



ATTACHMENT 24

LTWP Detailed Design Report - Appendix I - Stability Analysis Technical Memo

Appendix I

Stability Analysis Technical Memo

SUBJECT
Iqaluit LTWP Proposed Reservoir – Structure Stability Analyses

TO
City of Iqaluit

DATE
29 February 2024

OUR REF
301192375

DEPARTMENT
Geotechnical

PROJECT NUMBER

COPIES TO
Appendices – Preliminary Design Report

NAME
Ryan Janzen P.Eng., (Geotechnical)
Arun Phakade

1.0 Introduction

Arcadis Canada Inc. (Arcadis) was retained by the City of Iqaluit to complete a preliminary design for a raw water supply reservoir within the city limits of Iqaluit, Nunavut. As part of the reservoir system, eight (8) rock-fill water-retaining structures are proposed. This memorandum summarizes the slope stability analyses for seven (7) of the eight (8) proposed structures in the reservoir system. All retention structure design and configurations will be consistent with the design presented herein. Slope stability of all retention structures will be confirmed at a later design stage.

2.0 Slope Stability Analyses

Stability analyses for the retention structures were completed through critical cross-sections as shown on Drawings C301 of the Preliminary Design Report. Stability analyses were performed in consideration of various scenarios such as end of construction, static loading, Inflow Design Flood (IDF) loading, and earthquake (pseudo-static) loading conditions. These scenarios are summarized in Table 1 below.

2.1 Minimum Factors of Safety and Loading Conditions

The applicable minimum factors of safety (FoS) meeting the Canadian Dam Association (CDA) Dam Safety Guidelines (2013) were adopted for analyzed loading conditions and are summarized in Table 1 below.

Table 1: Specified Minimum Factors of Safety

Loading Conditions	Minimum Factor of Safety	Slopes Considered
End of construction (prior to filling)	1.3	Upstream, downstream
Static loading (normal reservoir level)	1.5	Upstream, downstream
Inflow Design Flood (IDF)	1.3	Upstream, downstream
Earthquake (pseudo-static)	>1.0	Upstream

2.2 Design Seismic Loading

The retaining structures have been designed considering a 1/10,000-year earthquake design event. The PGA corresponding to the 10,000-year design earthquake event is 0.143 (estimated by extrapolation of NBCC 2020 values). These values have been considered for the preliminary design; design parameters will be revised as part of the detailed design process to be completed after site-specific testing has been performed.

2.3 Reservoir Elevations

The reservoir water levels adopted in the analyses were based on the hydrology review (please see Technical Memorandum) and are summarized in Table 2 below.

Table 2: Reservoir Elevations

Condition	Water Level (masl)
End of Construction	117.0
Steady State	127.0
Inflow Design Flood	127.5
Seismic Loading	127.0

The phreatic surface is assumed to be controlled by the presence of an impermeable linear low-density polyethylene (LLDPE) liner. As dam and dyke structures have been designed such that seepage and surficial drainage will be channeled away from the toes of the structures, the phreatic surfaces were assumed to be at or below ground surface on the downstream side.

2.4 Material Properties

The material properties used in the stability analyses are listed in Table 3 below. The foundation is assumed to be impervious bedrock. Dam and dyke fill material properties were adopted based on relevant literature and Arcadis’ experience with similar project sites and materials. Material properties will be revised during the detailed design process, after site-specific geotechnical investigation has taken place and geotechnical testing performed on representative samples of the various aggregate materials at site.

Table 3: Material Properties

Material	Bulk Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (degrees)
Rock Fill	21	0	41
Cushion 1	20	0	35
Cushion 2	19	0	32
Riprap	21	0	41

2.5 Analyses and Results

Analyses were carried out using the computer software program Slope/W, a component of the GeoStudio 2022.1 software suite. Limit equilibrium methods with a half-sine function using the Morgenstern-Price method of slices were used to calculate the interslice side forces. Calculated factors of safety (FoS) for most critical and deeply seated slip surfaces are summarized in Table 4 below. The deep-seated critical slip surfaces are selected based on slip surfaces which could result in a loss of containment.

As noted above, the stability of the structure considered the following conditions:

- End of Construction: constructed dam or dyke without additional water loads;
- Steady State (Normal Operation): reservoir filled to normal operating level of 127.0masl;
- Inflow Design Flood (IDF): considered reservoir filled to an elevated condition of 127.5masl;
- Design Earthquake (Pseudo-Static): considered the reservoir filled to normal operating level (127.0masl) with pseudo-static analyses of the design earthquake acceleration.

The stability analyses are illustrated in the Figures attached at the rear of this memorandum.

The results of the slope stability analyses indicate that the proposed design for the water retaining structures (Dam 1 and Dykes 2, 3, 4, 5, 6 and 8) provide adequate factors of safety for all applicable loading conditions.

Table 4: Slope Stability Results

Analysis Condition	Factor of Safety													
	Dam 1		Dyke 2		Dyke 3		Dyke 4		Dyke 5		Dyke 6		Dyke 8	
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
End of Construction	2.062	2.718	2.240	2.717	2.161	2.776	2.410	2.700	2.512	2.717	2.199	2.680	2.116	2.681
Steady State	2.124	2.685	2.093	2.707	2.086	2.707	2.090	2.710	2.125	2.714	2.091	2.677	2.126	2.688
Inflow Design Flood	2.164	2.685	2.157	2.700	2.146	2.695	2.160	2.710	2.178	2.700	2.147	2.695	2.166	2.869
Seismic Loading	1.083	NA	1.130	NA	1.106	NA	1.200	NA	1.268	NA	1.126	NA	1.095	NA

Note: US = Upstream Slope and DS = Downstream Slope

3.0 Limitations of Analyses

This memorandum and its contents are intended for the sole use of the City of Iqaluit and their agents. Arcadis Canada Inc. (Arcadis) does not accept any responsibility for the accuracy of any of the data, the analyses, of the recommendations contained or referenced in the memo, when the memo is used or relied upon by any Party other than the City of Iqaluit, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use attached to the Preliminary Design Report or Contractual Terms and Conditions Executed by both parties.

These preliminary analyses have been performed based on assumed site conditions and estimated material properties. These assumptions will be revisited, and more detailed stability analyses be modeled, during the detailed design process to be conducted after site-specific geotechnical investigations have been performed.

4.0 Closure

We trust this technical memorandum meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Arcadis Canada Inc.

DRAFT

DRAFT

Prepared by:

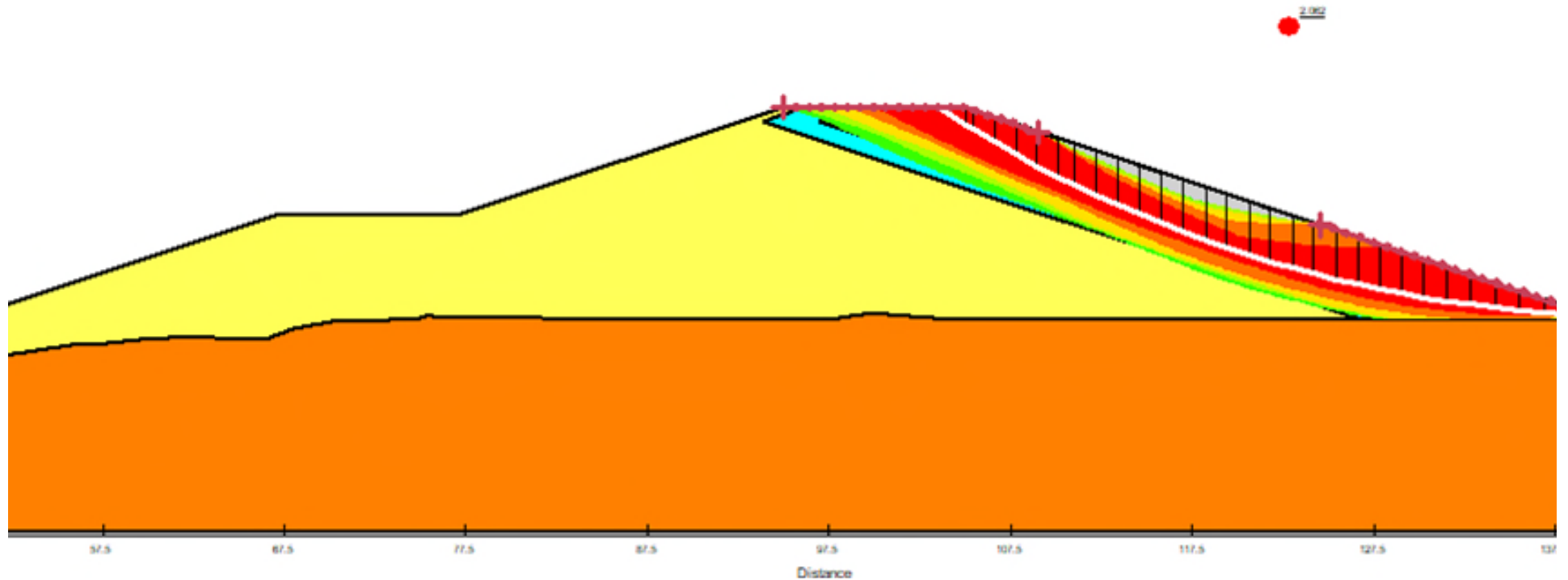
Mr. Arun Phakade, Geotechnical Specialist
Arun.Phakade@arcadis.com

Reviewed by:

Mr. Ryan Janzen, P.Eng., Senior Engineer
Ryan.Janzen@arcadis.com

Enc. Slope Stability Analyses Results (Cross-Sections)

Color	Name	Effective Friction Angle (°)
Orange	Bedrock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41



SLOPE STABILITY ANALYSIS

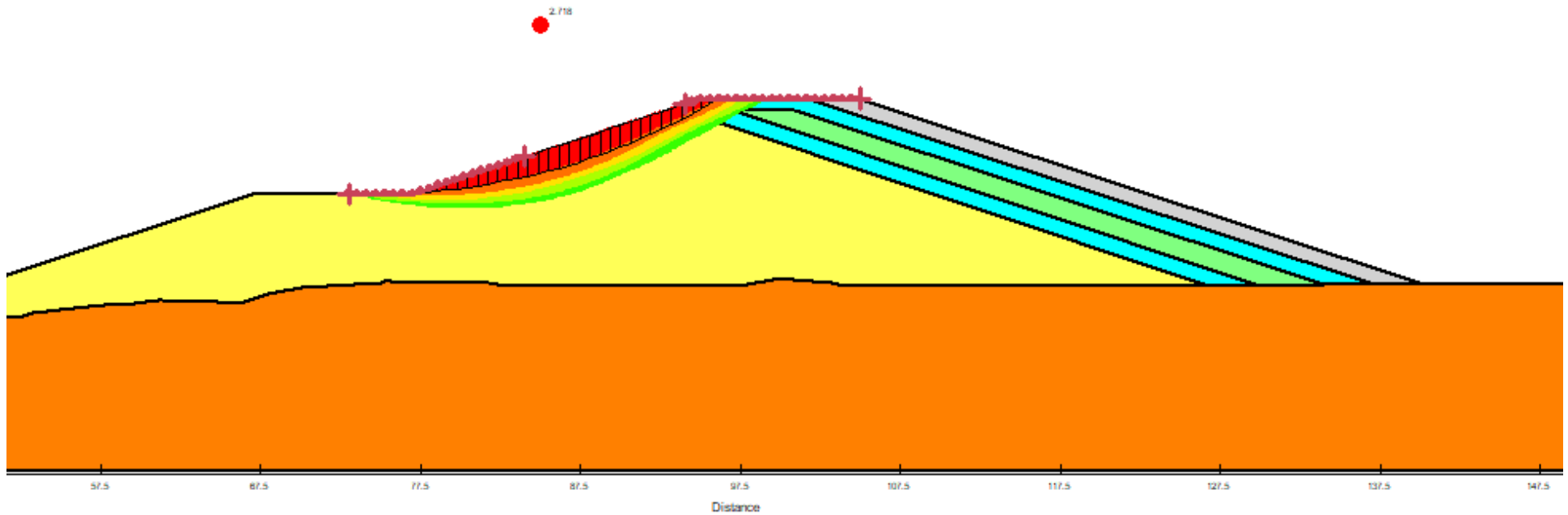
DAM 1
END OF CONSTRUCTION: UPSTREAM

 | FIGURE 1.1

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bedrock	
Cyan	Cushion1	35
Green	Cushion2	32
Grey	Riprap	41
Yellow	Rockfill	41

130.66667, 143.33333 m



SLOPE STABILITY ANALYSIS

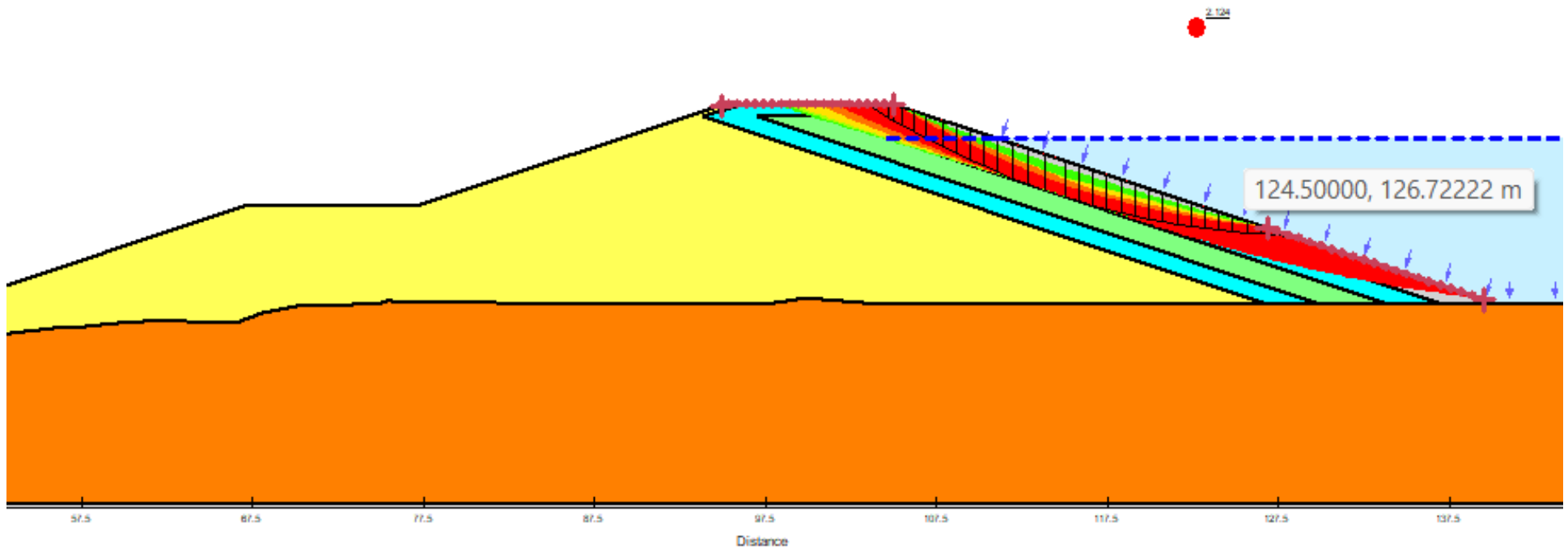
DAM 1 END OF CONSTRUCTION:
DOWNSTREAM

DRAFT
DRAFT

 **ARCADIS**

FIGURE
1.2

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bedrock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	



