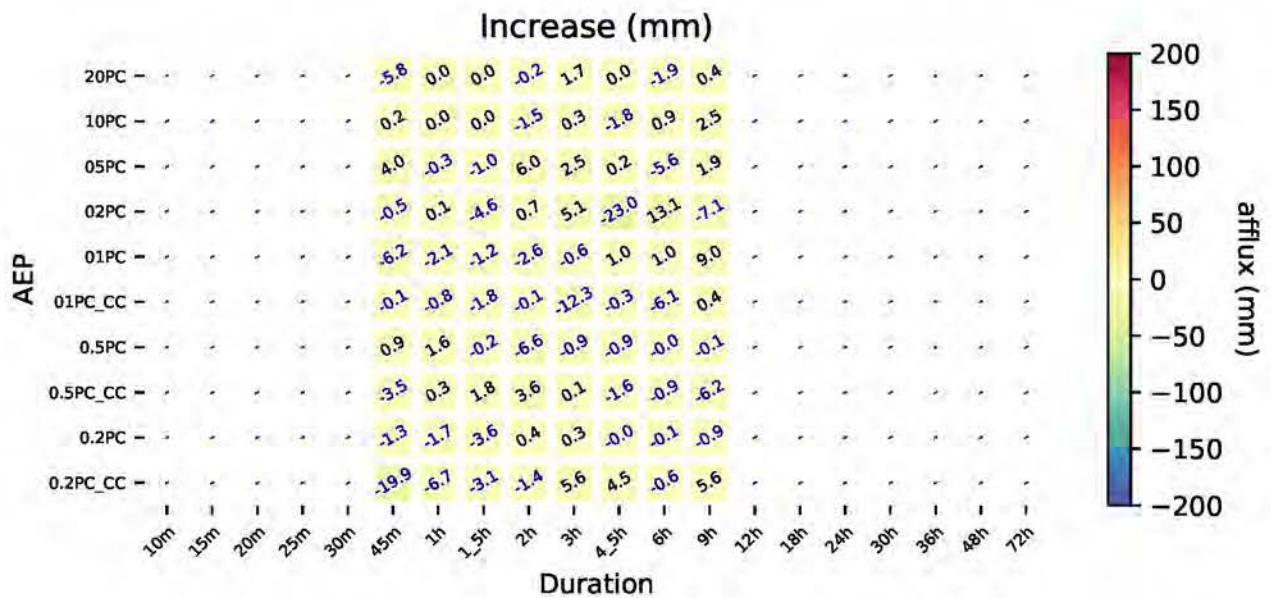
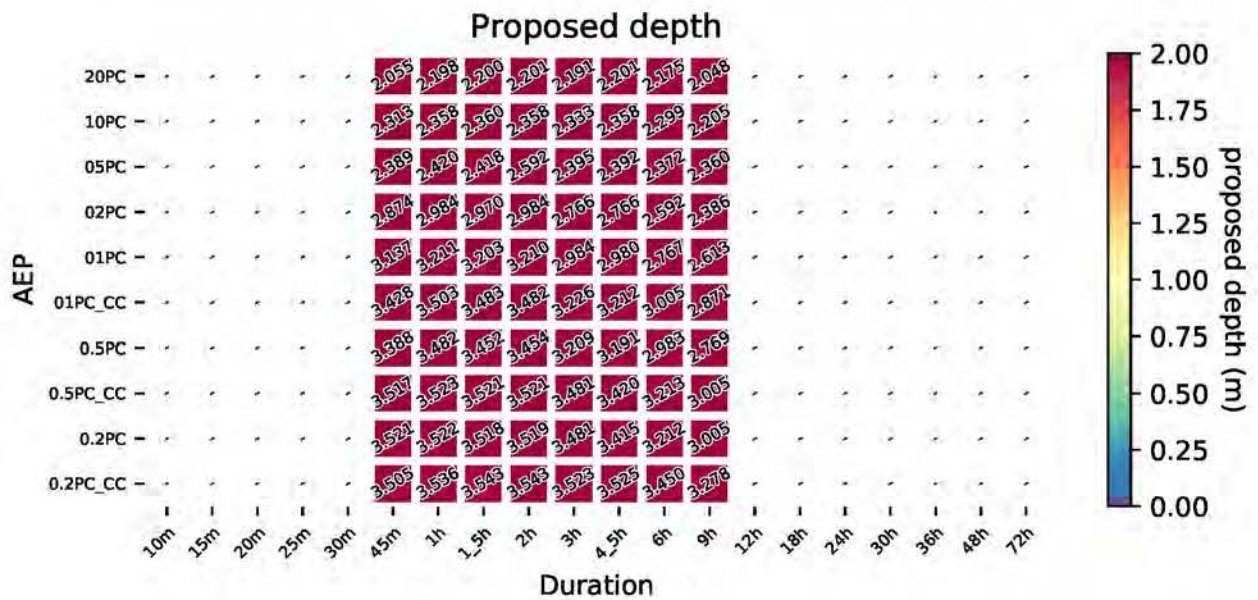
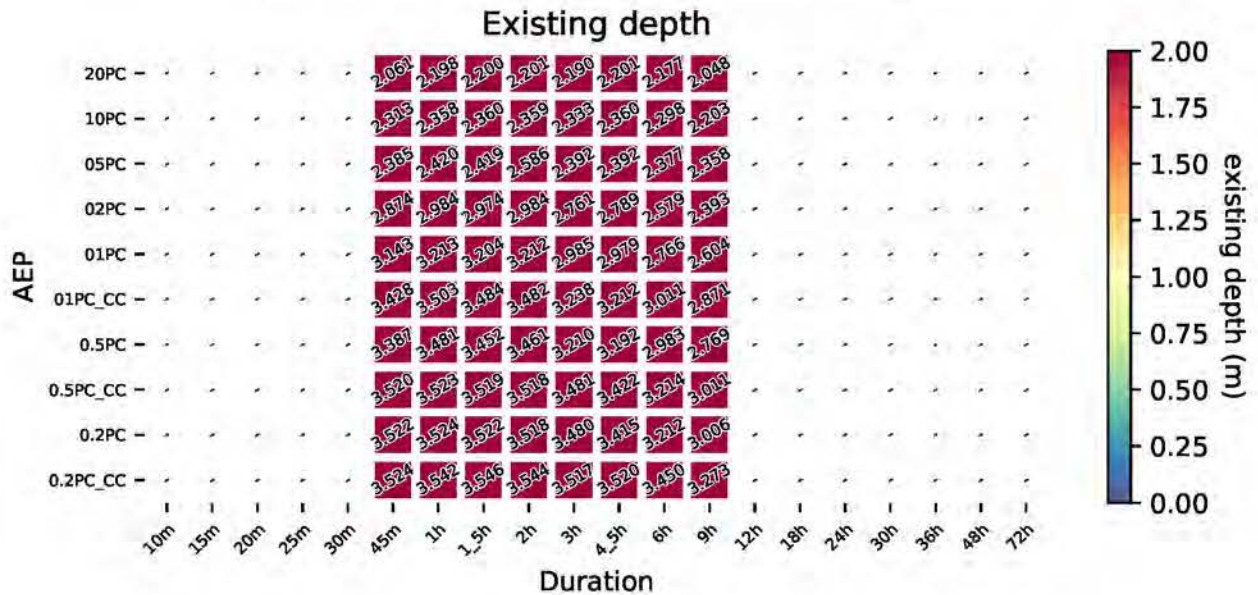


# Koonung Creek - Eram\_Rd\_Property

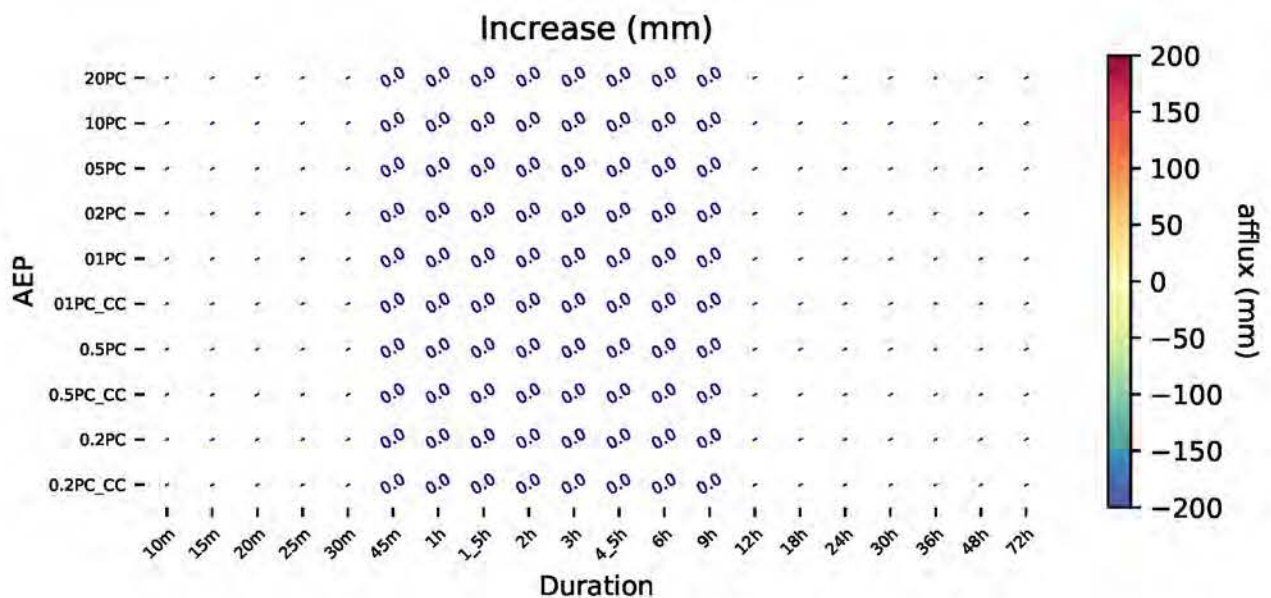
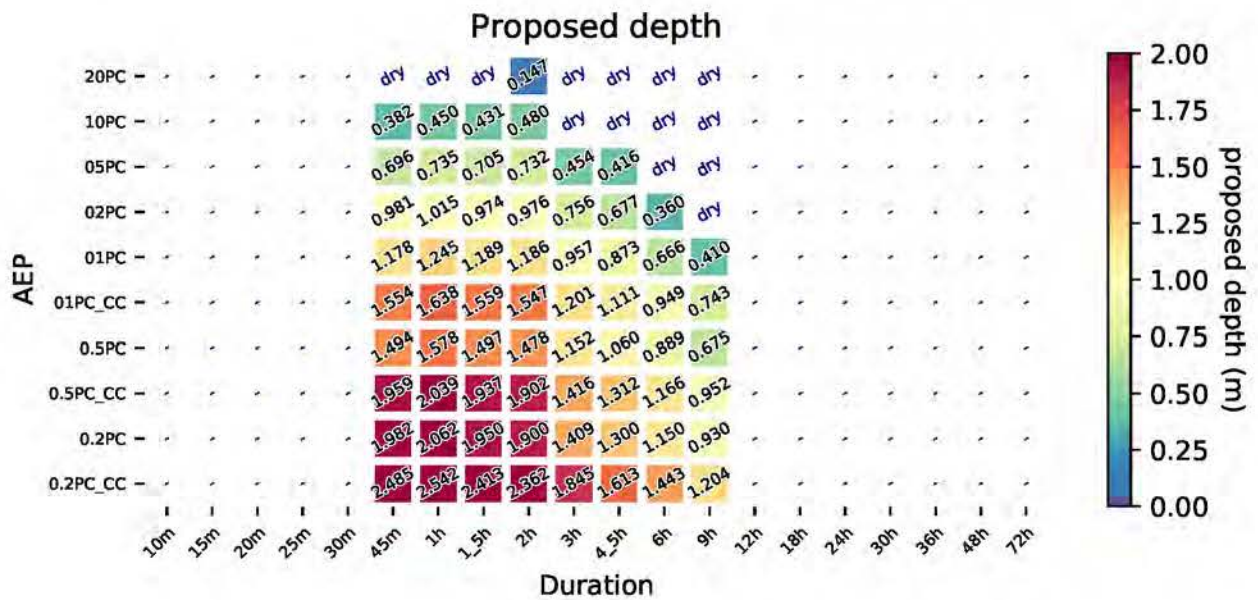
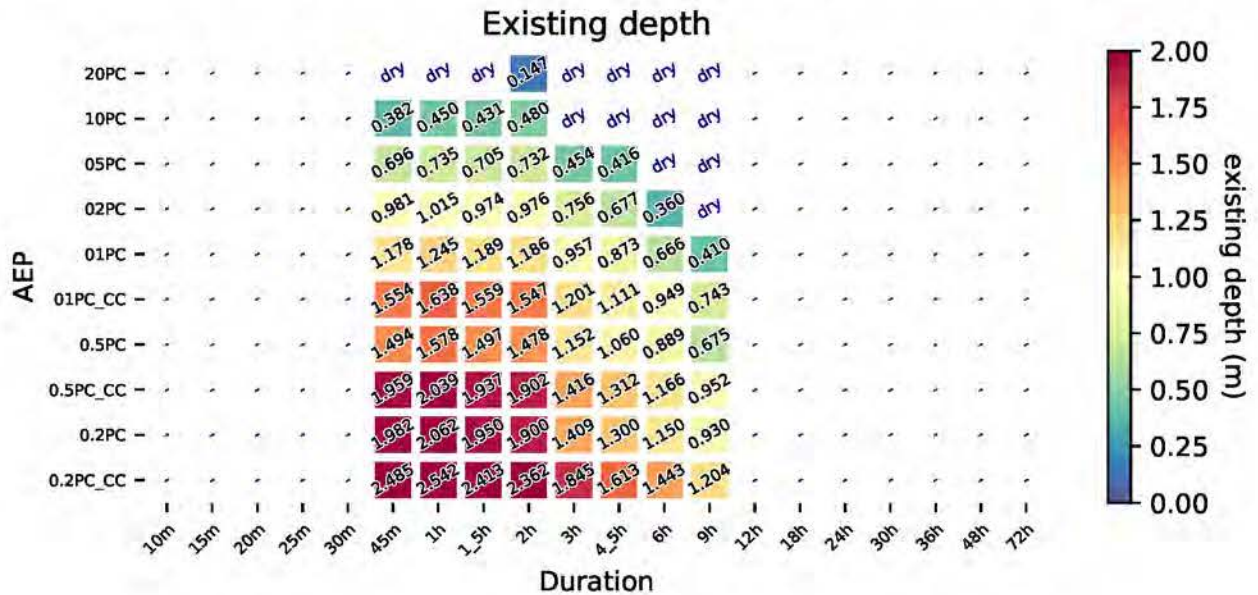




# Koonung Creek - Middleborough\_Rd

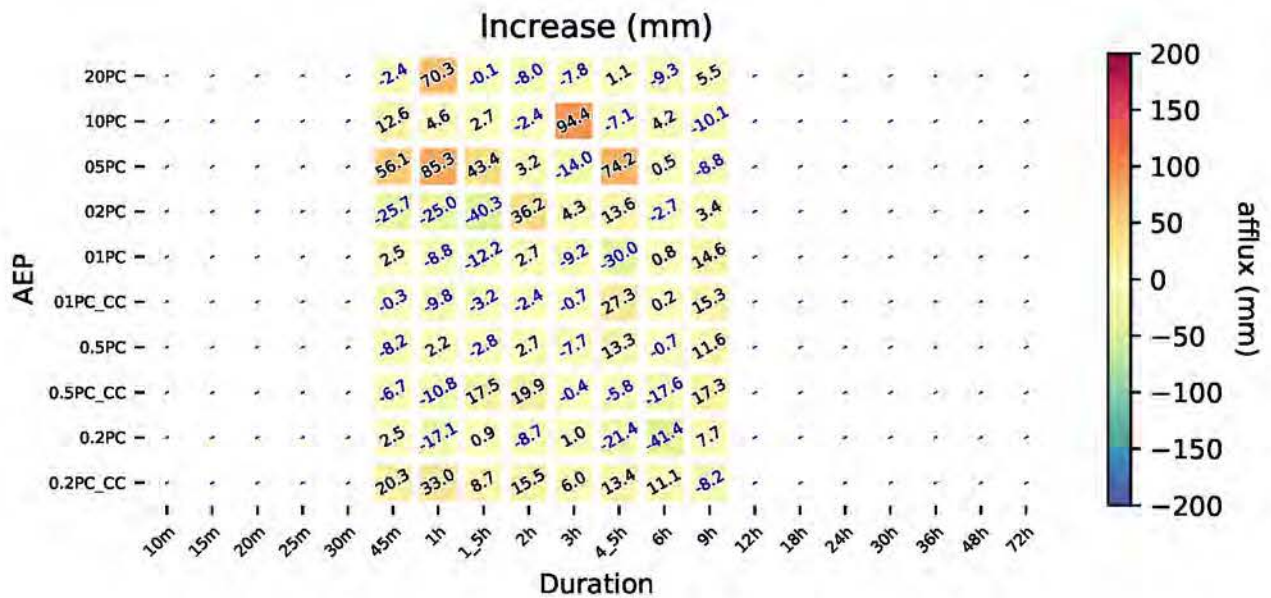
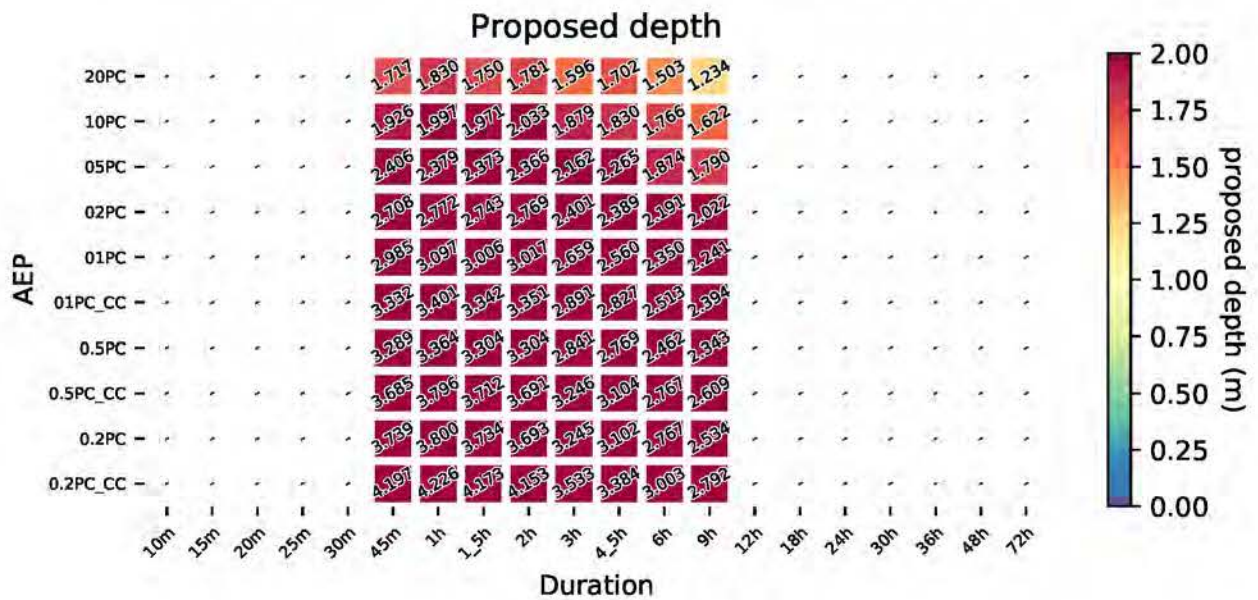
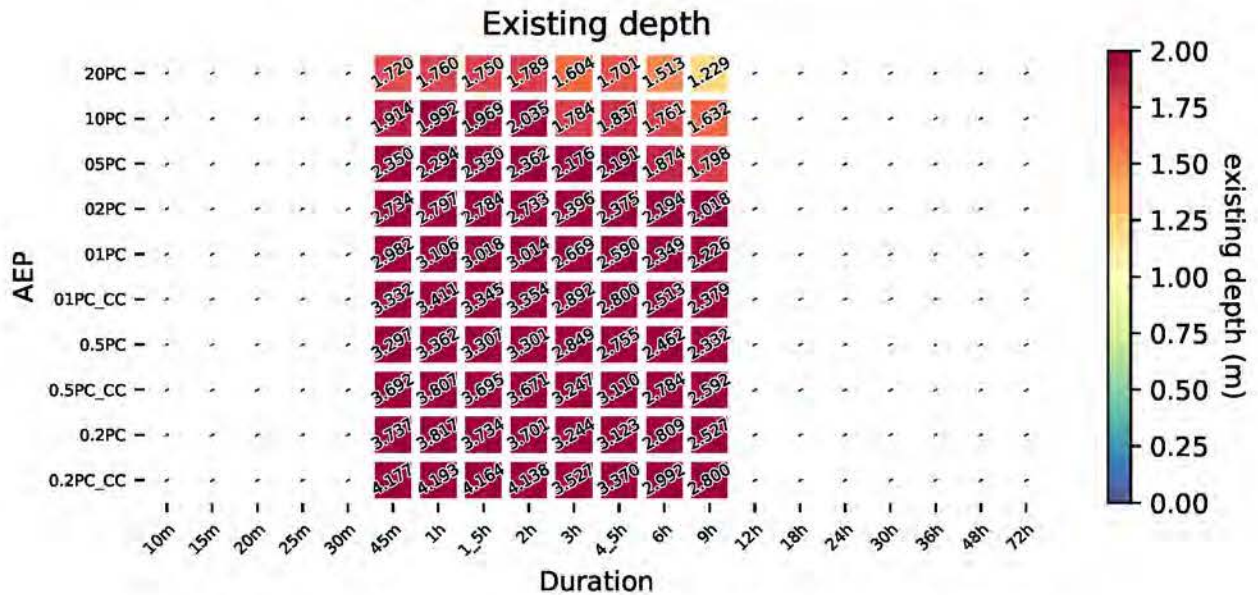


# Koonung Creek - Elizabethan\_Lodge(MiddleboroughRd)





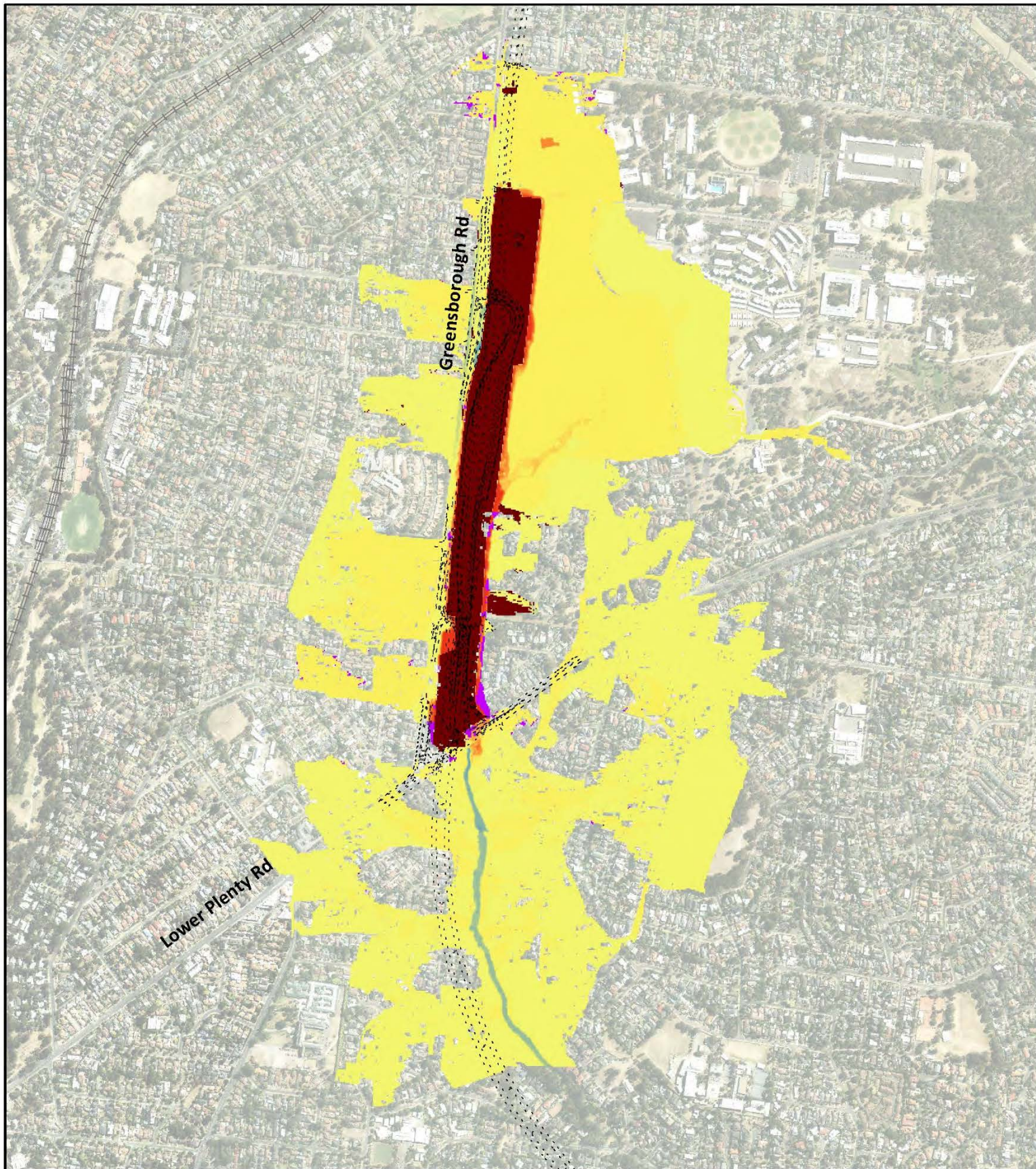
# Koonung Creek - u/s\_Blackburn\_Rd



## Appendix E – Alternative northern TBM launch site

E1	1% AEP peak flood depth afflux Banyule Creek
E2	1% AEP peak flood level afflux Banyule Creek
E3	1% AEP peak flood velocity difference Banyule Creek
E4	Banyule Creek Comparison Locations





Flood Depth Afflux (m)					
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500	
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500	
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet	
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200		
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300		



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Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1984  
Grid: GDA 1984 MGA Zone 55



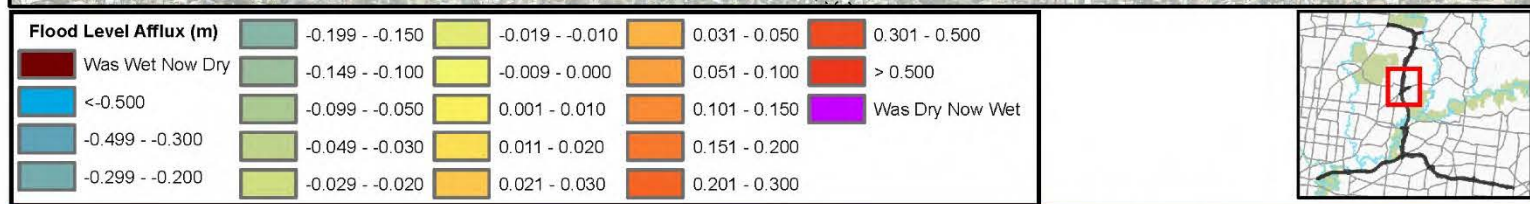
North East Link  
North East Link Project

