MEMO

Planning | Surveying | Engineering | Environmental

To:	Sunfield Developments Limited	**Date:**	10/10/2025
From:	Matías Silveira – Environmental Engineer	**CC:**	
Reviewed:	Zeb Worth – Principal Environmental Engineer	**CKL Ref:**	A24151
Re:	**Sunfield Development – Ardmore, Auckland**		

This memo is prepared to provide an initial high-level screening study potential erosion risks in the proposed Diversion Channel for the Sunfield Development located in Ardmore, Auckland. In order to accomplish this, the Erosion Screening Tool - HW-V2024.2 (EST) from the Auckland Council has been utilised, as well as existing documentation provided by the client.

1 Sources of information

The following files/documents have been taken as sources of the required inputs and necessary information to proceed with the study:

1- A24151- -For Information Only Perimeter Swale Levels & Width--.pdf: Containing the following drawings:
   a. Proposed Swales/Diversion Path Plan Sheet 1
   b. Proposed Swales/Diversion Path Long-Sections Sheet 2
   c. Proposed Swales/Diversion Path Cross-Sections Sheet 8

2- 2d_qnl_PR_R.shp:
   a. From the existing TUFLOW model provided by the client.
   b. Contains polygons showing the site location and locations for the different proposed channels and swales.

3- Sunfield_Eastern_EX_Blocked_CN74_100yrCC_24hr_PLOT_L.shp:
   a. From the existing TUFLOW model provided by the client.
   b. Contains the lines representing different sections of the 2D model.

4- Sunfield_Eastern_EX_Blocked_CN74_100yrCC_24hr_PLOT_R.shp:
   a. From the existing TUFLOW model provided by the client.
   b. Contains polygons showing the site location and locations for the different proposed channels and swales.

5- Files containing the model flow results (hydrographs) for the different analysed sections:
   a. Sunfield_Eastern_PR_CN74_2yrCC_24hr_2d_Q.csv
   b. Sunfield_Eastern_PR_CN74_5yrCC_24hr_2d_Q.csv
   c. Sunfield_Eastern_PR_CN74_10yrCC_24hr_2d_Q.csv
   d. Sunfield_Eastern_PR_CN74_20yrCC_24hr_2d_Q.csv
   e. Sunfield_Eastern_PR_CN74_50yrCC_24hr_2d_Q.csv
   f. Sunfield_Eastern_PR_CN74_100yrCC_24hr_2d_Q.csv

2 Scope

The post-development (proposed – PR) conditions plus Climate Change scenario was assessed.

Six different Average Recurrence Intervals (ARI), taken from the existing model, have been considered: 2, 5, 10, 20, 50 and 100 years.

A Manning's roughness coefficient (n) of 0.045 has been considered for the diversion channel, as well as a critical shear stress value of 33N/m^2, taken from TR2009/038 – 3.2.3 Erosion rates for Auckland cohesive soils (Auckland region median).

The assessment has been produced for the following sections along the proposed diversion channel: sections 15, 16, 17, 18, 42, 43 and 44, as shown in **Figure 1** and **Figure 2**:

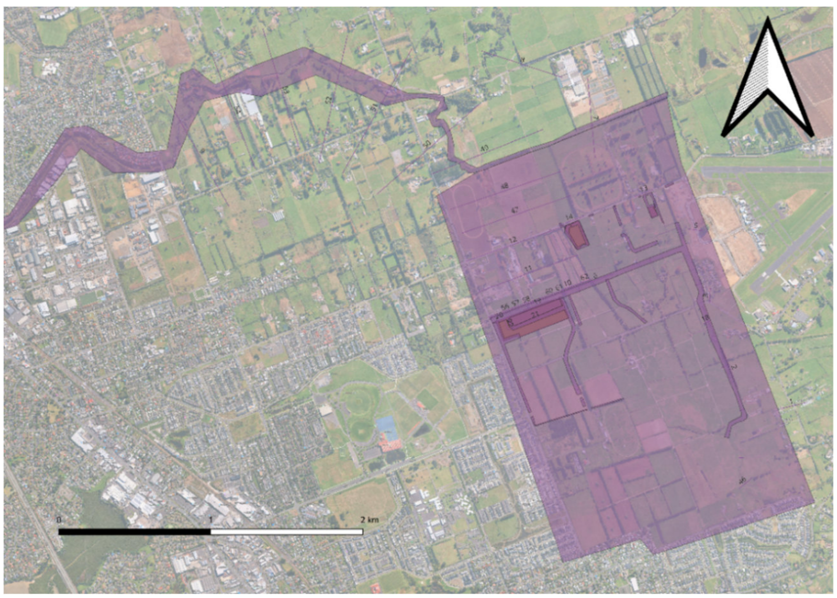

Figure 1: General Location of Site

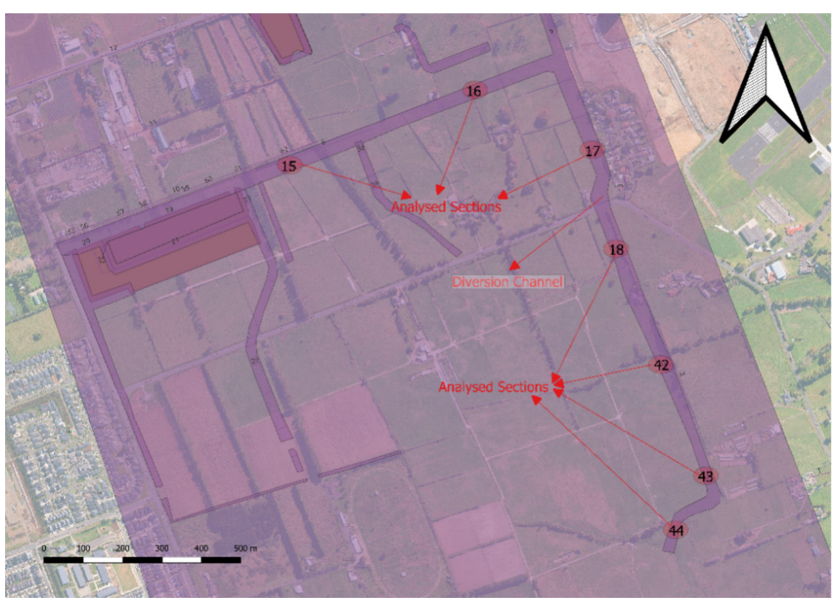

Figure 2: Analysed Sections Locations

3 Long-Section and Cross-Sections

The Diversion Channel has a length of 2220m, and its long-section was taken from the "Proposed Swales/Diversion Path Long-Sections Sheet 2" drawing. Where the Design Levels had unlikely elevations, these have been interpolated accordingly and taken instead of what is indicated in the drawing. Also, where depths were less than specified in the "Proposed Swales/Diversion Path Cross-Sections Sheet 8" drawing, the minimum indicated in the latest has been taken.

The chainages have been taken from the "Proposed Swales/Diversion Path Plan Sheet 1" drawing, and are shown in **Figure 3**:

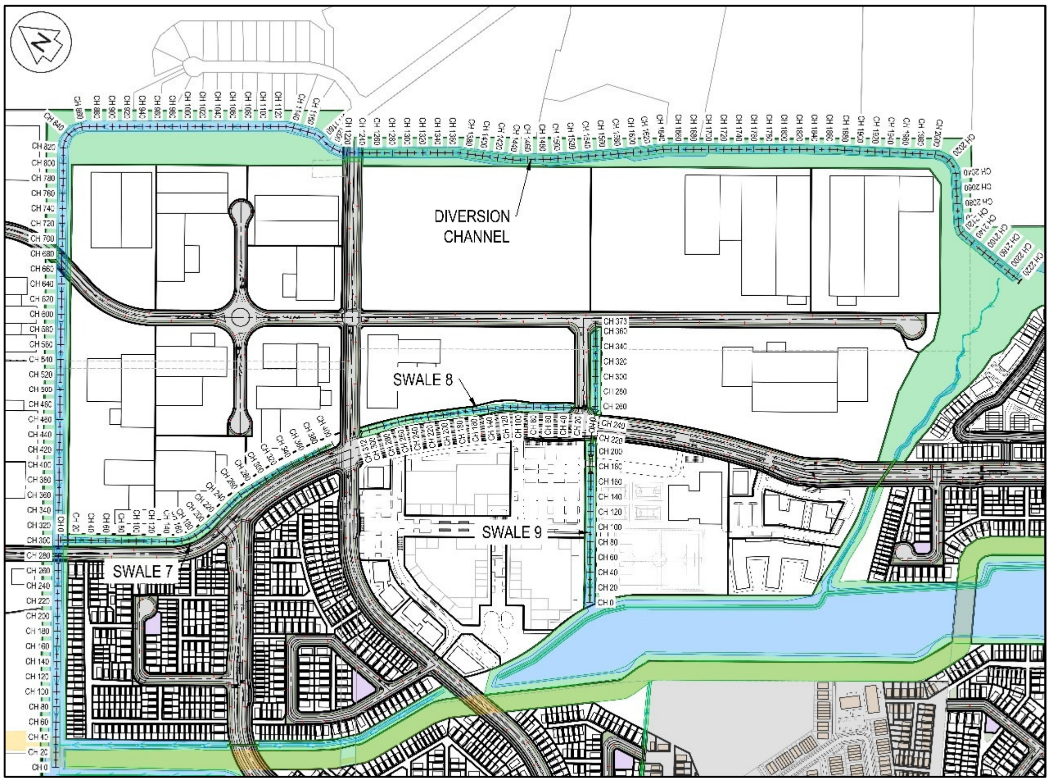

Figure 3: Diversion Channel Plan

Sections will be referred to with the number presented in **Figure 2** and with the chainage presented in **Figure 3** for better understanding.

Within the EST, the chainages have been reverted for its proper use and chainage 0 is chainage 2220 and vice versa.

The typical section of the diversion channel is depicted in **Figure 4**:

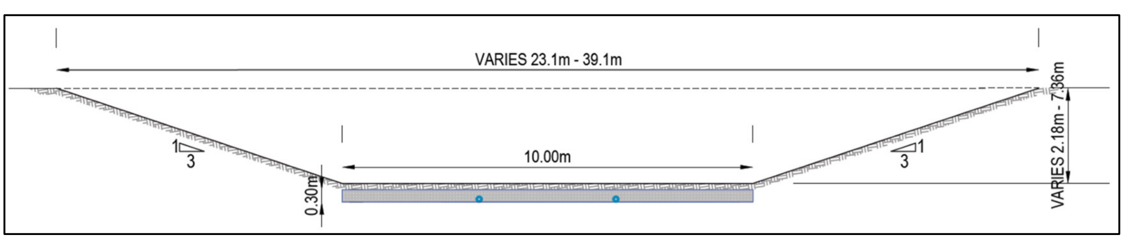

Figure 4: Typical Diversion Channel Section

A summary of each section's geometry is shown in **Table 1**:

Table 1: Sections' Geometry

Section/Chainage	15/80	16/640	17/1100	18/1320	42/1660	43/1960	44/2160
Top Width (m)	23.08	31.18	41.32	34.72	23.08	25.90	23.08
Depth (m)	2.18	3.53	5.22	4.12	2.18	2.65	2.18
Invert Level (m)	21.03	23.23	25.04	25.9	27.32	29.42	30.82

For more details on the sections' geometry, refer to **Appendix 1**.

4 Results

The relevant outputs and results are shown in **Table 2** for each Cross-Section considered and for the 50 year and 100year events. As mentioned before, the only scenario that has been taken under assessment is the post-development + CC scenario.

Table 2: Sections' Results

Section/Chainage	15/80	16/640	17/1100	18/1320	42/1660	43/1960	44/2160
Excess Shear Stress at peak – 50yr	2.49	3.59	2.86	3.93	3.21	1.85	1.98
Percentage of time 1 < ESS < 2 – 50yr	25.69	20.14	12.5	22.92	6.94	4.86	4.86
Percentage of time 2 < ESS < 10 – 50yr	13.89	9.72	6.25	9.72	6.94	0.00	0.00
Excess Shear Stress at peak – 100yr	3.16	3.02	3.55	5.04	4.4	2.58	2.78
Percentage of time 1 < ESS < 2 – 100yr	32.64	25.69	15.97	27.78	8.33	4.86	4.86
Percentage of time 2 < ESS < 10 – 100yr	18.75	11.81	7.64	11.81	9.03	1.39	1.39

For more details on the obtained results, including events other than the 50year and the 100year events, refer to **Appendix 2**.