SLOPE STABILITY ANALYSIS

DAM 1
STEADY STATE: UPSTREAM

DRAFT

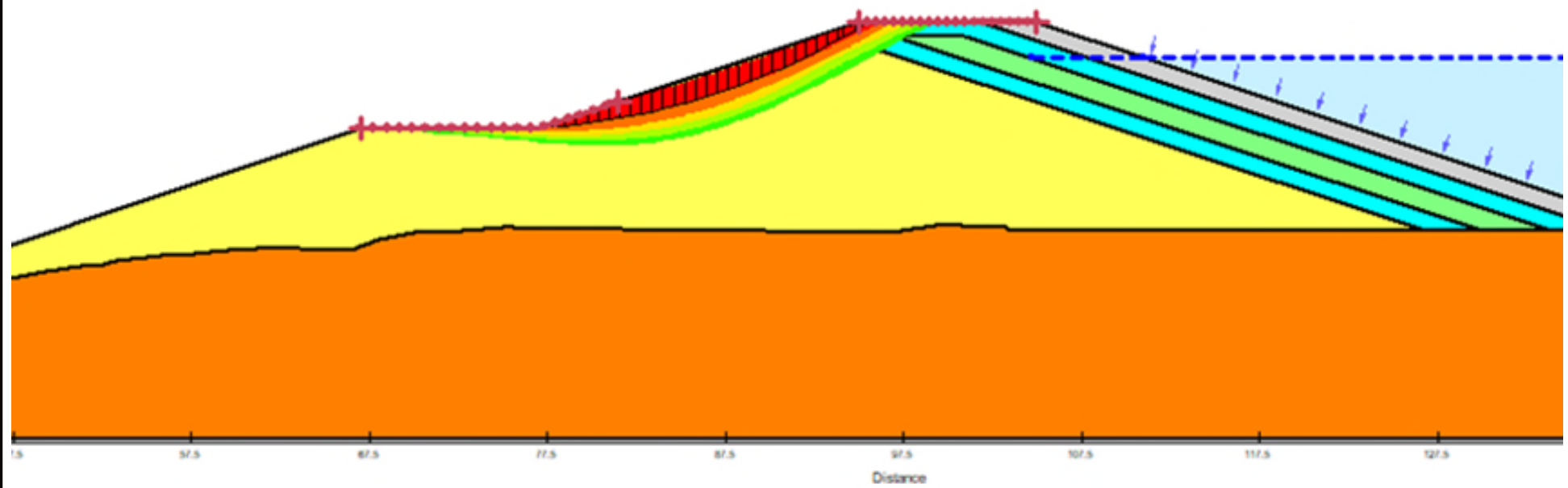


FIGURE
1.3

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bedrock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	

85.72222, 141.90000 m

2.655



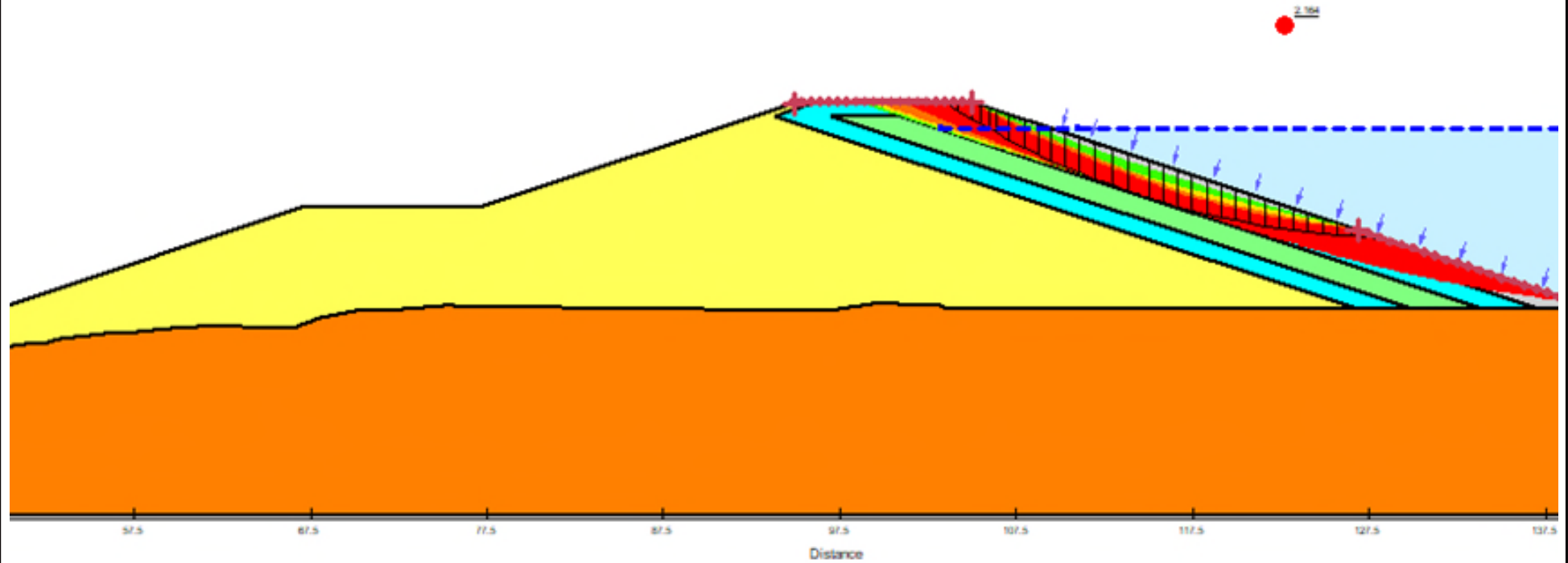
SLOPE STABILITY ANALYSIS

DAM 1
STEADY STATE: DOWNSTREAM

 | FIGURE 1.4

DRAFT

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bedrock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rakfill	41	



SLOPE STABILITY ANALYSIS

DAM 1
IDF: UPSTREAM



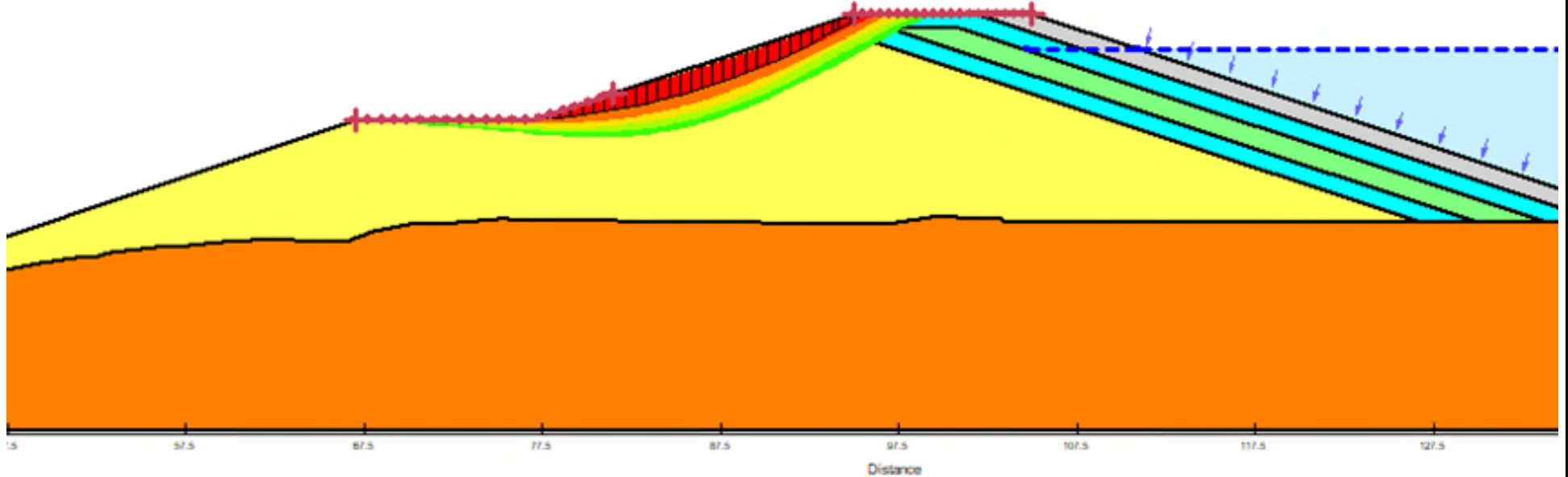
FIGURE
1.5

DRAFT

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bedrock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	

85.72222, 141.90000 m

2.655



SLOPE STABILITY ANALYSIS

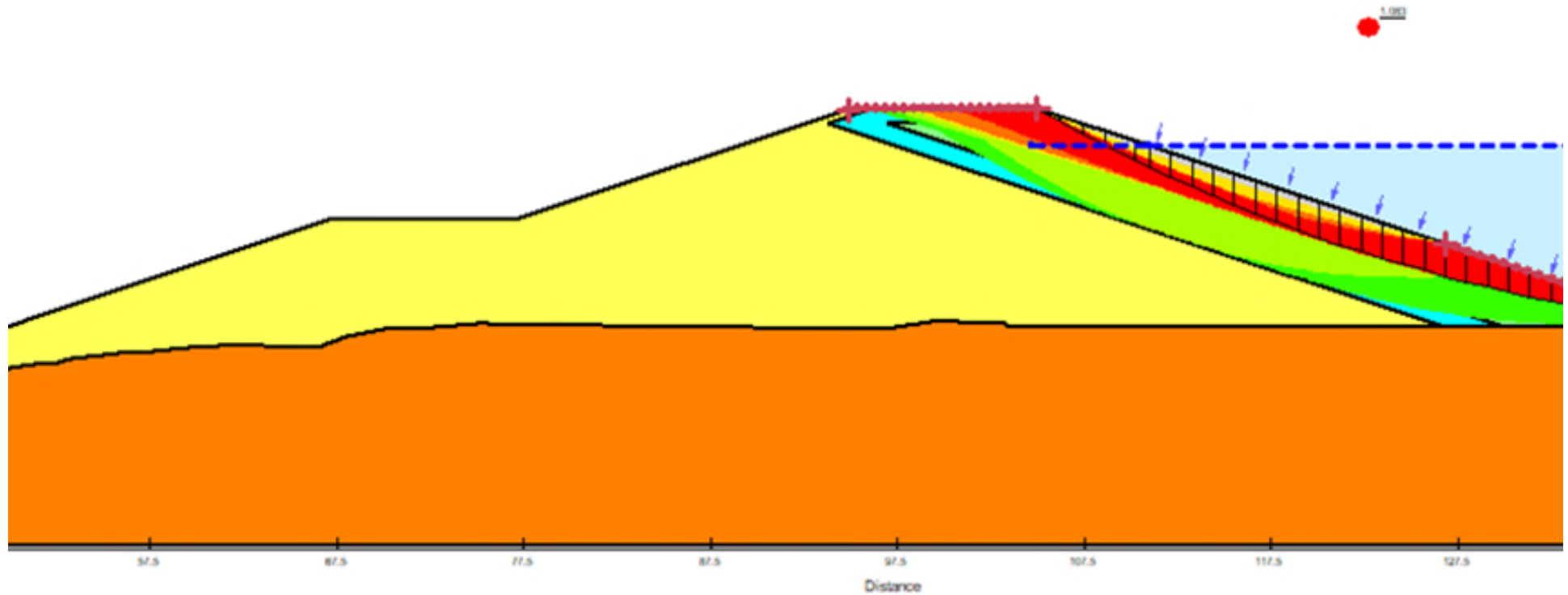
DAM 1
IDF: DOWNSTREAM



FIGURE
1.6

DRAFT

Color	Name	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)	Piezometric Surface
Orange	Bedrock				1
Cyan	Cushion 1	35	0	0	1
Green	Cushion 2	32	0	0	
Grey	Riprap	41	0	0	1
Yellow	Rockfill	41	0	0	