Job Number 31-35006  
Revision B  
Date 08/10/2018

1% AEP peak flood depth afflux  
Banyule Creek

Figure E-1





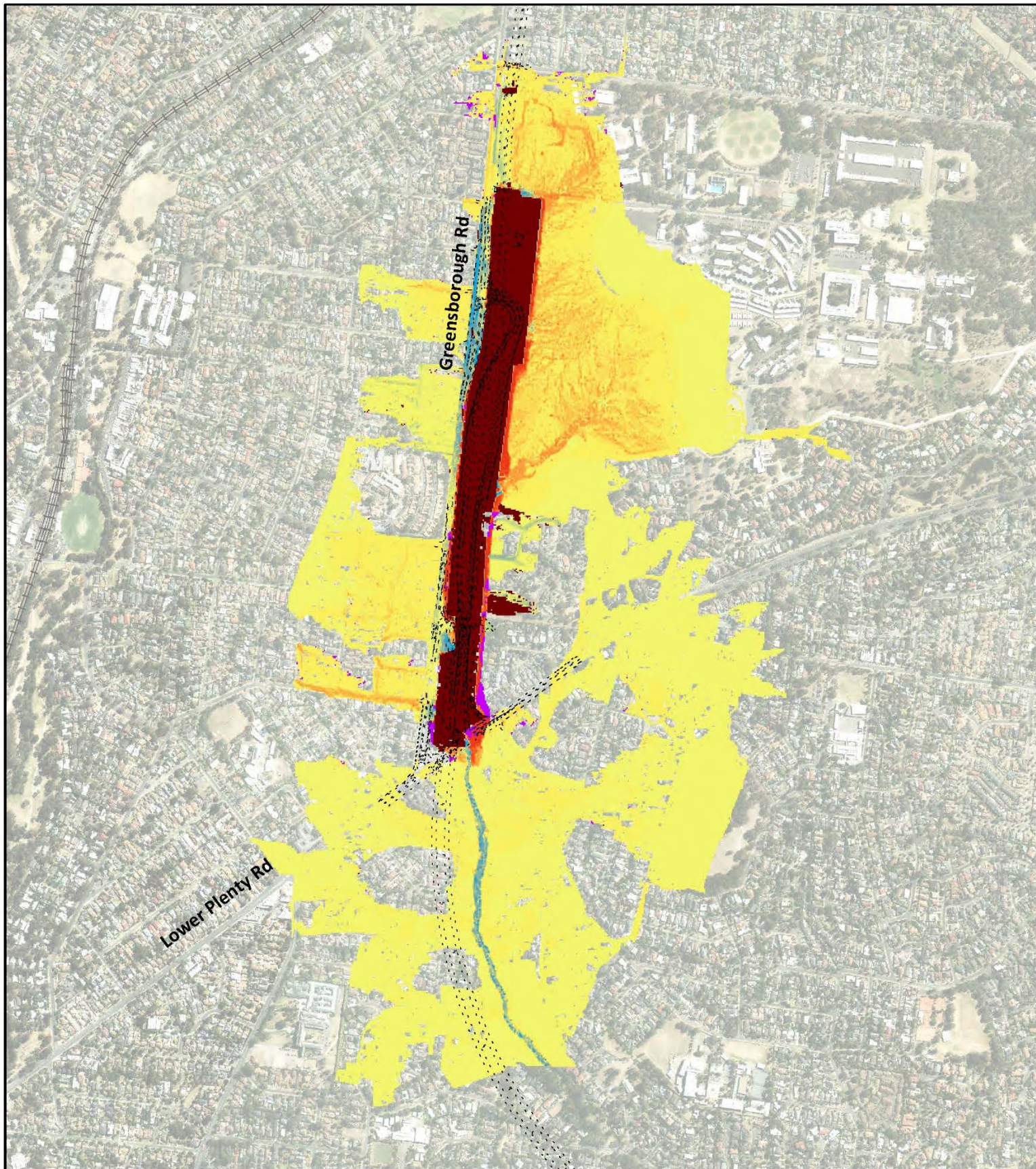
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Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55
























Job Number	31-35006
Revision	B
Date	08/10/2018

Figure E-2





Flood Velocity Difference(m/s)			-0.199 - -0.150		-0.019 - -0.010		0.031 - 0.050		0.301 - 0.500
	Was Wet Now Dry		-0.149 - -0.100		-0.009 - 0.000		0.051 - 0.100		> 0.500
	<-0.500		-0.099 - -0.050		0.001 - 0.010		0.101 - 0.150		Was Dry Now Wet
	-0.499 - -0.300		-0.049 - -0.030		0.011 - 0.020		0.151 - 0.200		
	-0.299 - -0.200		-0.029 - -0.020		0.021 - 0.030		0.201 - 0.300		



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Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1984  
Grid: GDA 1984 MGA Zone 55

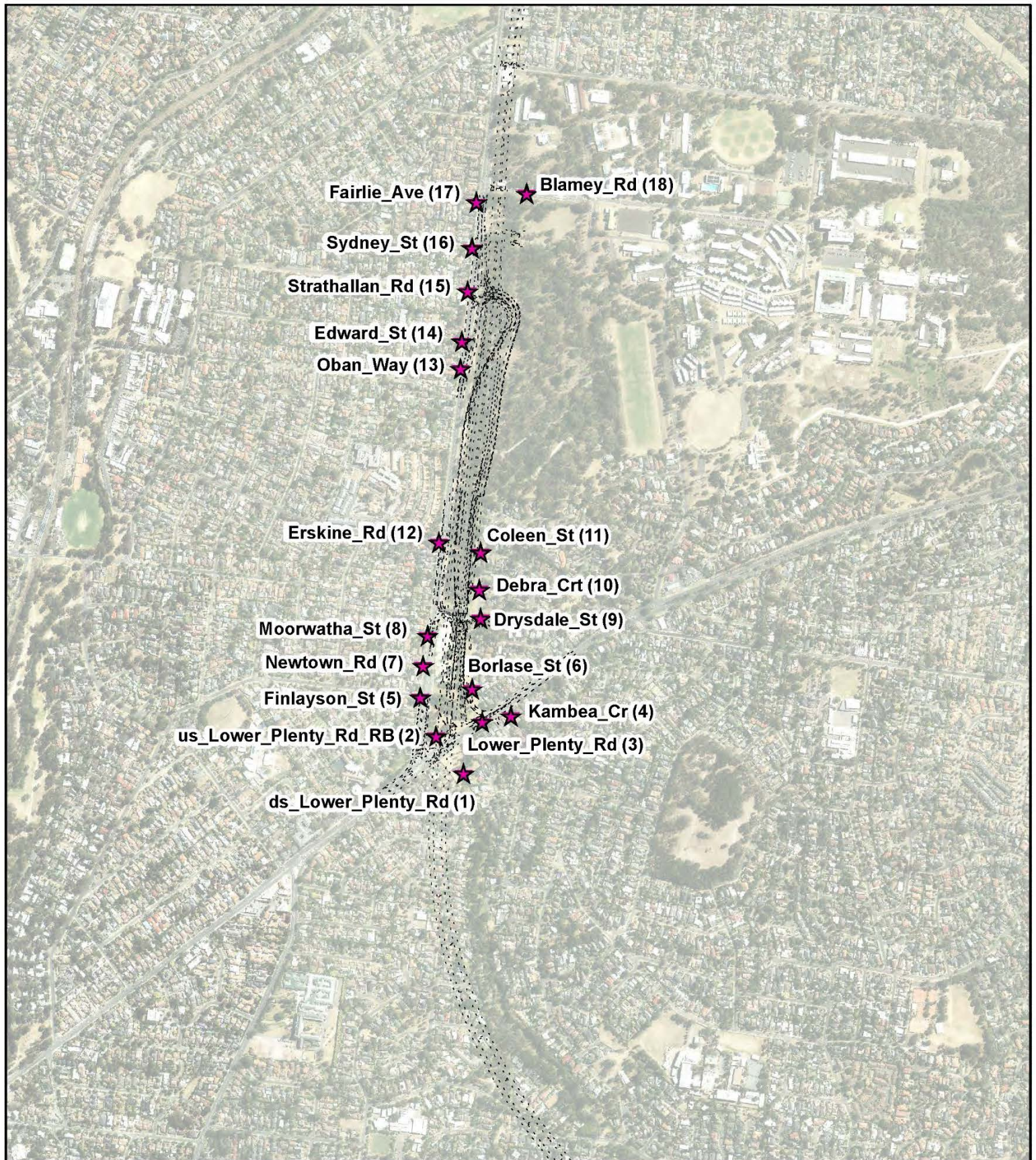


North East Link  
North East Link Project

Job Number 31-35006  
Revision B  
Date 08/10/2018

1% AEP peak flood velocity difference  
Banyule Creek  
Figure E-3





## LEGEND

★ Selected Locations



Paper Size A4  
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Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	C
Date	13/11/2018

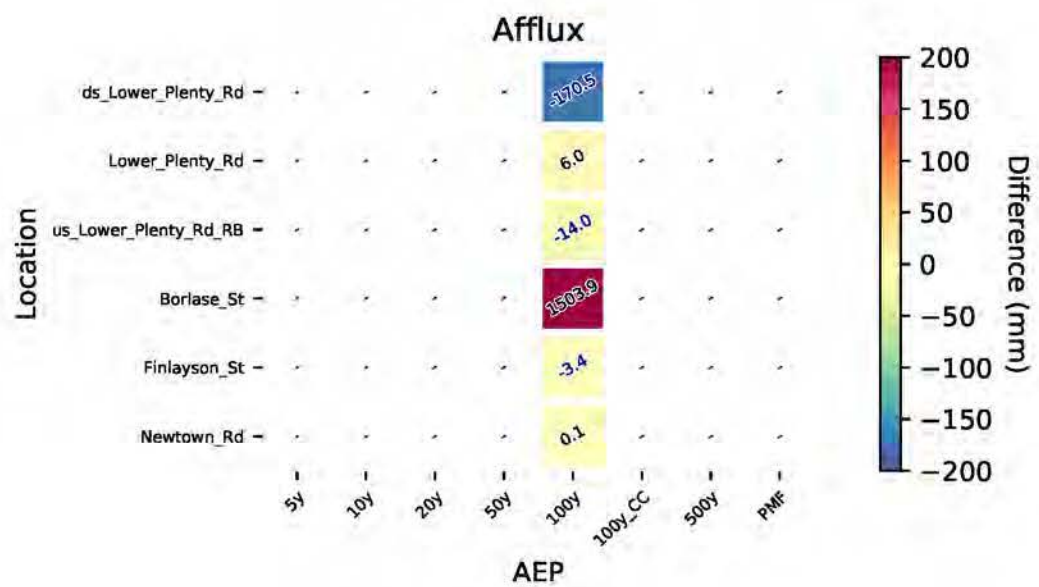
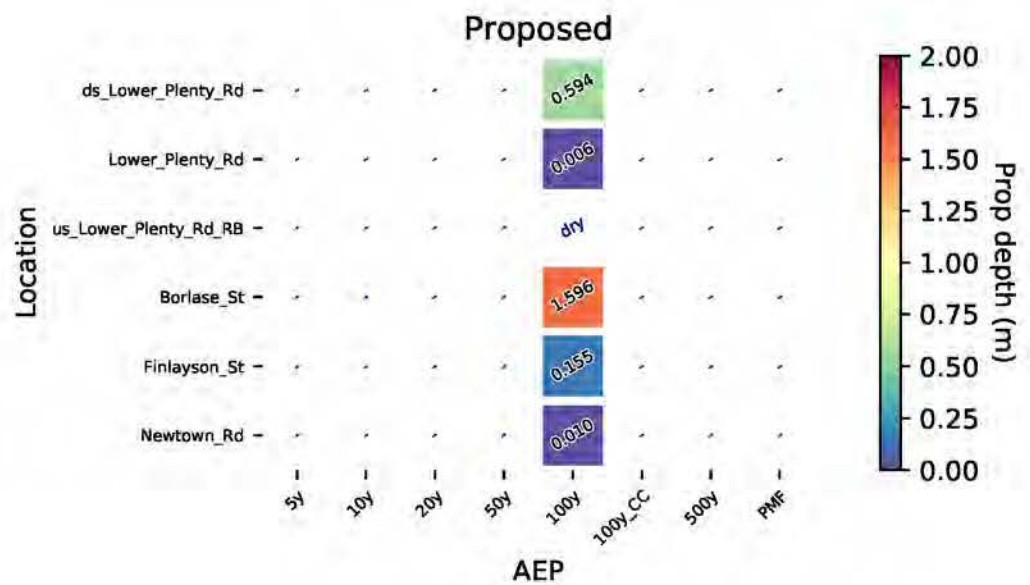
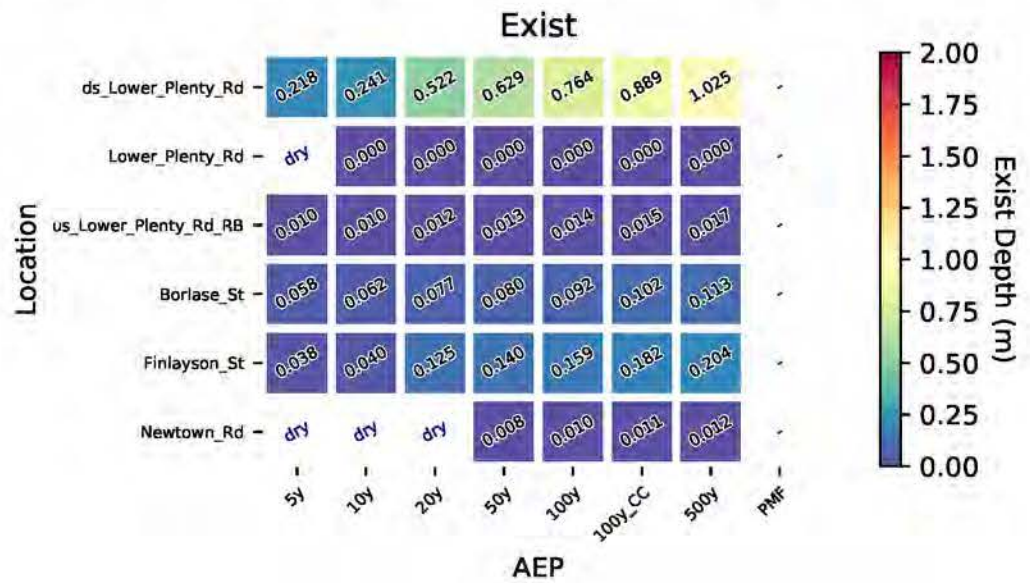
Banyule Creek  
Comparison Locations Appendix E-4

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

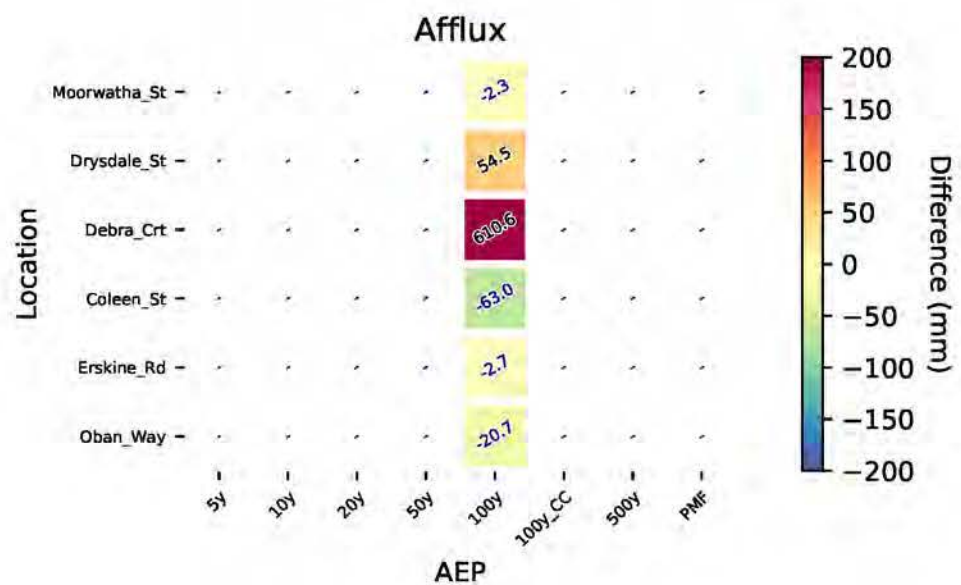
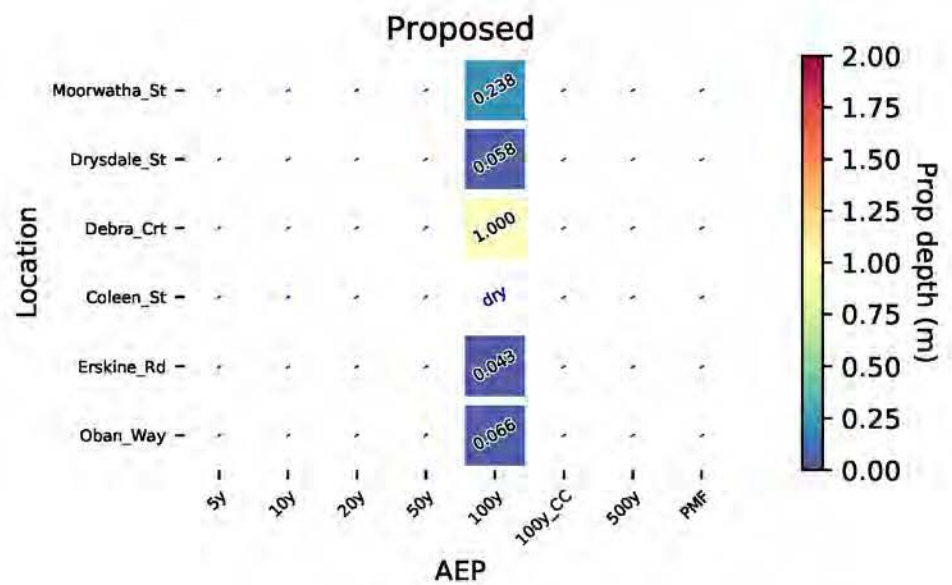
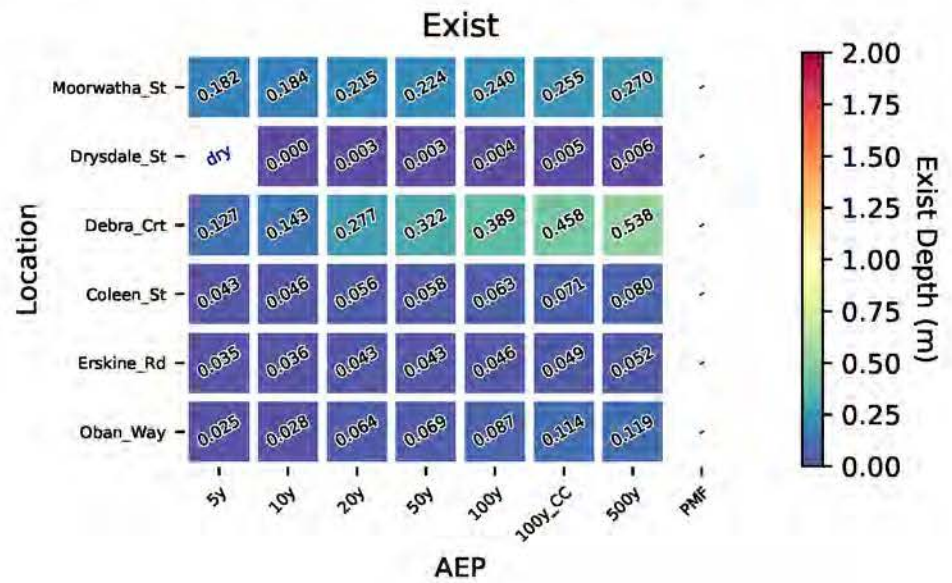
© 2018. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.



# Banyule Creek - Construction Alternative Overview

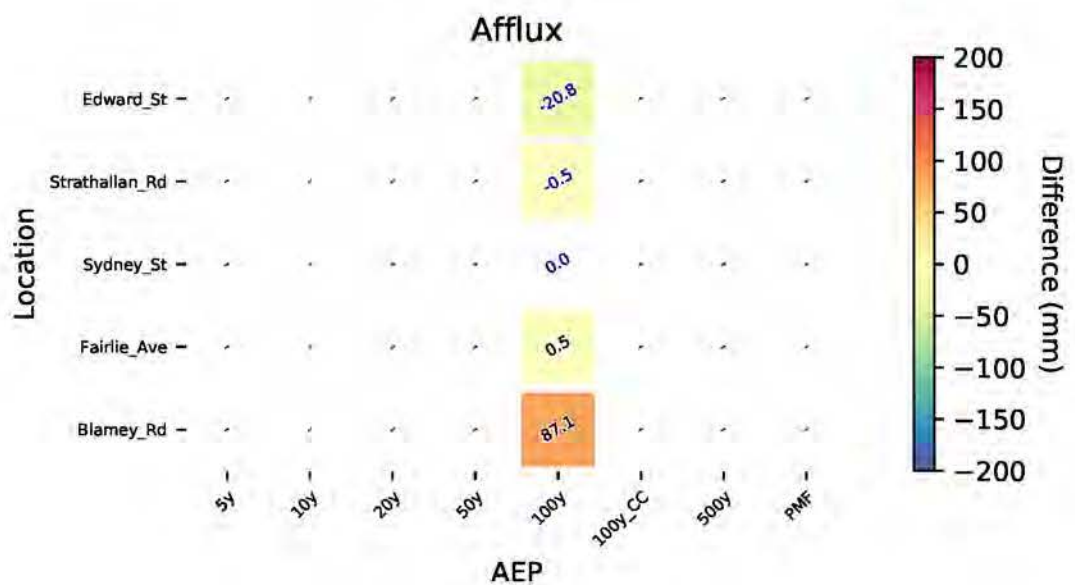
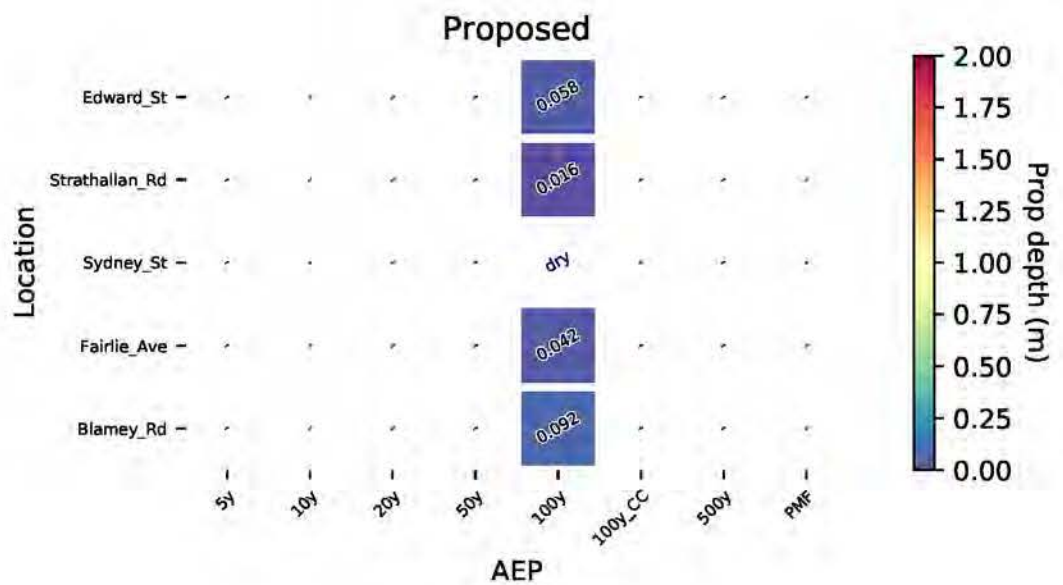
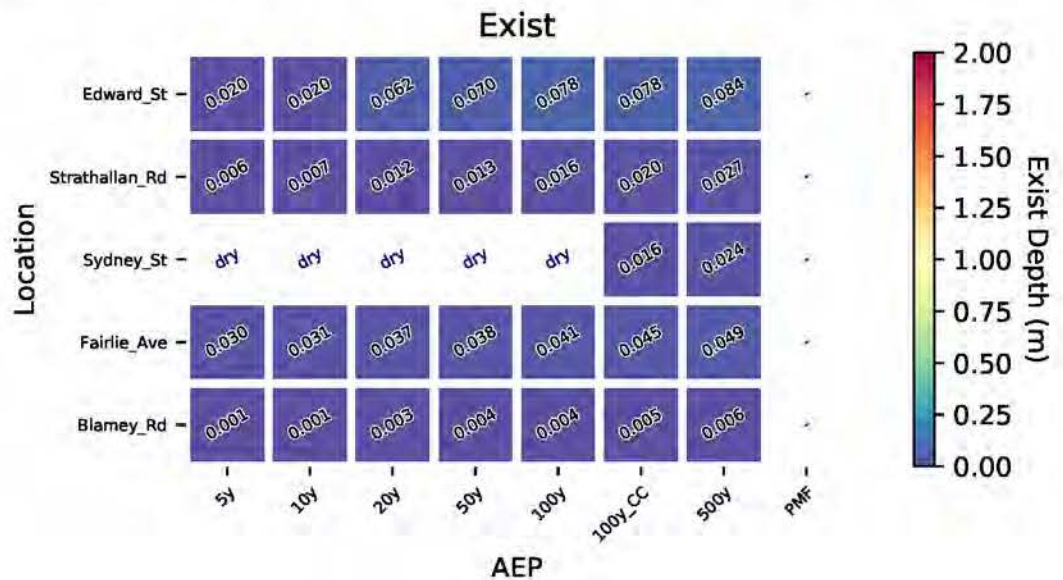