5 Conclusions

The erosion screening undertaken using the Auckland Council Erosion Screening Tool (HW-V2024.2) indicates that the proposed diversion channel is subject to moderate erosion risk under post-development conditions with climate change allowances. While peak excess shear stresses remain relatively low (below 6 N/m²) across all assessed sections, results show that for both the 50-year and 100-year ARI events, several sections experience sustained periods where shear stresses exceed the critical threshold of 33 N/m². In particular, sections 16, 17, 18, and 42 show the highest exceedances, with excess shear stresses at peak reaching between 28 and 133 N/m² above the critical value.

Although the magnitude of excess shear stress is not extreme, the duration and frequency of events above threshold levels suggest a potential for progressive channel erosion over the life of the development, particularly in the deeper and wider channel reaches. These findings highlight the importance of incorporating appropriate erosion protection measures (e.g., armouring, revegetation, or energy dissipation structures) during detailed design to mitigate this risk. Such measures can effectively increase the permissible shear stress well above the 33 N/m² value assumed for natural soils. For example, Class A vegetative lining has an allowable shear stress of approximately 177 N/m², while rock riprap with a D_{50} of 300 mm can withstand up to about 192 N/m² (based on HEC-15 guidance). Further refinement of the assessment during detailed design, supported by site-specific soil investigations and hydraulic modelling, is recommended to confirm the need and extent of such measures.

Appendix 1

1 Section 15 – Chainage 80

Figure 5, **Figure 6** and **Figure 7** show the referred cross-section and its characteristics, and the long-section up to that point:

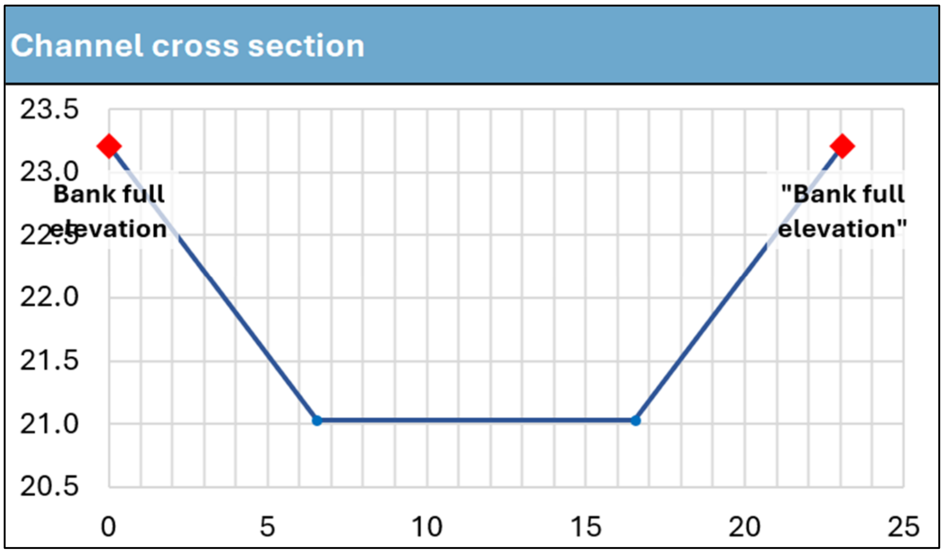

Figure 5: Section 15 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	23.08
Bank full water depth (m)	2.18
Bank full flow (m^3/s)	99.59
Bank full flow excess shear	3.3
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 6: Cross-Section Characteristics

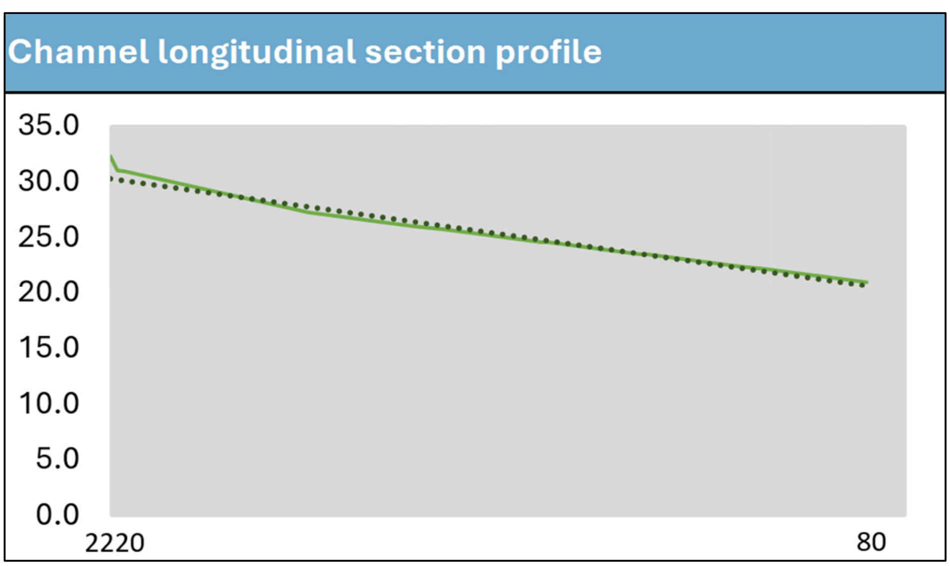

Figure 7: Long-Section up to Section 15

2 Section 16 – Chainage 640

Figure 8, **Figure 9** and **Figure 10** show the referred cross-section and its characteristics, and the long-section up to that point:

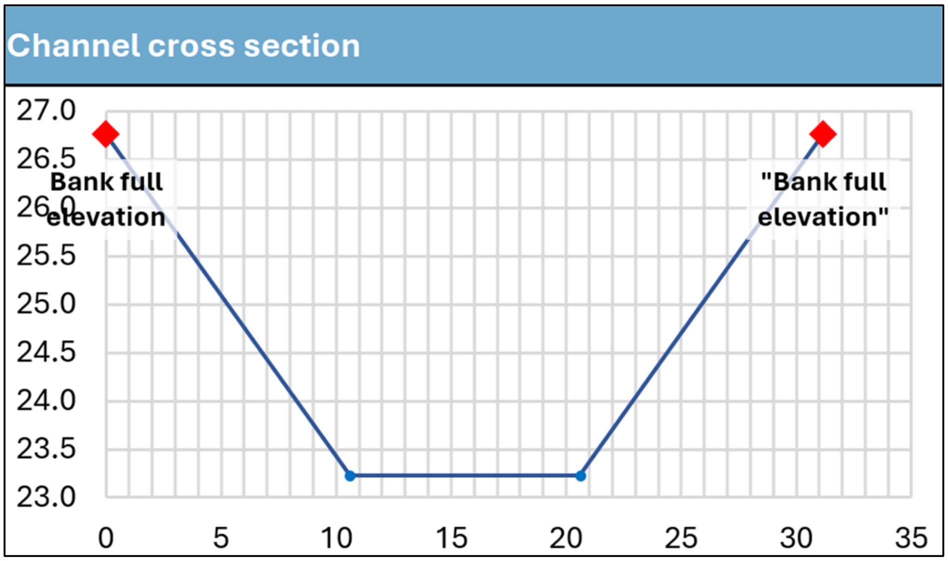

Figure 8: Section 16 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	31.18
Bank full water depth (m)	3.53
Bank full flow (m^3/s)	242.43
Bank full flow excess shear	4.5
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 9: Cross-Section Characteristics

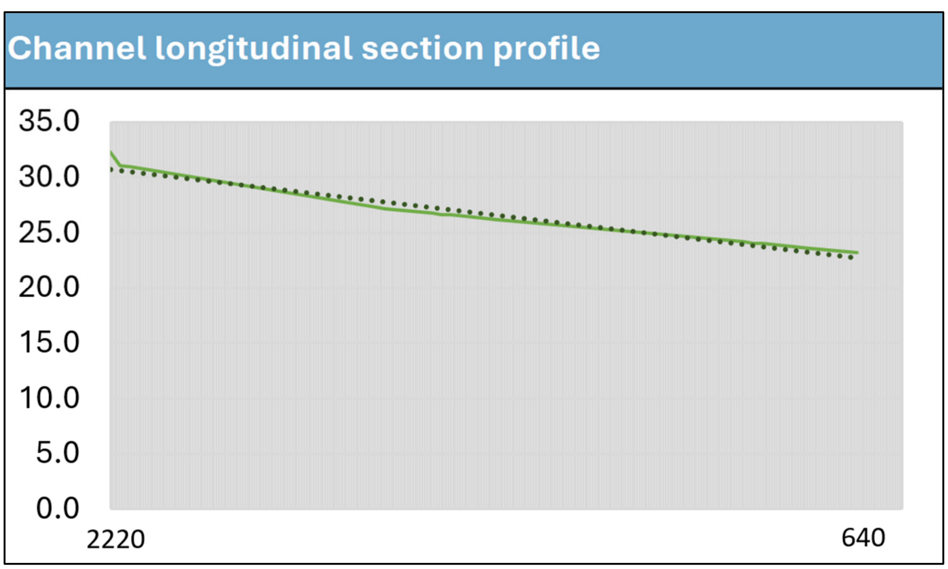

Figure 10: Long-Section up to Section 16

3 Section 17 – Chainage 1100

Figure 11, **Figure 12** and **Figure 13** show the referred cross-section and its characteristics, and the long-section up to that point:

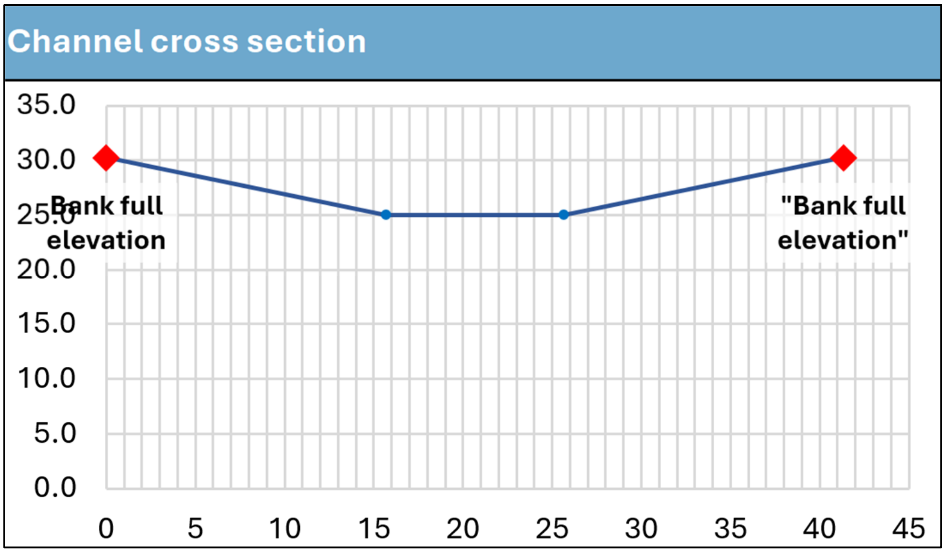

Figure 11: Section 17 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	41.32
Bank full water depth (m)	5.22
Bank full flow (m^3/s)	556.71
Bank full flow excess shear	6.5
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 12: Cross-Section Characteristics