SLOPE STABILITY ANALYSIS

DAM 1
SEISMIC: UPSTREAM



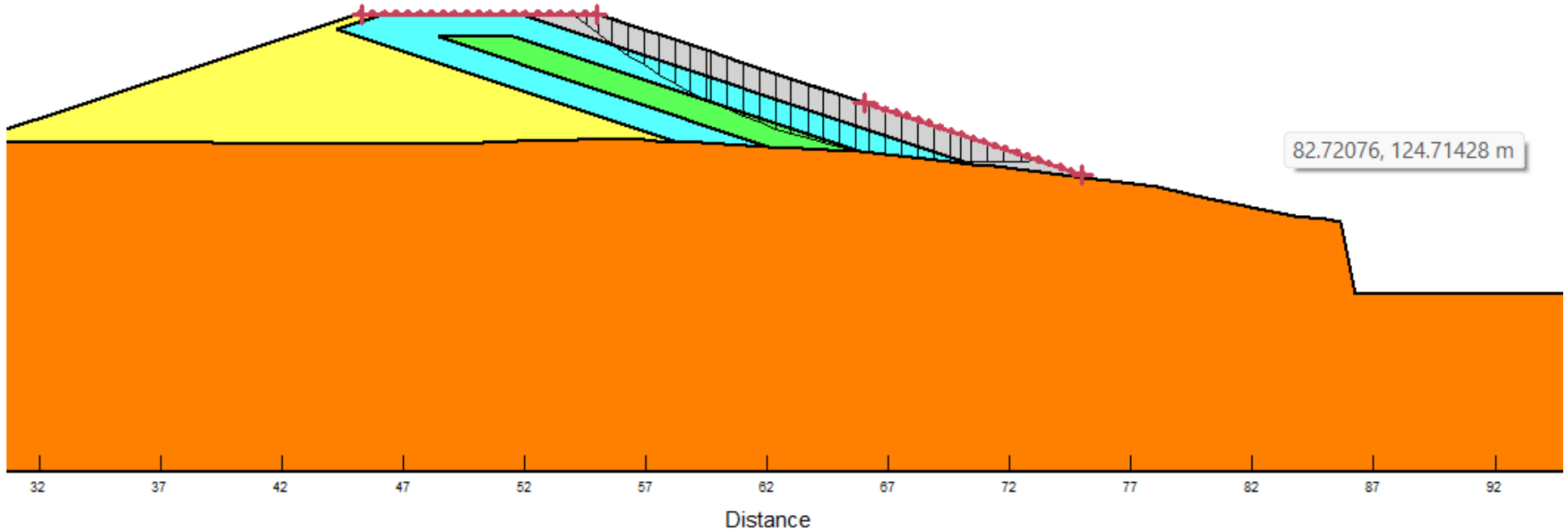
FIGURE
1.7

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

2.240

82.72076, 124.71428 m



SLOPE STABILITY ANALYSIS

DYKE 2

END OF CONSTRUCTION: UPSTREAM

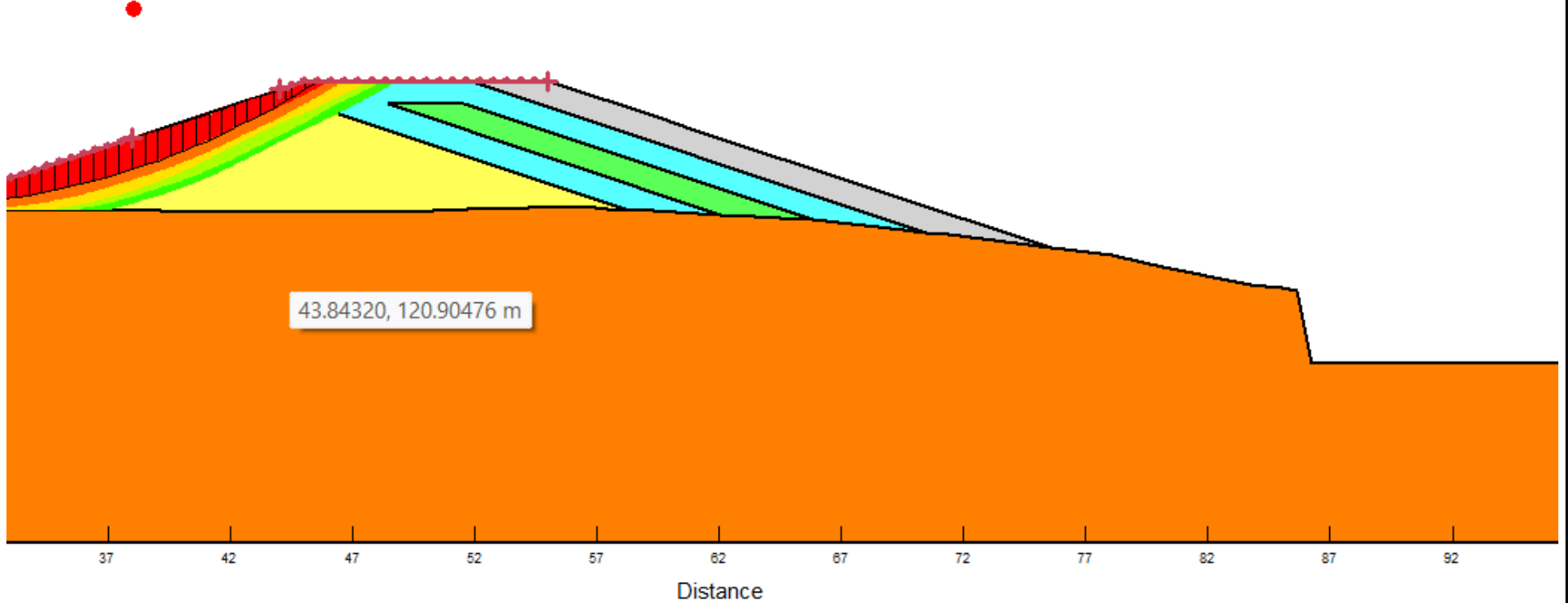
DRAFT



FIGURE 2.1

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

2.717



SLOPE STABILITY ANALYSIS

DYKE 2 END OF CONSTRUCTION:
DOWNSTREAM

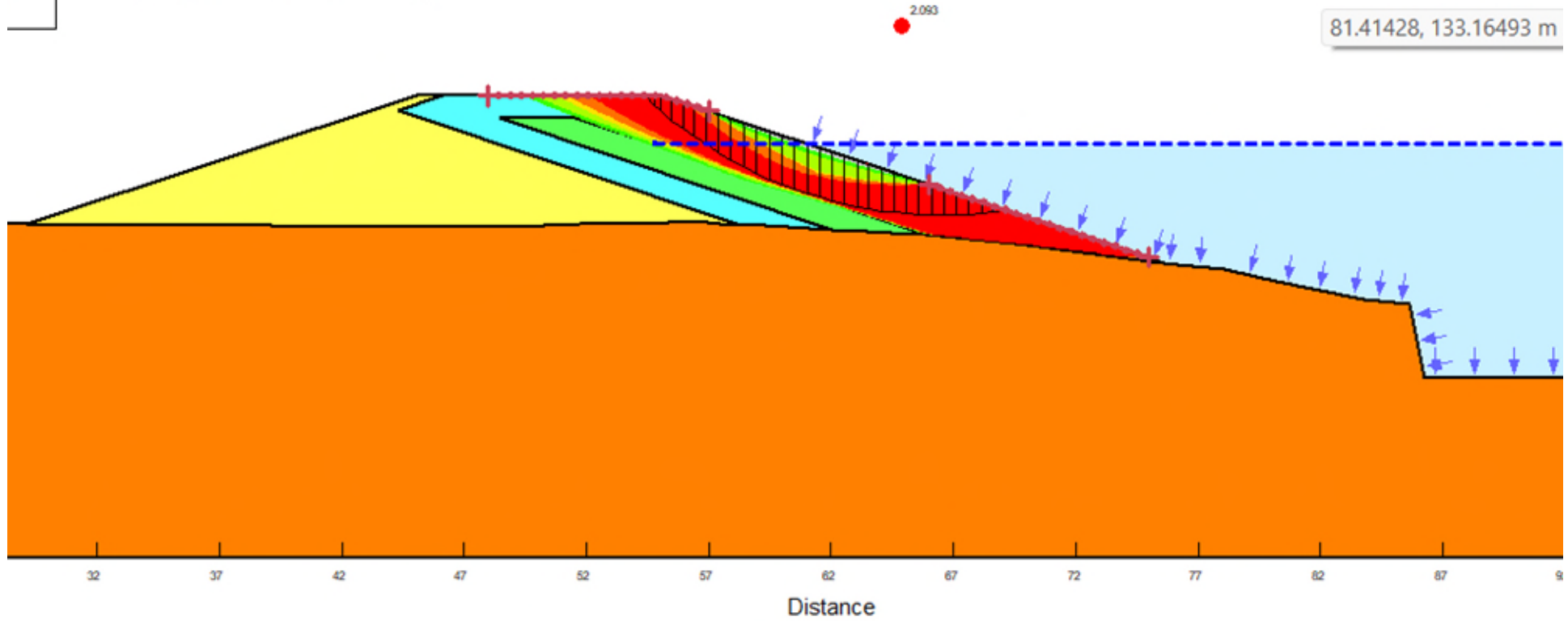


FIGURE
2.2

DRAFT
DRAFT

ifety
 91
 91
 91
 91
 91
 91
 91
 91

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	1



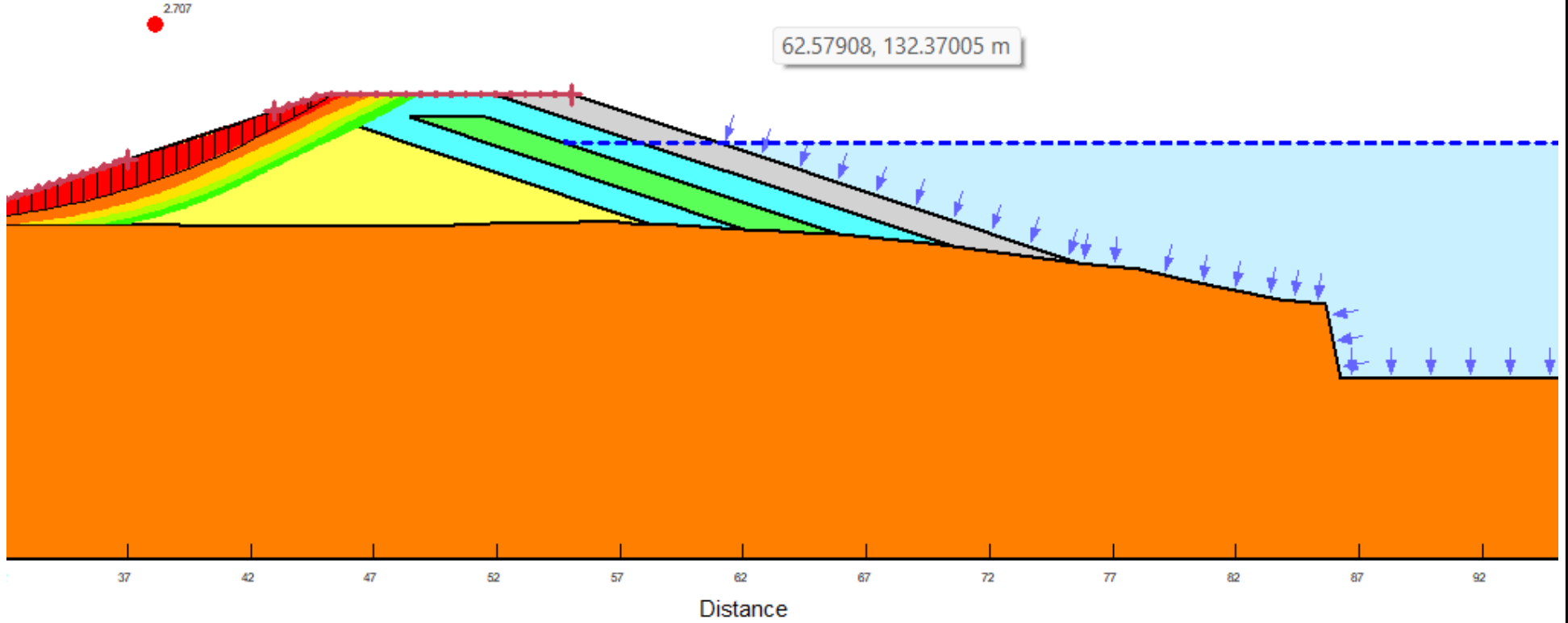
SLOPE STABILITY ANALYSIS


DYKE 2
 STEADY STATE: UPSTREAM

 | FIGURE 2.3

DRAFT

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	1
Grey	Riprap	41	1
Yellow	Rockfill	41	1

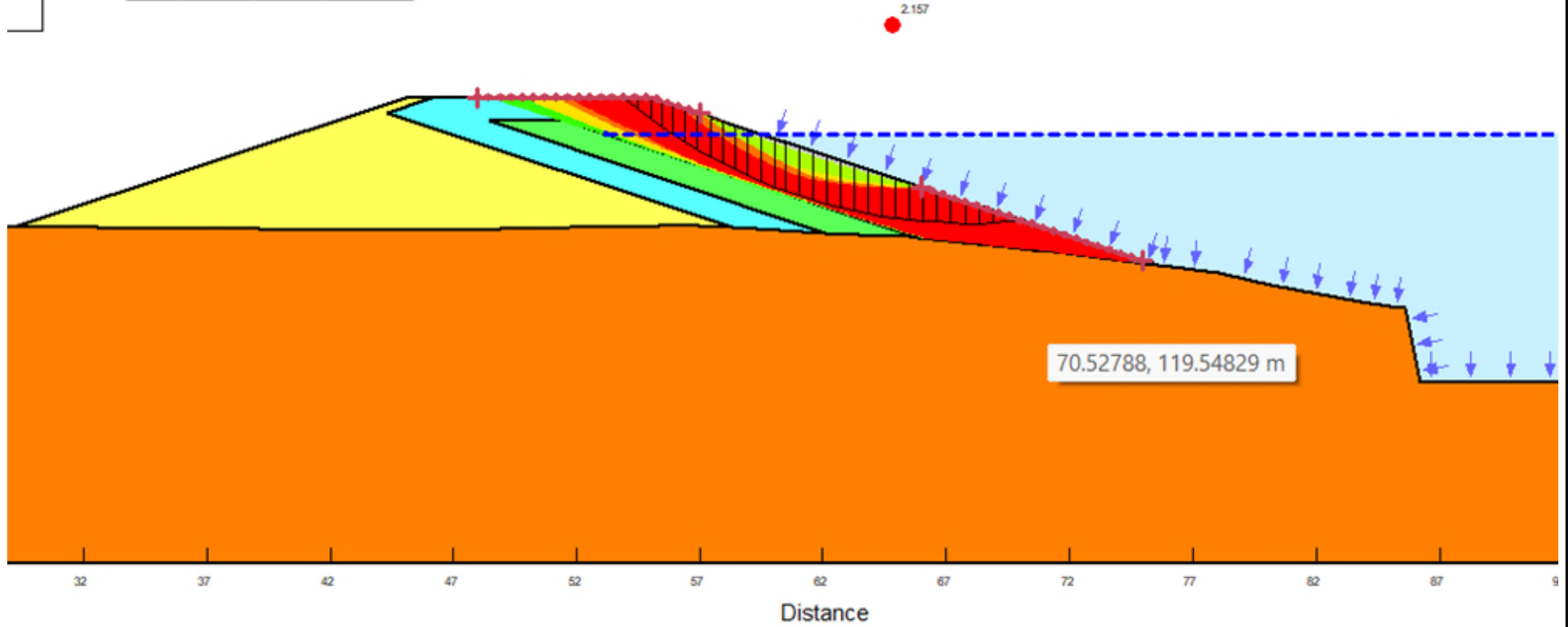


SLOPE STABILITY ANALYSIS	
DYKE 2 STEADY STATE: DOWNSTREAM	
	FIGURE 2.4

DRAFT

ity
5
3
3
3
3
3
3
3

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	1



SLOPE STABILITY ANALYSIS

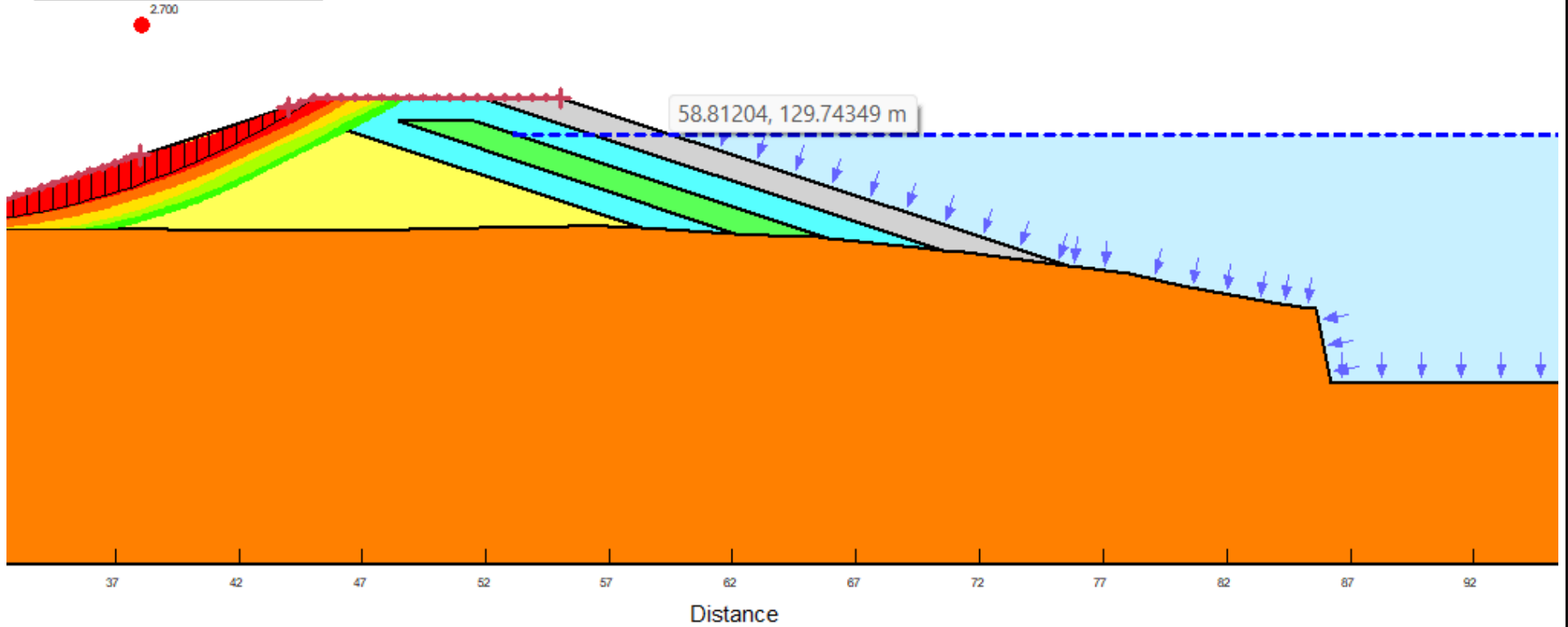
DYKE 2
IDF: UPSTREAM

 ARCADIS

FIGURE
2.5

DRAFT

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	1



SLOPE STABILITY ANALYSIS

DYKE 2
IDF: DOWNSTREAM



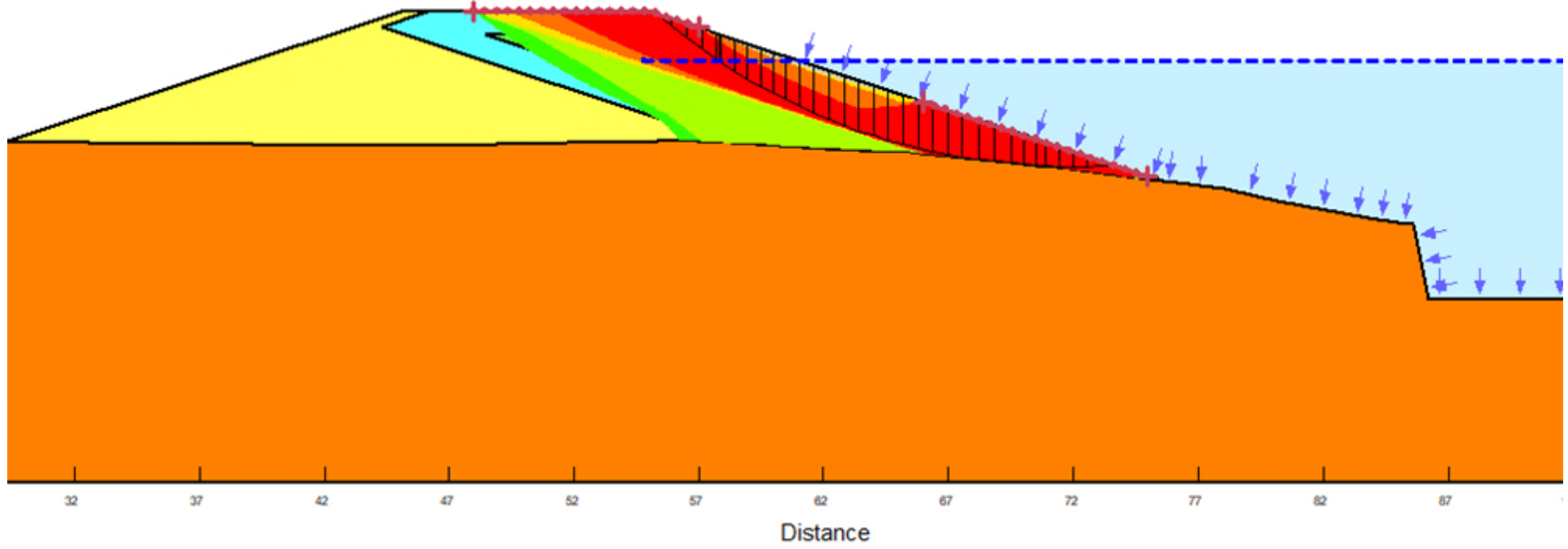
FIGURE
2.6

DRAFT

y

Color	Name	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)	Piezometric Surface
Orange	Bed Rock				1
Cyan	Cushion II	35	0	0	1
Green	Cushion 2	32	0	0	
Grey	Riprap	41	0	0	1
Yellow	Rockfill	41	0	0	1