# Banyule Creek - Construction Alternative Overview

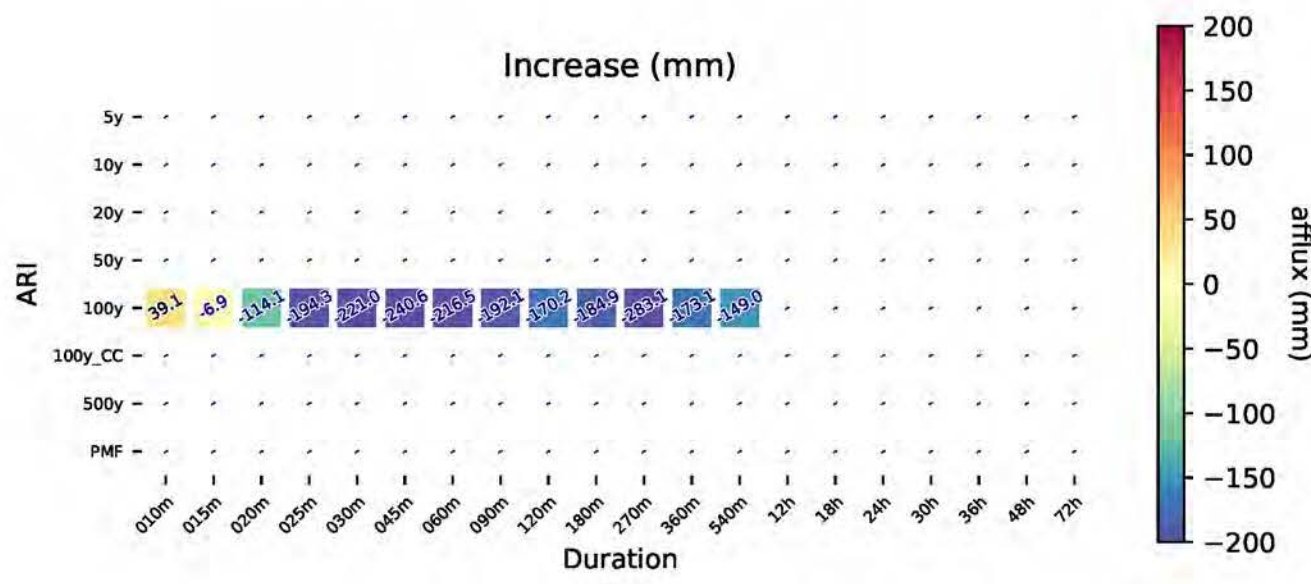
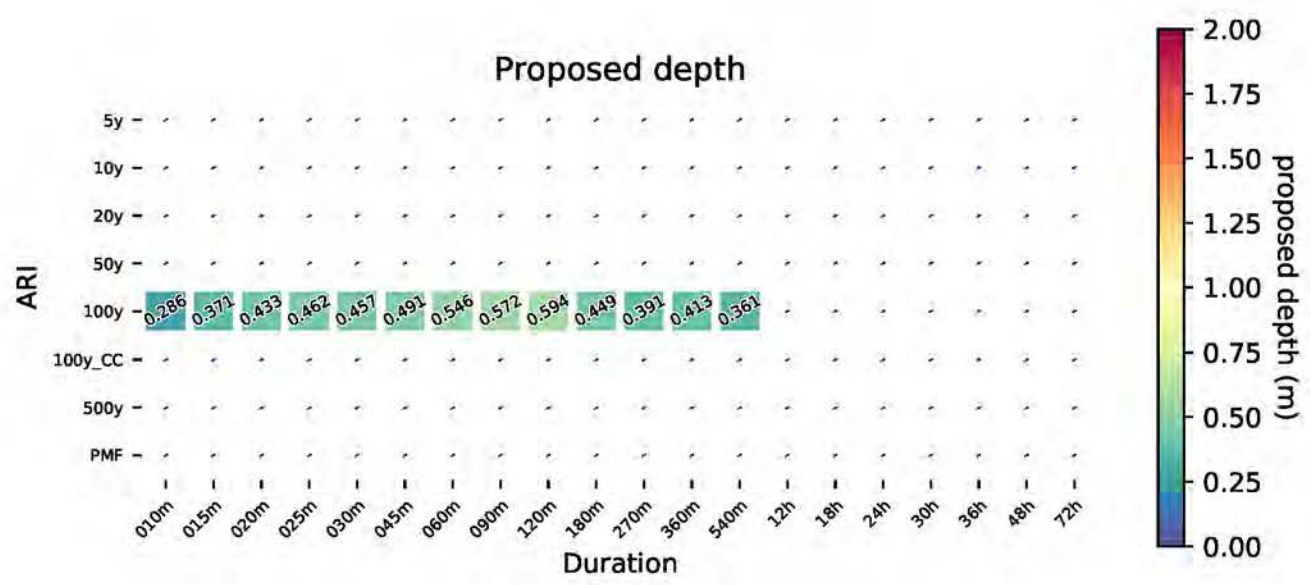
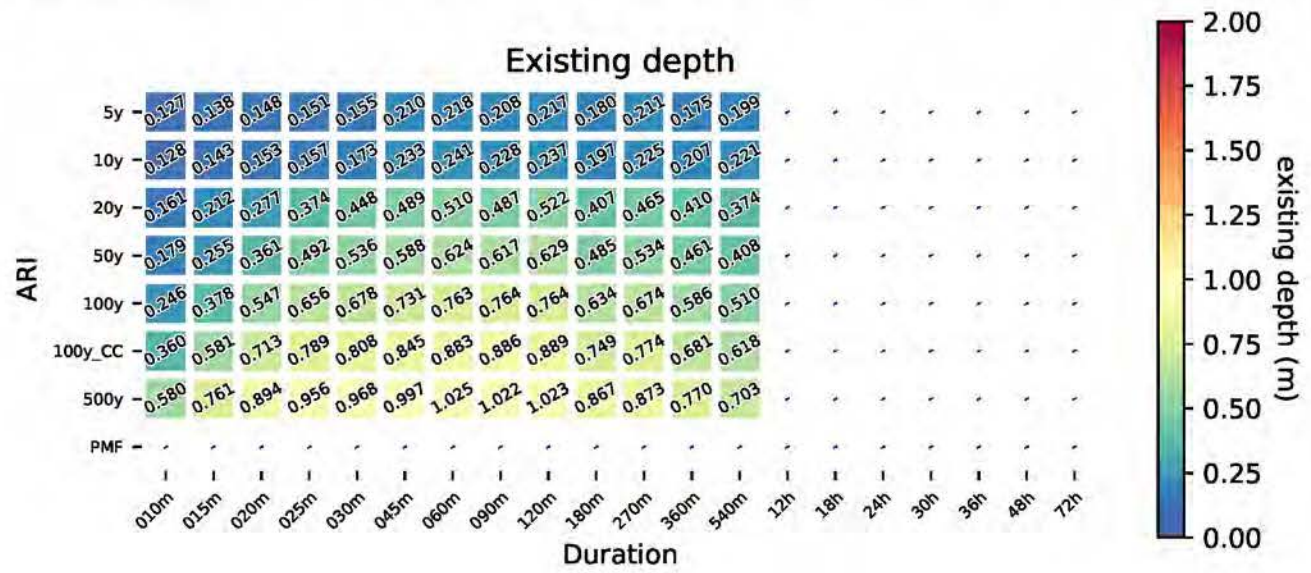




# Banyule Creek - Construction Alternative Overview

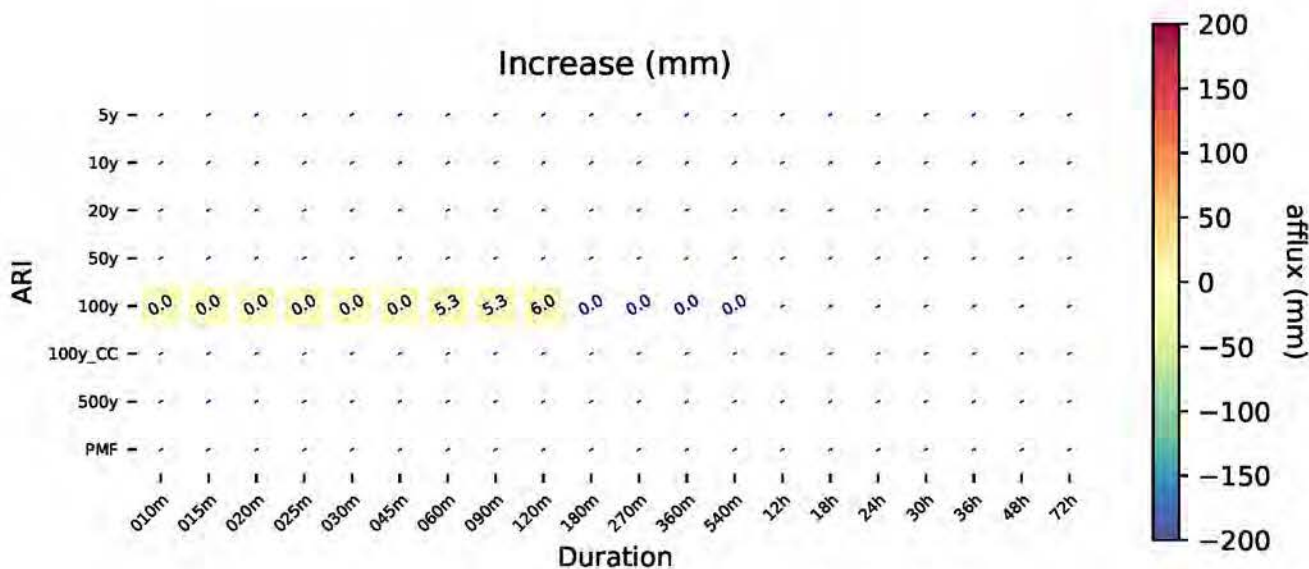
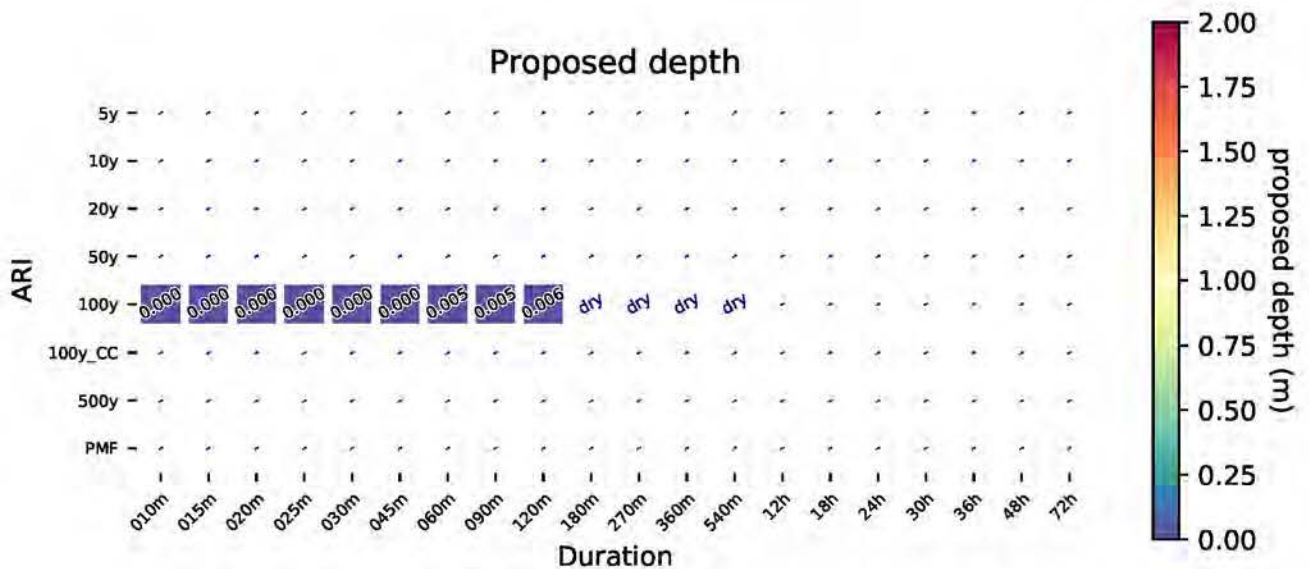
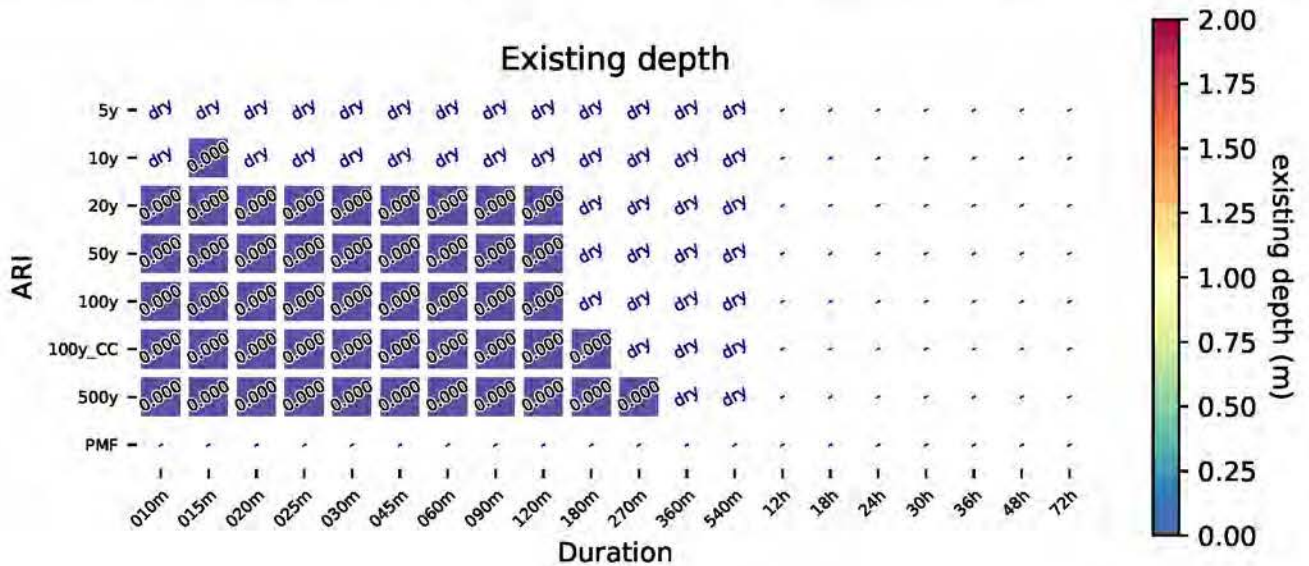


Banyule Creek Construction Alternate NthSth - ds\_Lower\_Plenty\_Rd

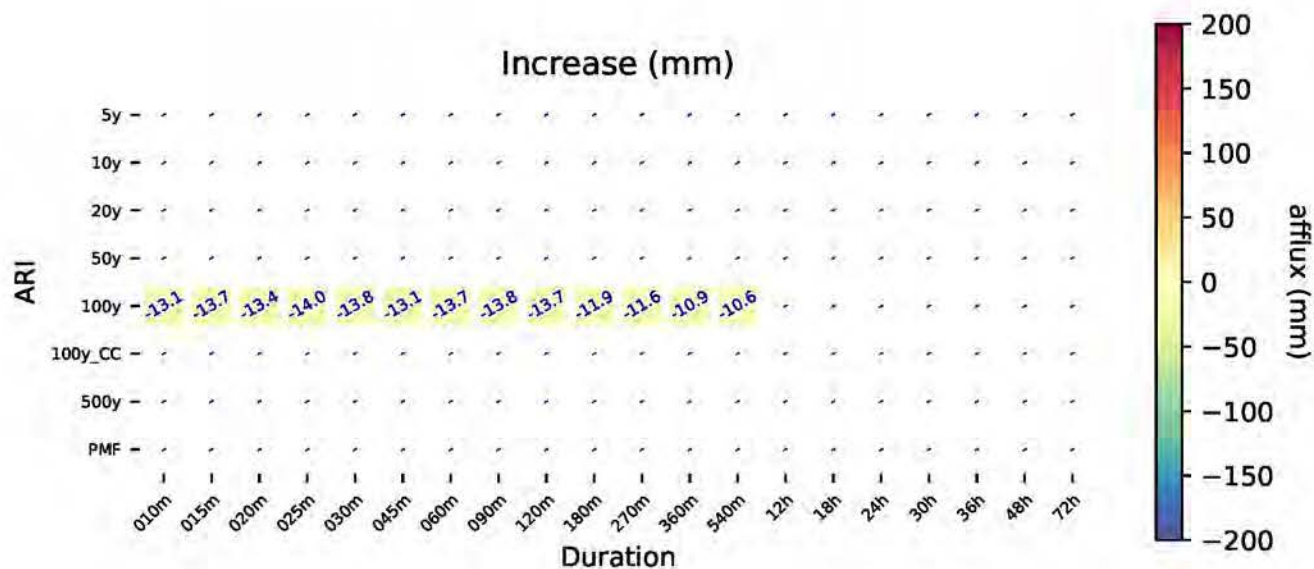
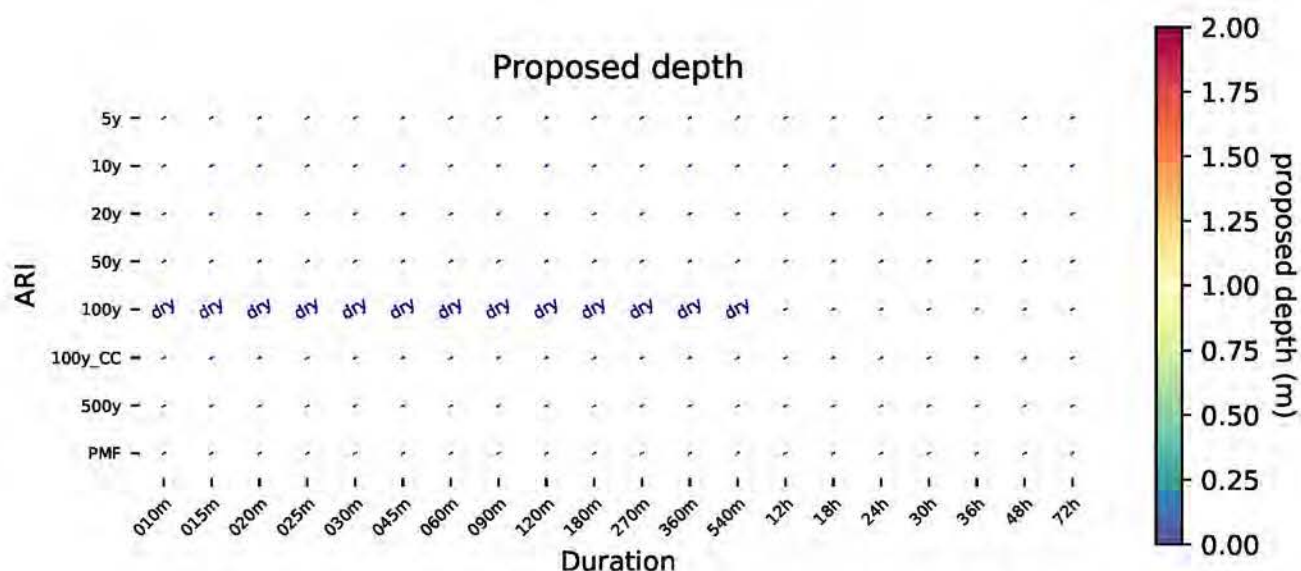
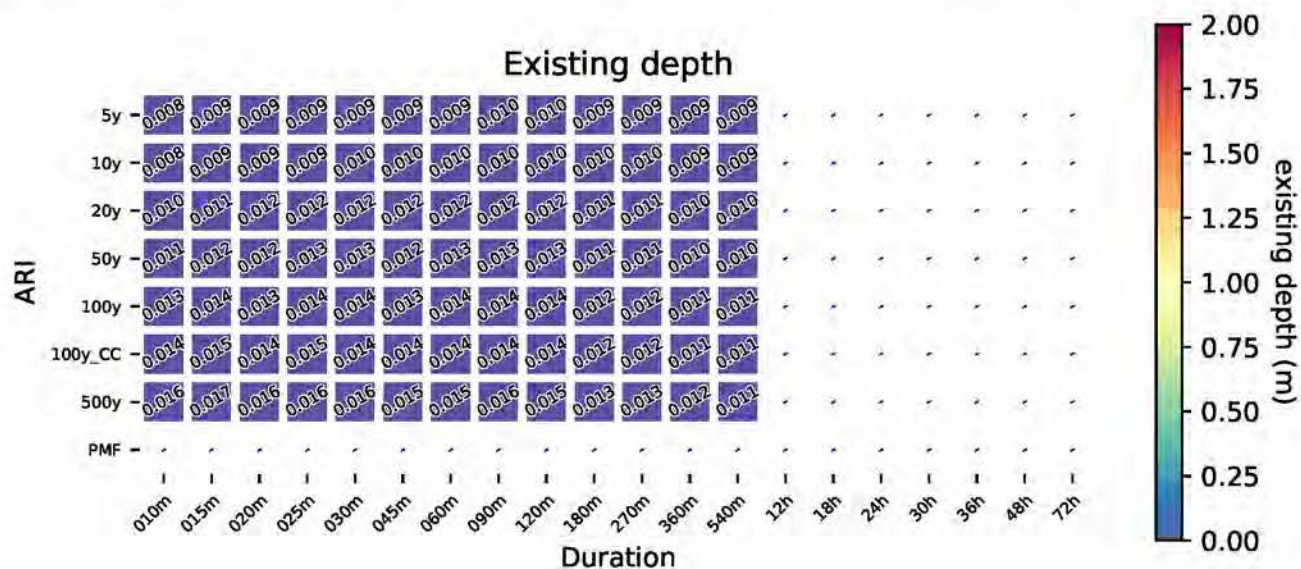




# Banyule Creek Construction Alternate NthSth - Lower\_Plenty\_Rd

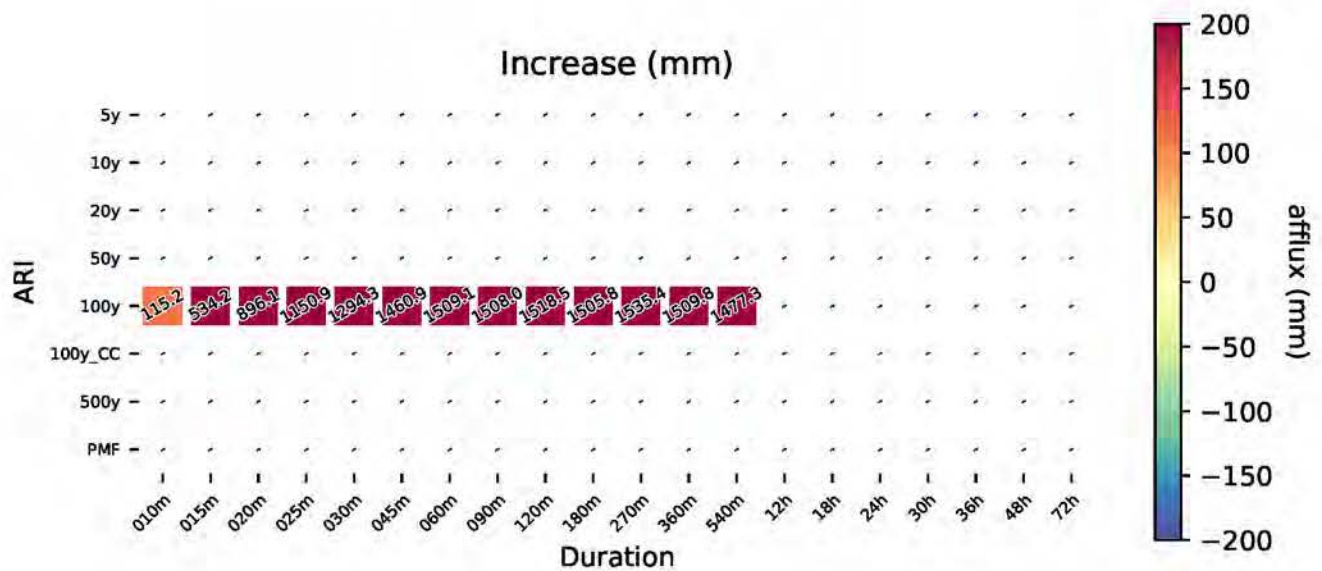
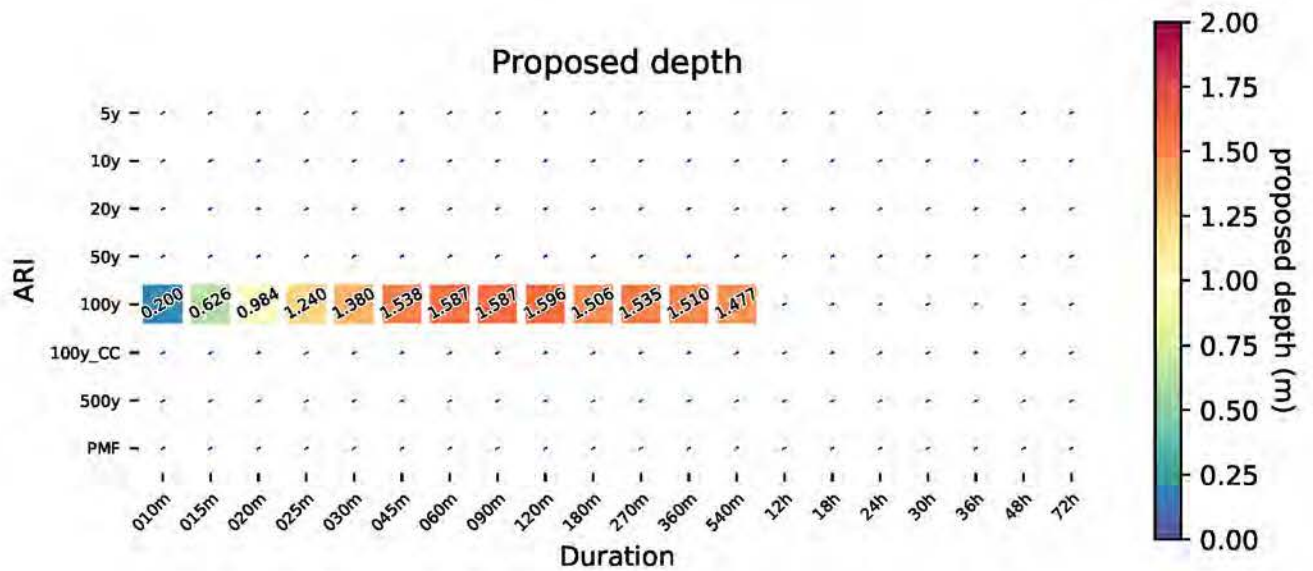
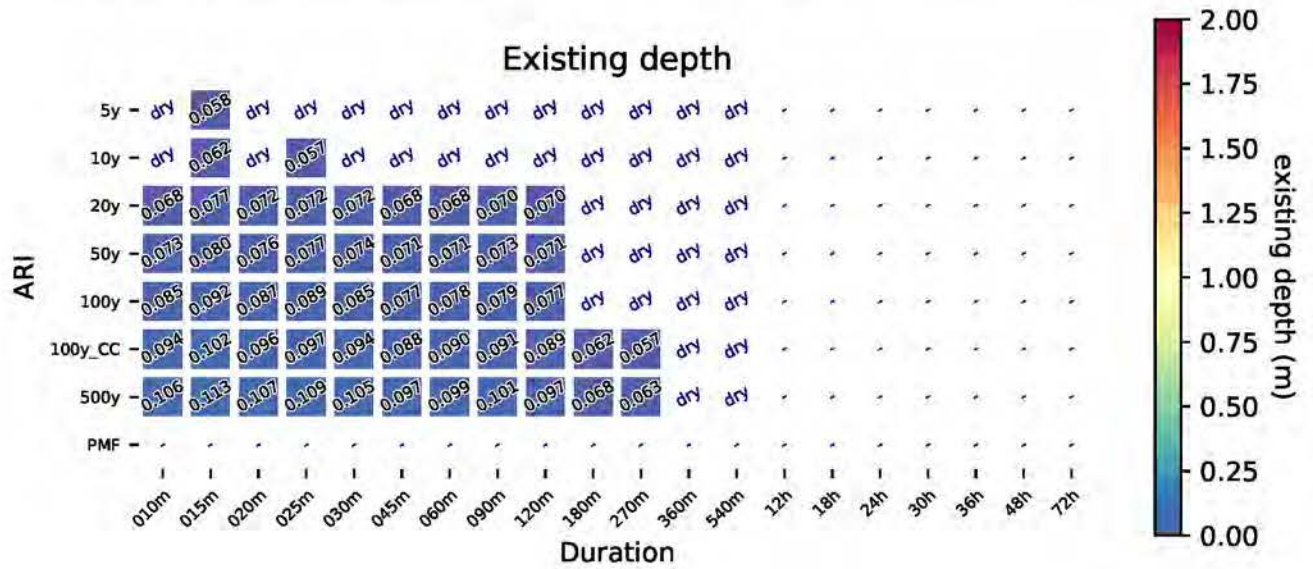