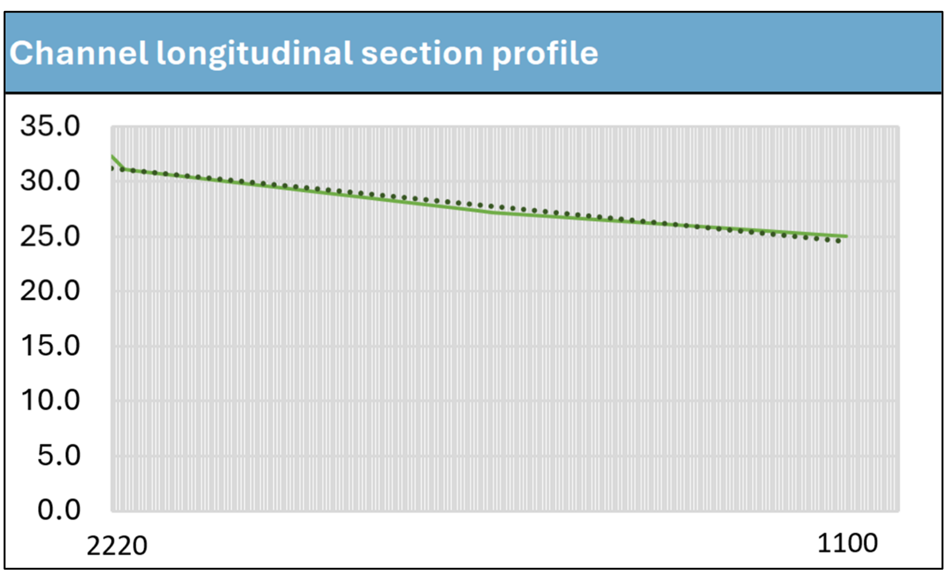

Figure 13: Long-Section up to Section 17

4 Section 18 – Chainage 1320

Figure 14, **Figure 15** and **Figure 16** show the referred cross-section and its characteristics, and the long-section up to that point:

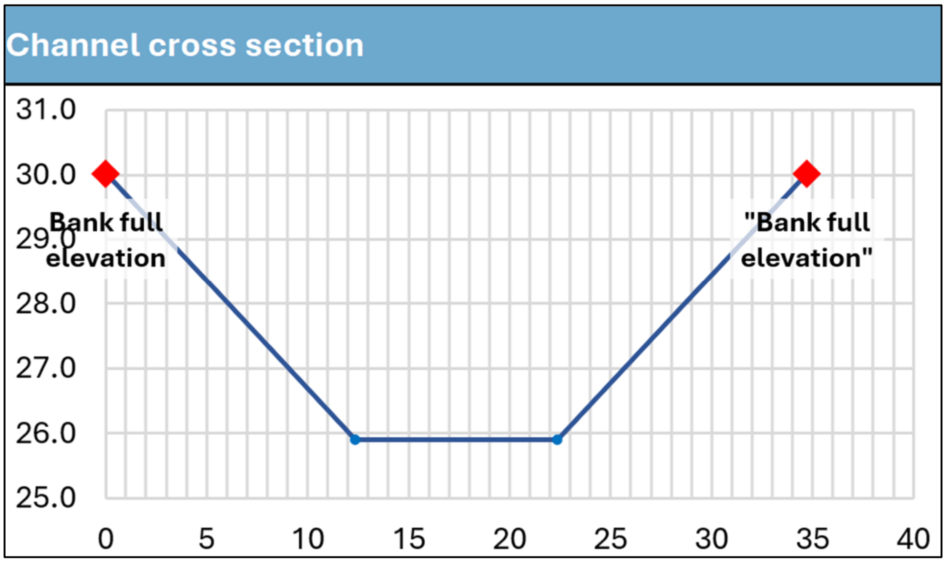

Figure 14: Section 18 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	34.72
Bank full water depth (m)	4.12
Bank full flow (m^3/s)	366.03
Bank full flow excess shear	6.3
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 15: Cross-Section Characteristics

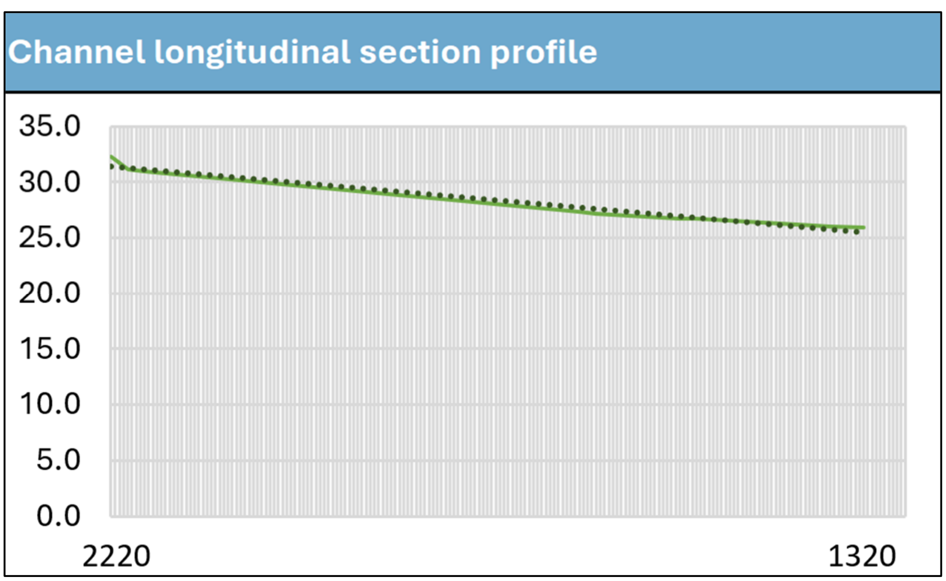

Figure 16: Long-Section up to Section 18

5 Section 42 – Chainage 1660

Figure 17, **Figure 18** and **Figure 19** show the referred cross-section and its characteristics, and the long-section up to that point:

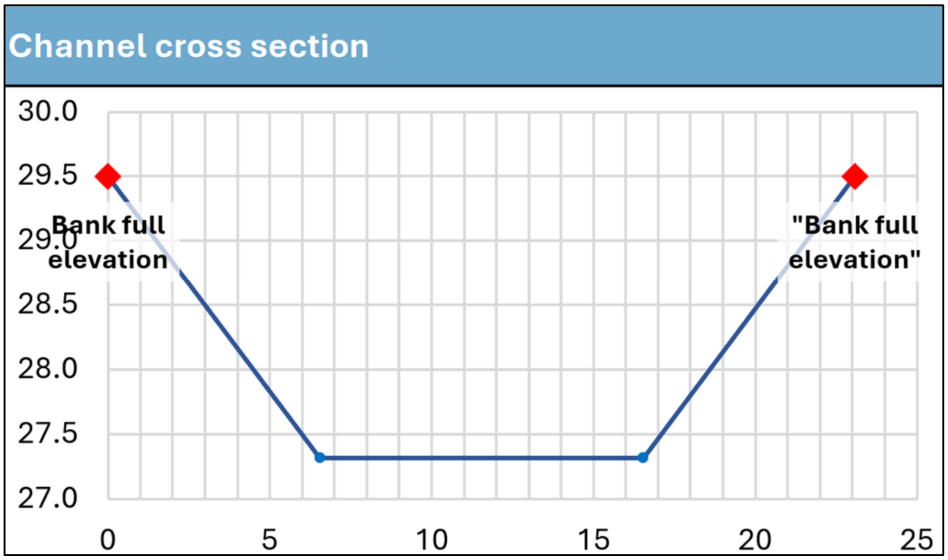

Figure 17: Section 42 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	23.08
Bank full water depth (m)	2.18
Bank full flow (m^3/s)	127.16
Bank full flow excess shear	5.4
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 18: Cross-Section Characteristics

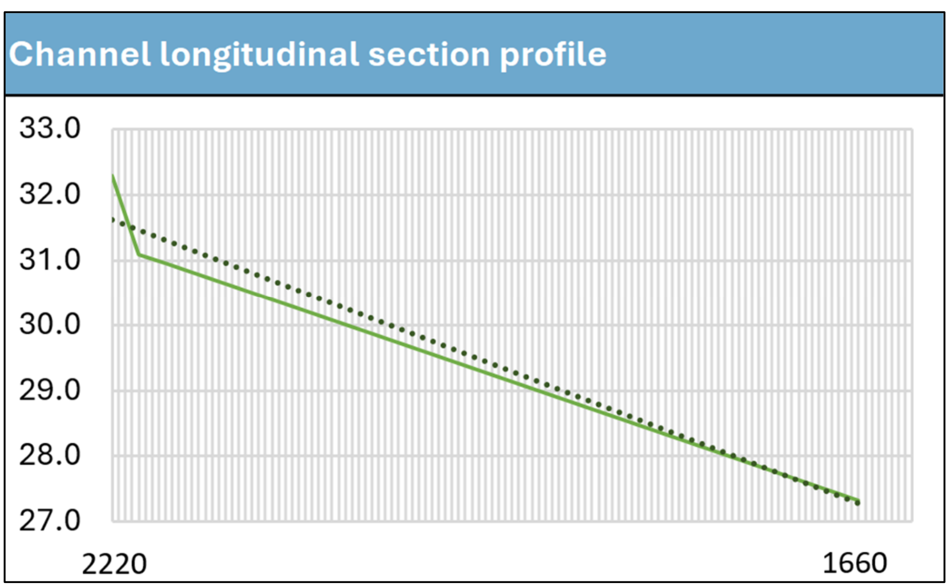

Figure 19: Long-Section up to Section 42

6 Section 43 – Chainage 1960

Figure 20, **Figure 21** and **Figure 22** show the referred cross-section and its characteristics, and the long-section up to that point:

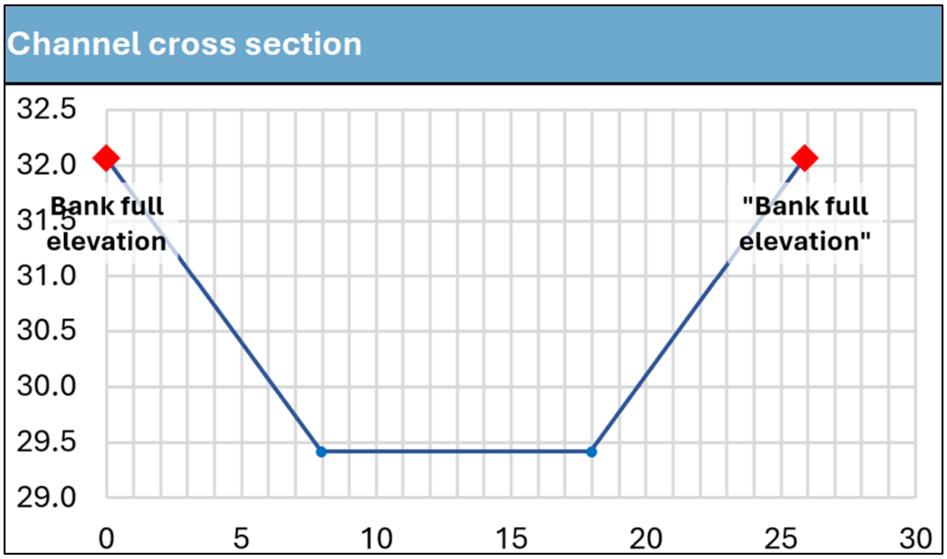

Figure 20: Section 43 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	25.90
Bank full water depth (m)	2.65
Bank full flow (m^3/s)	176.97
Bank full flow excess shear	5.9
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 21: Cross-Section Characteristics

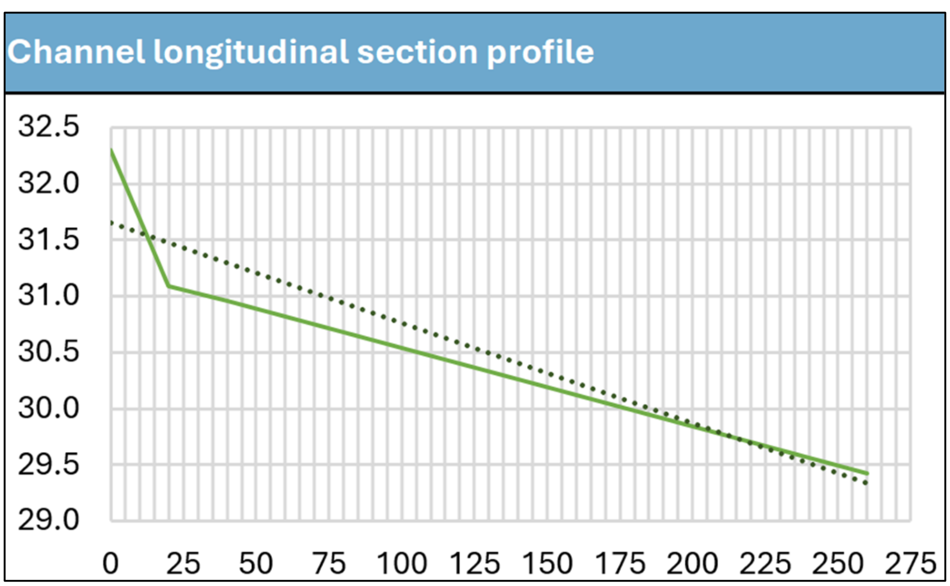

Figure 22: Long-Section up to Section 43

7 Section 44 – Chainage 2160

Figure 23, **Figure 24** and **Figure 25** show the referred cross-section and its characteristics, and the long-section up to that point:

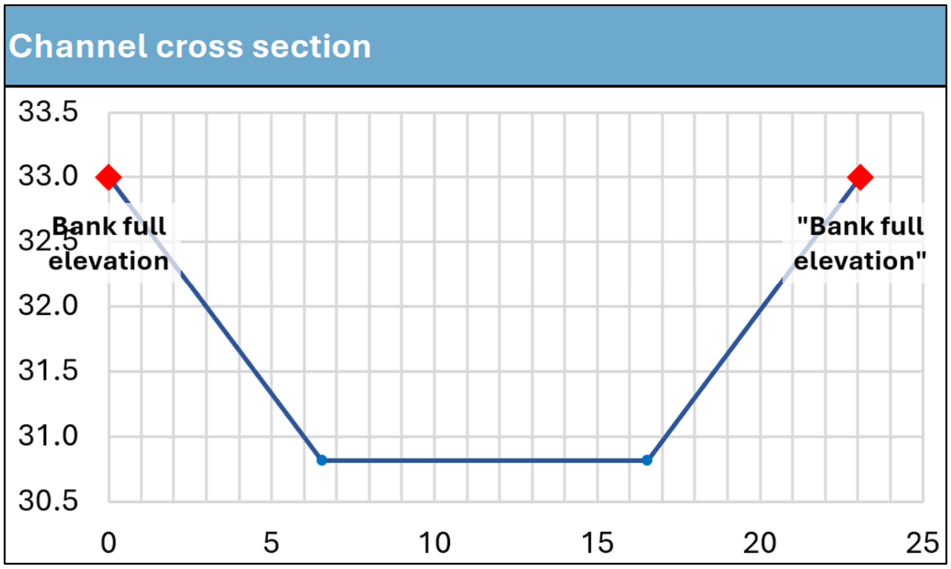

Figure 23: Section 44 Cross-Section

Results - Bank Full Channel Identification	
Approximate channel width (m)	23.08
Bank full water depth (m)	2.18
Bank full flow (m^3/s)	124.96
Bank full flow excess shear	5.2
Annual fullest flow as represented by the mean annual flood (m^3/s)	0.01
Annual fullest flow as represented by the mean annual flood excess shear	0.0

Figure 24: Cross-Section Characteristics

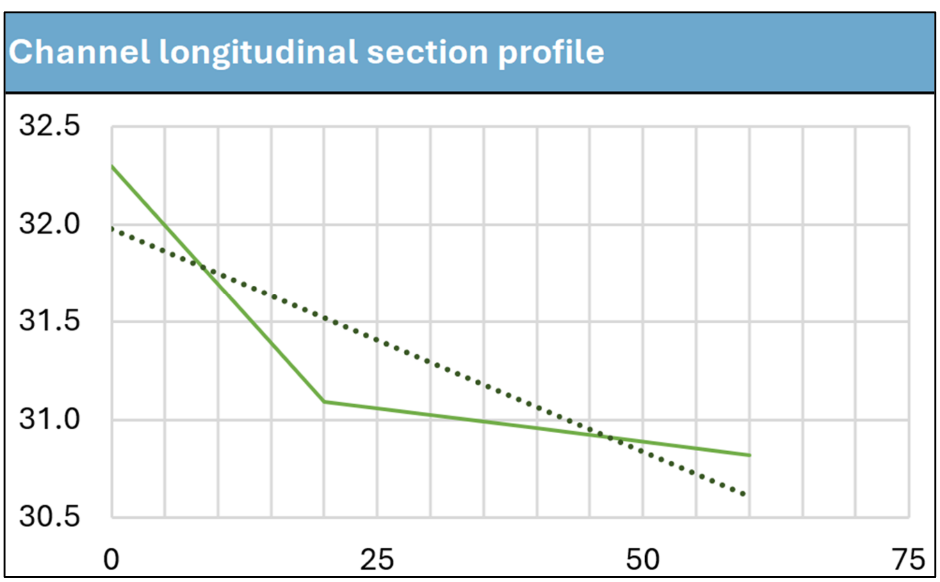

Figure 25: Long-Section up to Section 44

Appendix 2

The results are presented in the following way:

1- The hydrographs for every event considered.
2- The excess shear stress time series for the events ranging from 2 year to 20 year.
3- Bank shear stress at peak, excess shear stress at peak, bank shear stress event mean, and excess shear stress event mean values for every event. Also, the amount of time that certain thresholds have been exceeded on each event.
4- The excess shear stress in terms percentages of the 24h event.
5- The excess shear stress at the peak of each design storm.
6- The average excess shear stress for each design storm.

1 Section 15 – Chainage 80

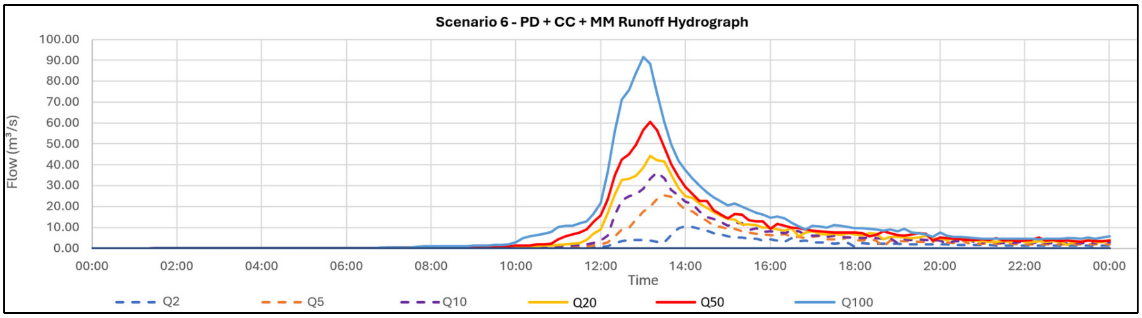

Figure 26: Hydrographs for every event

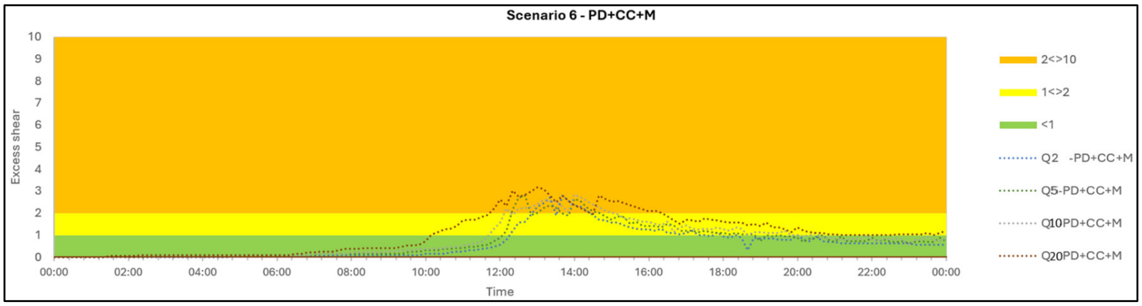

Figure 27: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	56.61	62.61	77.57	86.49	82.16	104.44
ESS at peak	1.72	1.90	2.35	2.62	2.49	3.16
BSS event mean	13.36	20.15	23.71	26.84	30.46	35.43
ESS event mean	0.40	0.61	0.72	0.81	0.92	1.07
ESS exceedance (min)						
<1 (min)	1310	1130	1030	960	870	700
>1 & <2 (min)	130	230	290	310	370	470
>2 & <10 (min)	0	80	120	170	200	270
>10 (min)	0	0	0	0	0	0