1.130



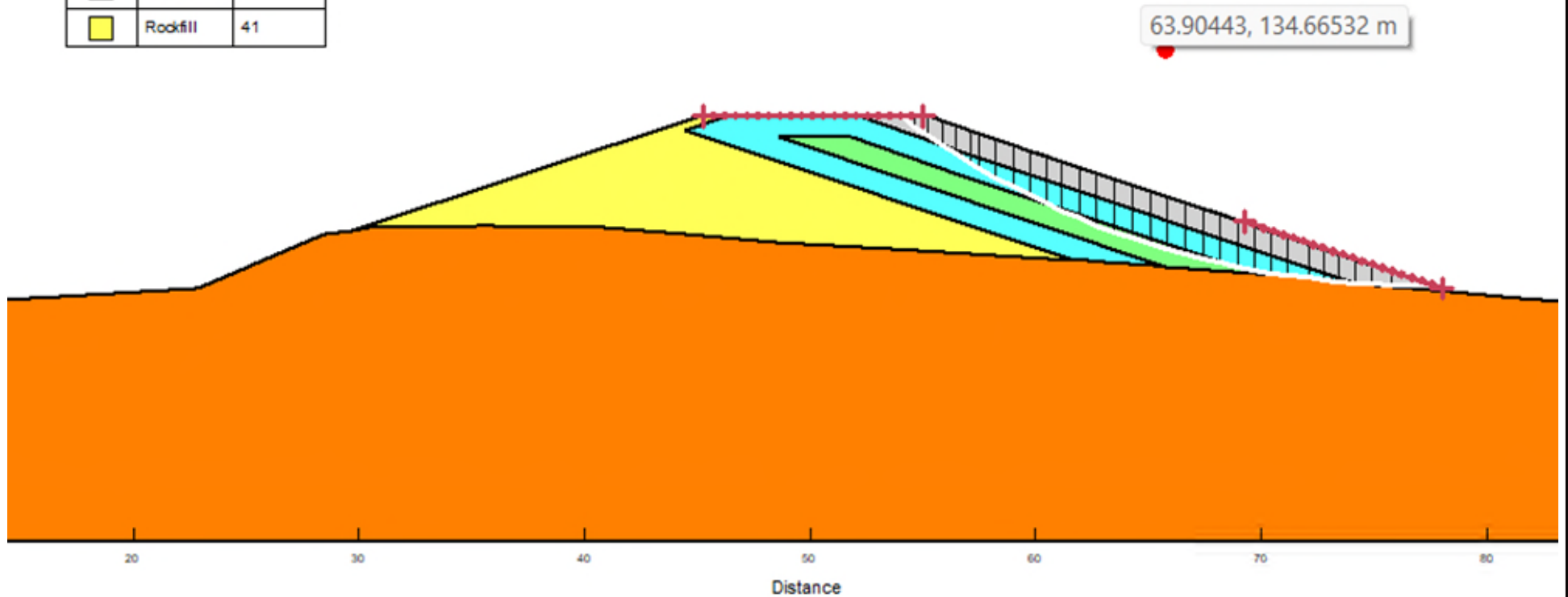
SLOPE STABILITY ANALYSIS

DYKE 2
SEISMIC: UPSTREAM

 | FIGURE 2.7

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41



SLOPE STABILITY ANALYSIS

DYKE 3
END OF CONSTRUCTION: UPSTREAM

DRAFT

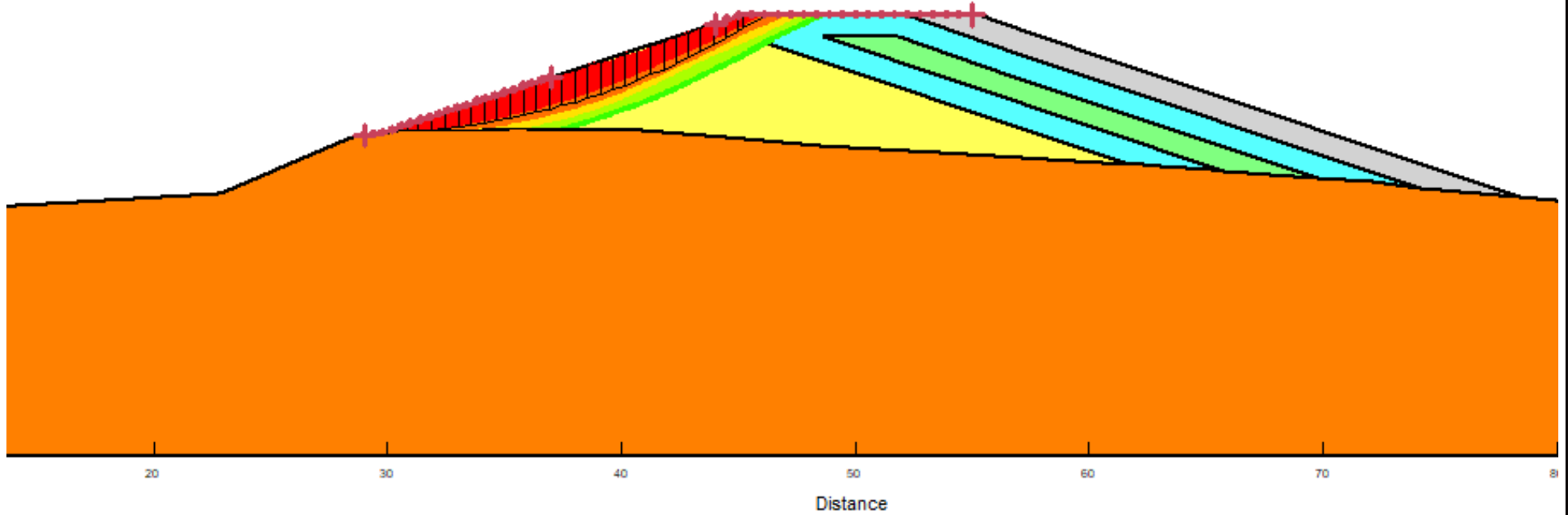


FIGURE
3.1

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

62.59831, 139.56327 m

2.776



SLOPE STABILITY ANALYSIS

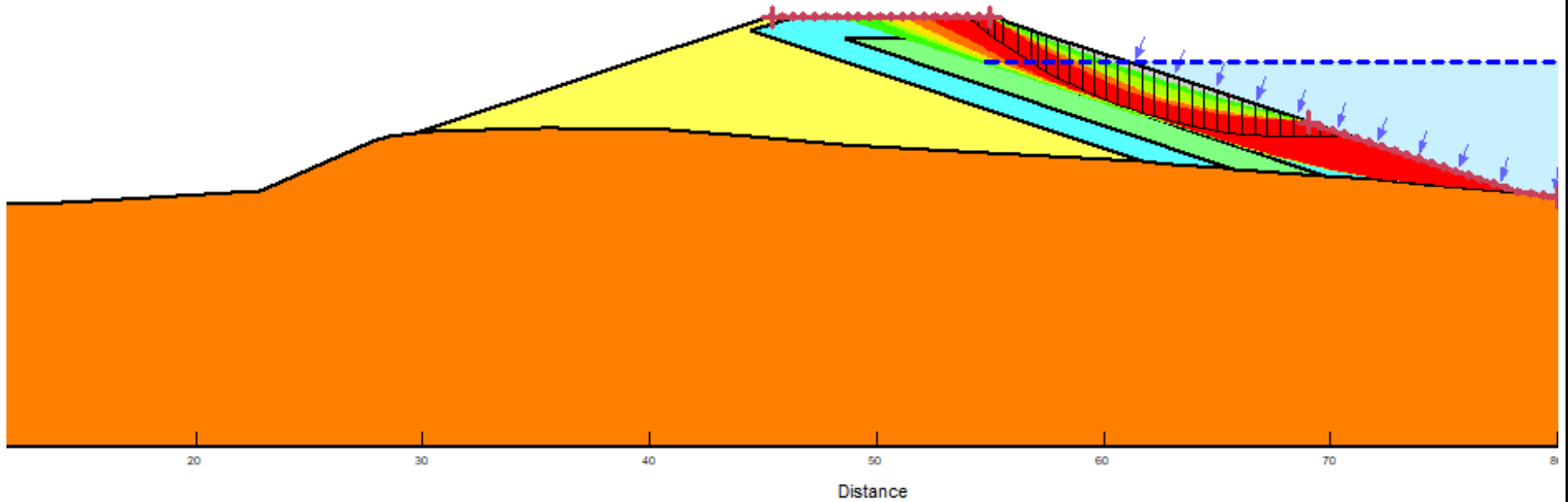
DYKE 3 END OF CONSTRUCTION:
DOWNSTREAM


DRAFT
DRAFT



FIGURE
3.2

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

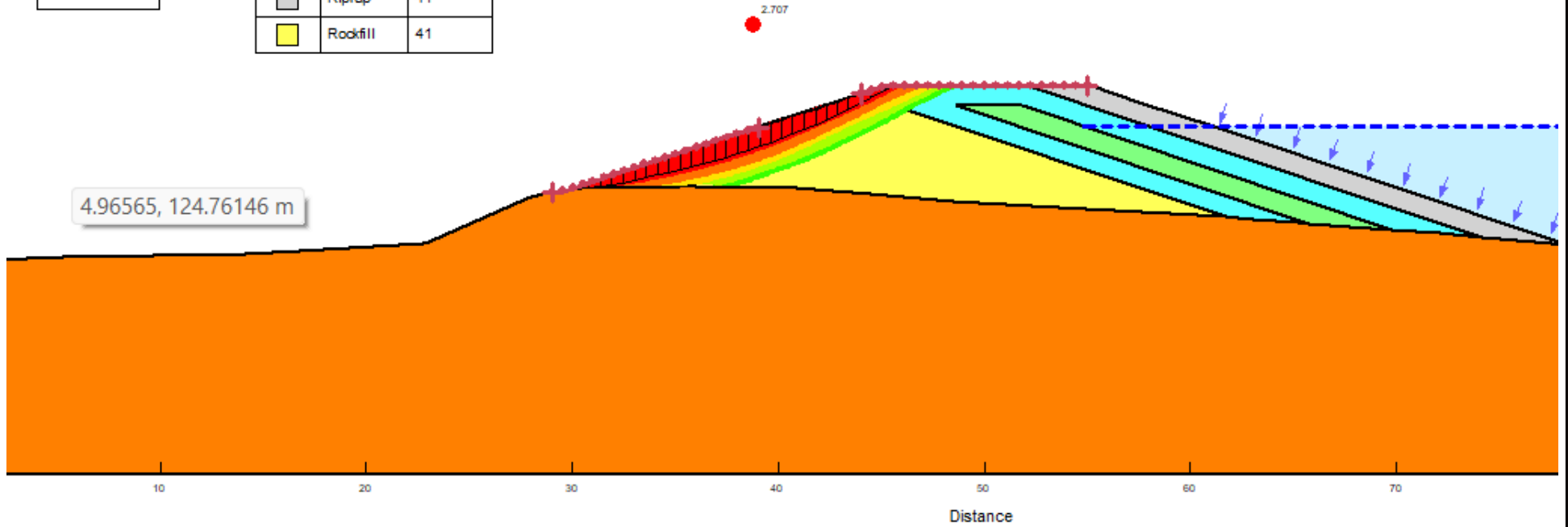


SLOPE STABILITY ANALYSIS	
DYKE 3 STEADY STATE: UPSTREAM	
	FIGURE 3.3

DRAFT

Factor of Safety	
■	2.650 - 2.750
■	2.750 - 2.850
■	2.850 - 2.950
■	2.950 - 3.050
■	3.050 - 3.150
■	3.150 - 3.250
■	3.250 - 3.350
■	3.350 - 3.450
■	3.450 - 3.550
■	≥ 3.550

Color	Name	Effective Friction Angle (°)
■	Bed Rock	
■	Cushion 1	35
■	Cushion 2	32
■	Riprap	41
■	Rockfill	41