# Banyule Creek Construction Alternate NthSth - us\_Lower\_Plenty\_Rd\_RB

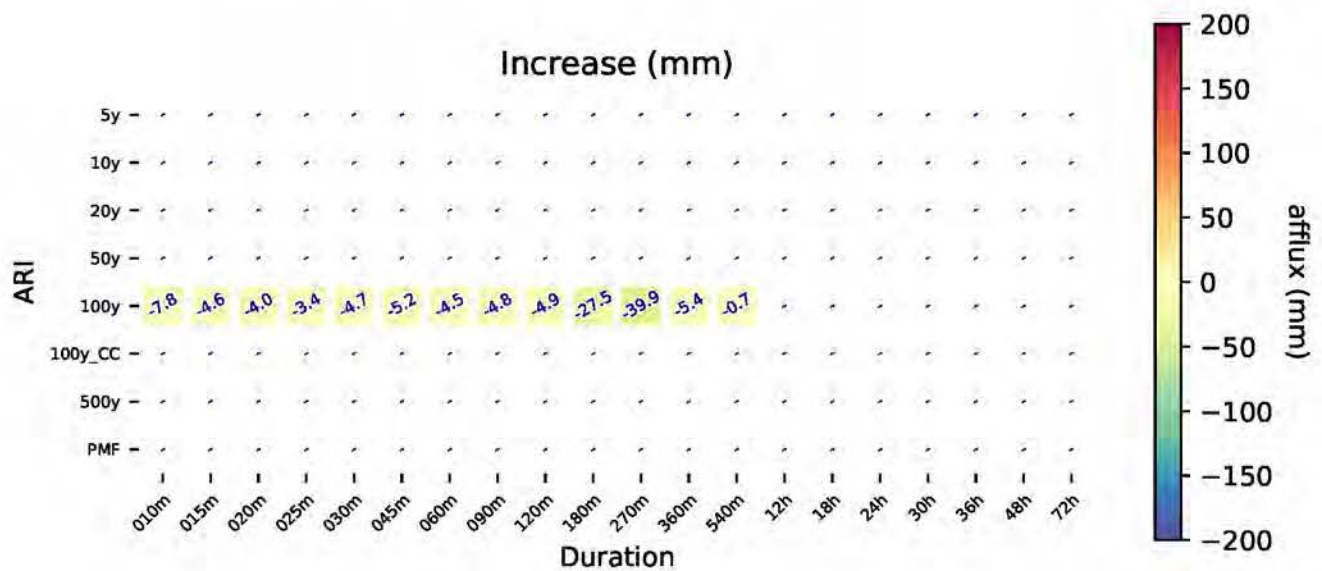
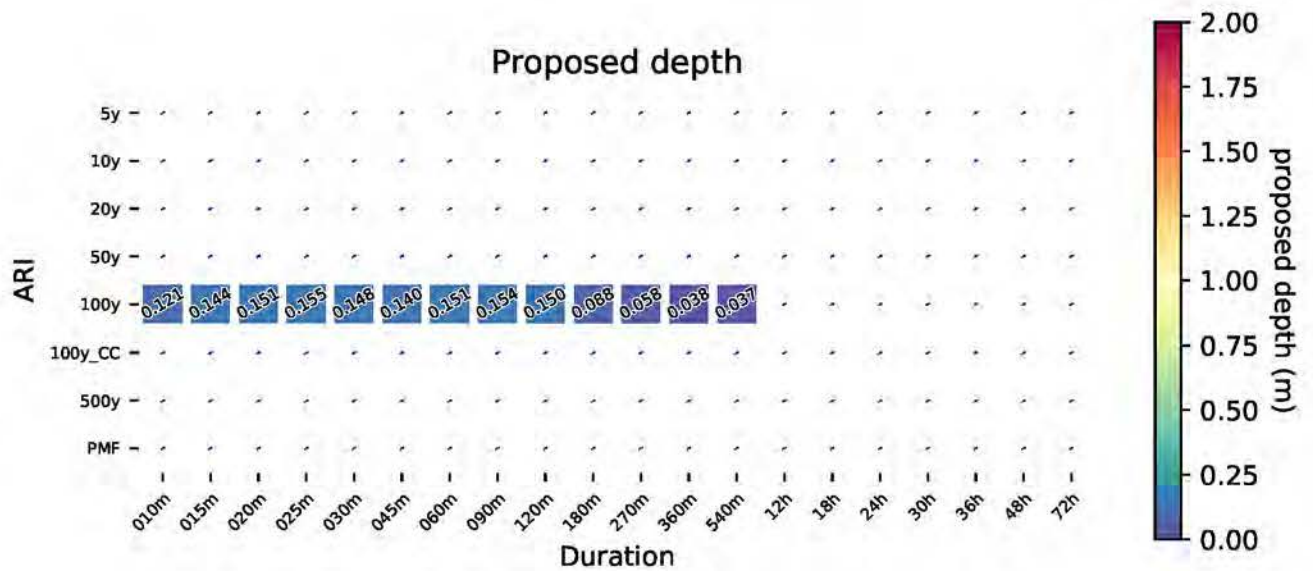
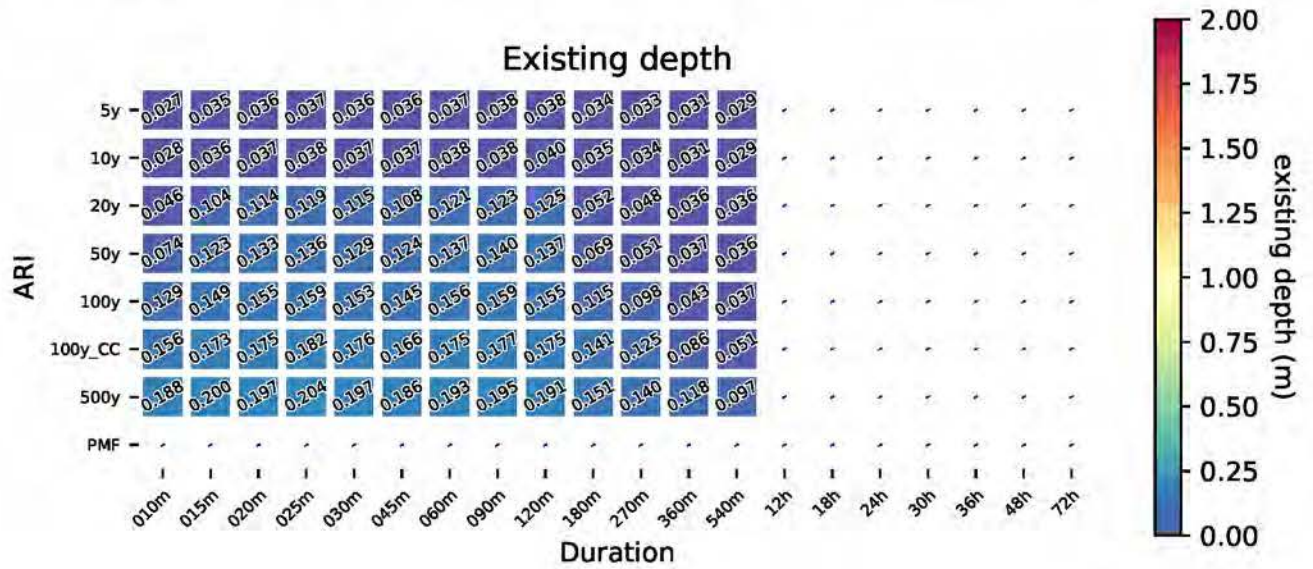




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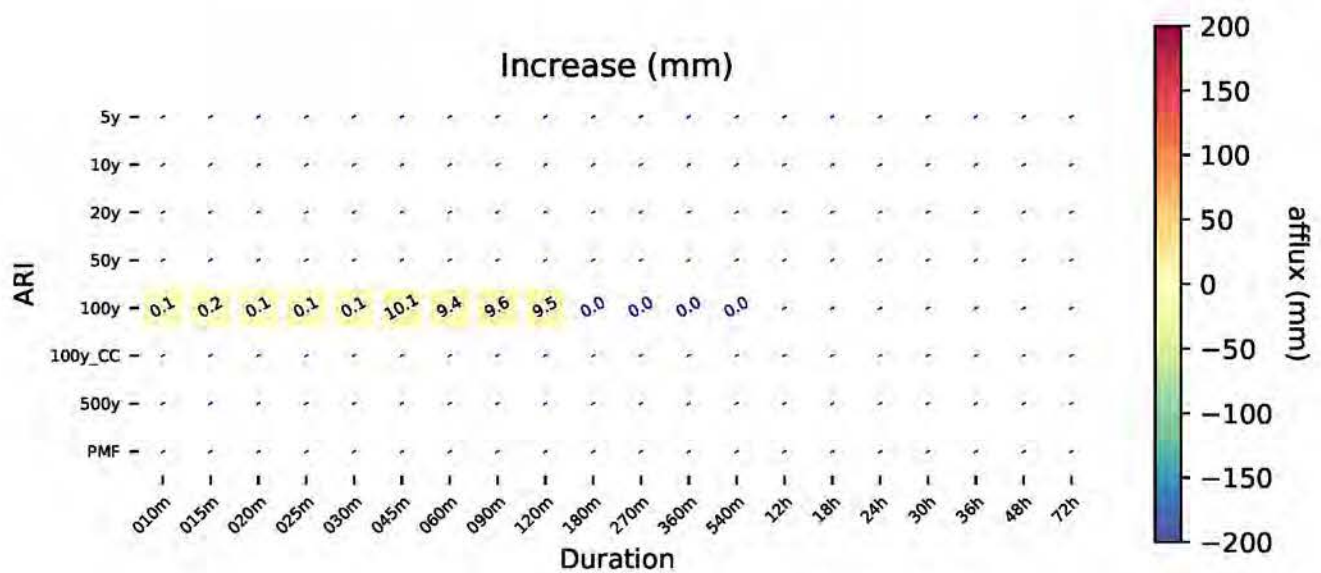
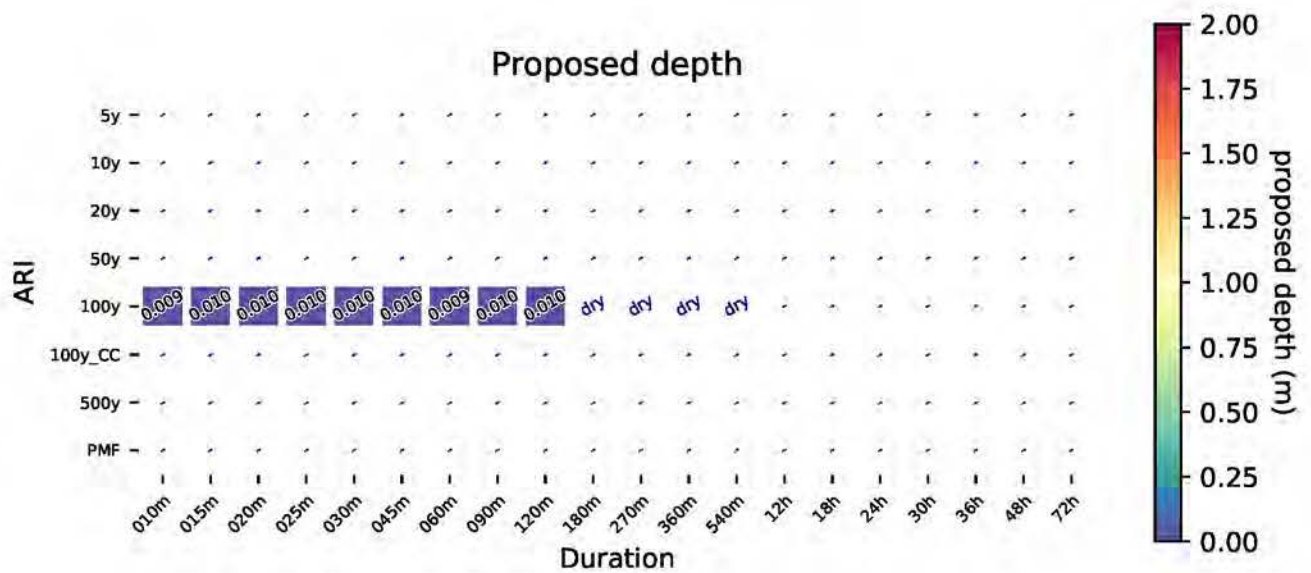
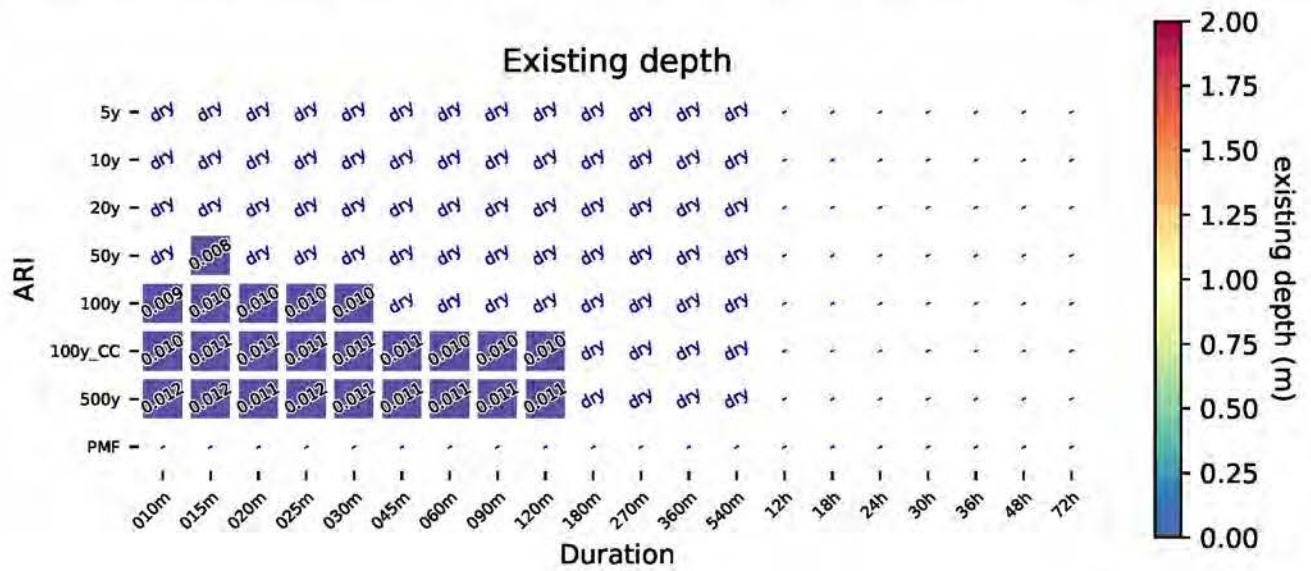


# Banyule Creek Construction Alternate NthSth - Finlayson\_St

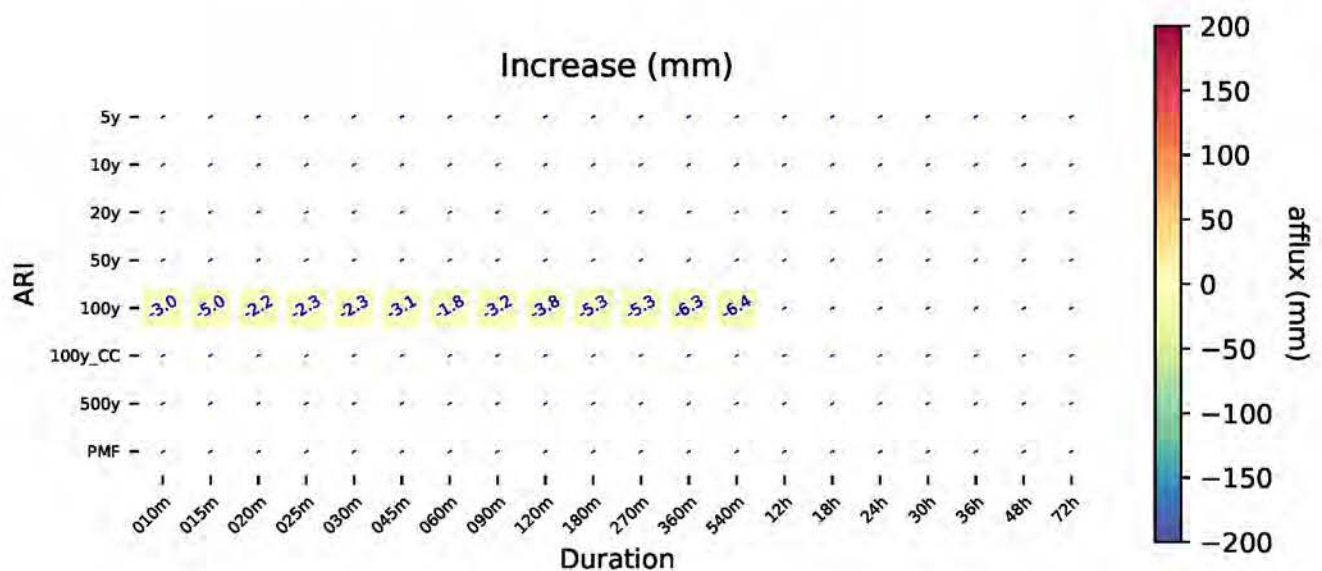
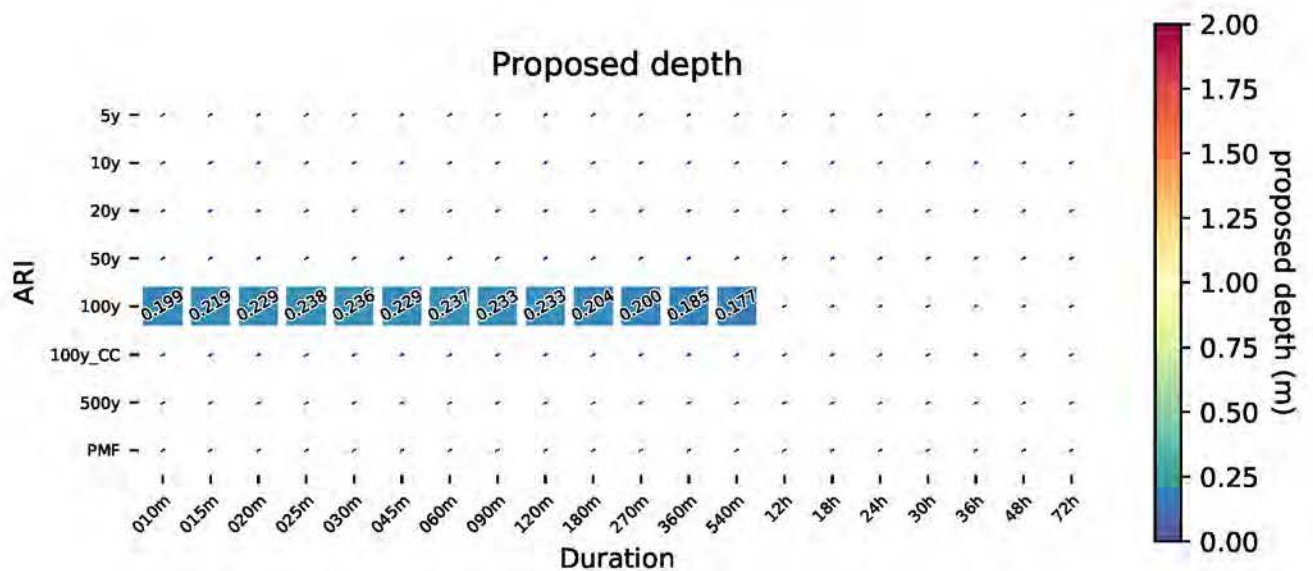
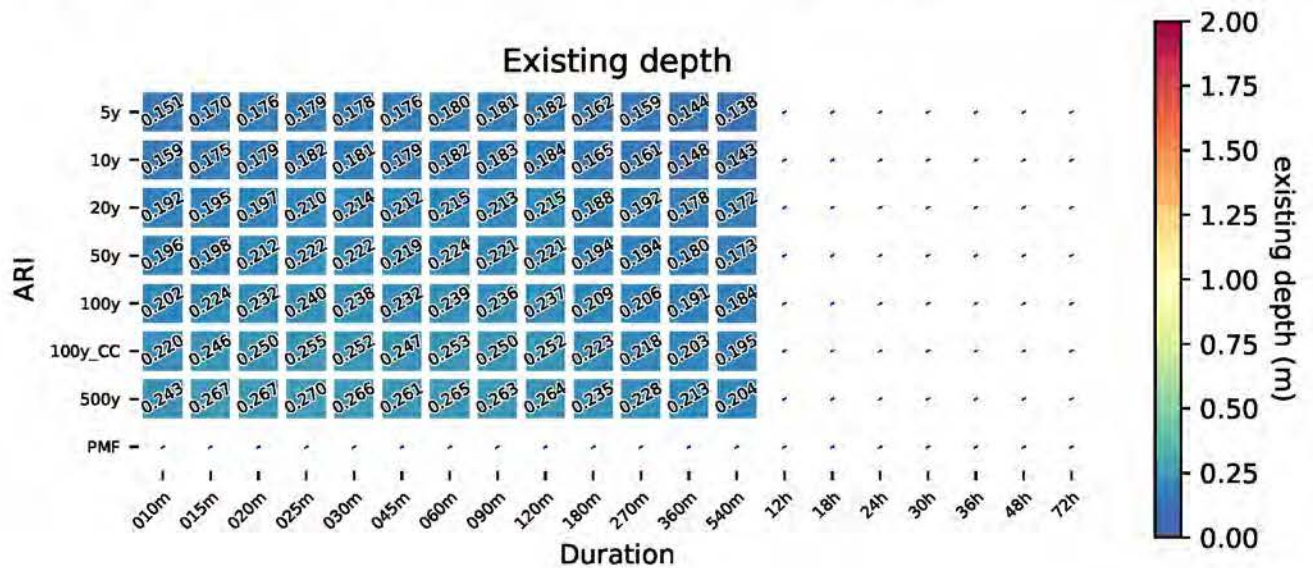




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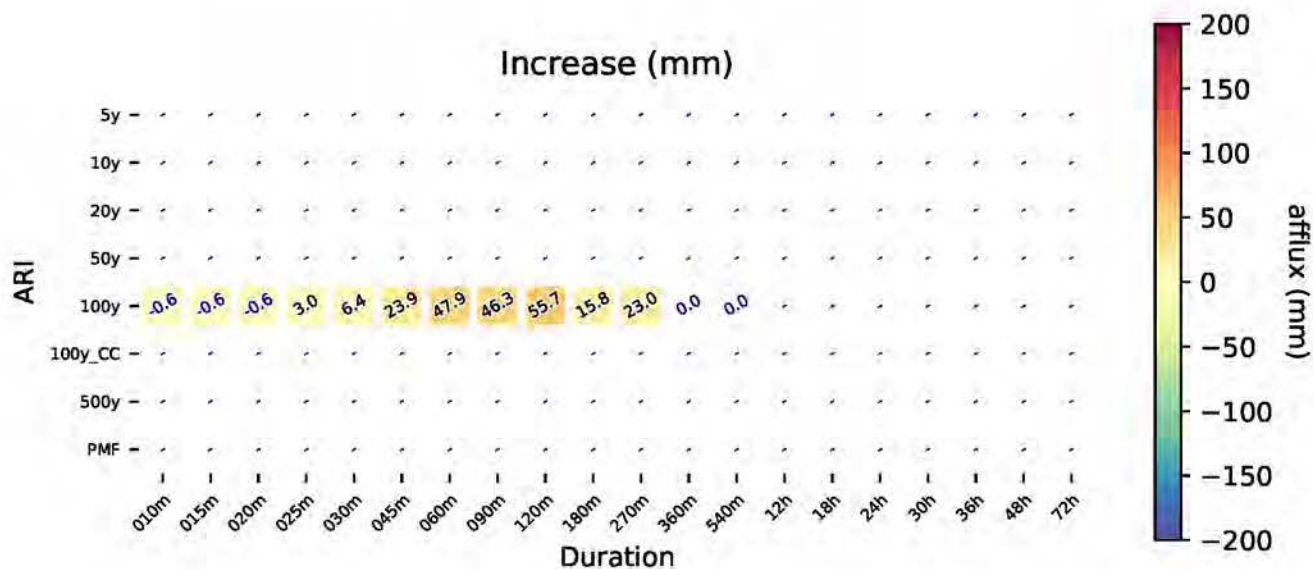
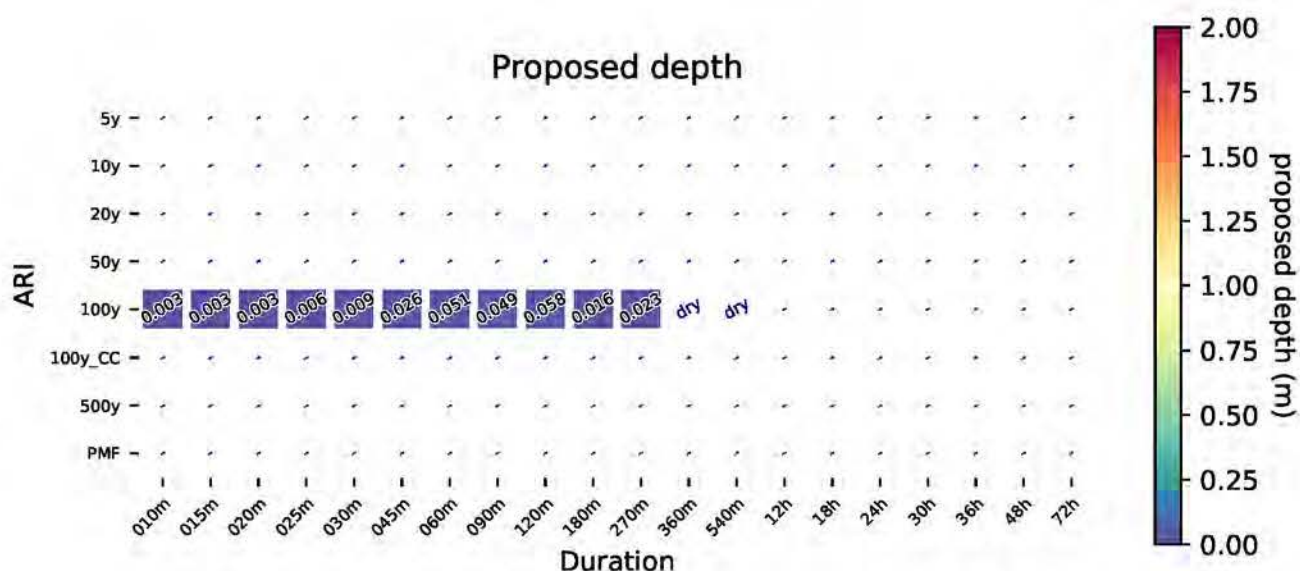
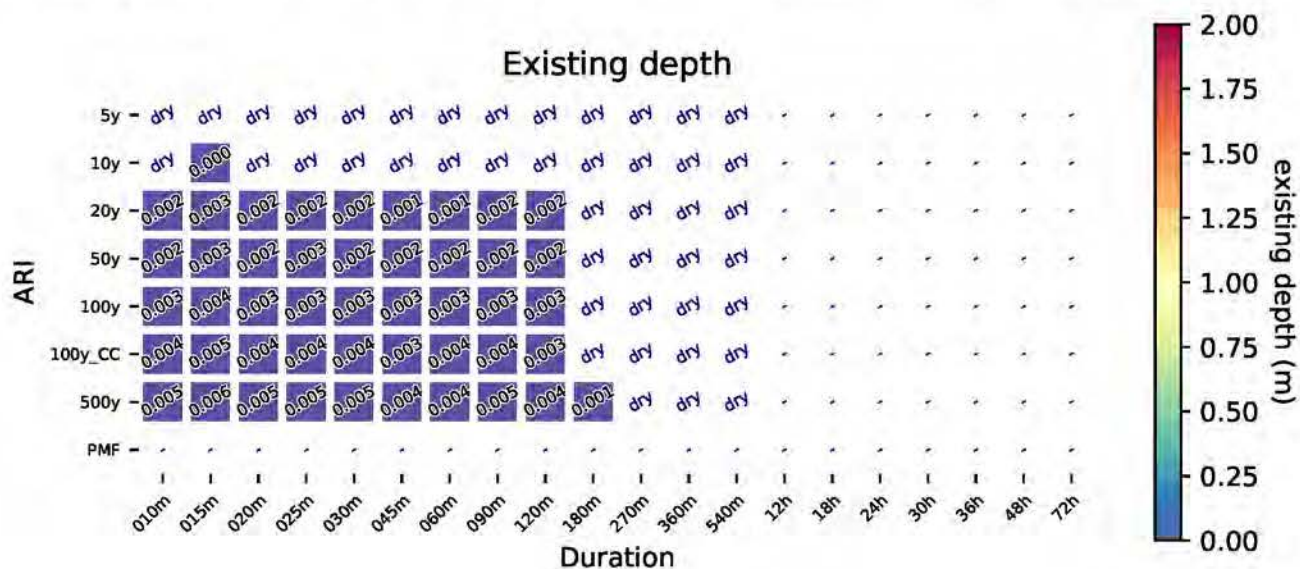