Figure 28: Summary results

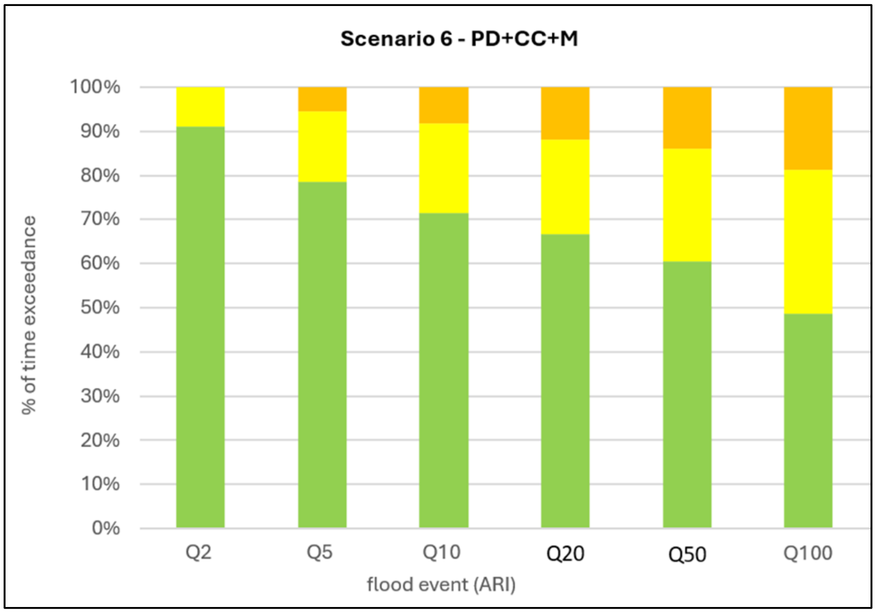

Figure 29: % of time exceedance for each event

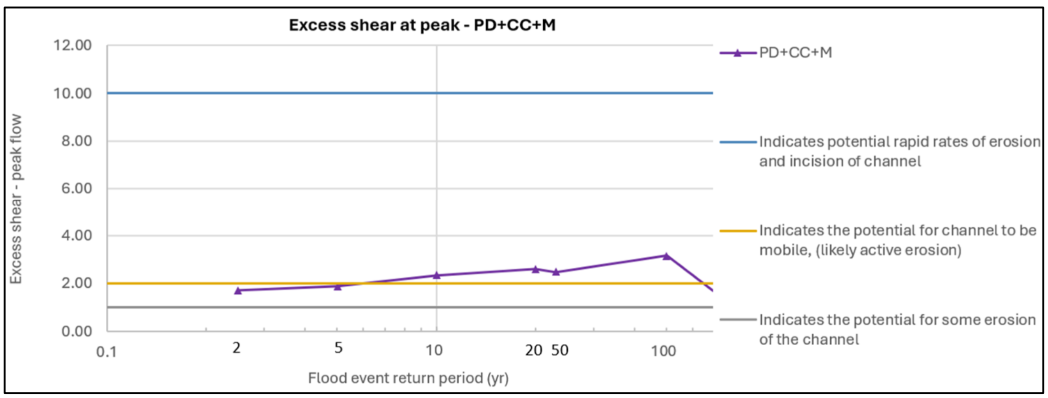

Figure 30: Excess shear at peak for each event

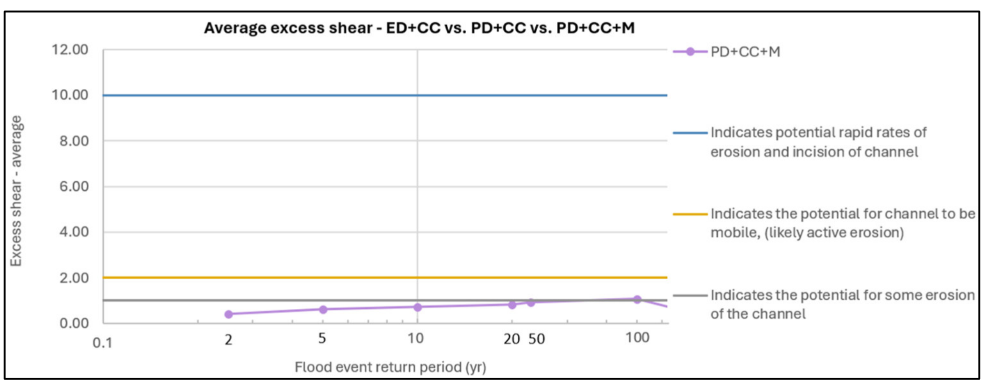

Figure 31: Average excess shear for each event

2 Section 16 – Chainage 640

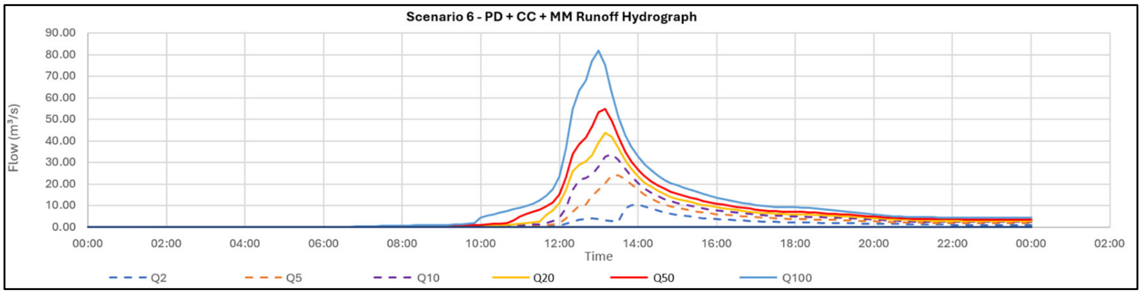

Figure 32: Hydrographs for every event

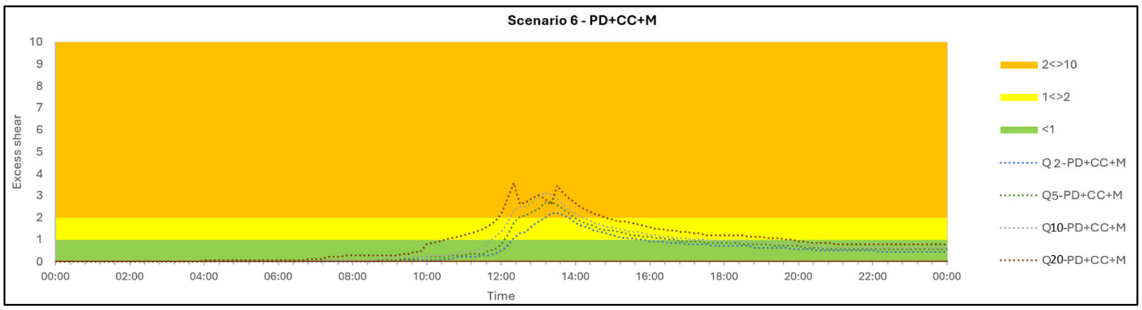

Figure 33: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	44.58	72.21	90.23	103.48	118.63	99.58
ESS at peak	1.35	2.19	2.73	3.14	3.59	3.02
BSS event mean	9.77	15.22	19.12	22.20	25.71	29.63
ESS event mean	0.30	0.46	0.58	0.67	0.78	0.90
ESS exceedance (min)						
<1 (min)	1370	1240	1180	1120	1010	900
>1 & <2 (min)	70	170	170	200	290	370
>2 & <10 (min)	0	30	90	120	140	170
>10 (min)	0	0	0	0	0	0

Figure 34: Summary results

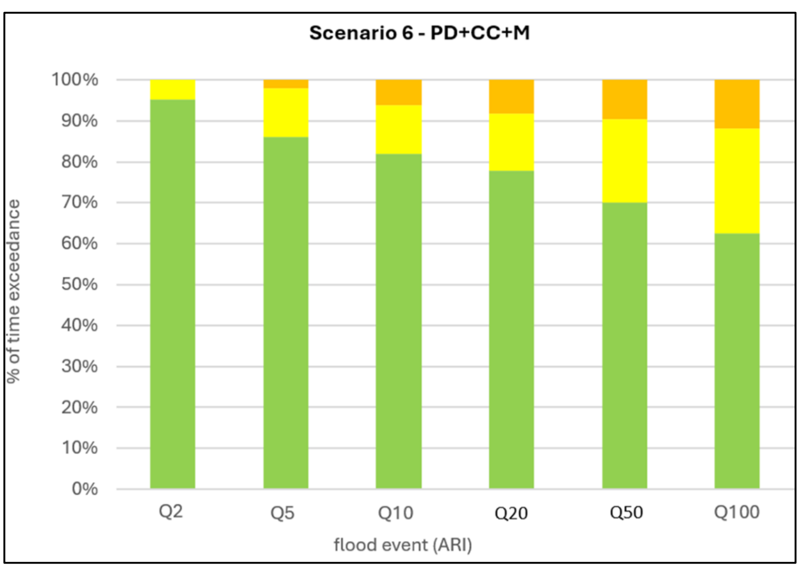

Figure 35: % of time exceedance for each event

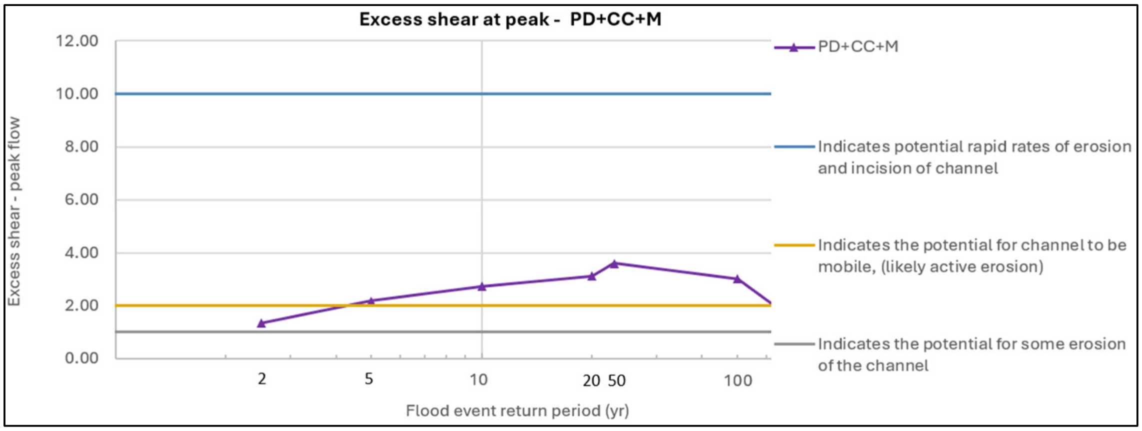

Figure 36: Excess shear at peak for each event

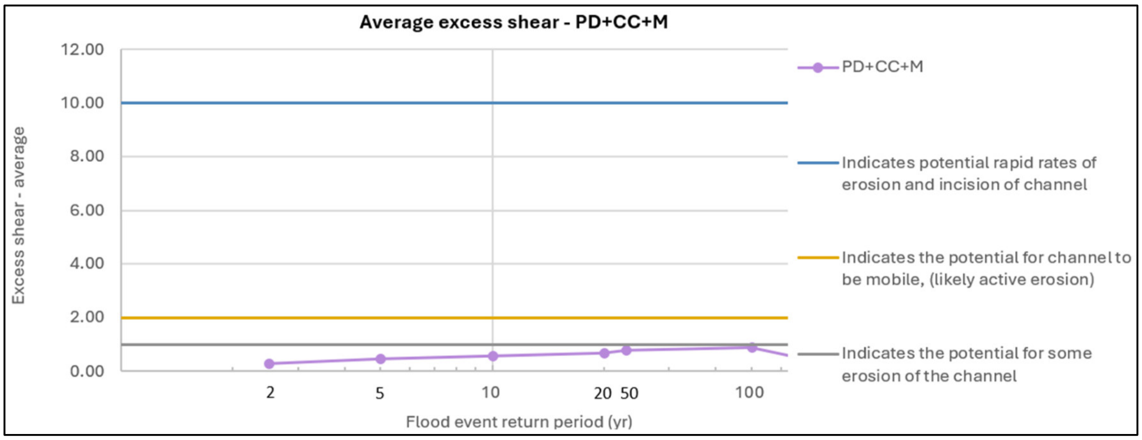

Figure 37: Average excess shear for each event

3 Section 17 – Chainage 1100

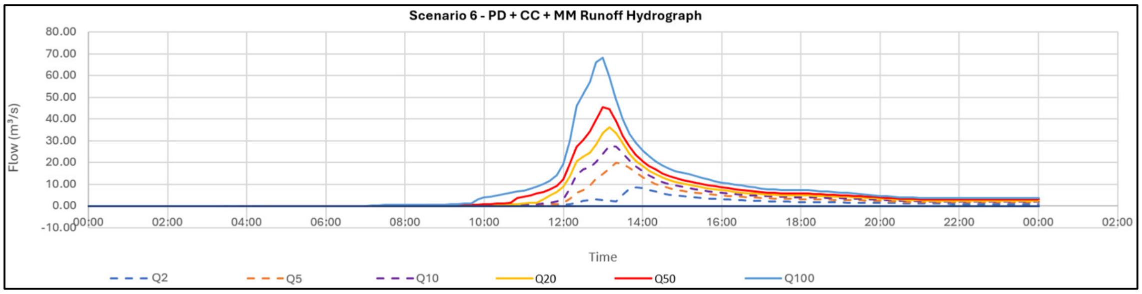

Figure 38: Hydrographs for every event

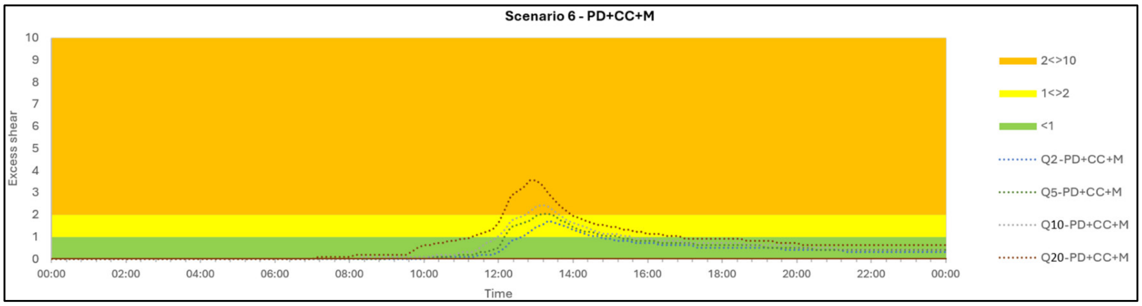

Figure 39: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	33.97	57.61	67.68	81.04	94.31	117.25
ESS at peak	1.03	1.75	2.05	2.46	2.86	3.55
BSS event mean	6.89	11.13	13.91	16.15	18.90	23.61
ESS event mean	0.21	0.34	0.42	0.49	0.57	0.72
ESS exceedance (min)						
<1 (min)	1420	1310	1250	1220	1170	1100
>1 & <2 (min)	20	130	170	170	180	230
>2 & <10 (min)	0	0	20	50	90	110
>10 (min)	0	0	0	0	0	0