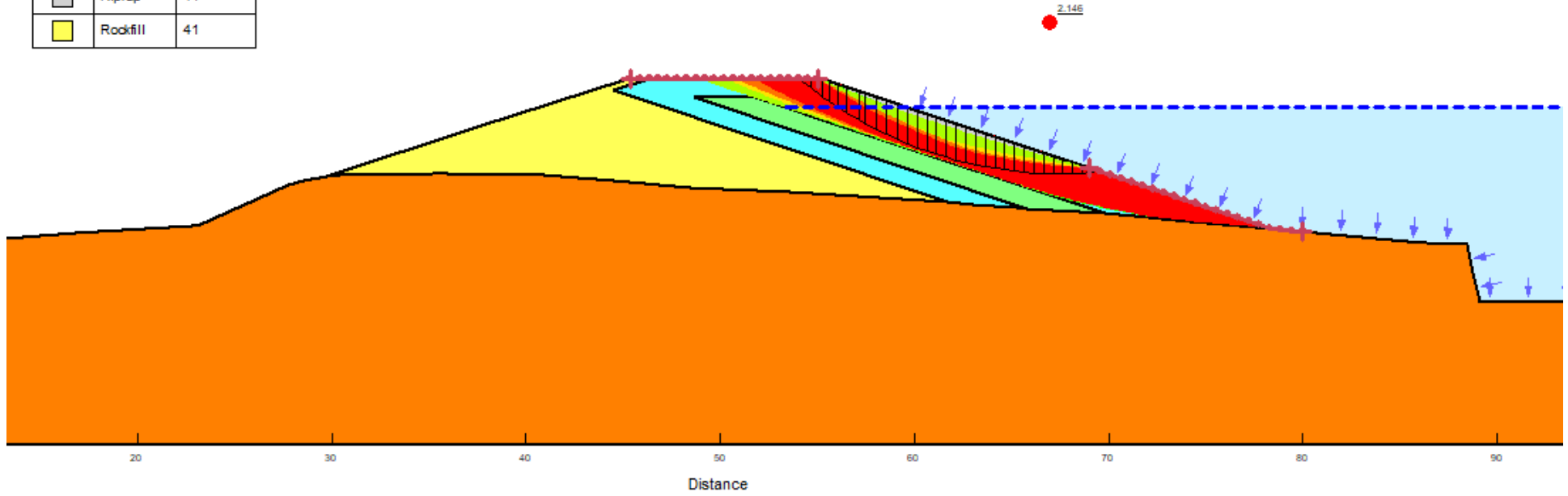
SLOPE STABILITY ANALYSIS

DYKE 3
STEADY STATE: DOWNSTREAM

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

75.29218, 141.00636 m



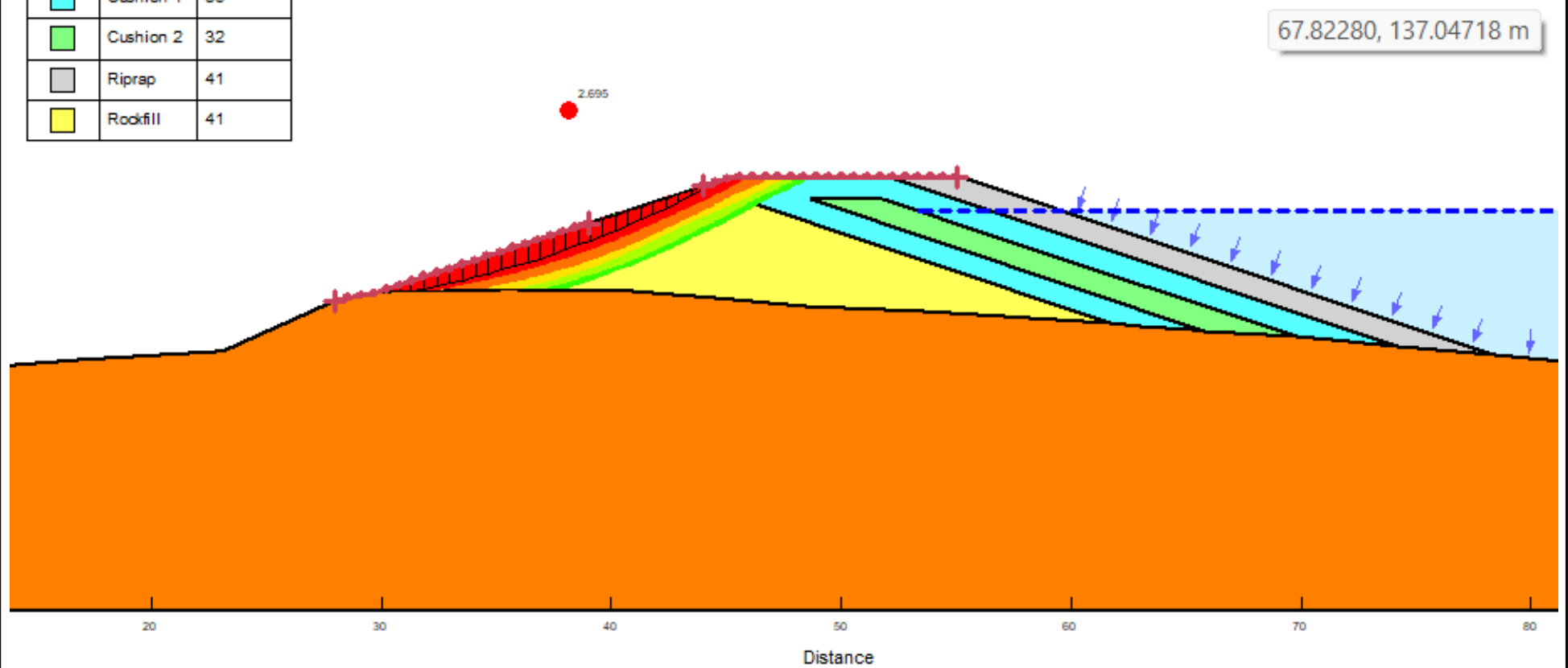
SLOPE STABILITY ANALYSIS

DYKE 3
IDF: UPSTREAM

 | FIGURE 3.5

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41



SLOPE STABILITY ANALYSIS

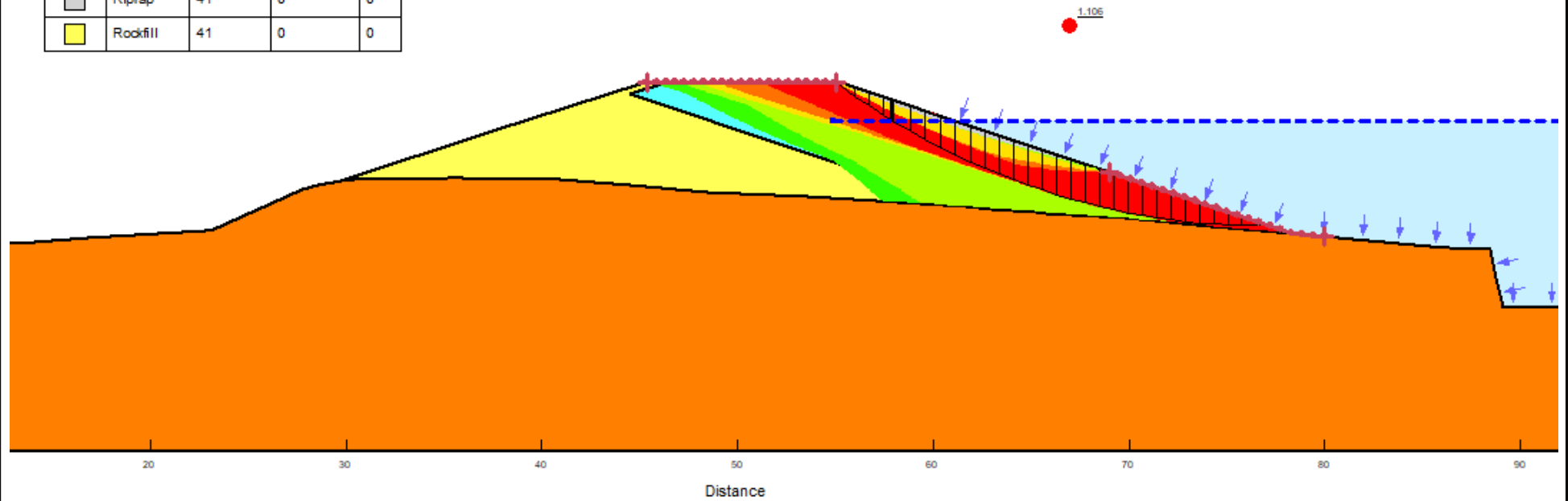
DYKE 3
IDF: DOWNSTREAM

 | FIGURE 3.6

DRAFT

Color	Name	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)
Orange	Bed Rock			
Cyan	Cushion 1	35	0	0
Green	Cushion 2	32	0	0
Grey	Riprap	41	0	0
Yellow	Rockfill	41	0	0

76.23096, 136.31248 m



SLOPE STABILITY ANALYSIS

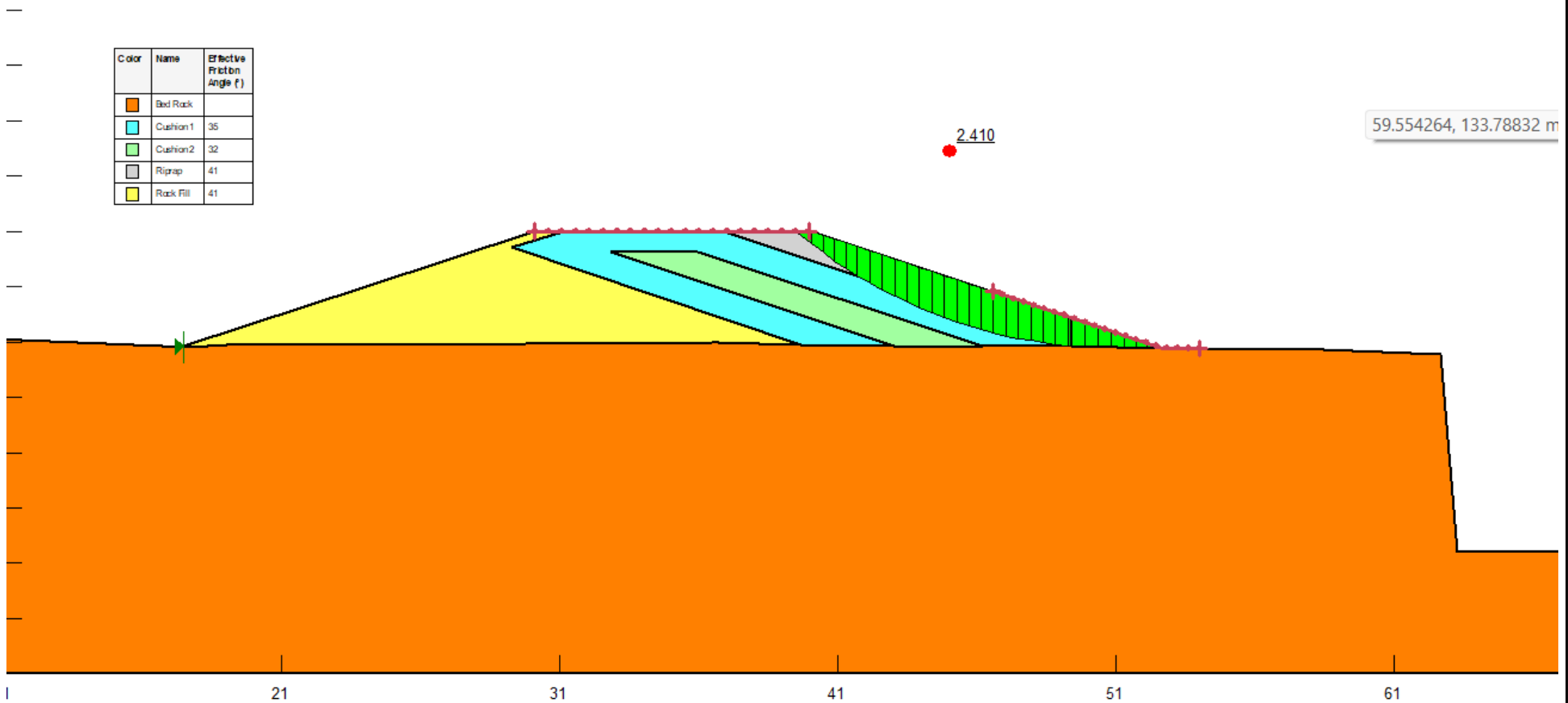
DYKE 3
SEISMIC: UPSTREAM



FIGURE
3.7

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion1	35
Green	Cushion2	32
Grey	Riprap	41
Yellow	Rock Fill	41