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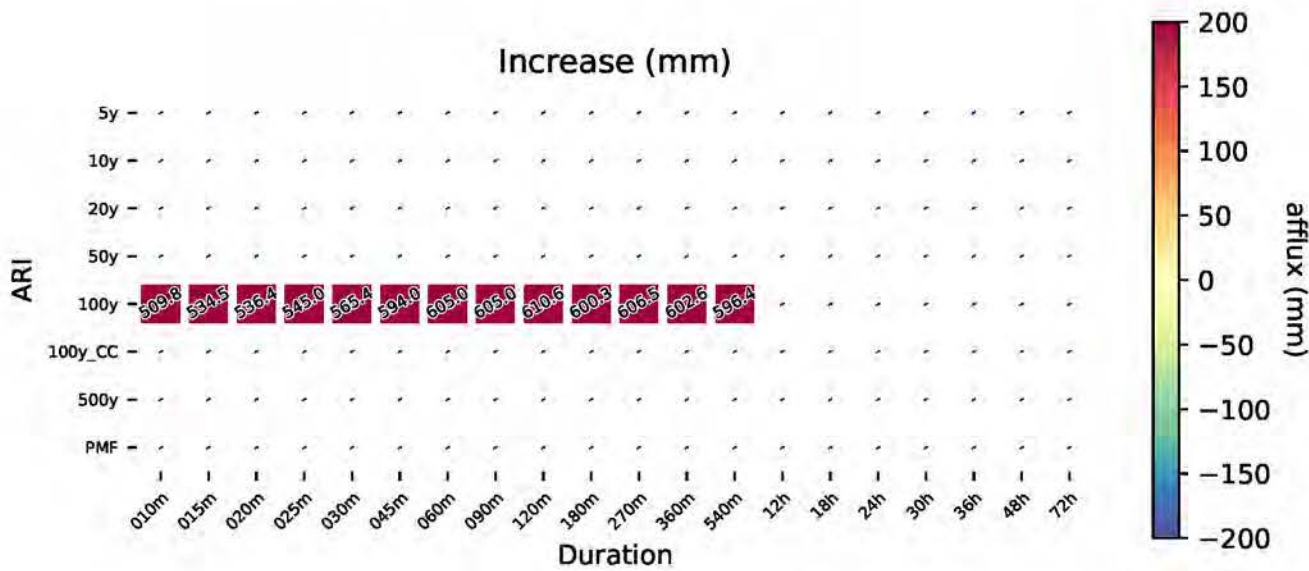
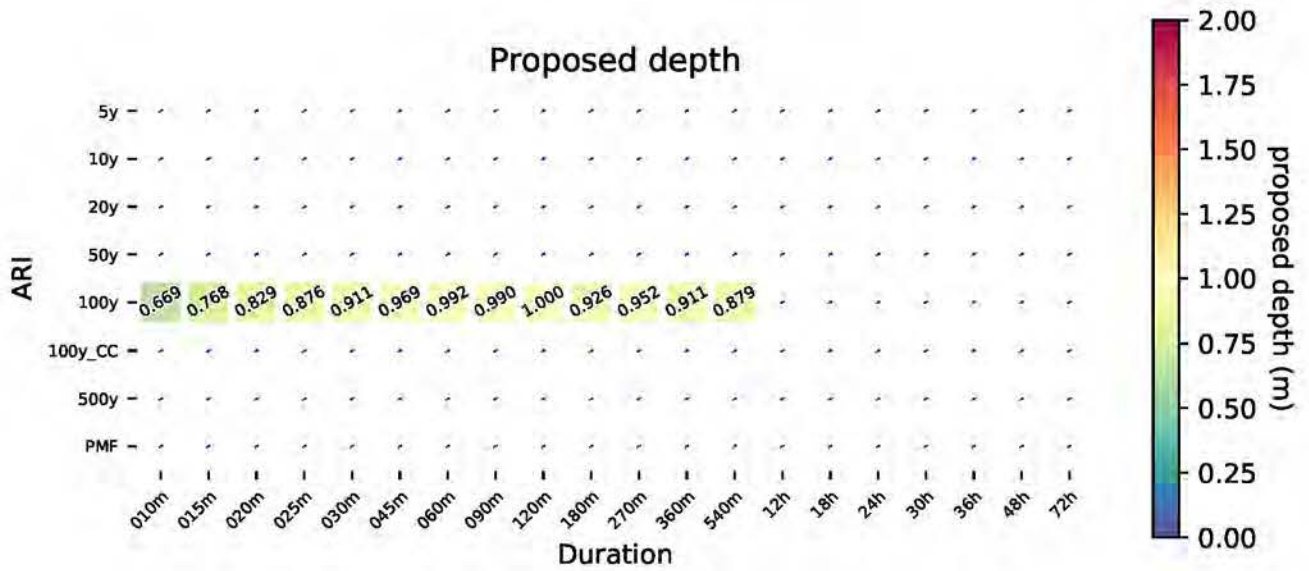
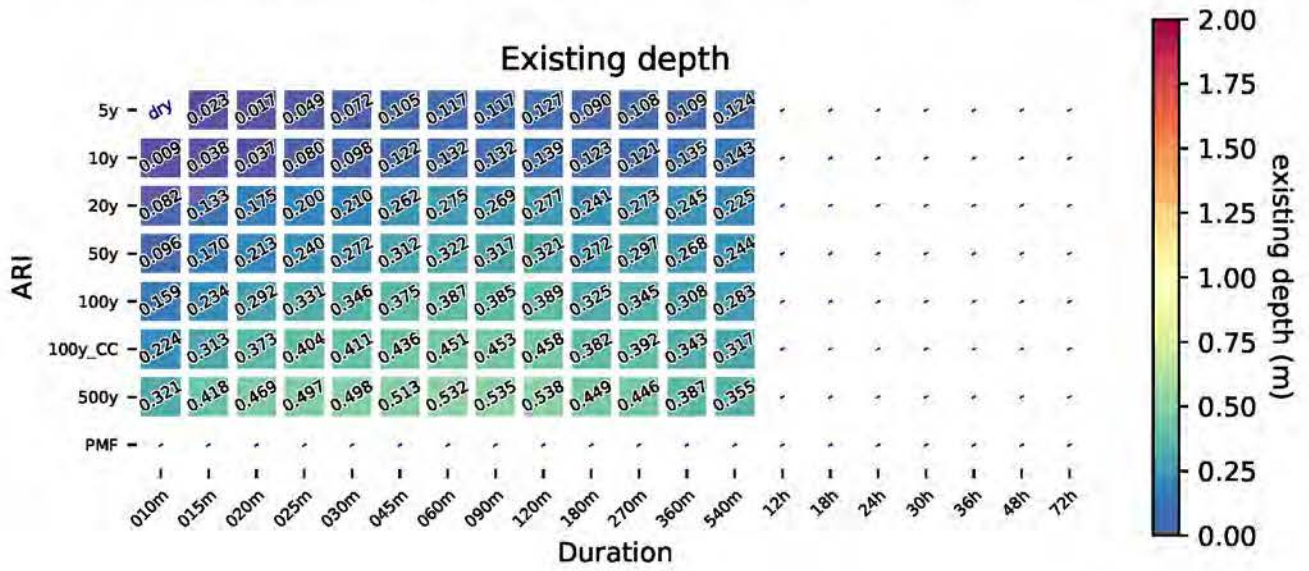




# Banyule Creek Construction Alternate NthSth - Drysdale\_St

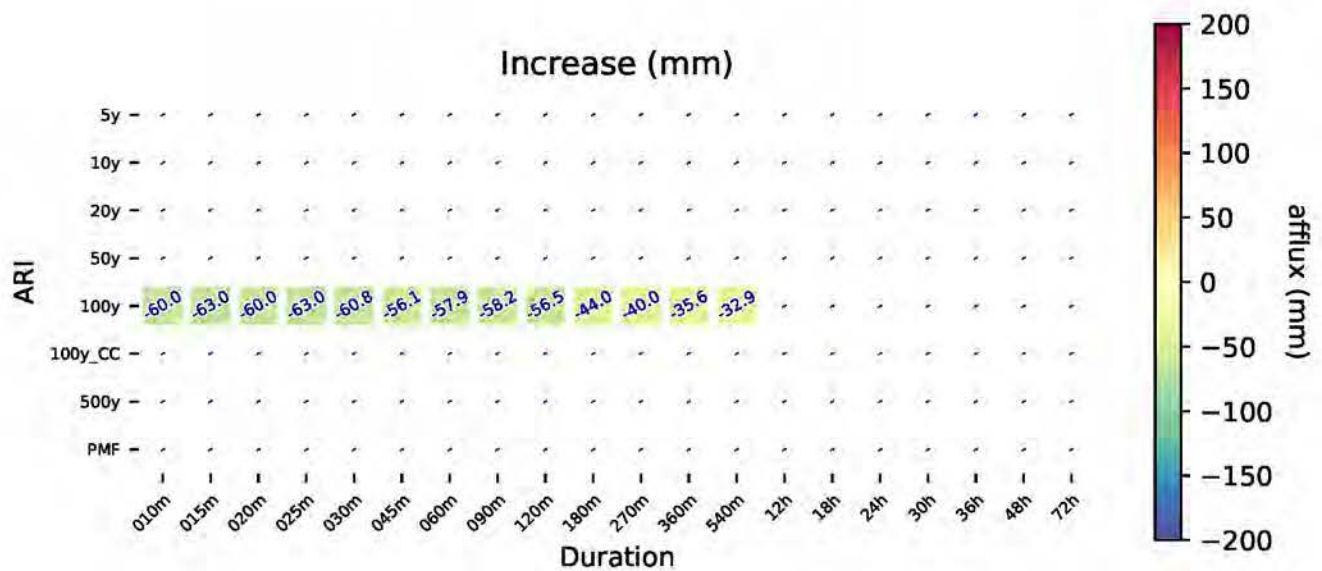
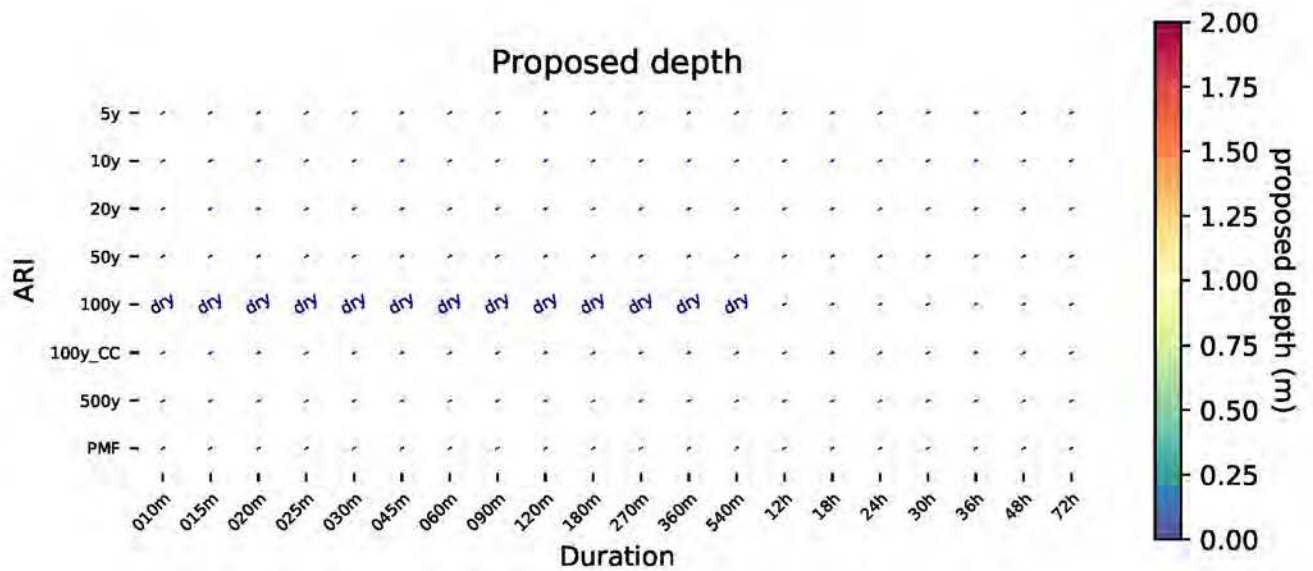
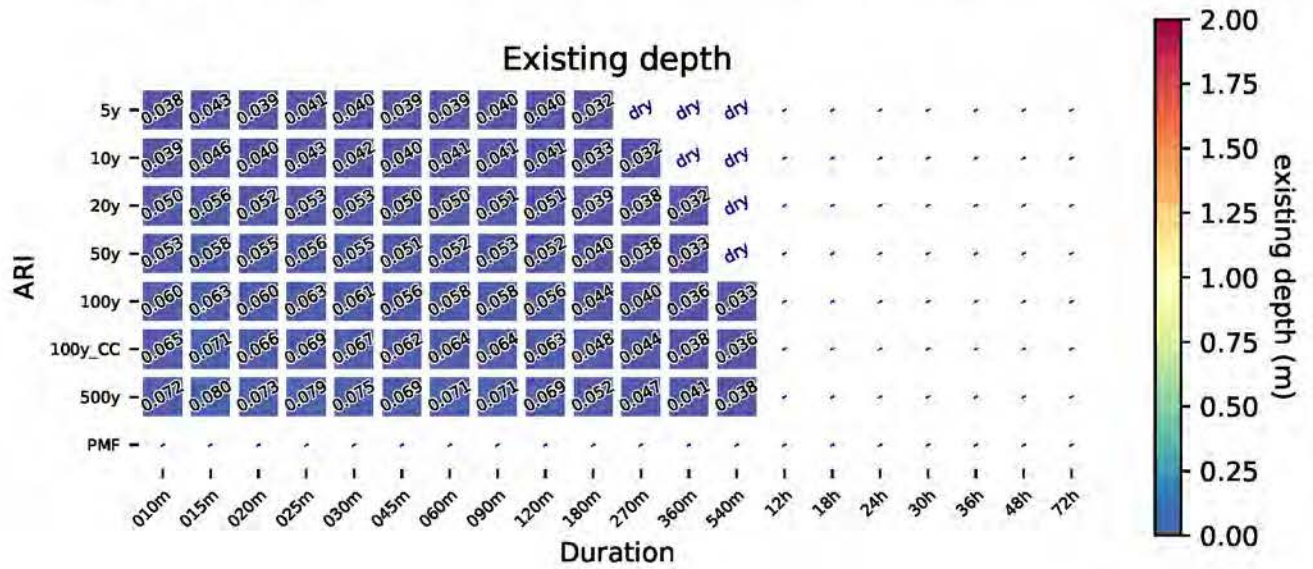


Banyule Creek Construction Alternate NthSth - Debra\_Crt

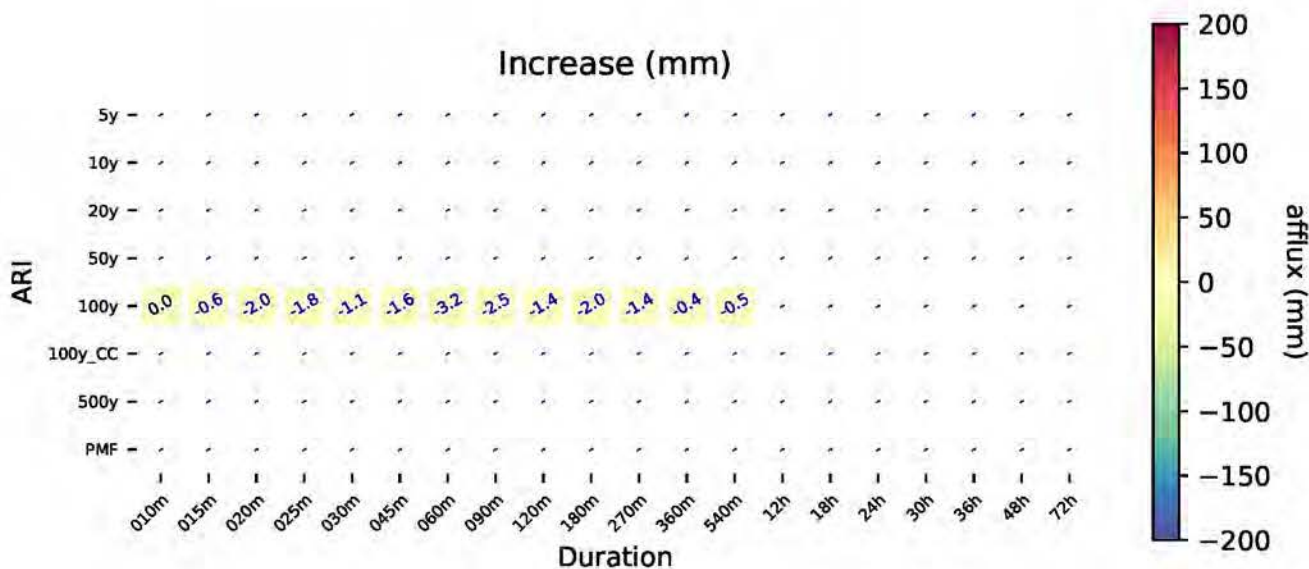
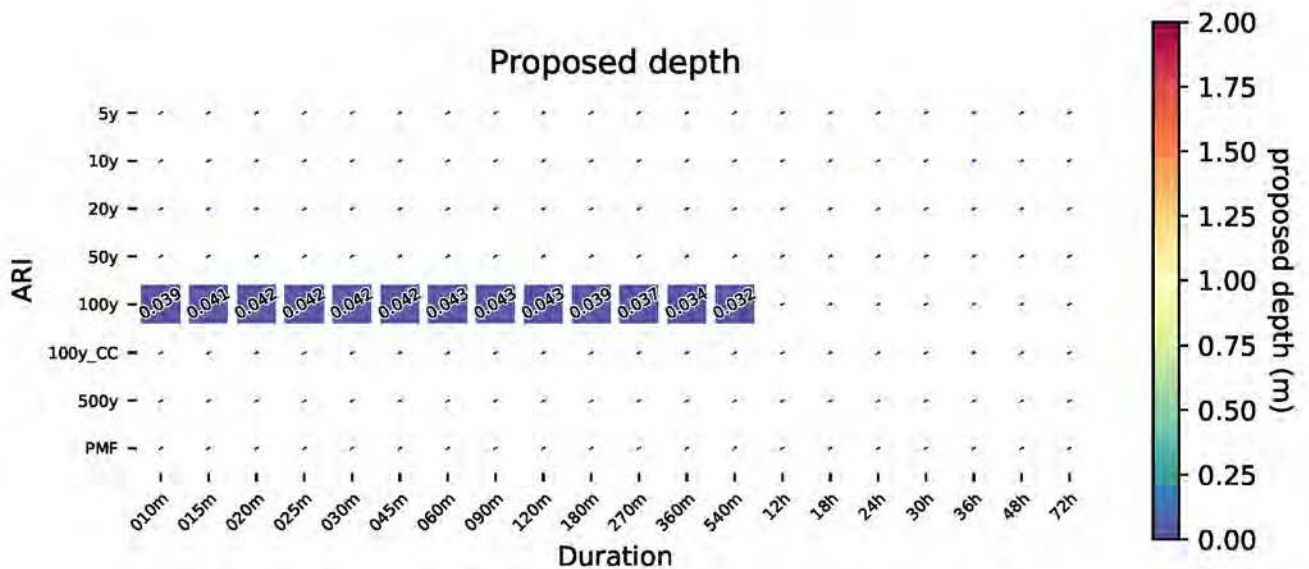
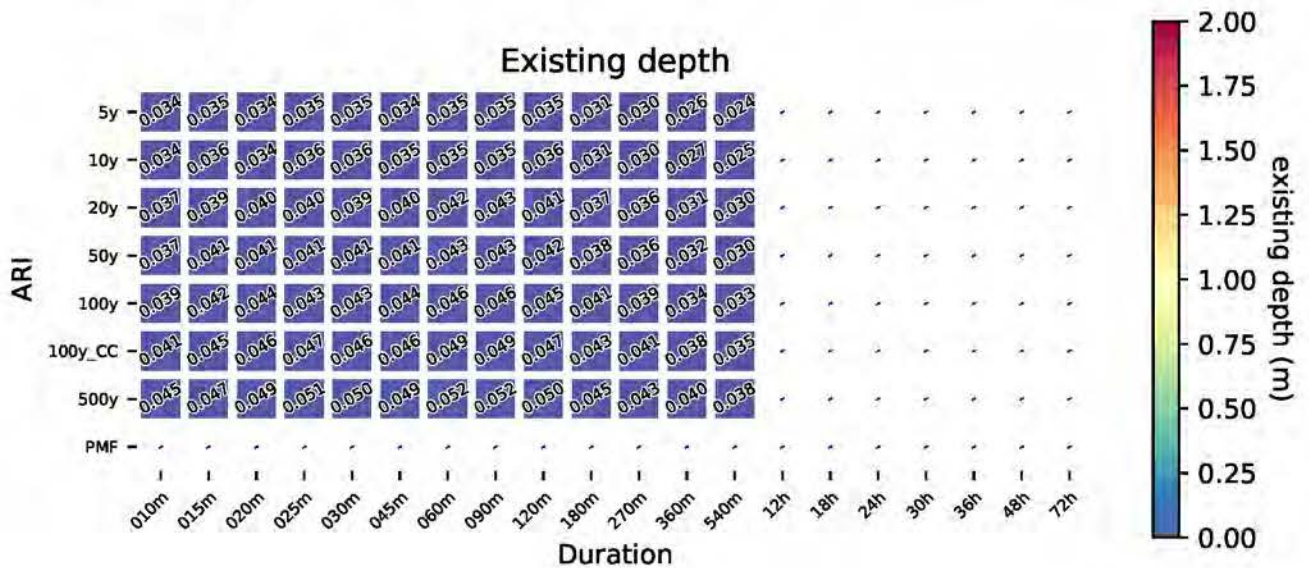