Figure 40: Summary results

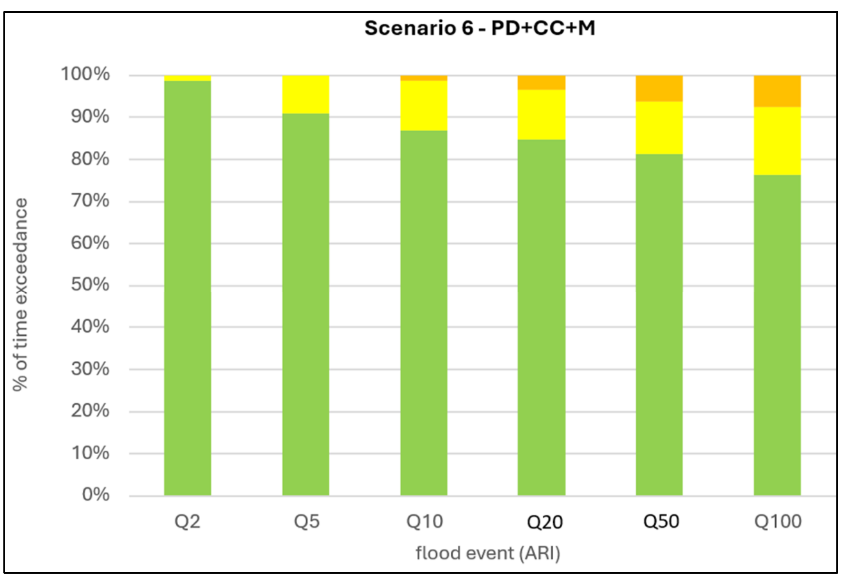

Figure 41: % of time exceedance for each event

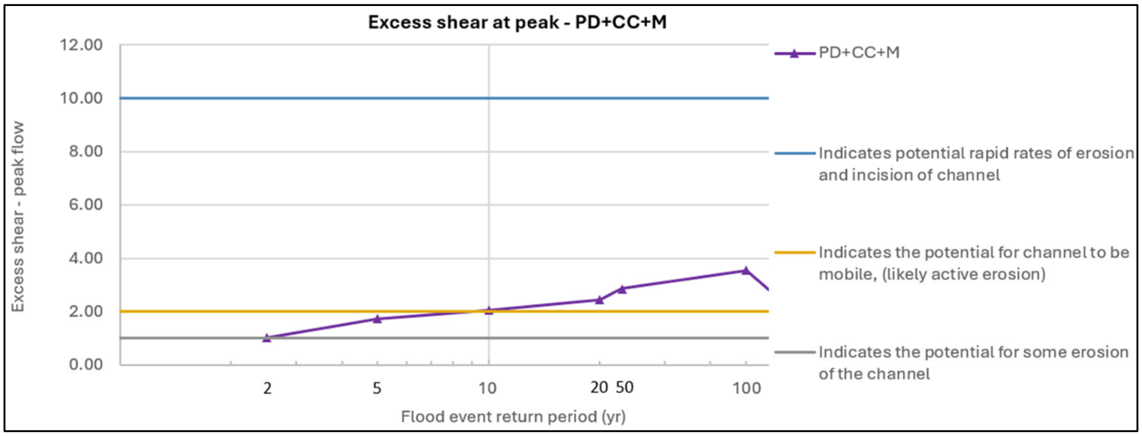

Figure 42: Excess shear at peak for each event

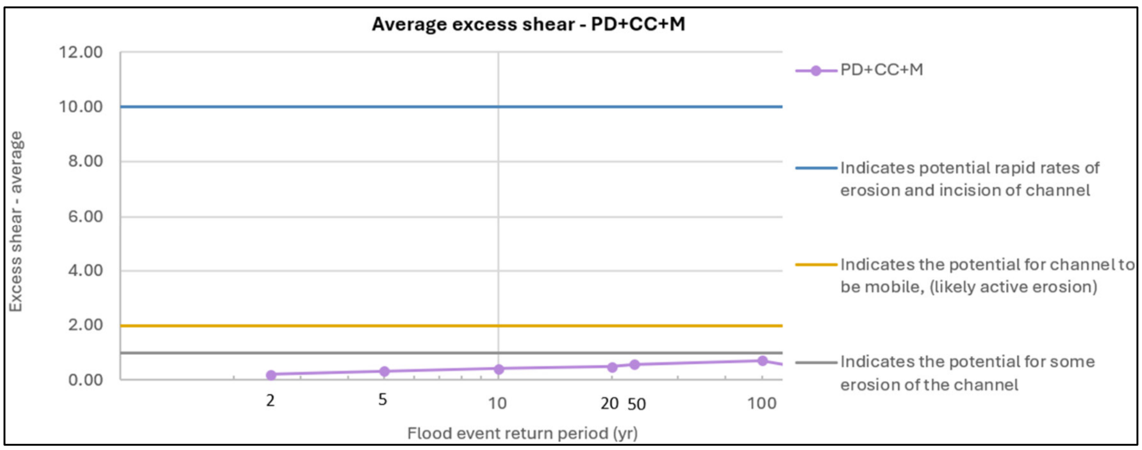

Figure 43: Average excess shear for each event

4 Section 18 – Chainage 1320

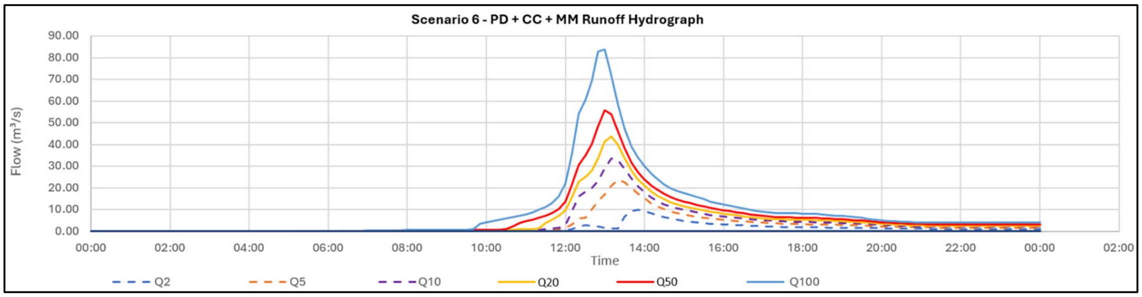

Figure 44: Hydrographs for every event

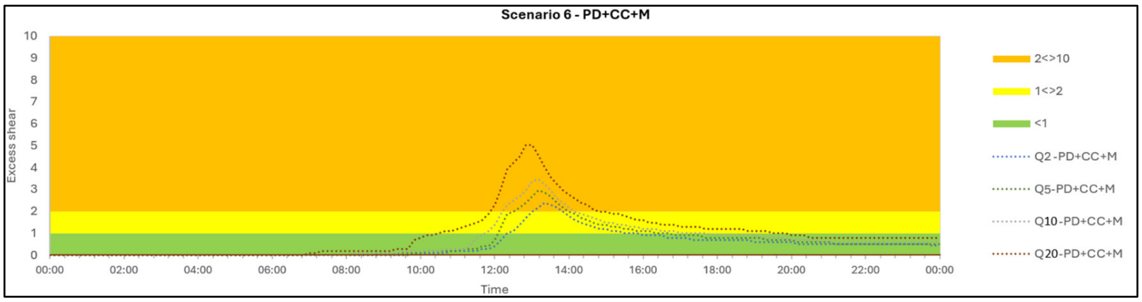

Figure 45: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	46.18	78.79	98.10	114.00	129.69	166.41
ESS at peak	1.40	2.39	2.97	3.45	3.93	5.04
BSS event mean	9.14	15.18	18.52	21.98	25.83	31.98
ESS event mean	0.28	0.46	0.56	0.67	0.78	0.97
ESS exceedance (min)						
<1 (min)	1360	1220	1160	1080	970	870
>1 & <2 (min)	80	180	200	250	330	400
>2 & <10 (min)	0	40	80	110	140	170
>10 (min)	0	0	0	0	0	0