SLOPE STABILITY ANALYSIS

DYKE 4
END OF CONSTRUCTION: UPSTREAM



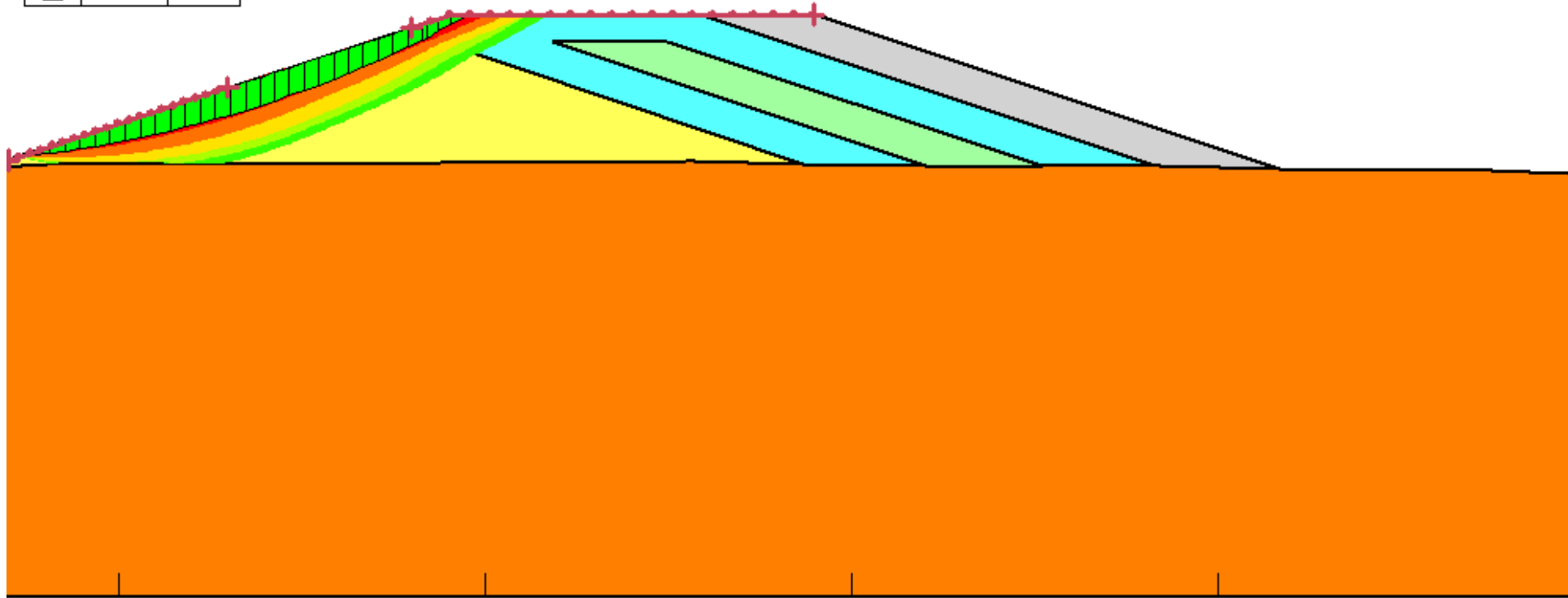
FIGURE
4.1

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Rrap	41
Yellow	Rock Fill	41

34.410586, 135.12931 m

2.70



21

31

41

51

SLOPE STABILITY ANALYSIS

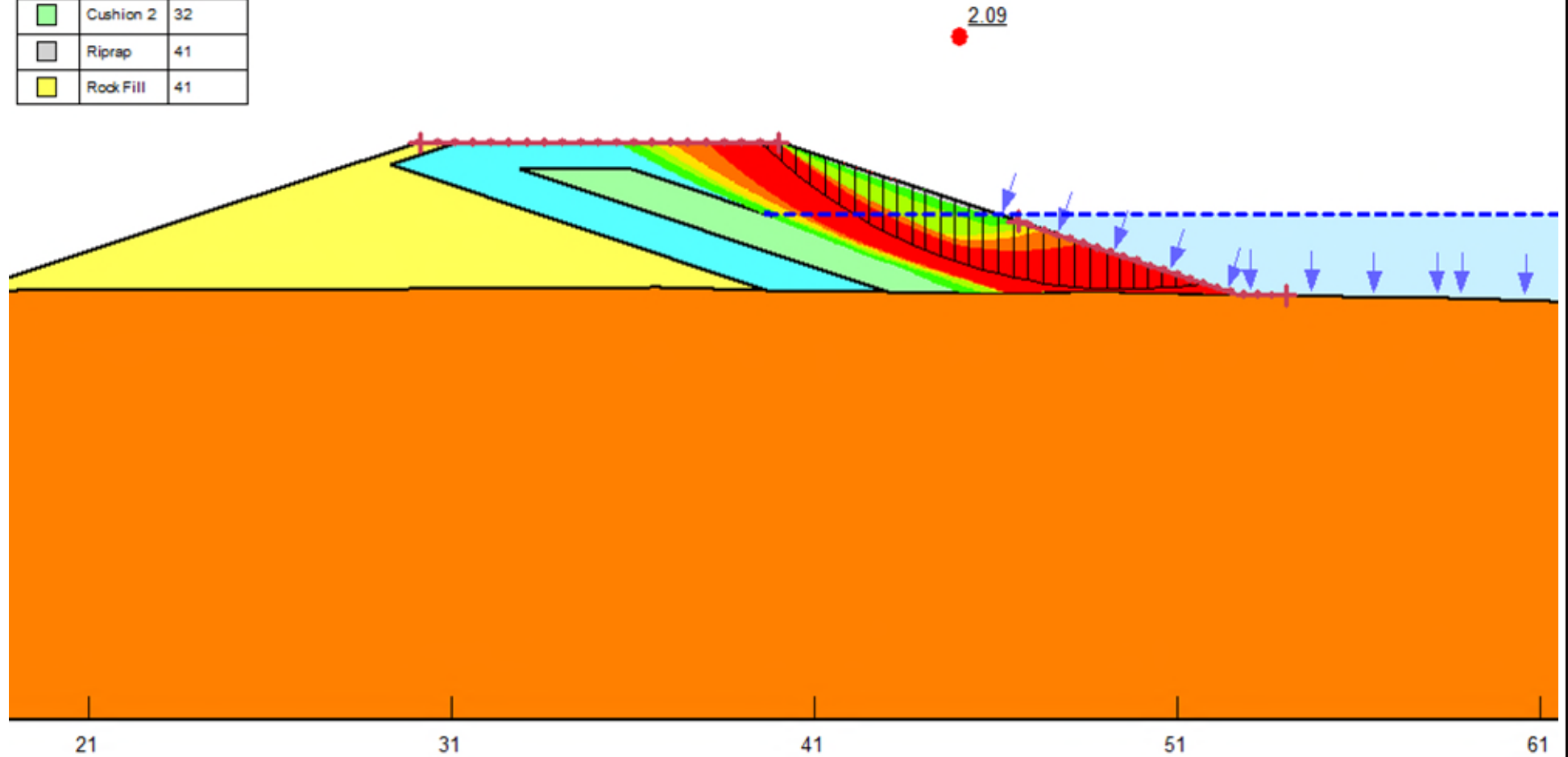
DYKE 4 END OF CONSTRUCTION:
DOWNSTREAM



FIGURE
4.2

DRAFT
DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rock Fill	41



SLOPE STABILITY ANALYSIS

DYKE 4
STEADY STATE: UPSTREAM

DRAFT

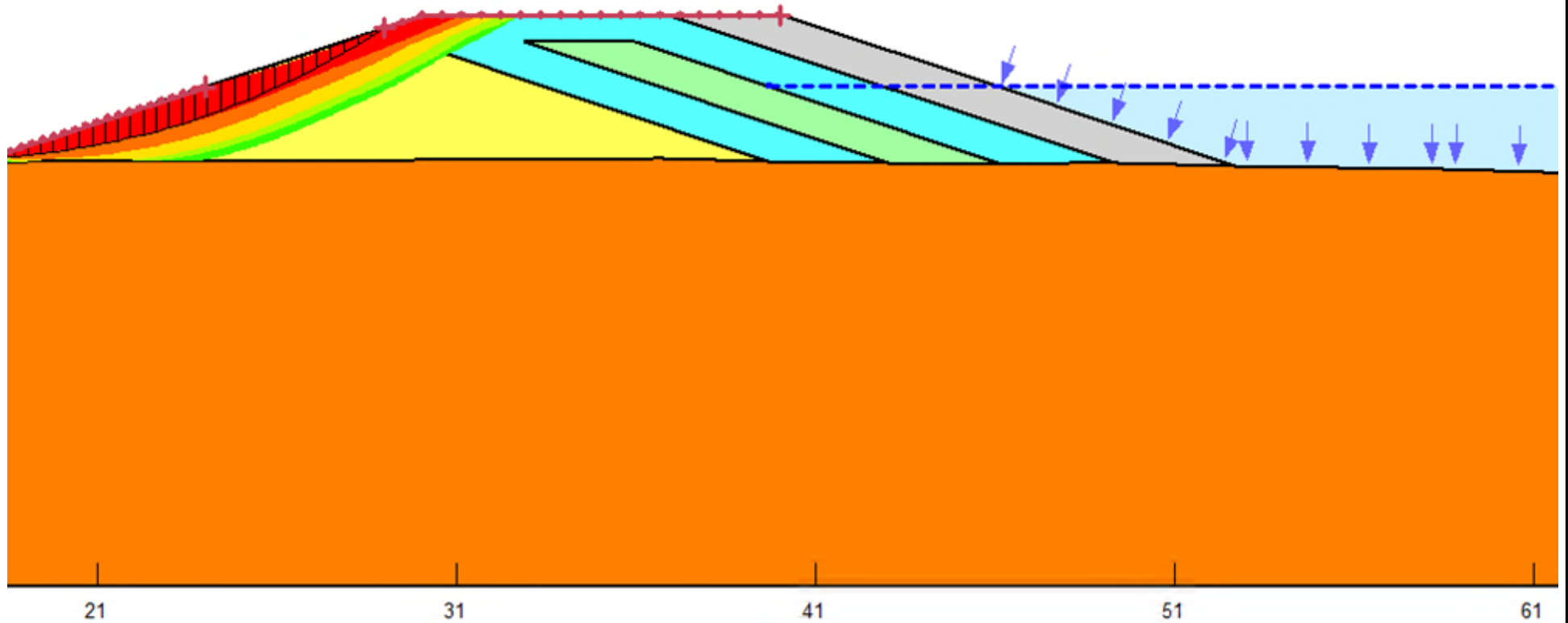


FIGURE
4.3

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rock Fill	41

30.914418, 135.36878 m

2.71



SLOPE STABILITY ANALYSIS

DYKE 4
STEADY STATE: DOWNSTREAM



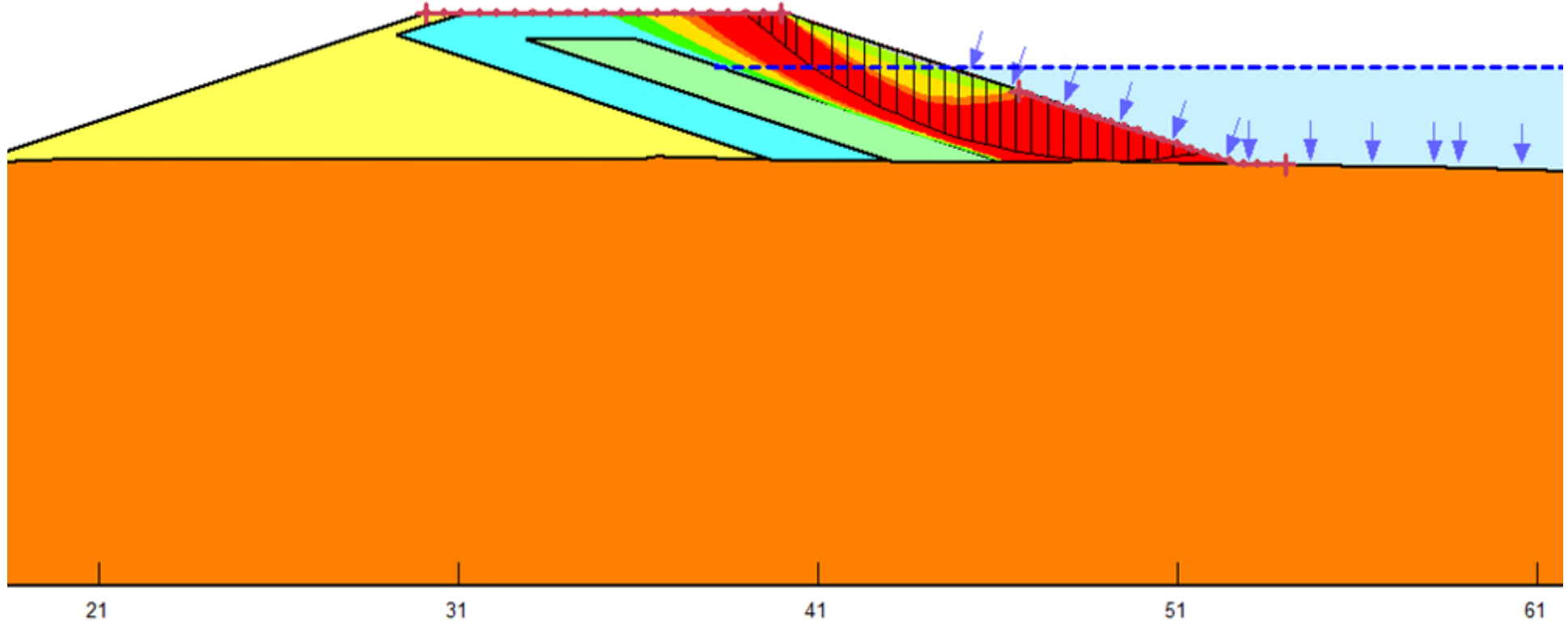
FIGURE
4.4

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rock Fill	41

44.731467, 135.39273 m

2.16



SLOPE STABILITY ANALYSIS