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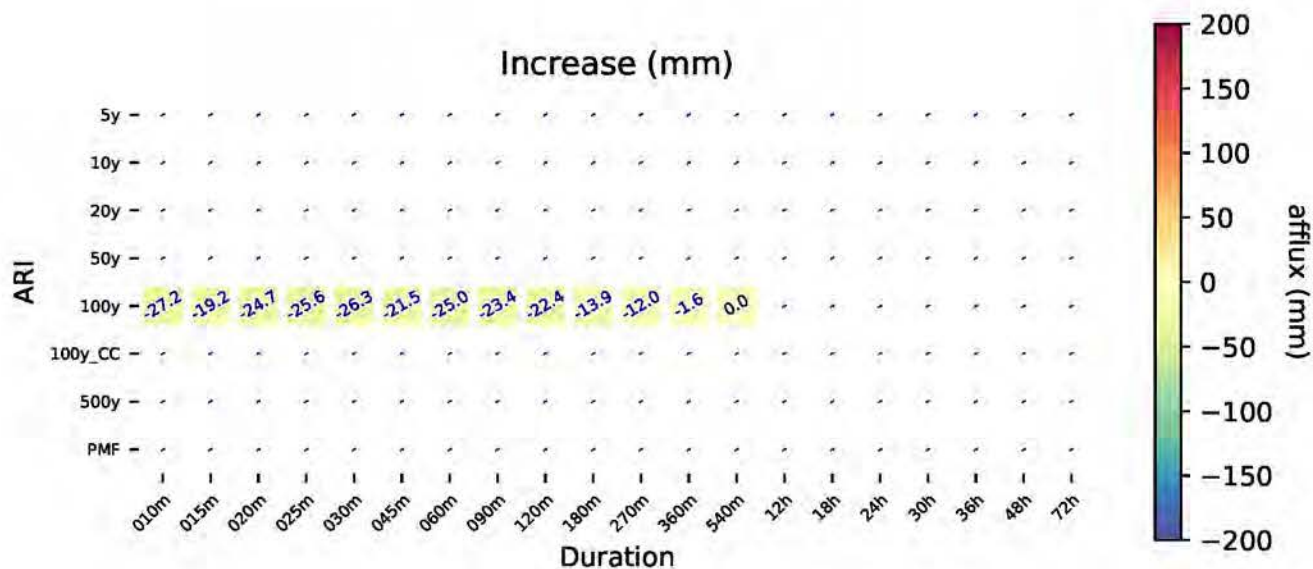
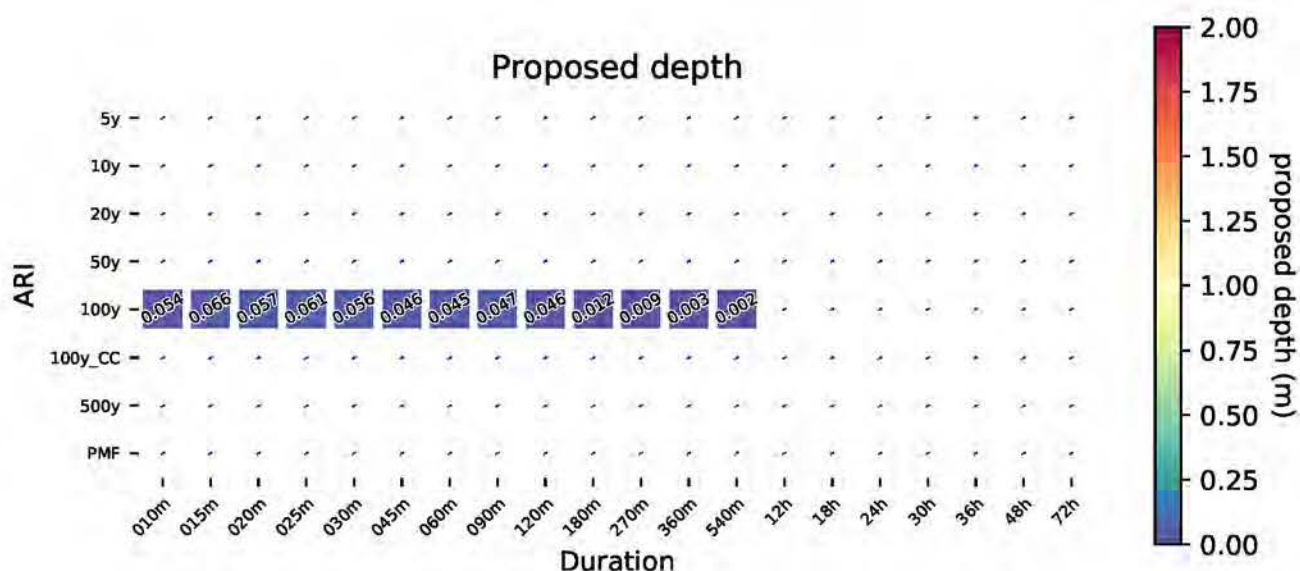
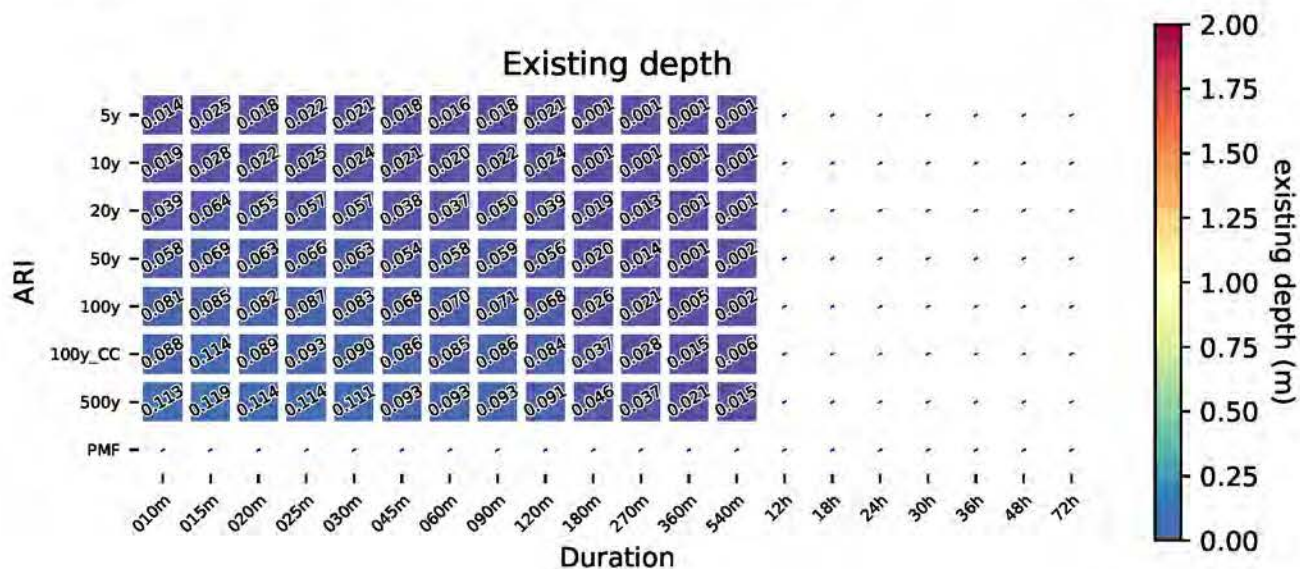


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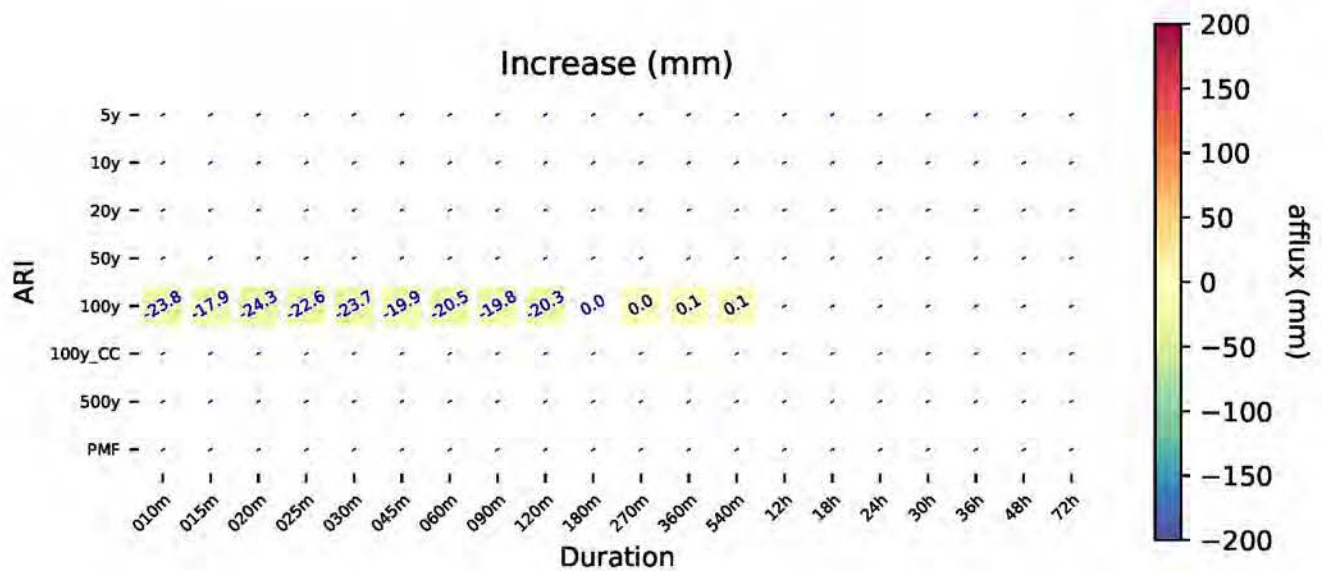
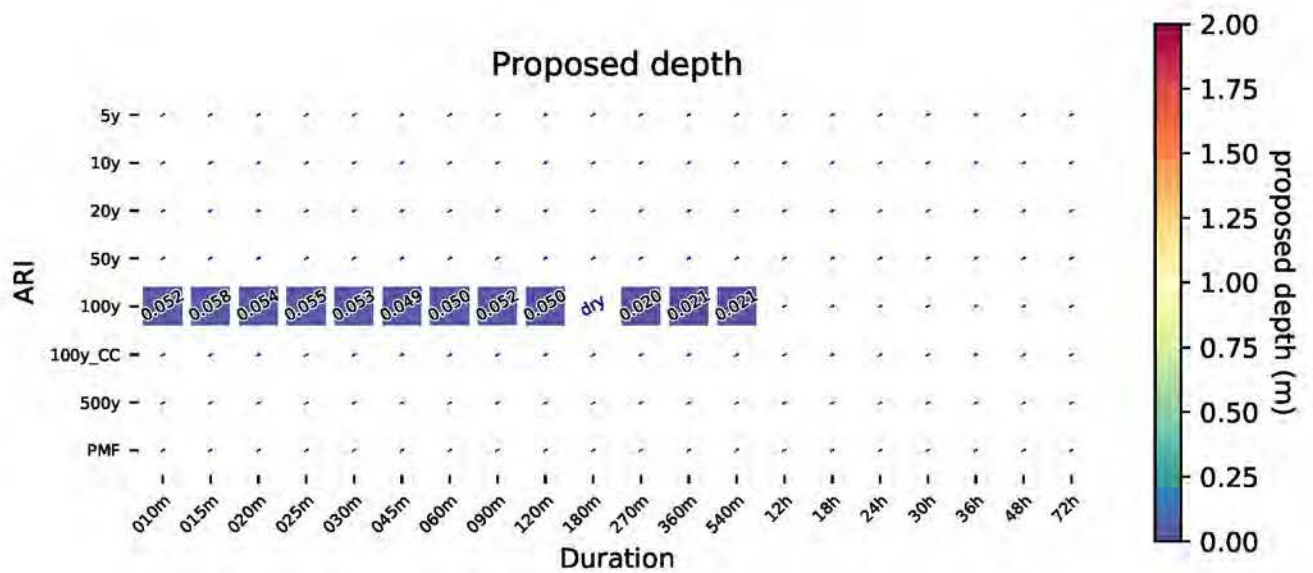
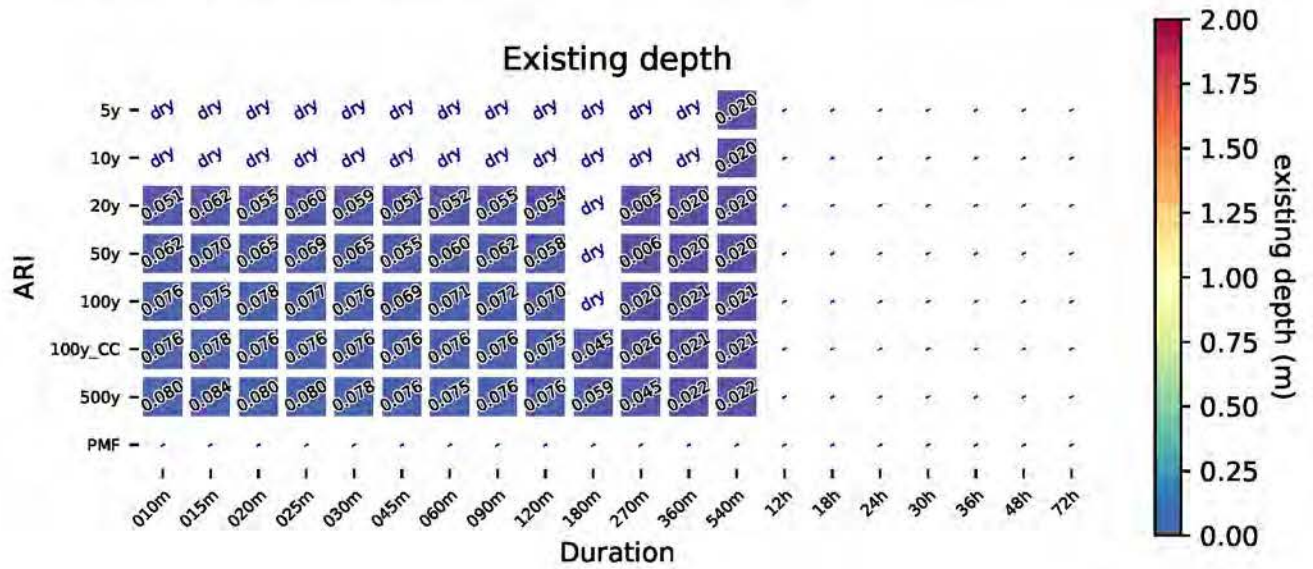




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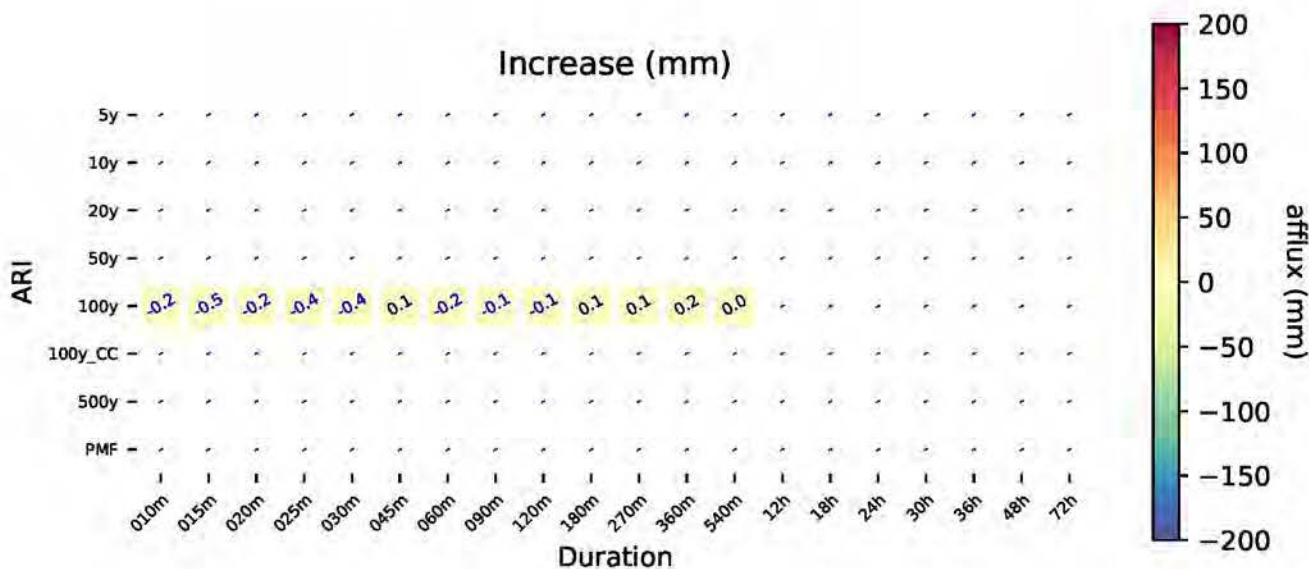
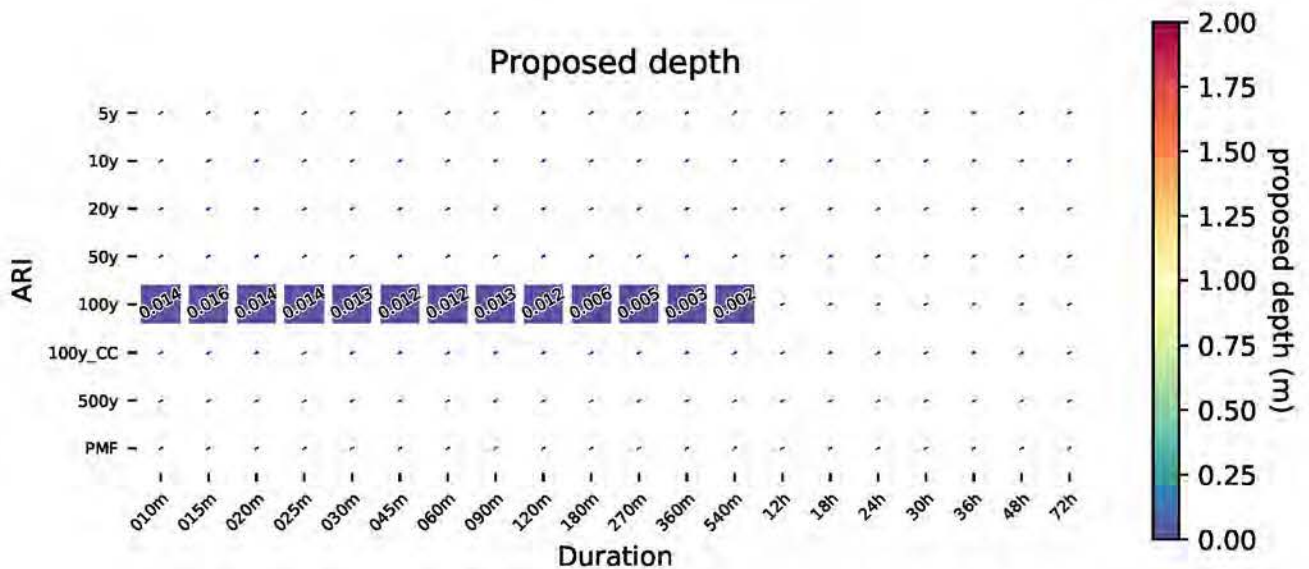
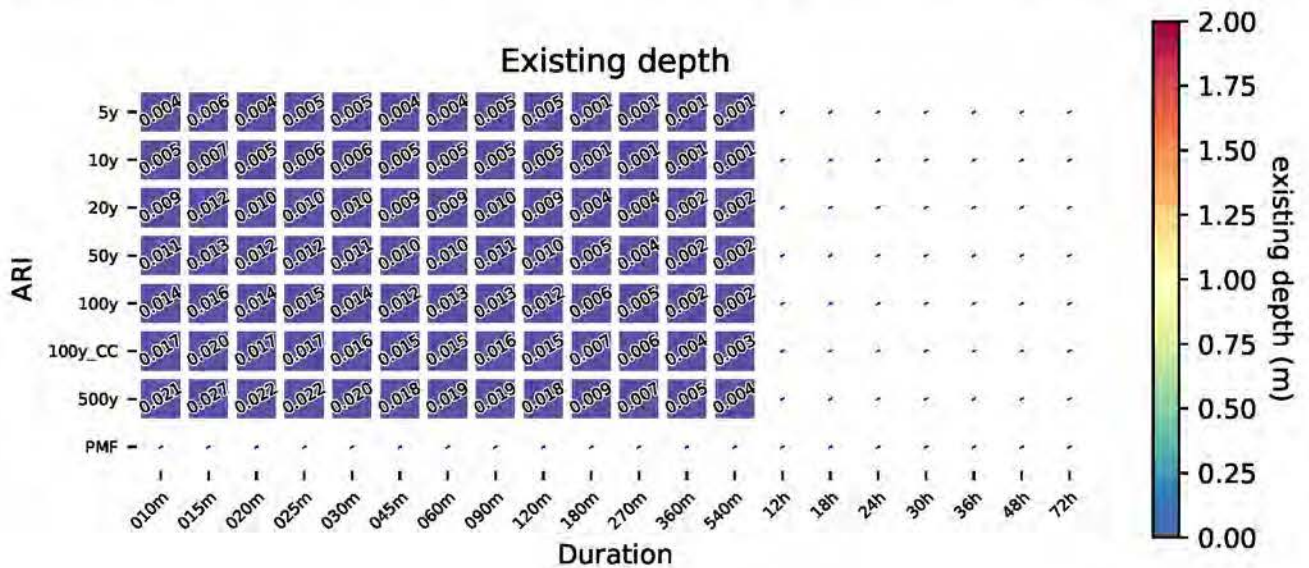


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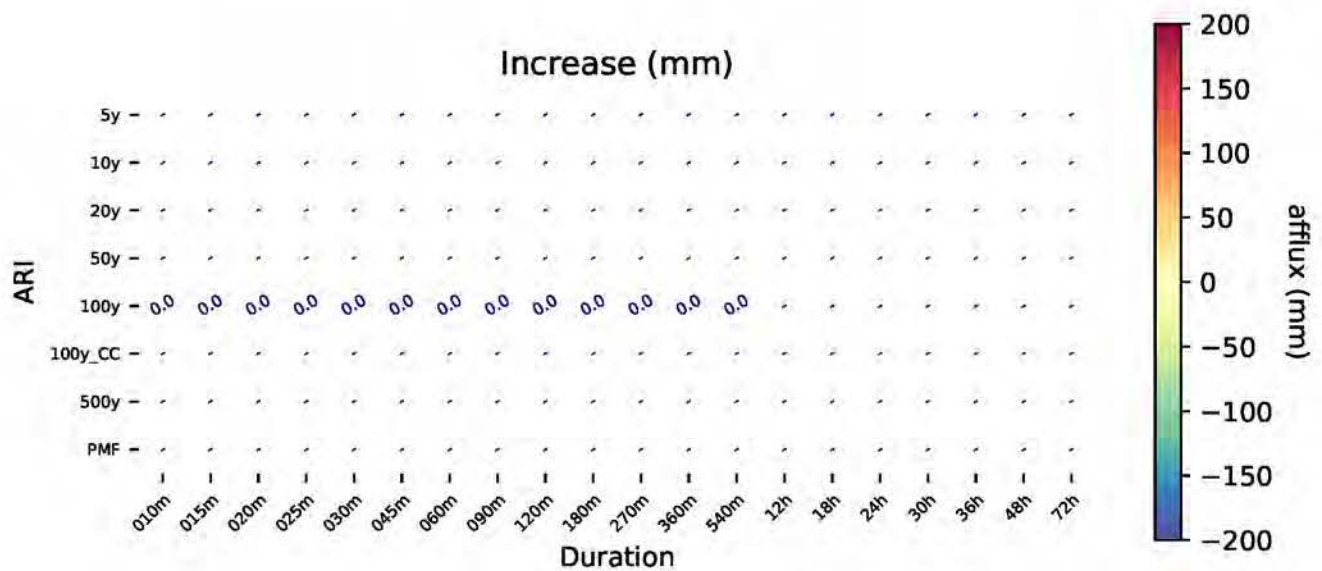
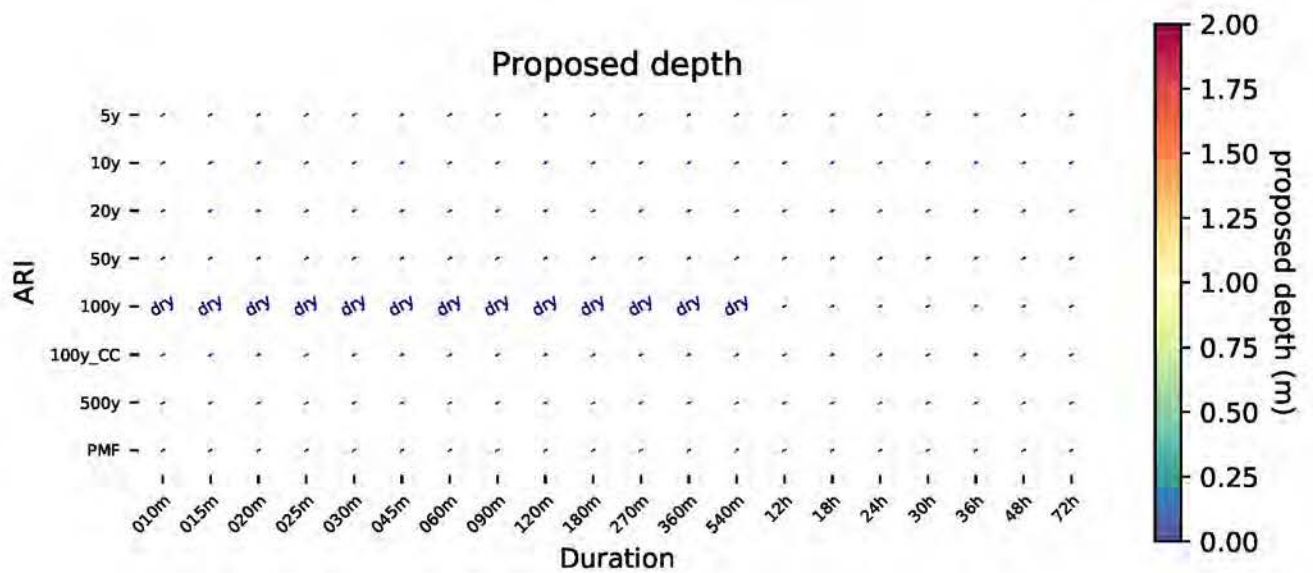
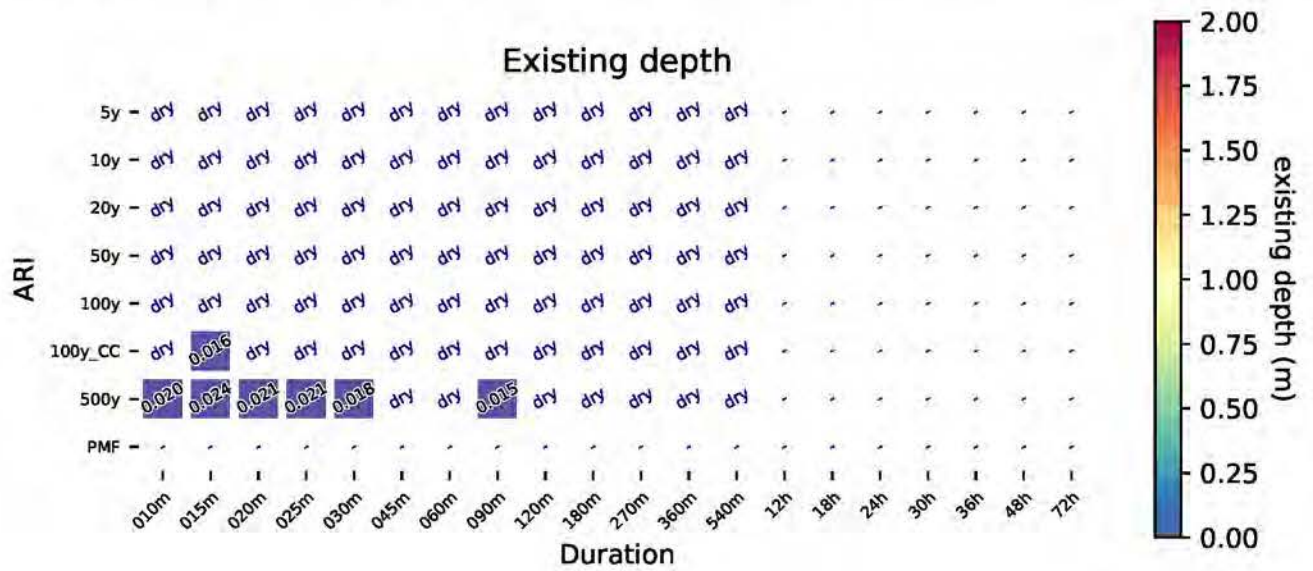