Figure 46: Summary results

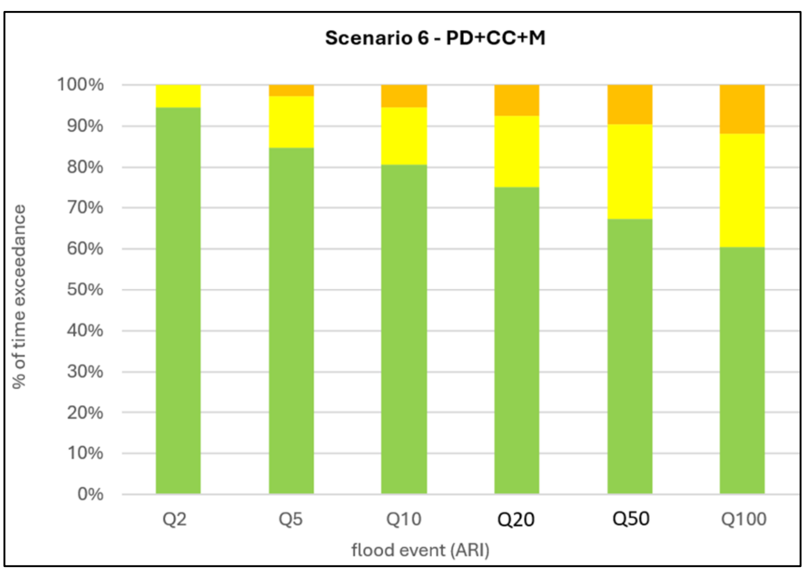

Figure 47: % of time exceedance for each event

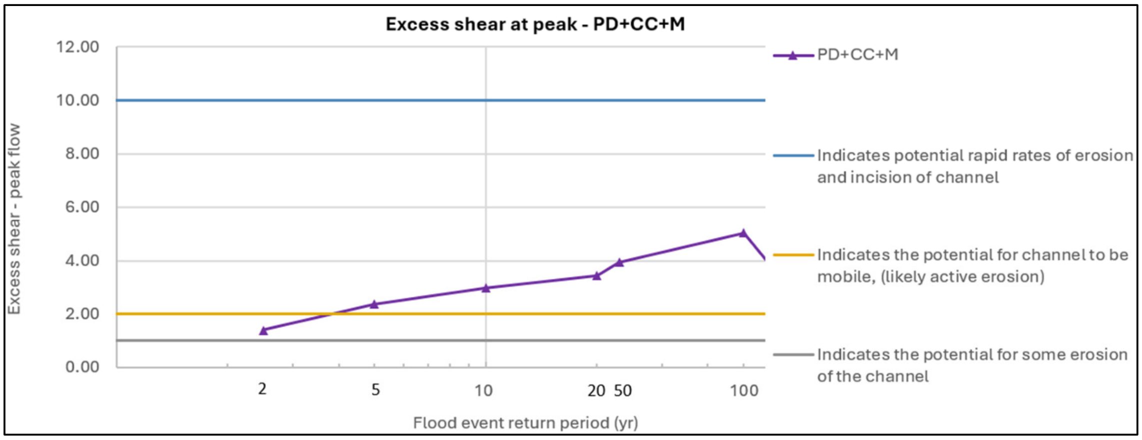

Figure 48: Excess shear at peak for each event

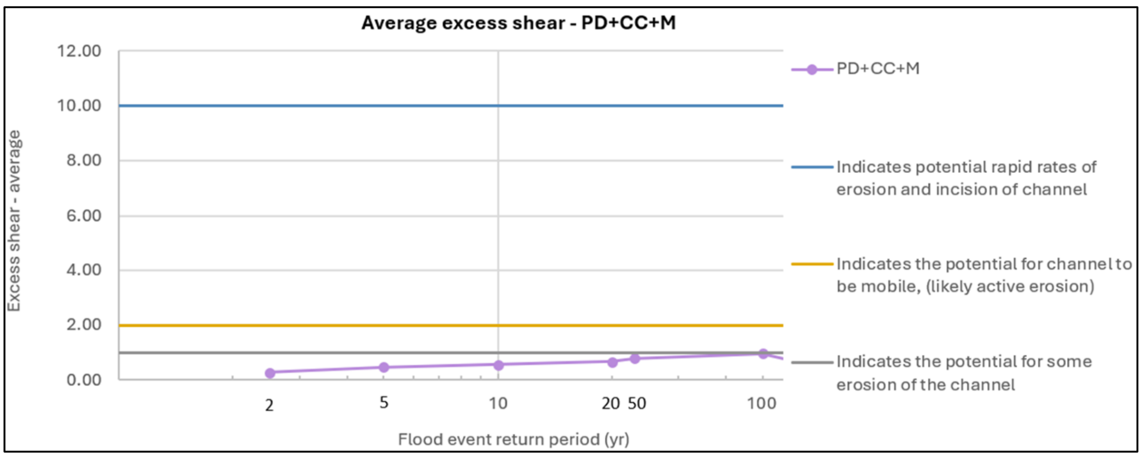

Figure 49: Average excess shear for each event

5 Section 42 – Chainage 1660

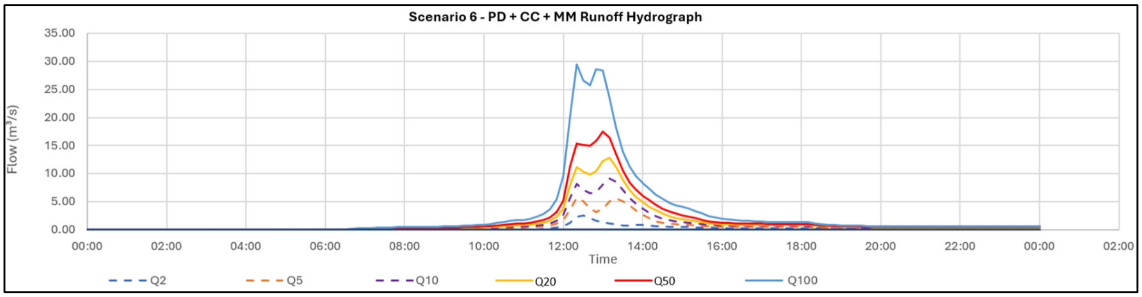

Figure 50: Hydrographs for every event

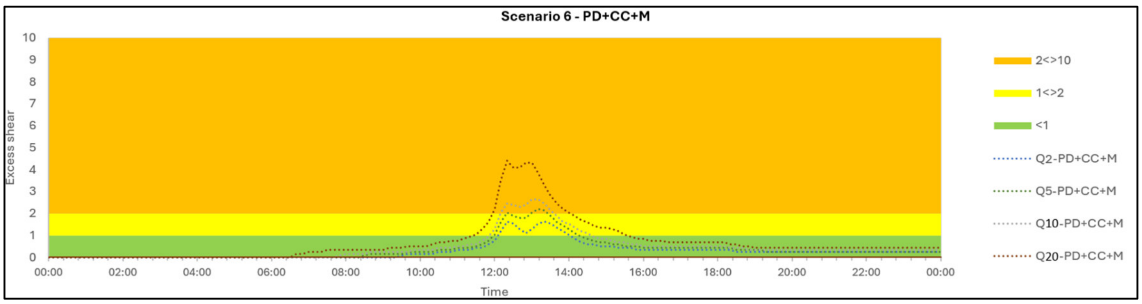

Figure 51: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	31.13	53.62	73.08	86.84	105.82	145.22
ESS at peak	0.94	1.62	2.21	2.63	3.21	4.40
BSS event mean	5.16	9.37	12.03	15.05	17.67	23.01
ESS event mean	0.16	0.28	0.36	0.46	0.54	0.70
ESS exceedance (min)						
<1 (min)	1440	1320	1300	1280	1240	1190
>1 & <2 (min)	0	120	100	70	100	120
>2 & <10 (min)	0	0	40	90	100	130
>10 (min)	0	0	0	0	0	0

Figure 52: Summary results

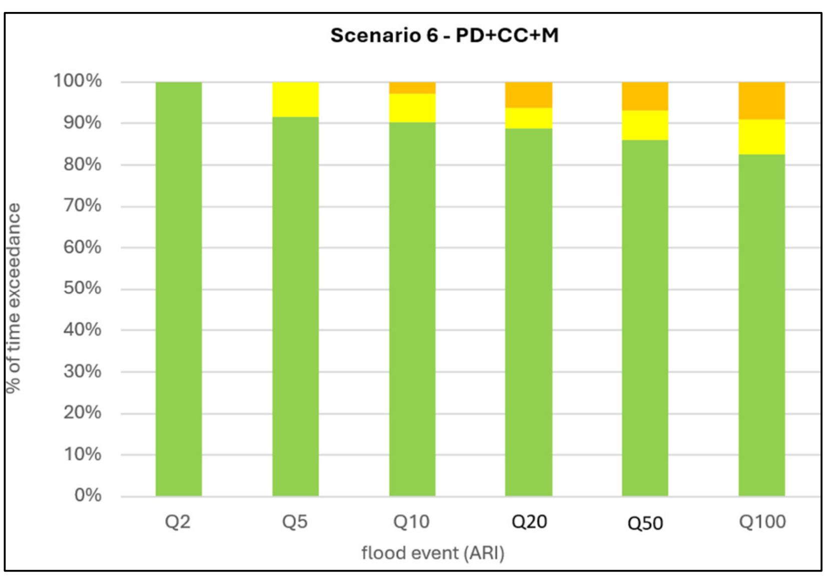

Figure 53: % of time exceedance for each event

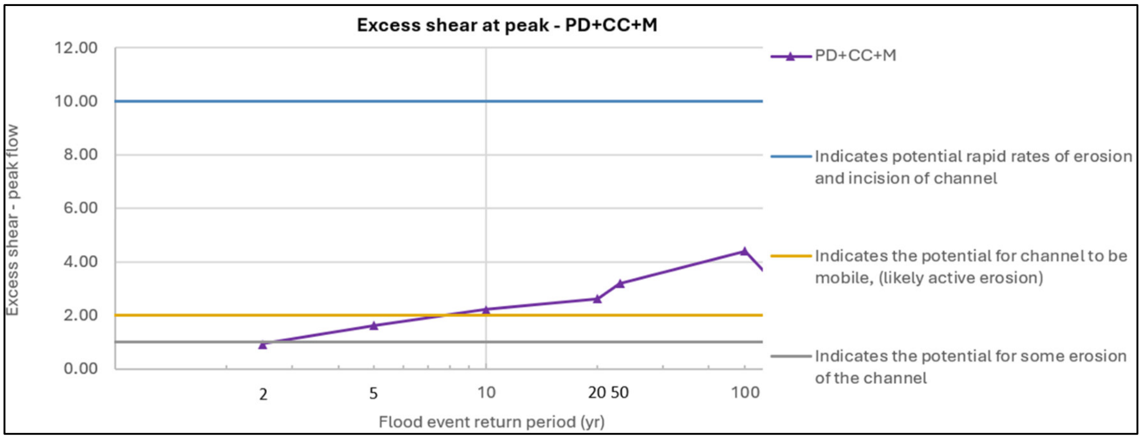

Figure 54: Excess shear at peak for each event

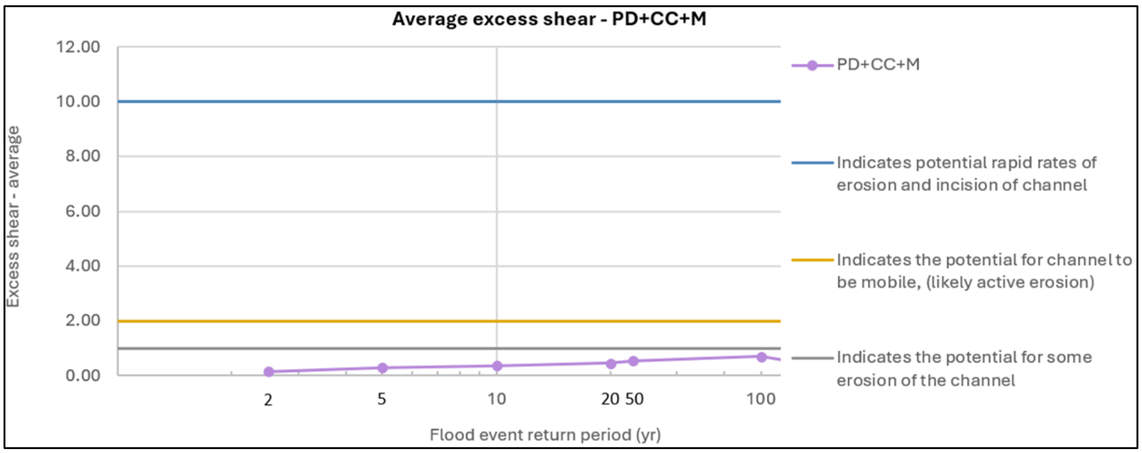

Figure 55: Average excess shear for each event

6 Section 43 – Chainage 1960

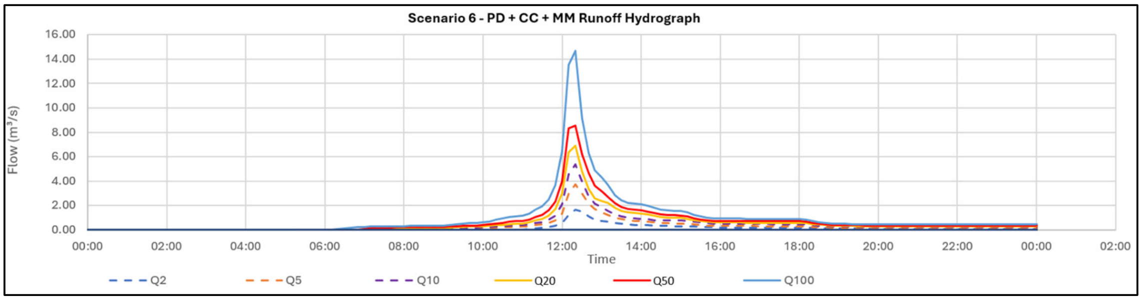

Figure 56: Hydrographs for every event

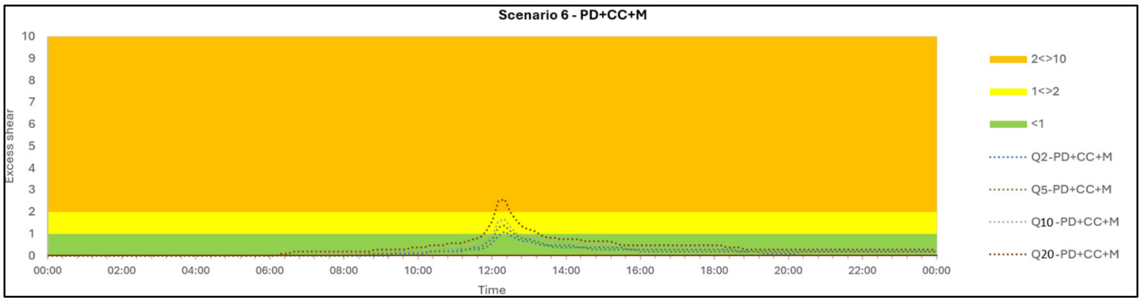

Figure 57: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	21.48	36.77	45.92	55.04	61.09	85.13
ESS at peak	0.65	1.11	1.39	1.67	1.85	2.58
BSS event mean	3.24	5.23	6.67	8.06	9.90	12.05
ESS event mean	0.10	0.16	0.20	0.24	0.30	0.37
ESS exceedance (min)						
<1 (min)	1440	1430	1410	1400	1370	1350
>1 & <2 (min)	0	10	30	40	70	70
>2 & <10 (min)	0	0	0	0	0	20
>10 (min)	0	0	0	0	0	0