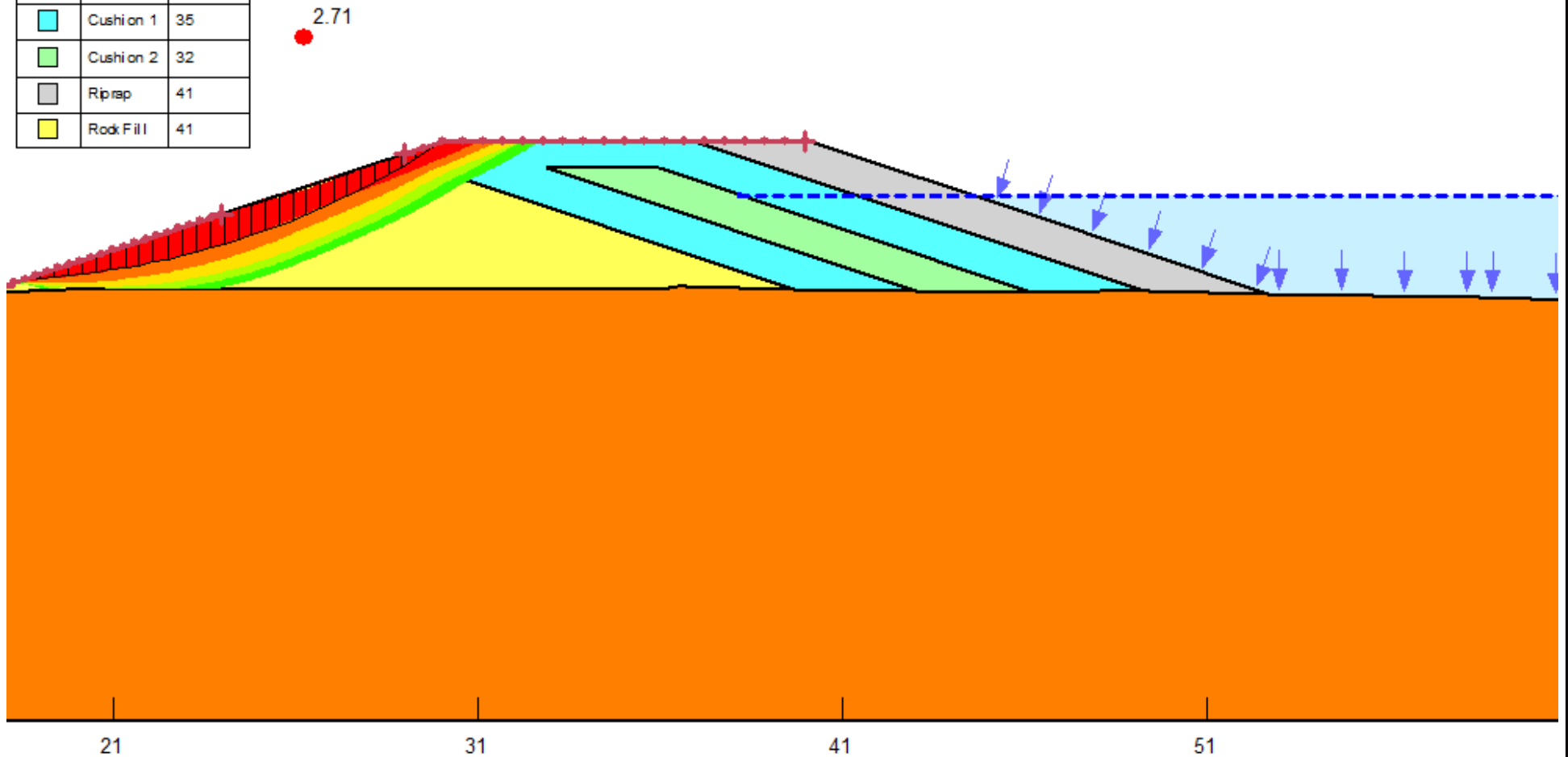
DYKE 4
IDF: UPSTREAM



FIGURE
4.5

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rock Fill	41



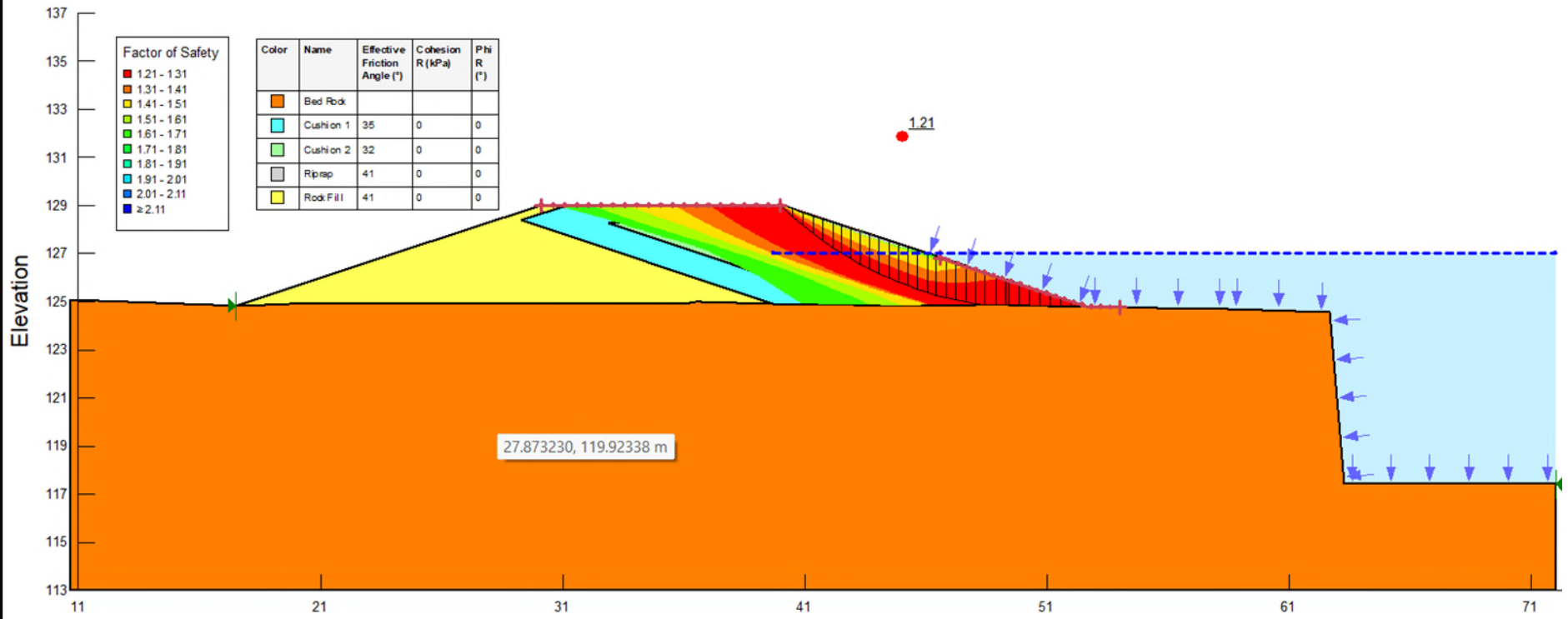
SLOPE STABILITY ANALYSIS

DYKE 4
IDF: DOWNSTREAM

DRAFT



FIGURE
4.6



SLOPE STABILITY ANALYSIS

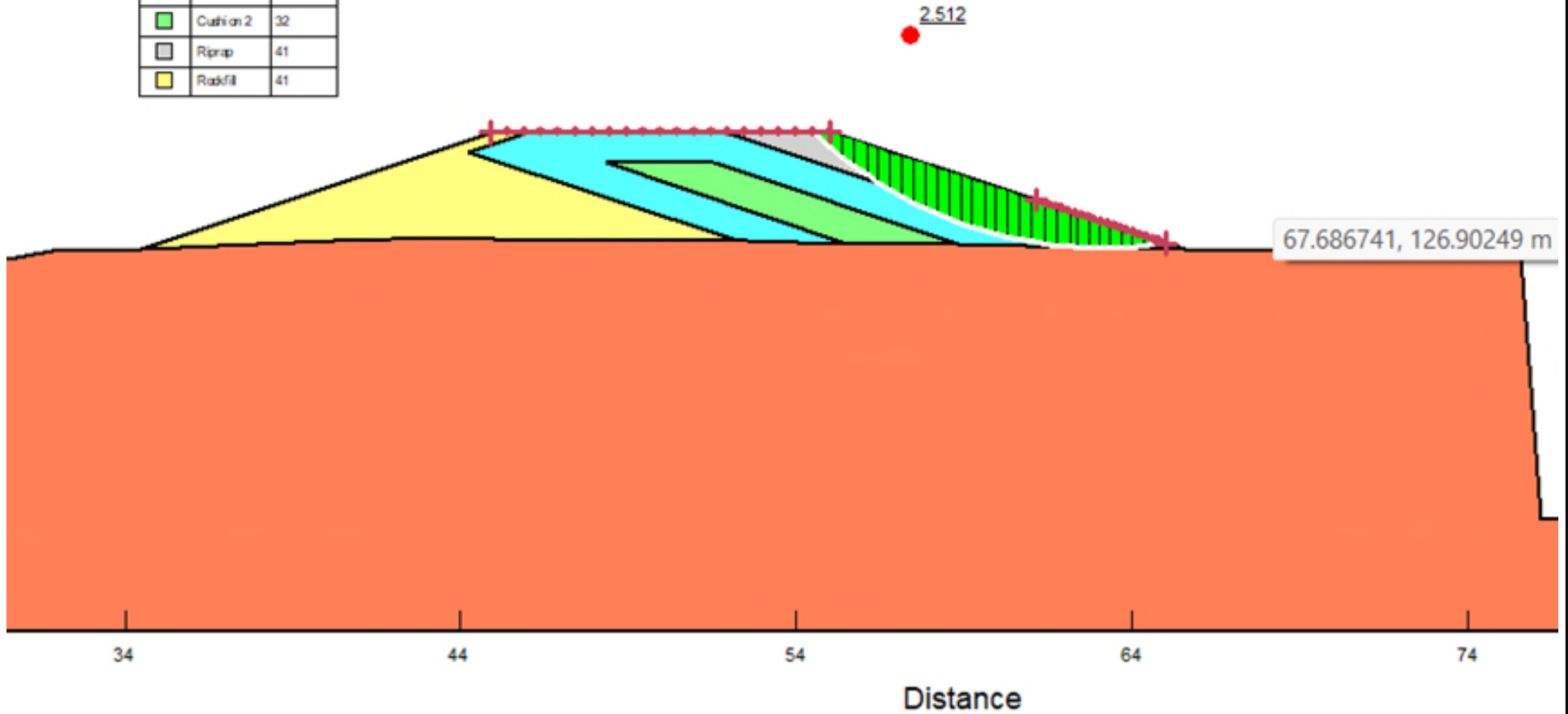
DYKE 4
SEISMIC: UPSTREAM

DRAFT



FIGURE
4.7

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rakfil	41



SLOPE STABILITY ANALYSIS

DYKE 5
END OF CONSTRUCTION: UPSTREAM

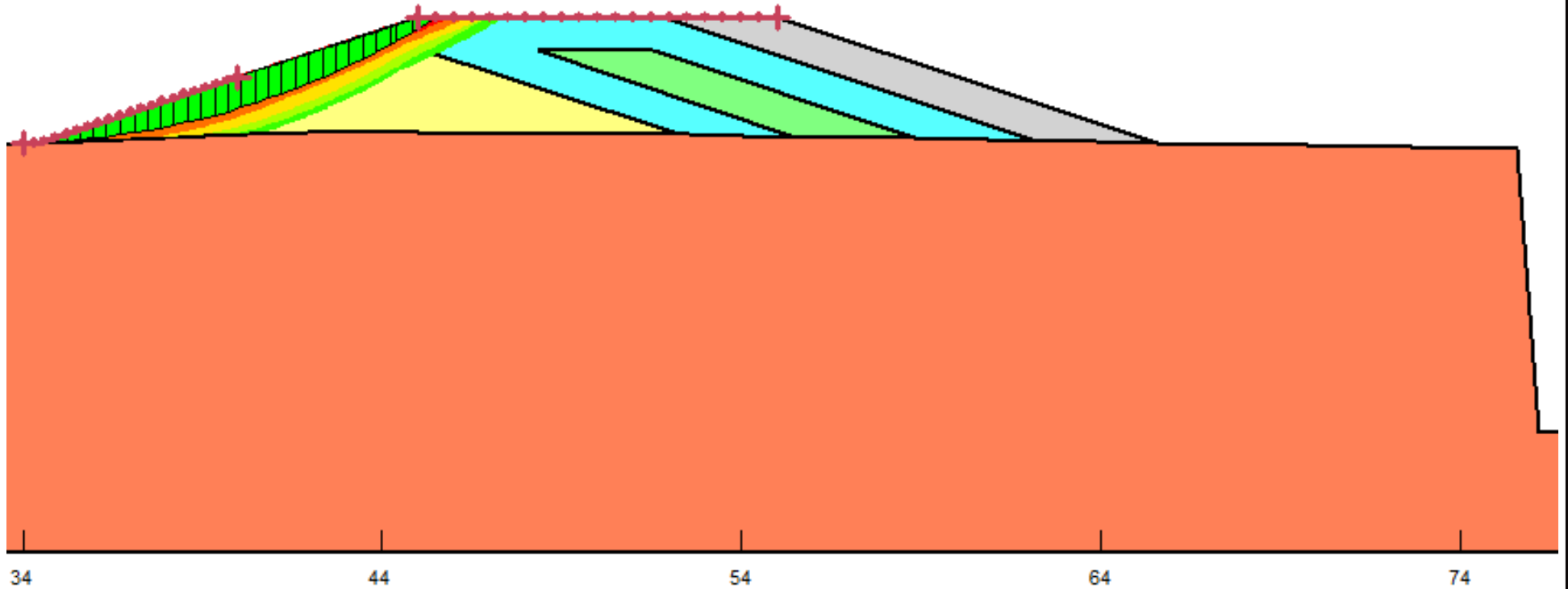
DRAFT



FIGURE
5.1

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

2.711



SLOPE STABILITY ANALYSIS

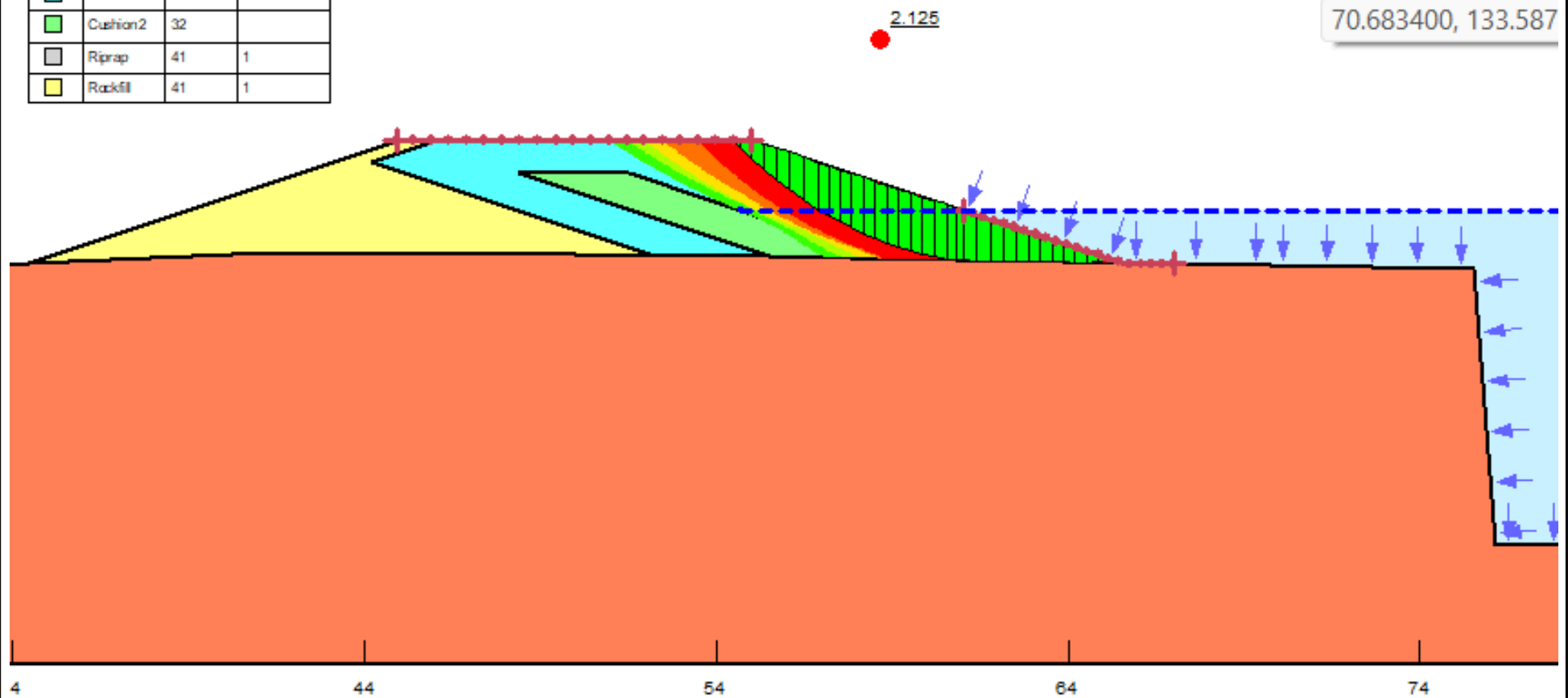
DYKE 5 END OF CONSTRUCTION:
DOWNSTREAM

DRAFT
DRAFT



FIGURE
5.2

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Red	Bed Rock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	1