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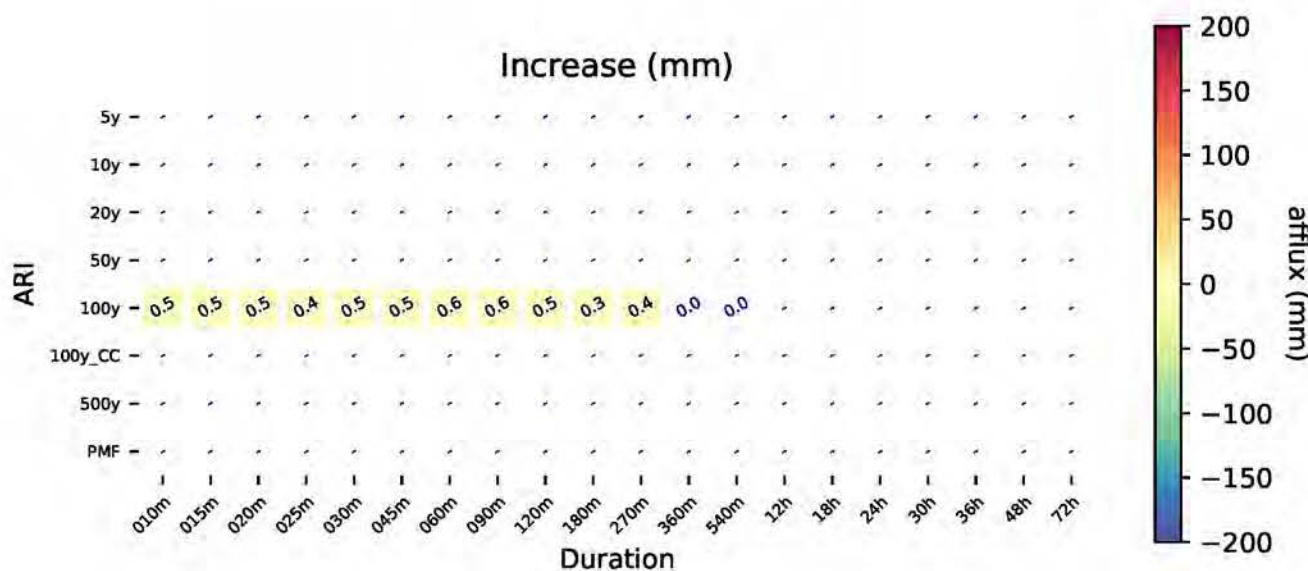
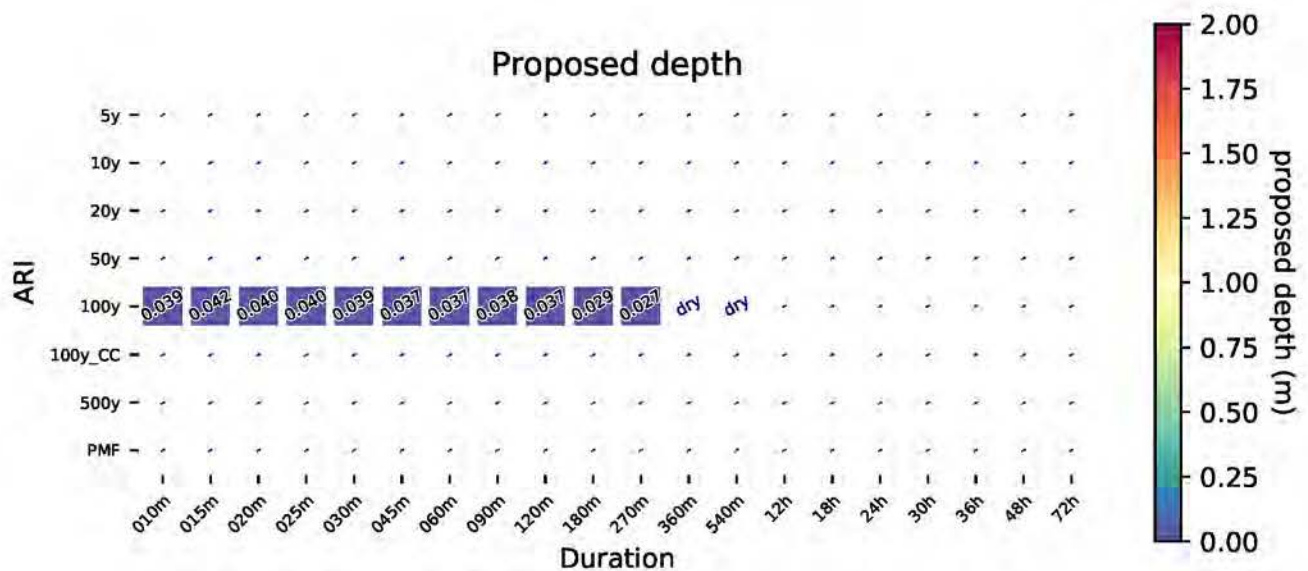
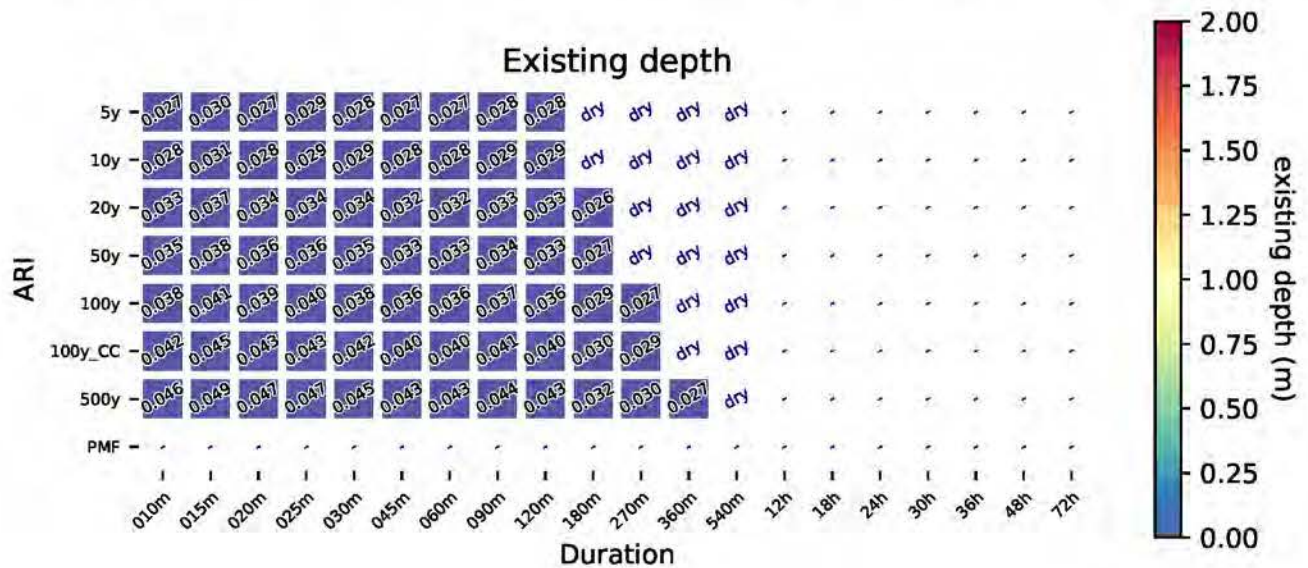


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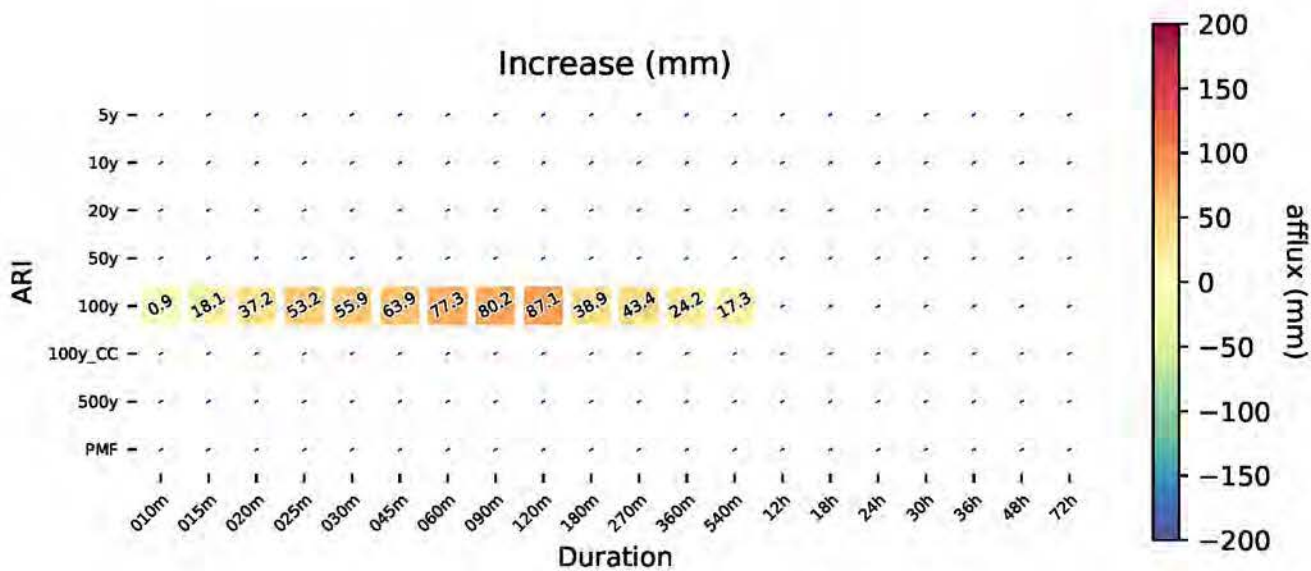
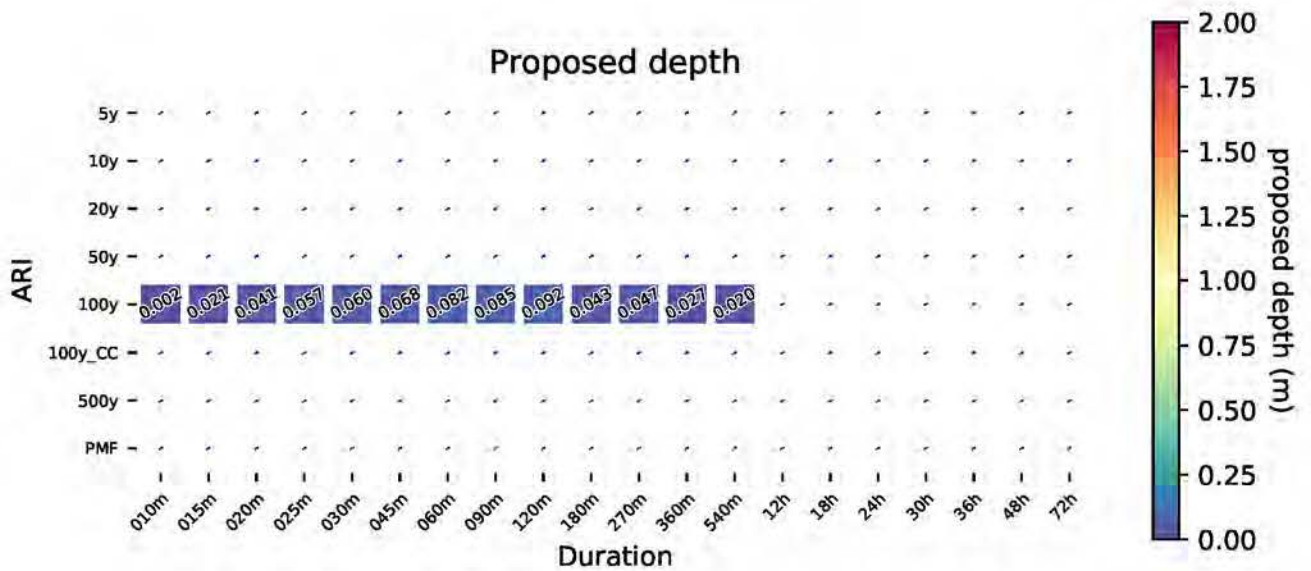
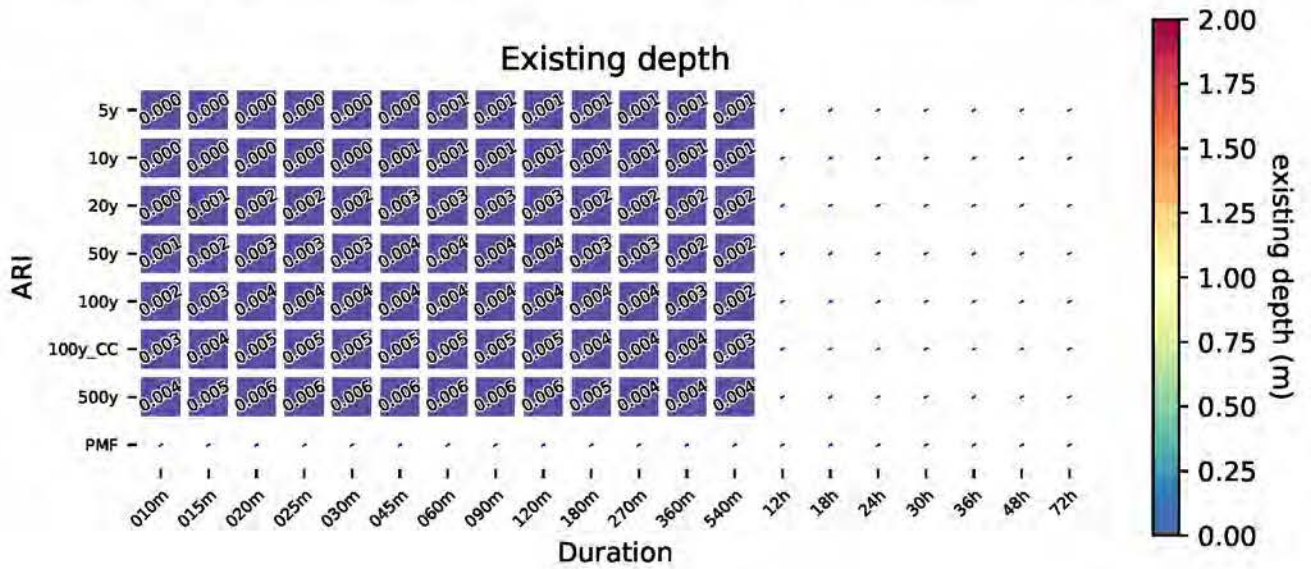




# Banyule Creek Construction Alternate NthSth - Fairlie\_Ave



# Banyule Creek Construction Alternate NthSth - Blamey\_Rd



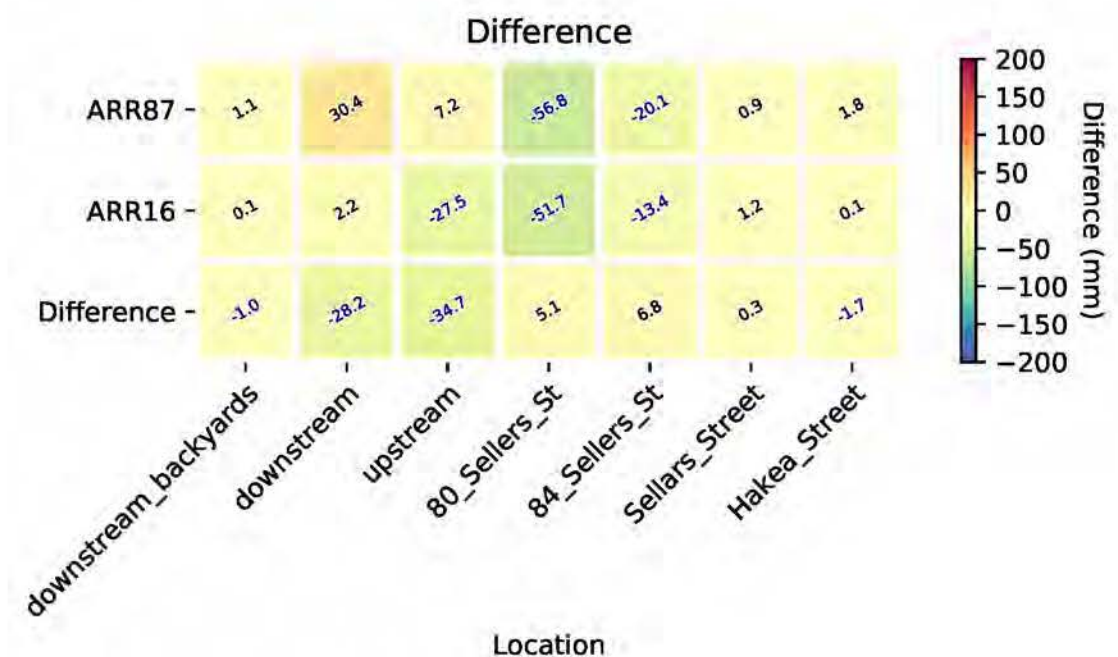
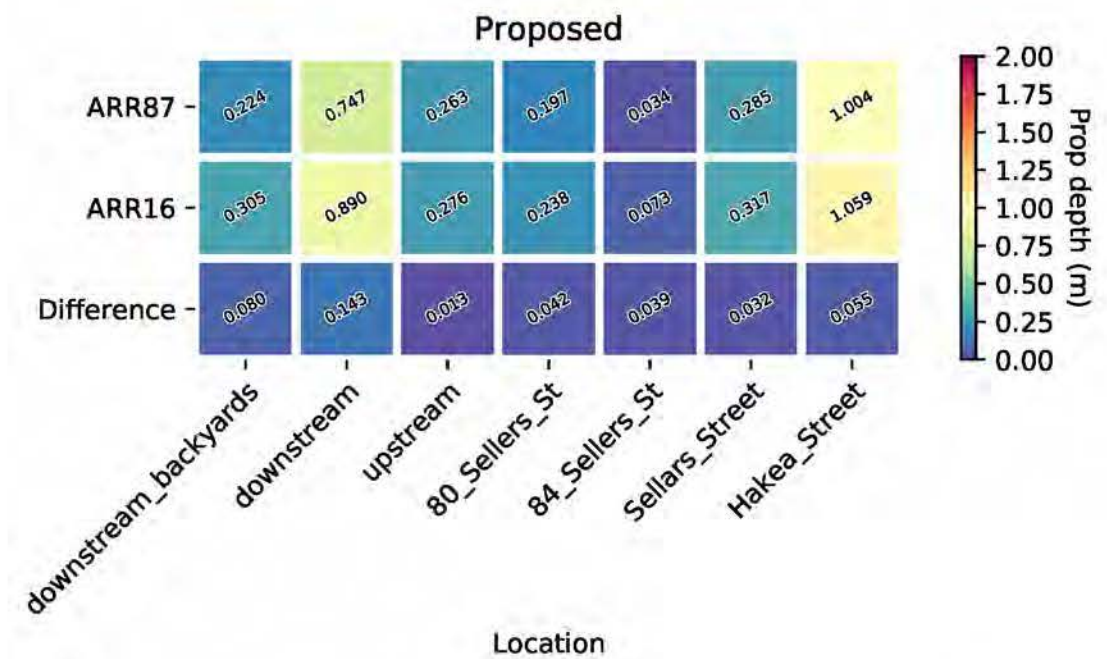
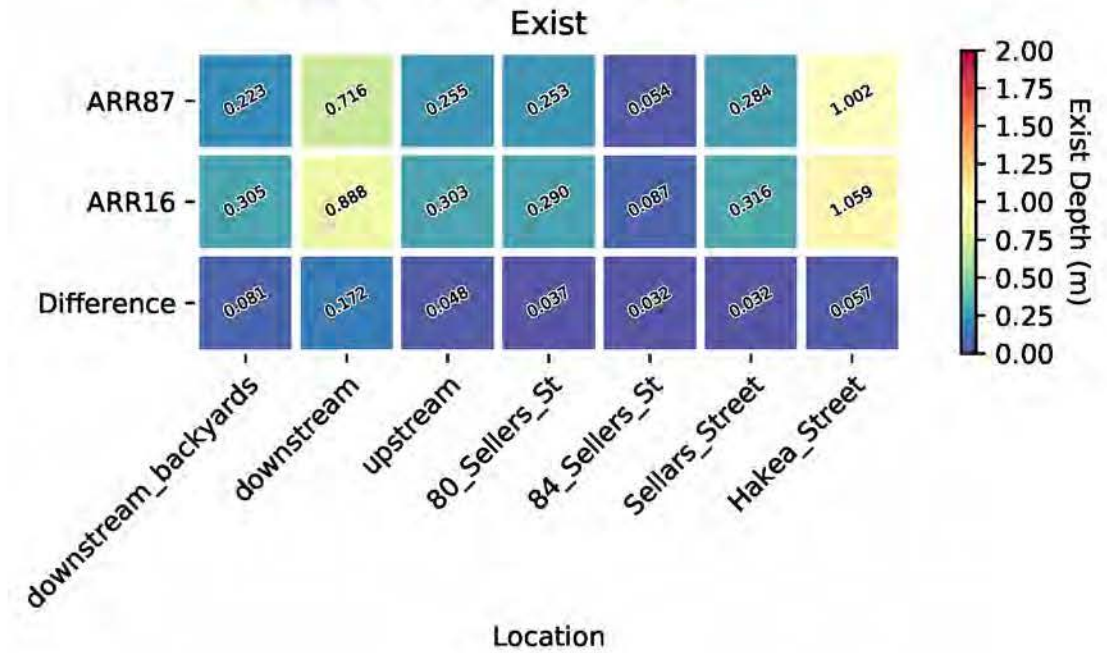




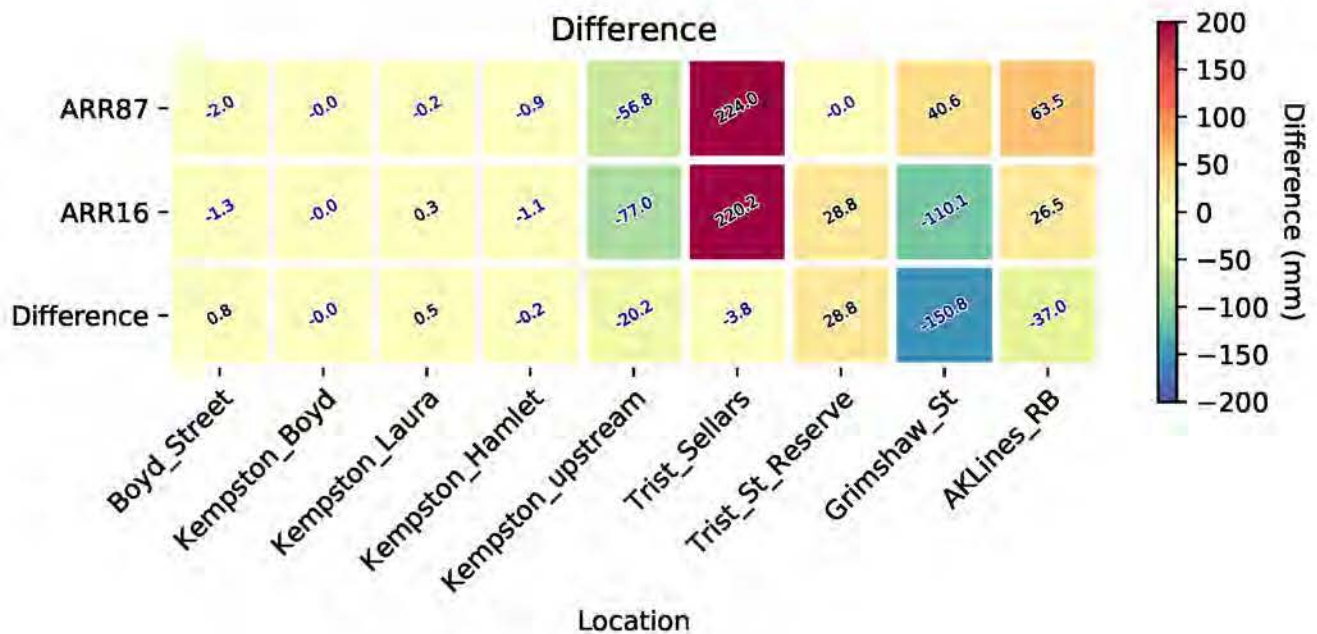
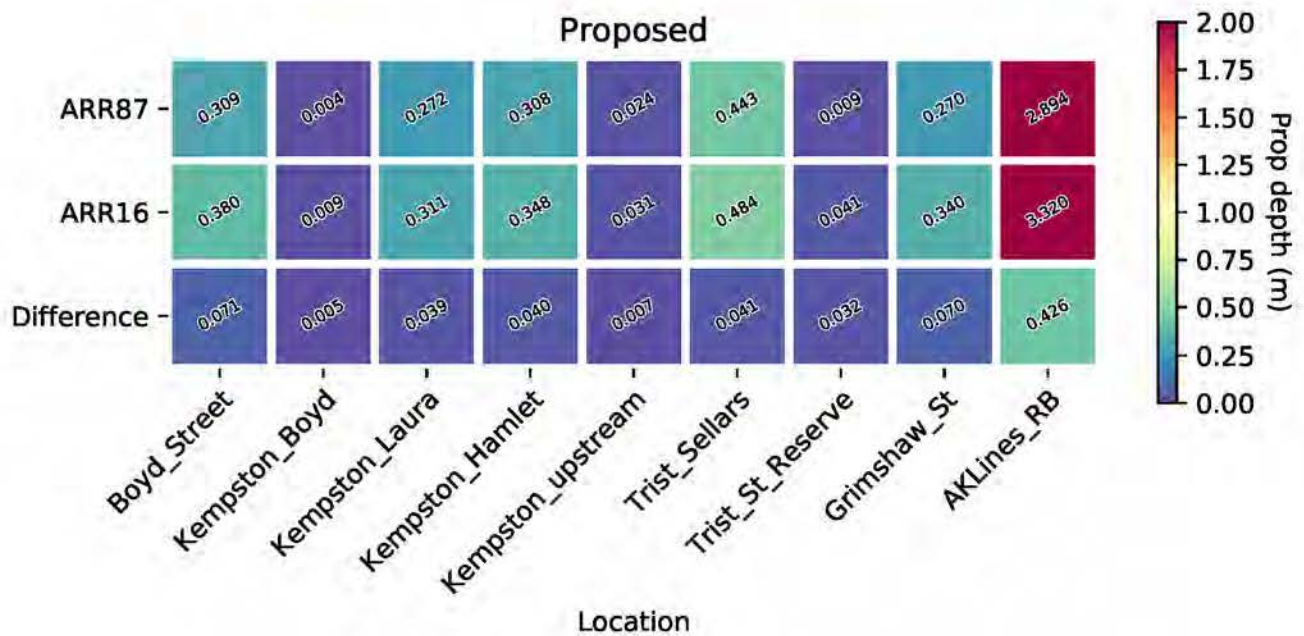
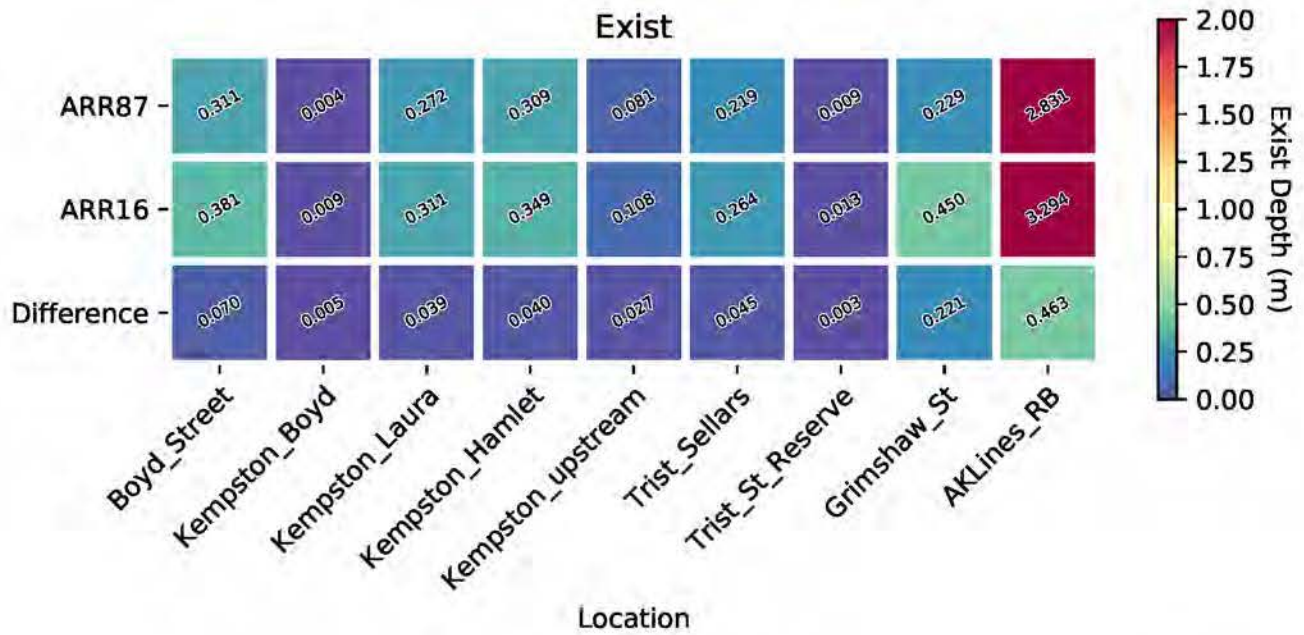
## Appendix F – ARR 2016 sensitivity testing