Figure 58: Summary results

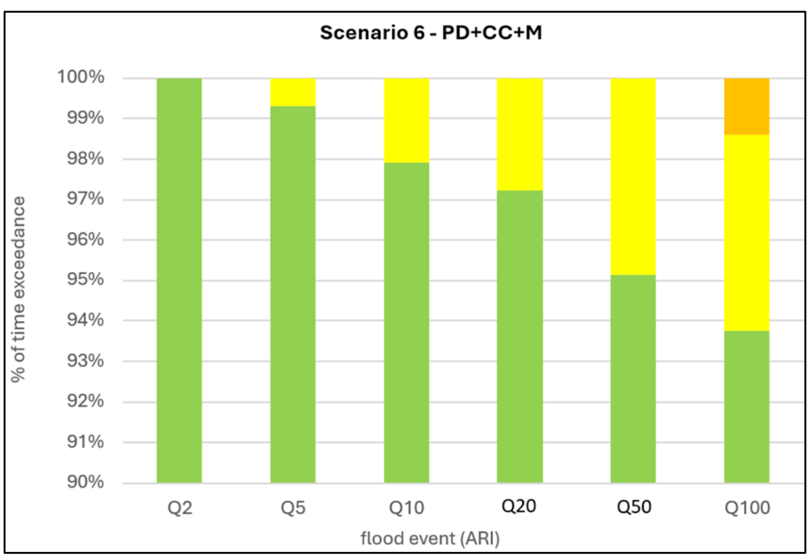

Figure 59: % of time exceedance for each event

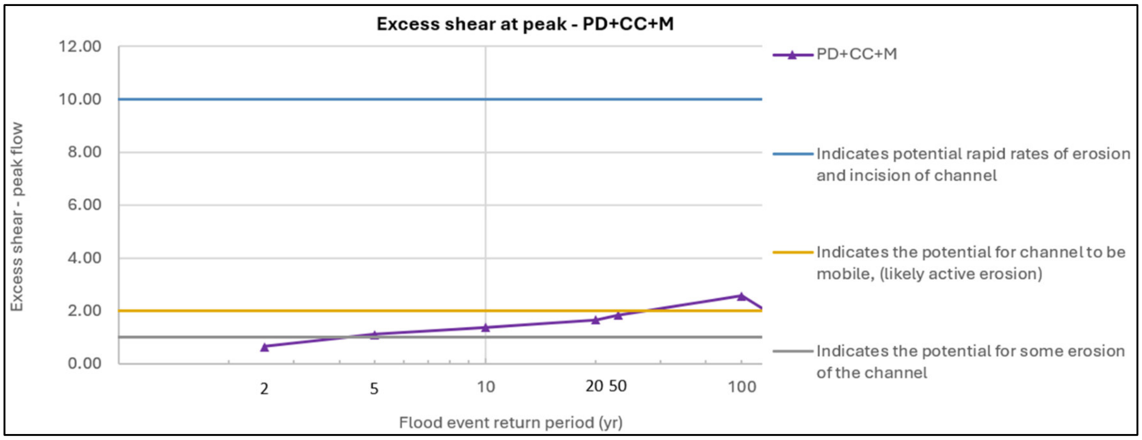

Figure 60: Excess shear at peak for each event

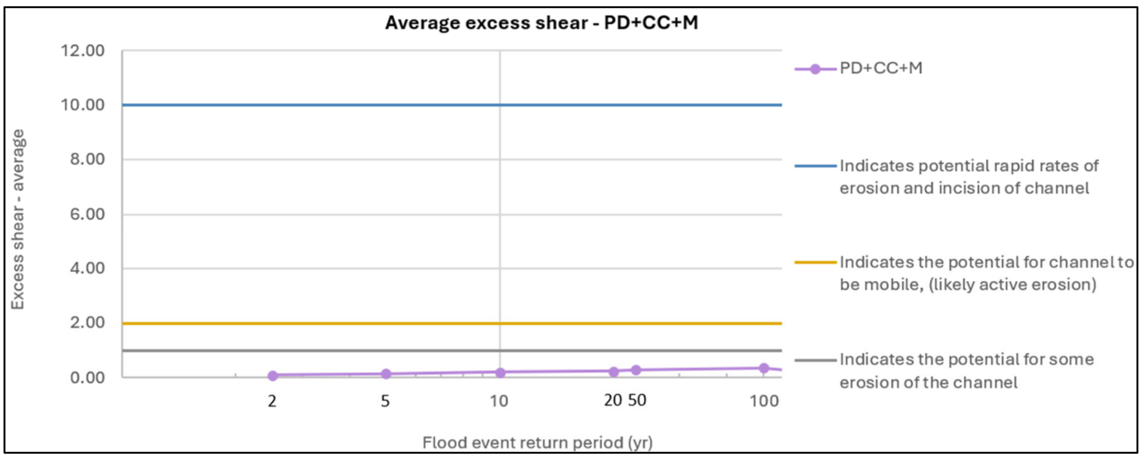

Figure 61: Average excess shear for each event

7 Section 44 – Chainage 2160

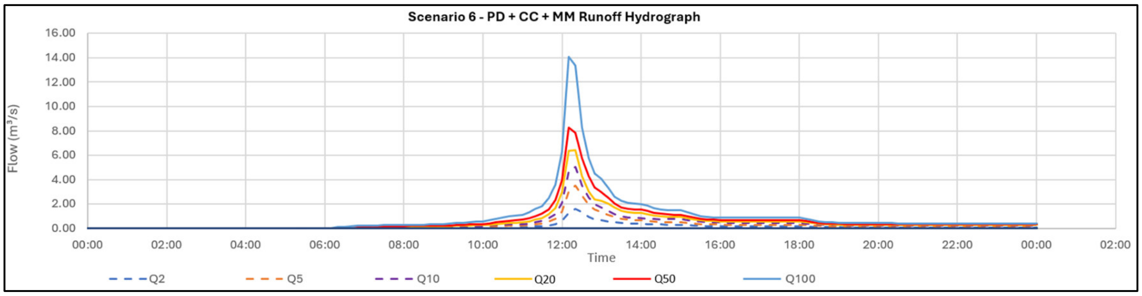

Figure 62: Hydrographs for every event

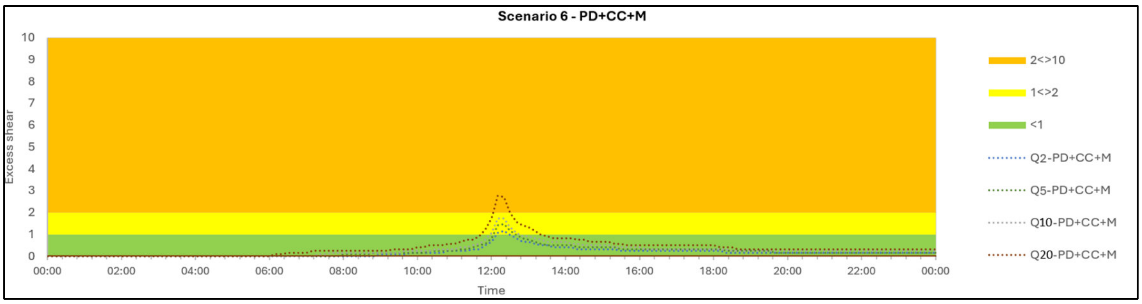

Figure 63: Excess shear stress time series

ARI (yr)	2	5	10	20	50.00	100
Scenario 6 PD+CC+M						
BSS at peak (N/m^2)	24.61	38.23	49.07	57.17	65.23	91.75
ESS at peak	0.75	1.16	1.49	1.73	1.98	2.78
BSS event mean	3.30	5.74	7.17	8.92	10.27	13.20
ESS event mean	0.10	0.17	0.22	0.27	0.31	0.40
ESS exceedance (min)						
<1 (min)	1440	1420	1410	1390	1370	1350
>1 & <2 (min)	0	20	30	50	70	70
>2 & <10 (min)	0	0	0	0	0	20
>10 (min)	0	0	0	0	0	0

Figure 64: Summary results

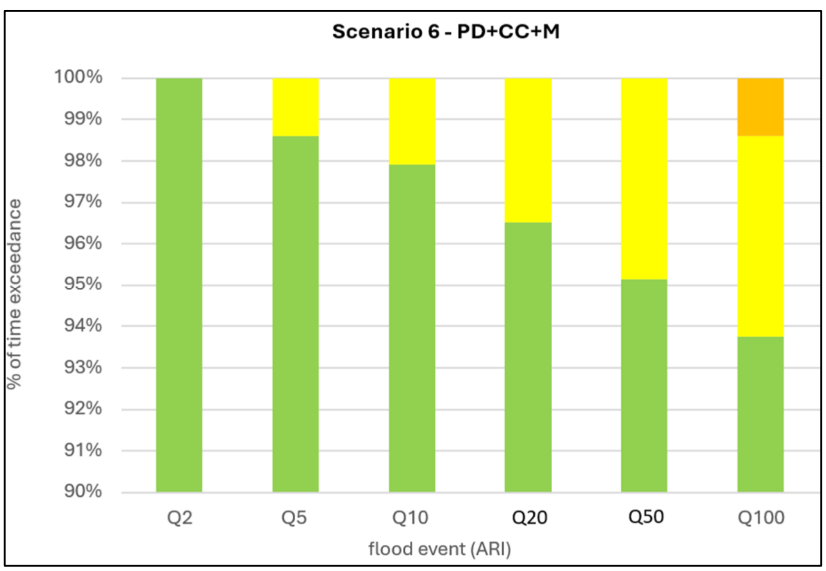

Figure 65: % of time exceedance for each event

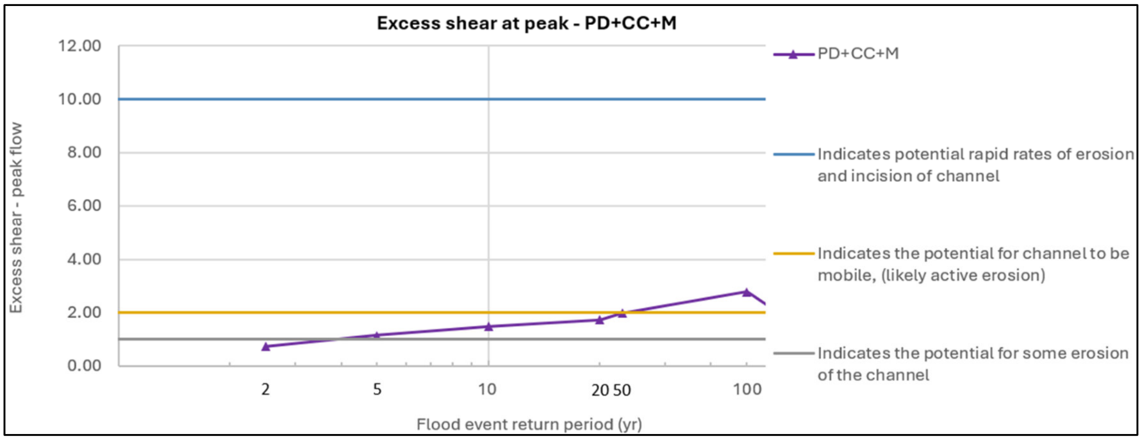

Figure 66: Excess shear at peak for each event

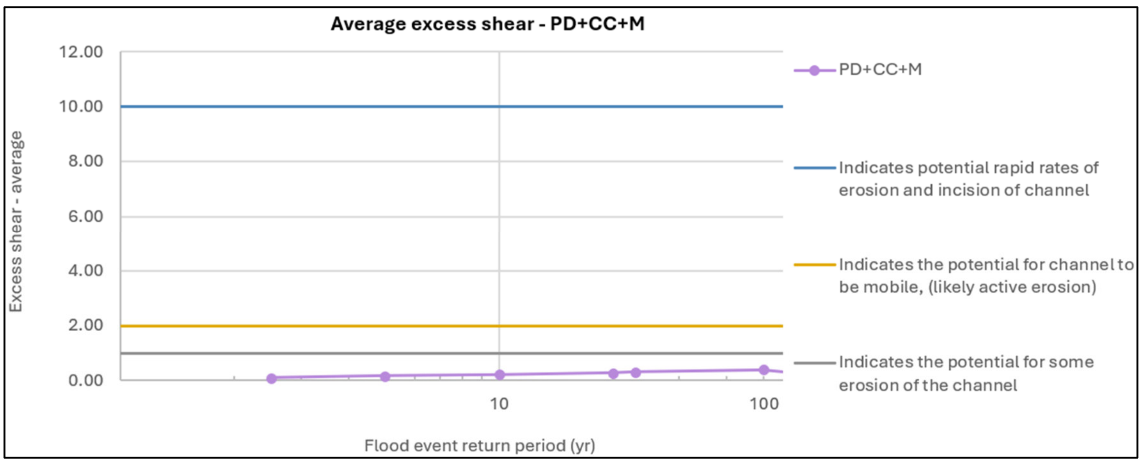

Figure 67: Average excess shear for each event