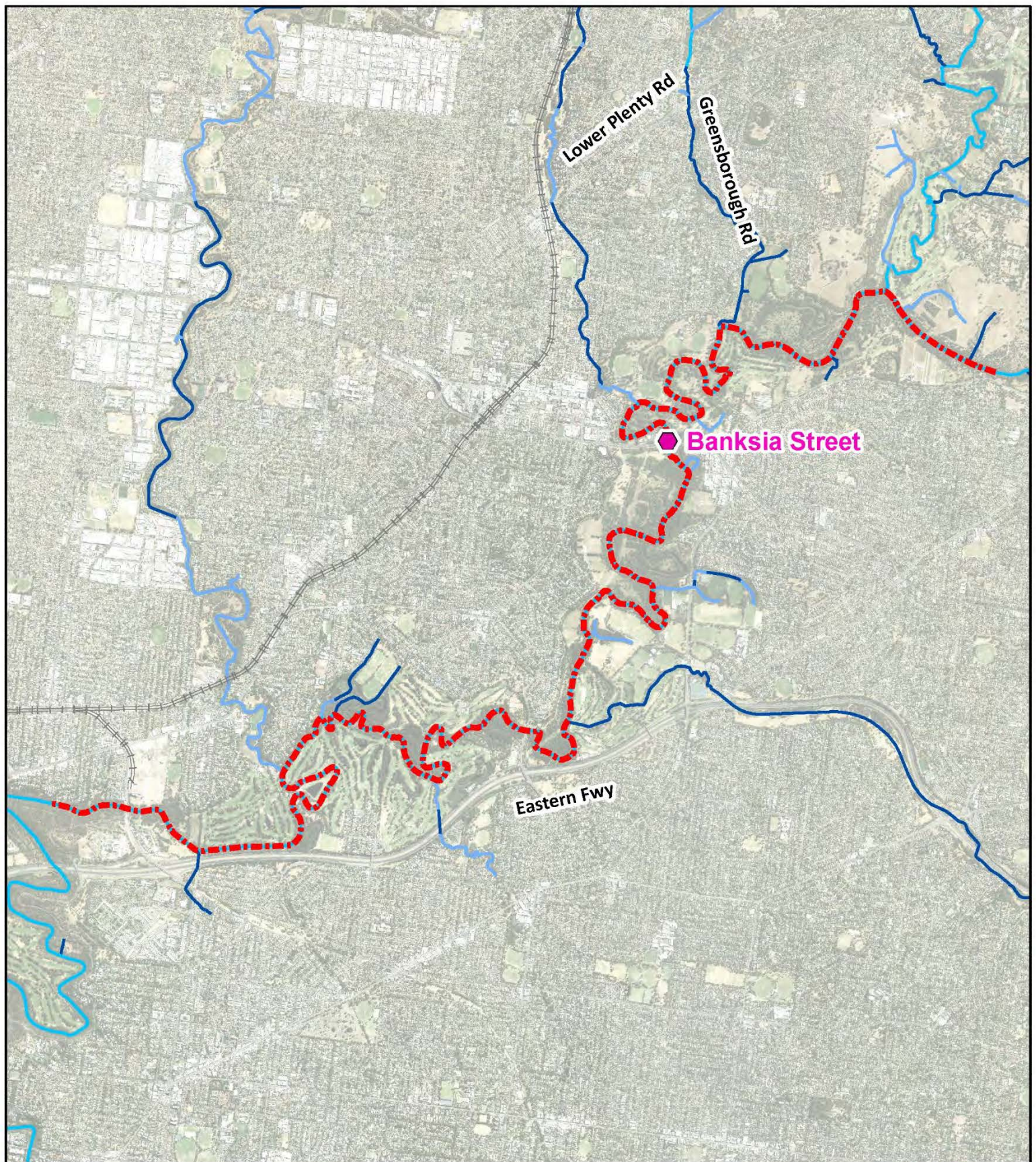
# Yando Street Main Drain



# Kempston Street Main Drain







## LEGEND

- ◆ Banksia Street
- Yarra Long Section
- River
- Stream
- Channel
- Drain



Paper Size A4

0 280 560 1,120  
Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



North East Link  
North East Link Project

Job Number	31-35006
Revision	A
Date	23/10/2018

Comparison point and long section  
Yarra River

Figure F-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\EE\Groundwater and Hydrology\Surface\_Water\35006\_Hydraulic\Banksia Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com  
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

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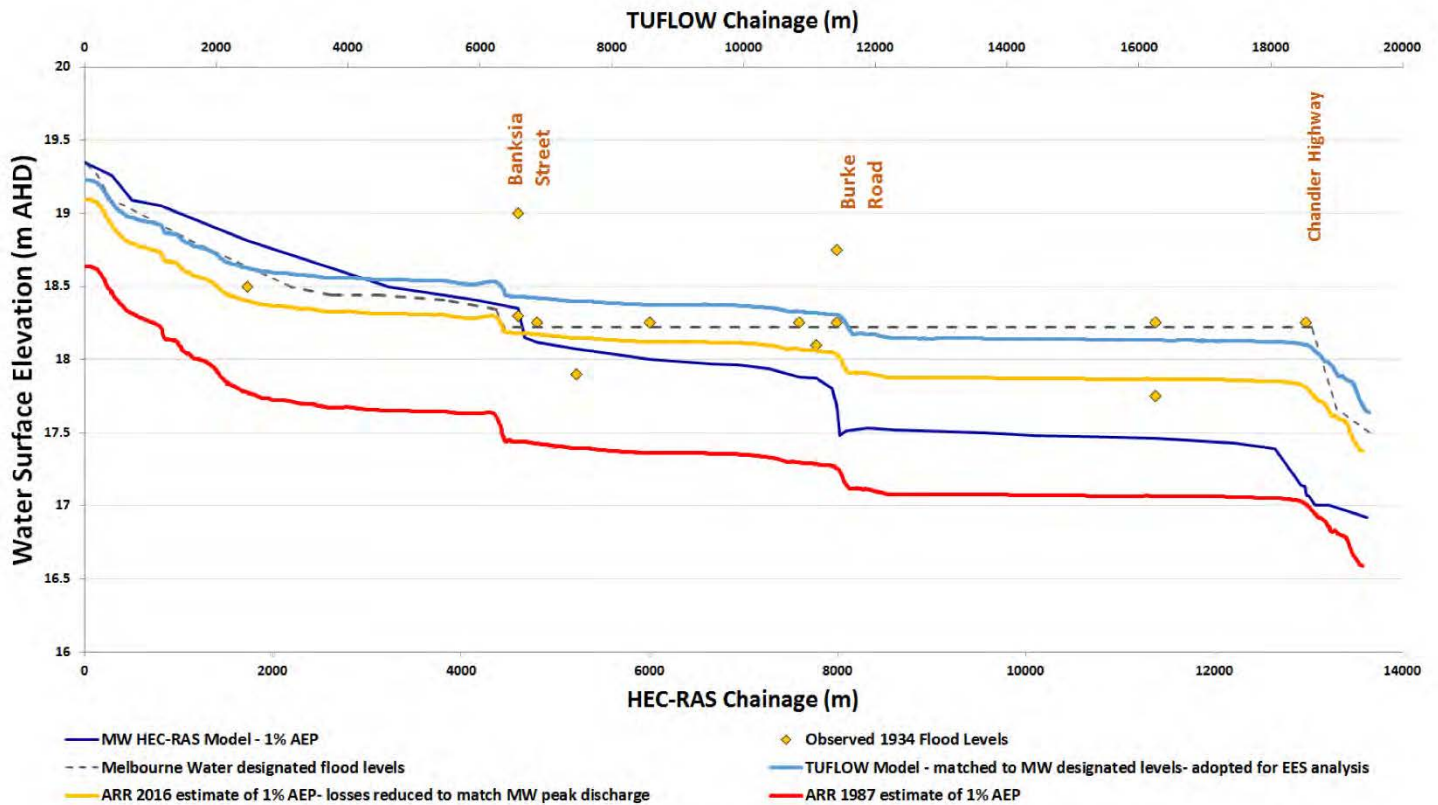


Figure F-2 Yarra River long sections and water surface elevation comparison

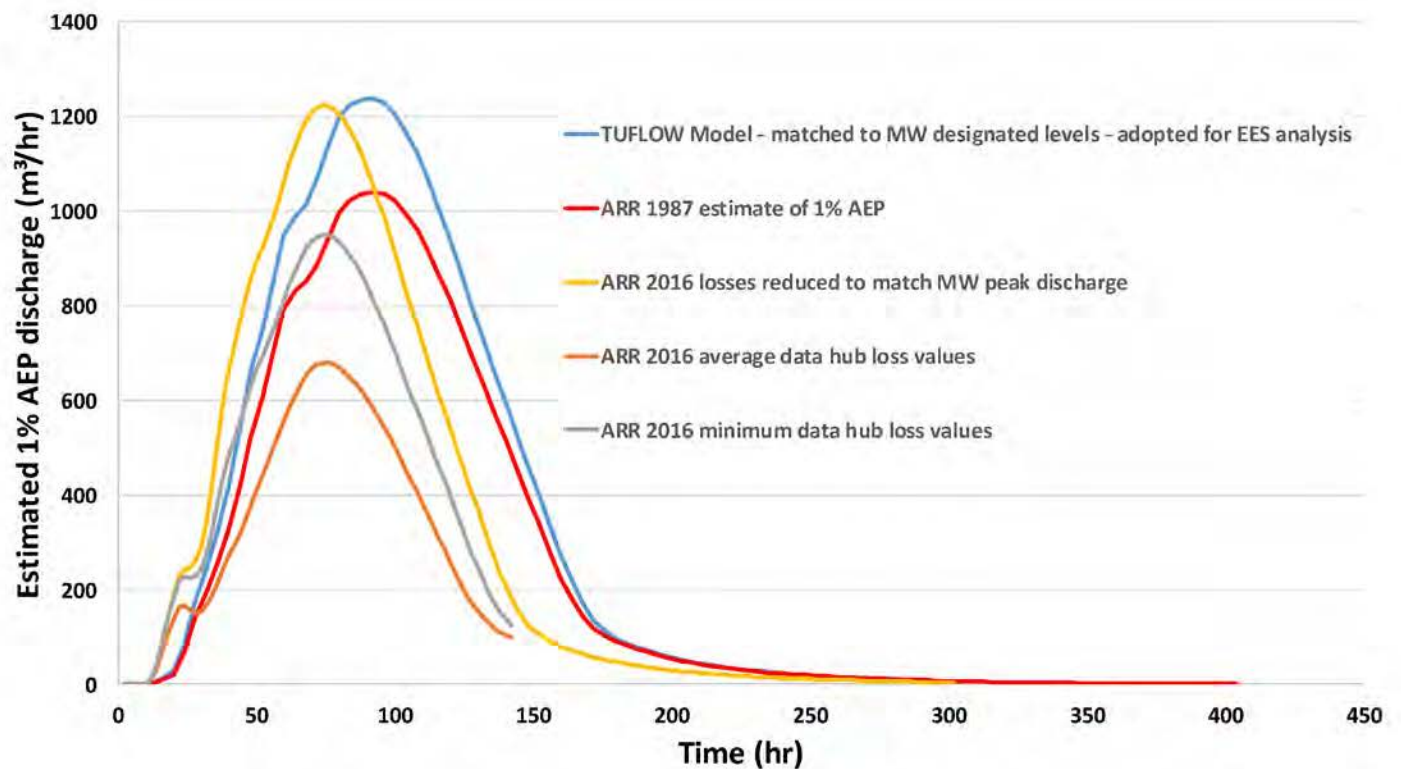


Figure F-3 Hydrograph comparison at Banksia street





# Appendix G – Peer review report



## EXPERT PEER REVIEW - SURFACE WATER

North East Link Project

4 March 2019

Prepared by Hydro-Electric Corporation  
ABN48 072 377 158

t/a Entura, Level 25, 500 Collins St.  
Melbourne VIC 3000 Australia



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## Document information

Title	Expert Peer Review - Surface Water
	North East Link Project
Client organisation	Clayton Utz
Client contact	Chris Wiseman
Document number	E307417
Project manager	David Fuller
Project reference	514279

## Revision history

### Revision 1

Revision description	Final		
Prepared by	David Fuller		4 Mar 2019
Reviewed by	N/A		
Approved by	David Fuller		4 Mar 2019
	(name)	(signature)	(date)
Distributed to	Chris Wiseman	Clayton Utz	4 Mar 2019
	(name)	(organisation)	(date)

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Annexure - Qualifications



# 1. Introduction

This is my independent review of the North East Link Project Surface Water Report.

In undertaking this review and preparing this report I have relied upon my own knowledge, skills and experience in engineering hydrology, hydraulic modelling, water quality and environmental hydrology.

## 1.1 Name and address

David Allan Fuller

Principal Water Management & Technology

Hydro Tasmania t/a Entura

Level 25, 500 Collins Street, Melbourne, VIC 3000

## 1.2 Area of expertise

### 1.2.1 Qualifications

My qualifications and experience are detailed in Annexure A.

I hold the following degrees:

- Bachelor of Science (Physics/Mathematics)
- Postgraduate Diploma in Statistics
- Master of Business Administration
- Master of Economics
- I also successfully completed the Masters level Post-graduate Course in Hydrology at the University of New South Wales.

### 1.2.2 Experience

For the past 37 years I have practiced in engineering hydrology, hydraulics, stream gauging, water quality, environmental hydrology, water management and the environmental impacts of developments across all states and territories of Australia and internationally.

I have worked in private firms as a consultant, for a major hydro-electric utility and for a State regulatory agency. My clients have included national and international corporations, State authorities, developers, Commonwealth agencies and private companies.

### 1.3 Scope

Entura was engaged to undertake the expert peer review to:

- (a) assess the process, methodology and assessment undertaken in preparation of the Impact Assessment Report including any assessment criteria applied or assumptions relied upon;
- (b) identify any additional matters which should be considered in order to address the EES Scoping Requirements, "public works" declaration or to otherwise adequately assess the likely impacts of NEL;
- (c) assess the adequacy of proposed Environmental Performance Requirements to manage potential adverse impacts arising from NEL.

The peer review process was limited to a review of reports and discussions with technical personnel who had contributed to the report regarding the assumptions made, the conclusions reached, the approaches taken, the standards used, and the data and calibration methods supporting the modelled results.

No detailed hands-on technical evaluation of the hydraulic or hydrological models was undertaken.

### 1.4 Reports reviewed in preparing this document

A number of versions of the draft surface water report were provided to Entura during the course of the review. The authors addressed comments made by Entura on the reports during each round of this process.

### 1.5 Persons assisting with this work

Nil. The views presented in this report reflect my opinions based upon my independent review of reports, maps and analyses presented.

## 2. Peer review findings

The surface water report is a substantial report that includes the analysis of the potential impacts on surface water flooding depths, velocities and areas of inundation from works associated with the North East Link project. In addition, the report provides an assessment of the likely water quality and geomorphological risks associated with the project.

### 2.1 Summary

The analysis presented in the report is dependent on the level of design associated with the project. This includes the definitions of the location and extent of the physical footprint, works required to divert or otherwise manage flows, and the viability of proposed mitigation measures.

During the rounds of review it was clear that substantial progress was made in refining the report to account for peer review comments and changes in the basic design.



The most substantial change was in response to peer review comments on the first draft report. This change was the result of more detailed investigations undertaken to allow a better appreciation of the potential impacts of the project.

Further refinements in later drafts were largely either typographical or rewording for reader clarity to demonstrate the evidence for the conclusions made by the authors. Substantial improvements in mapping and figures also occurred to make them more readable and intelligible to the public.

## **2.2 Key observations**

### **Design standards**

I am satisfied that the consultants have adopted appropriate design standards in accordance with the Australian guidelines and standards cited in the report. These standards appear appropriate for most components of the project. However, the standards used are effectively default standards that do not take into account the desired level-of-service required by NELP.

I recommend that during final design NELP considers the desired functionality and level-of-service for the project as-a-whole and consider whether the default standards for some road segments, tunnel portals and flood barriers are appropriate to meet these requirements.

### **Design rainfalls**

There is currently a significant shift in the design guidelines used in Australia for flood modelling and management – Australian Rainfall and Runoff (ARR). The latest version of these guidelines (i.e. ARR 2016) is still in draft form and has not been formally adopted in many places. There is some concern within the industry that the latest draft guidelines are challenging and, in some cases, inconsistent.

All modelling undertaken in the first draft report was based on the use of the 1987 version of ARR; not the latest draft guidelines. This matter was discussed with the consultants and following further interaction with Melbourne Water it is understood that firmer guidelines were established around this issue.

Additional analysis was undertaken to assess the potential differences in flood outcomes associated with the North East Link project. The results indicate to me that the changes in pre to post North East Link are of the same order of magnitude regardless of the ARR guideline used.

I am satisfied that the level of analysis presented in the latest report is appropriate and provides a credible and suitable assessment of the uncertainties in flood modelling and the risks associated with changes in flood conditions arising from the North East Link project.

### **Hydraulic modelling**

My review of the general approach, tools and detail of the hydraulic modelling used to quantify the changes in flood behaviour from pre to post North East Link development suggests that it is consistent with current industry practice and Melbourne Water guidelines.

Following queries were raised with respect to the first draft report regarding the study authors' interaction with Melbourne Water as the regulatory authority. In later drafts the consultants provided evidence that supported their assumptions and modelling approaches arising from meetings with that authority. This evidence provides an added level of confidence that the approach



and acceptability of the modelling is appropriate for the purposes of assessing changes in flood conditions and impacts.

### **Qualitative vs semi-quantitative assessment of risk**

A combination of quantitative and qualitative risk assessment has been included in the various drafts of the report. Both risk assessments have been conducted within the wide risk framework applied in the planning approvals process.

I am satisfied that with respect to flooding, risks assessments are quantitative and provide an appropriately conservative assessment of flood risk and mitigation measures.

Water quality risks are treated in a more qualitative manner but the two main risks – spills and construction activities are identified. The risks associated with road spills are appropriately mitigated using design standards for local storage (i.e. consistent with AustRoads guideline requirements). Risks associated with construction are proposed to be mitigated through best practice construction techniques including bunding to manage spills and minimise flooding of works areas, and erosion controls.

Geomorphological risks are assessed qualitatively based on expert opinion and field visits to sites taking into account the existing disturbed nature of many stream lines (some reconstructed during the construction of the Eastern Freeway). It is clear from the evidence provided that appropriate water sensitive urban design approaches and erosion protection works are intended for detailed design to mitigate these risks.

Appropriate timing and scheduling of construction works is important to manage the project risks and should be given special attention as part of detailed design.

### **Tunnel portals**

The flood protection of tunnel portals has been considered as part of the assessment. This is an important matter not only in terms of loss of life if tunnels are inundated, but also in terms of loss of service reducing the economic benefits of the project.

I am satisfied that the tunnel portal design has considered guidelines and the risks of flooding appropriately at this stage of design. However, I recommend that these features are given special focus in detailed design with special account given to the required project level of service.

### **Scoping requirements and environmental matters**

The analyses, conclusions and proposed mitigation measures described in the surface water report meet the Scoping Requirements (NELP, 2018) 4.10 Catchment Values – to avoid or minimise adverse effects on surface water.

However, the surface water report does not deal with other environmental matters such as impacts on wetlands, ecology, subsidence and groundwater. The authors specifically identified these matters as outside the scope of the report.

The analysis and results presented in the current report are in my opinion appropriate to support analysis of environmental risks in other assessments.



## 2.3 Conclusions

I have conducted my peer review of the surface water report in a manner consistent with the requirements of the letter of engagement dated 8 June 2018.

I draw the following conclusions with respect to the three key matters that I have been requested to review:

### 2.3.1 Process, methodology and assessment:

The analysis presented in the report is dependent on the level of design associated with the project. This includes the definitions of the location and extent of the physical footprint, works required to divert or otherwise manage flows, and the viability of proposed mitigation measures.

I believe the analysis of surface water impacts associated with the North East Link project is appropriate to meet the terms of reference for the report. The methodologies and processes used are appropriate and the use of Australian standards is consistent with best practice. The assumptions made are clearly stated and appropriate. The authors' conclusions are clearly stated and are based on evidence that is appropriately demonstrated.

### 2.3.2 Scoping requirements

- In my view the analyses, conclusions and proposed mitigation measures described in the surface water report meet the Scoping Requirements (NELP, 2018) to avoid or minimise adverse effects on surface water.

### 2.3.3 Additional matters for consideration

Detailed design should consider:

- The level-of-service required for the whole of the project and whether this may affect the selection of appropriate hydrological design standards.
- The appropriateness and detail of tunnel portal design
- Best practice stormwater management to protect water quality and geomorphology.

### 2.3.4 Adequacy of the proposed Environmental Performance Requirements

In my view the environmental performance requirements are appropriate and mitigate surface water impacts that might be encountered from the development of the North East Link project.

- It is recommended that best practice stormwater management practices are used to protect water quality and geomorphology.
- It is noted that impacts on wetlands were not within the scope of the surface water report. However, the information developed in this report is appropriate to consider environmental impacts such as these.
- Appropriate timing and scheduling of construction works is important to manage the project risks and should be given special attention as part of detailed design.

### 3. References

Clayton Utz (2018). North East Link Authority: Environmental Effects Statement for North East Link, letter dated 8 June 2018.

NELP (2018). Draft Scoping Requirements for North East Link Project, May 2018.

### 4. Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld.

Signed ..... 

Dated 4 March 2019



## Annexure - Qualifications

### Qualifications

Bachelor of Science (Physics/Mathematics), University of Tasmania, 1982

Post-graduate Course in Hydrology, University of New South Wales, 1984

Diploma in Statistics, University of New England, 1988

Master of Business Administration, La Trobe University, 2005

Master of Economics, University of New England, 2014

I have also undertaken the following post-graduate residential workshops:

Stochastic Data Generation Workshop, University of Melbourne, 1989

Water Quality in Catchment Management Workshop, University of Canberra, 1993

### Professional associations

American Geophysical Union

Australian Water and Wastewater Association

International Association of Hydrological Sciences

### Employment history and achievements

1982 – 1991	Hydrologist / Principal Hydrologist, Hydro-Electric Commission, Tasmania
1991 – 2002	Manager Water Resource Assessment, Department Primary Industries, Water and Environment, Tasmania
2002 – 2014	Senior Principal Consultant, URS Australia Pty Ltd
2014 - 2016	Director, DeepRiver Associates Pty Ltd
2016 - 2019	Principal Water Management & Technology, Hydro Tasmania t/a Entura

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Key areas of expertise include:

- Water balance and demand modelling including multiple use reservoir systems, yield estimation and drought management.
- Flood hydrology including extreme flood estimation, development of regional estimation procedures, flood frequency analysis and stochastic data generation.
- Water quality and ecosystem health monitoring and modelling including environmental flow estimation and ecological risk assessment
- Stream gauging and water data collection systems
- Real-time data management systems
- Water allocation systems, management and planning.
- Managing trade-offs between resource managers, users, and the environment.
- Hydro-economics & evaluation of water resource investment strategies and programs.
- Development and review of water management policies and strategies.
- Hydrological statistics, trend analysis and time series modelling
- Hydraulic modelling review and assessment

Some relevant project experience includes:

- Expert reviewer, Water Balance Modelling –Project Nammaldi, Rio Tinto
- Expert reviewer, Water Balance Modelling, Kevin’s Corner Coal Mine, Hancock Coal
- Project Director – Development of a method for assessment of salinity impacts of environmental works and measures, MDBC
- Project Director, Gladstone coal seam gas project water studies and management strategy, Santos
- Consortium leader - Development of SIMRAT model to assess the salinity impacts of interstate trade in the Murray-Darling Basin, MDBC
- Project Director - Review of water management and sustainability issues Latrobe Valley, DPI Vic
- Chair State of Environment Report - Inland Waters and Wetlands chapter, SOE Unit
- Project Director, Great Barrier Reef Pesticide Usage Monitoring System, DEWHA
- Project Director, Heavy Metals in the River Murray project, MDBC
- Project Director, National Chemical Monitoring Initiative, DEWHA
- Lead Expert Reviewer, Impact Assessment of Hydro-reregulation of Tasmania’s Rivers, Basslink Project EIS, Department of Primary Industries, Water and Environment, Tasmania
- Expert Reviewer, Development of Water Balance and Sedimentation Models, Confidential Copper Mine, Indonesia
- Project Specialist, Development of a World-wide Water Risk Management Tool, The Coca Cola Company, North America



- Expert Peer Reviewer, Confidential Heavy Metals Mitigation Project, Government of Queensland
- Subject Expert, Independent Audit of WaterNSW Flood Management and Operations, Ernst and Young, NSW
- Independent Expert Reviewer surface water impacts, Melbourne Metro Rail Project, Victoria.
- Independent review of water balance modelling, flood estimation and dam break analysis, Independence Group, Benambra, Victoria.
- Lead Author – Critical Impacts of Coal Seam Gas and Coal Mining Techniques on the Water Environment, Department of the Environment, Canberra.
- Chair Independent Expert Review, Lower Lachlan Groundwater Sharing Plan Natural Resources Commission, NSW.
- Independent peer review, Wailoa hydropower scheme on Viti Levu, Fiji Electricity Authority.
- Independent Reviewer pit water balance modelling for Latrobe Valley mine closures and setting of appropriate environmental bonds, Department of Economic Development, Jobs, Transport and Resources, Victoria
- Independent Expert Reviewer, Kakamas Hydro-Electric Project, South Africa
- Expert Reviewer, Aquatic environmental impacts for the Senex Coal Seam Gas Project EIS AECOM, Queensland.
- Independent Reviewer, Water balance modelling and sustainable diversion limits, Murray-Darling Basin Authority, Canberra.
- Auditor, River Crossings and Water Quality: North-South Pipeline Project, Melbourne Water, Victoria
- Independent Reviewer, Engineering, economic and water savings reviews for major irrigation investments DSEWPaC, Canberra.
- Independent Reviewer, Engineering, economic and water savings reviews for environmental flows projects, Department of Agriculture and Water, Canberra.
- Lead reviewer of surface water impacts arising from the re-regulation of the hydro-electric system arising from the establishment of the Basslink cable.
- Lead author, Development of an evaluation framework for NSW water sharing plans, Natural Resources Commission, New South Wales.
- Expert witness, Cherry Tree Wind Farm surface and groundwater impacts, Cherry Tree Hill Wind Farm Ltd, New South Wales.
- Independent Expert Witness - Commonwealth planning tribunal for Moorabin Airport redevelopment, Victoria. Department of Industry, Canberra.
- Due diligence assessment of water allocation and availability for power generation. Pacific Energy, New South Wales
- Leader independent value engineering review of a proposed water storage in the Mitchell River catchment, Southern Rural Water, Victoria.

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#### Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
FINAL	G Hay	K Aldous		M Roser		April 2019



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