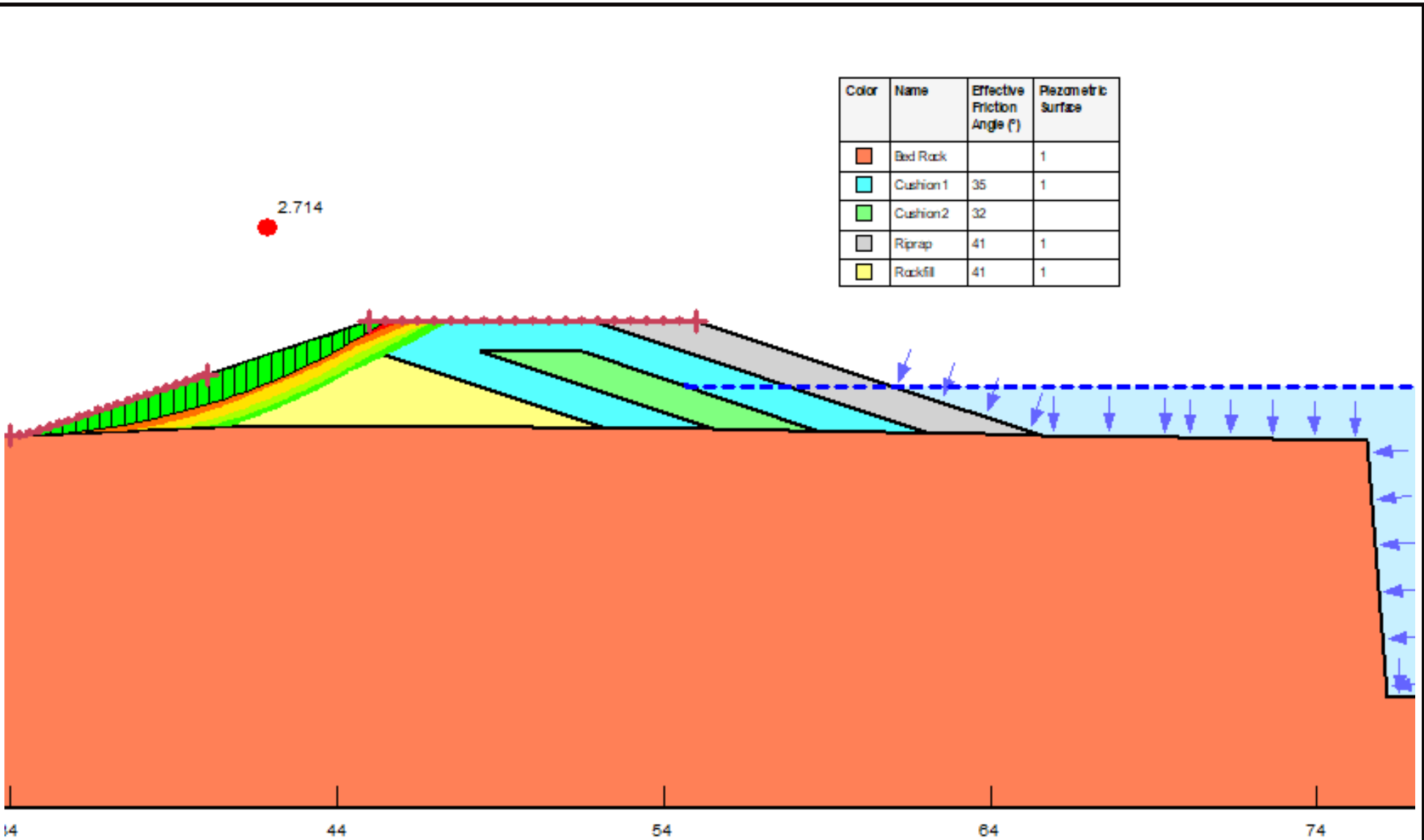
SLOPE STABILITY ANALYSIS

DYKE 5
STEADY STATE: UPSTREAM

 **ARCADIS**

FIGURE
5.3

DRAFT



Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	1

SLOPE STABILITY ANALYSIS

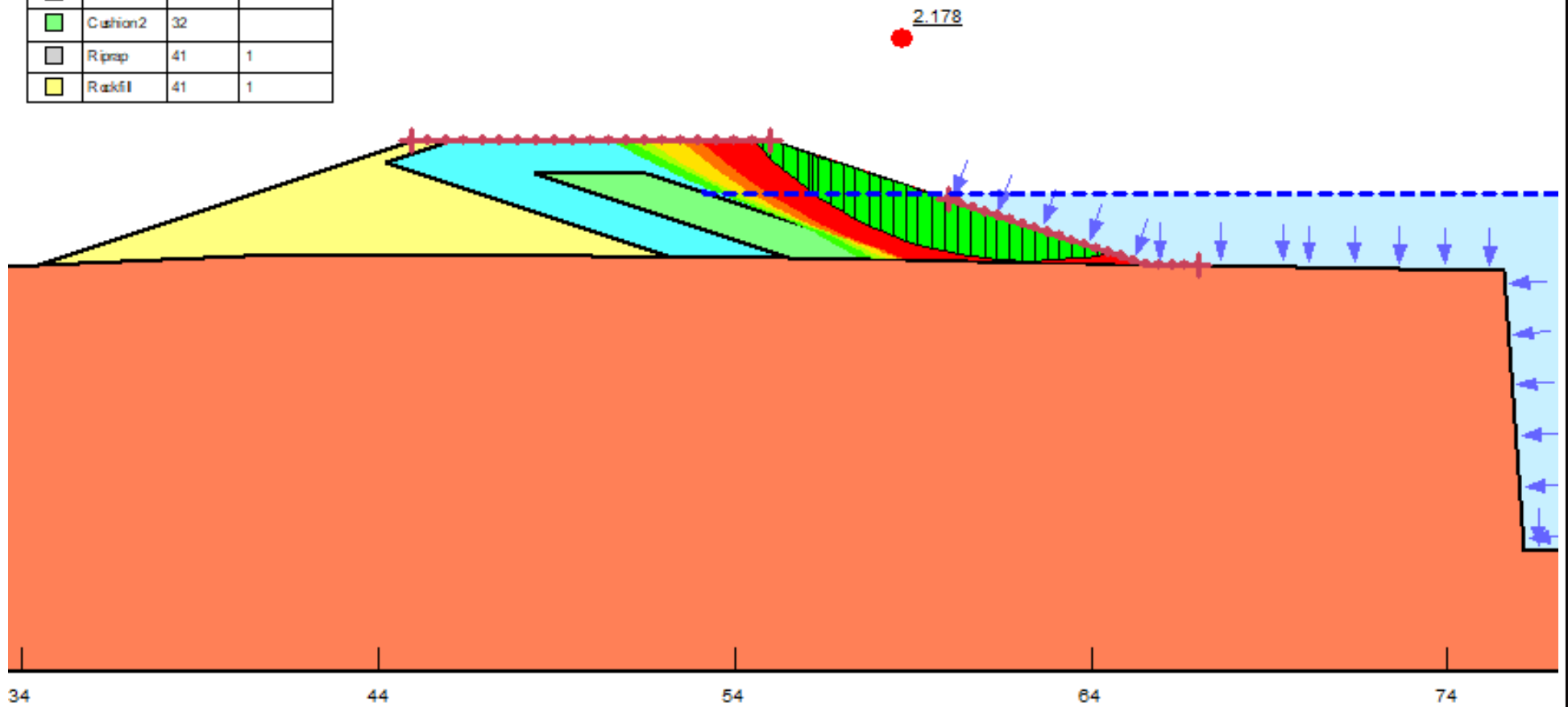
DYKE 5
STEADY STATE: DOWNSTREAM

DRAFT




FIGURE
5.4

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Red	Bed Rock		1
Cyan	Cushion1	35	1
Green	Cushion2	32	
Grey	Riprap	41	1
Yellow	Rackfill	41	1



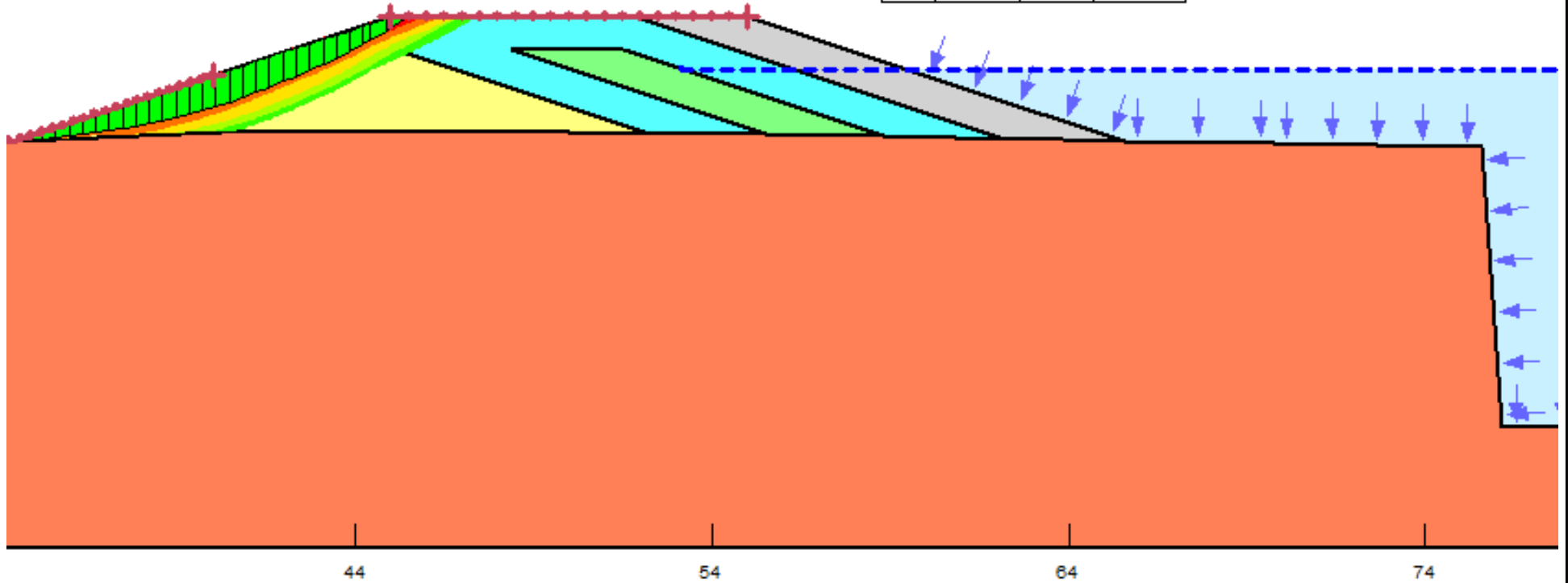
DRAFT

SLOPE STABILITY ANALYSIS	
DYKE 5 IDF: UPSTREAM	
	FIGURE 5.5

Color	Name	Effective Friction Angle (°)	Piezometric Surface
			1
■	Cushion1	35	1
■	Cushion2	32	
■	Riprap	41	1
■	Rockfill	41	1

54.152200, 134.62473 m

2.711



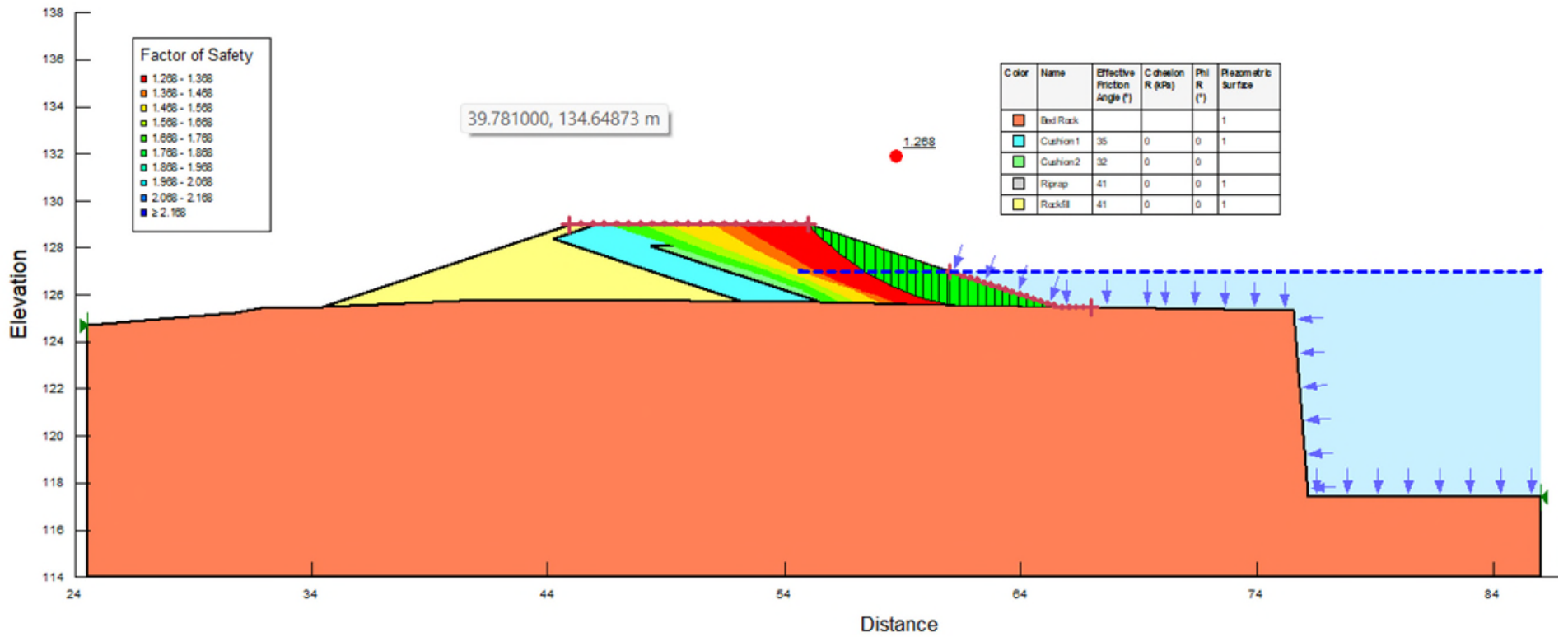
SLOPE STABILITY ANALYSIS

DYKE 5
IDF: DOWNSTREAM

 **ARCADIS**

FIGURE
5.6

DRAFT



SLOPE STABILITY ANALYSIS

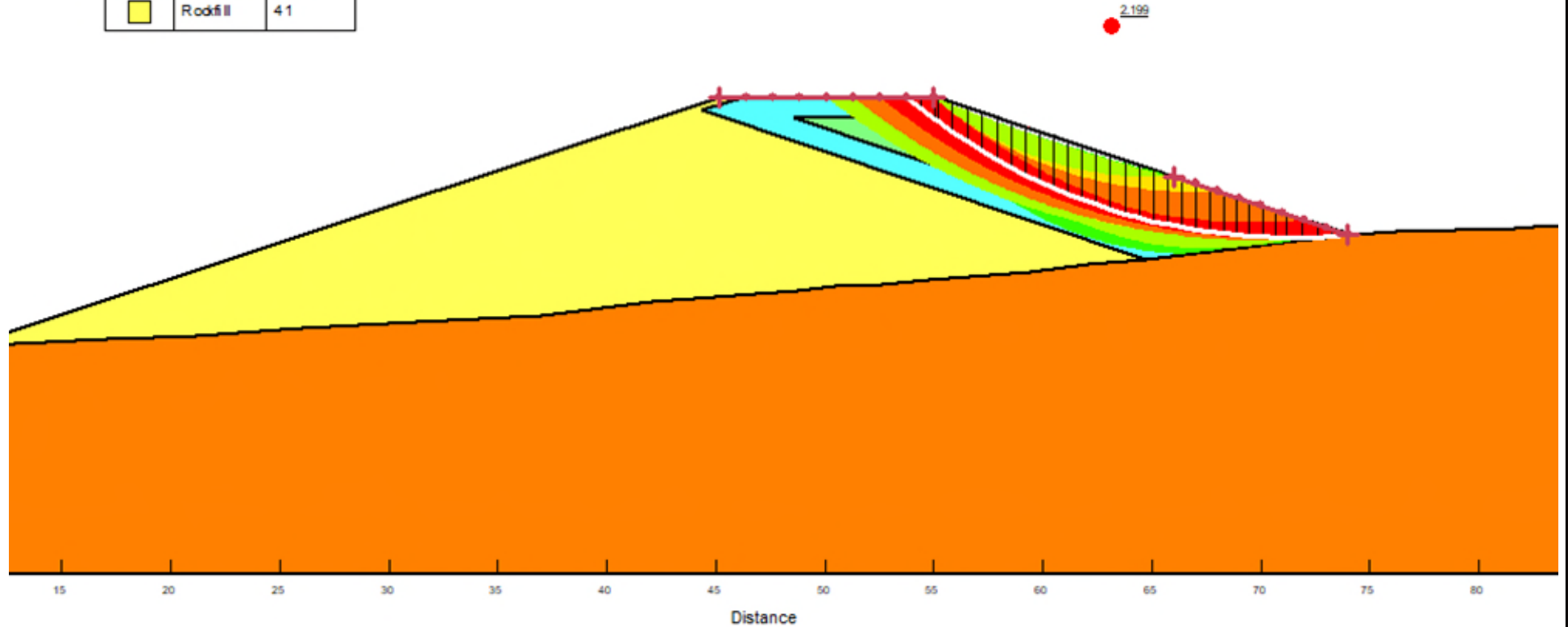
DYKE 5
SEISMIC: UPSTREAM



FIGURE
5.7

DRAFT

Color	Name	Effective Friction Angle(°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rodfill	41



SLOPE STABILITY ANALYSIS

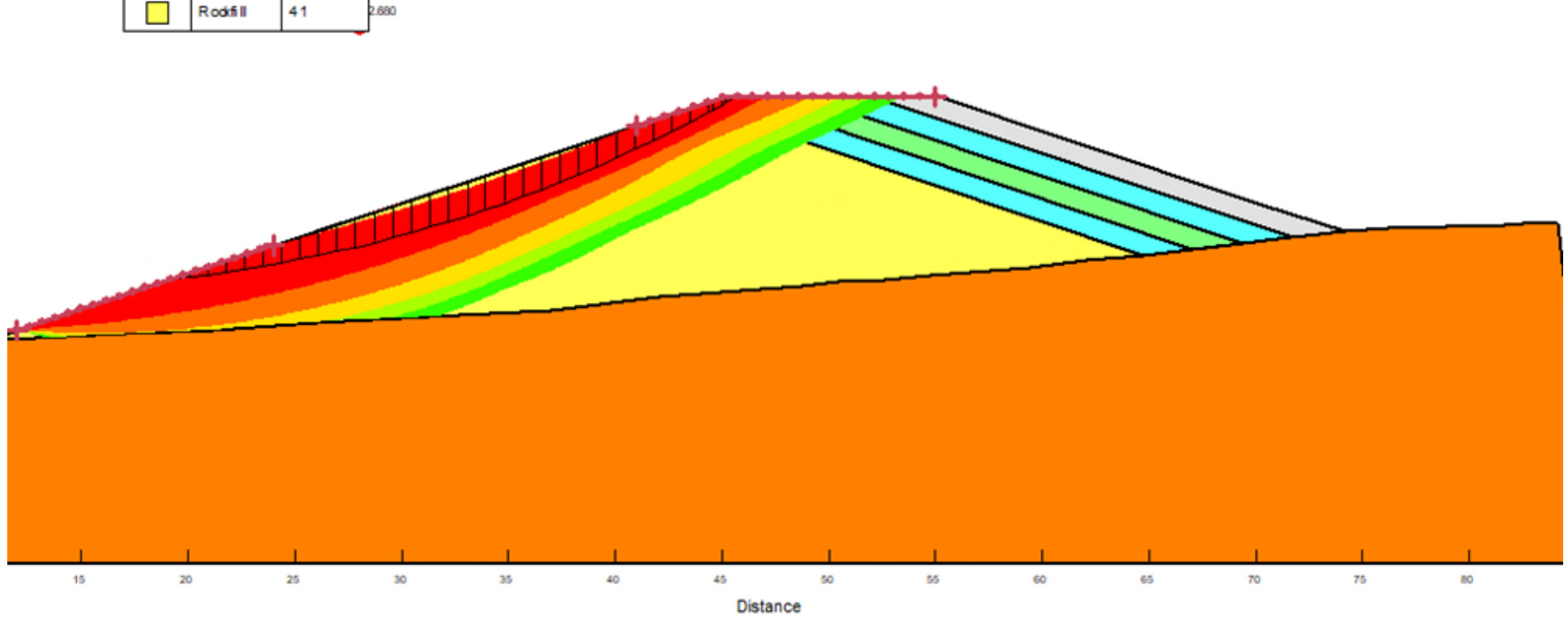
DYKE 6
END OF CONSTRUCTION: UPSTREAM

DRAFT



FIGURE
6.1

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rodfill	41



SLOPE STABILITY ANALYSIS

DYKE 6 END OF CONSTRUCTION:
DOWNSTREAM

DRAFT
DRAFT

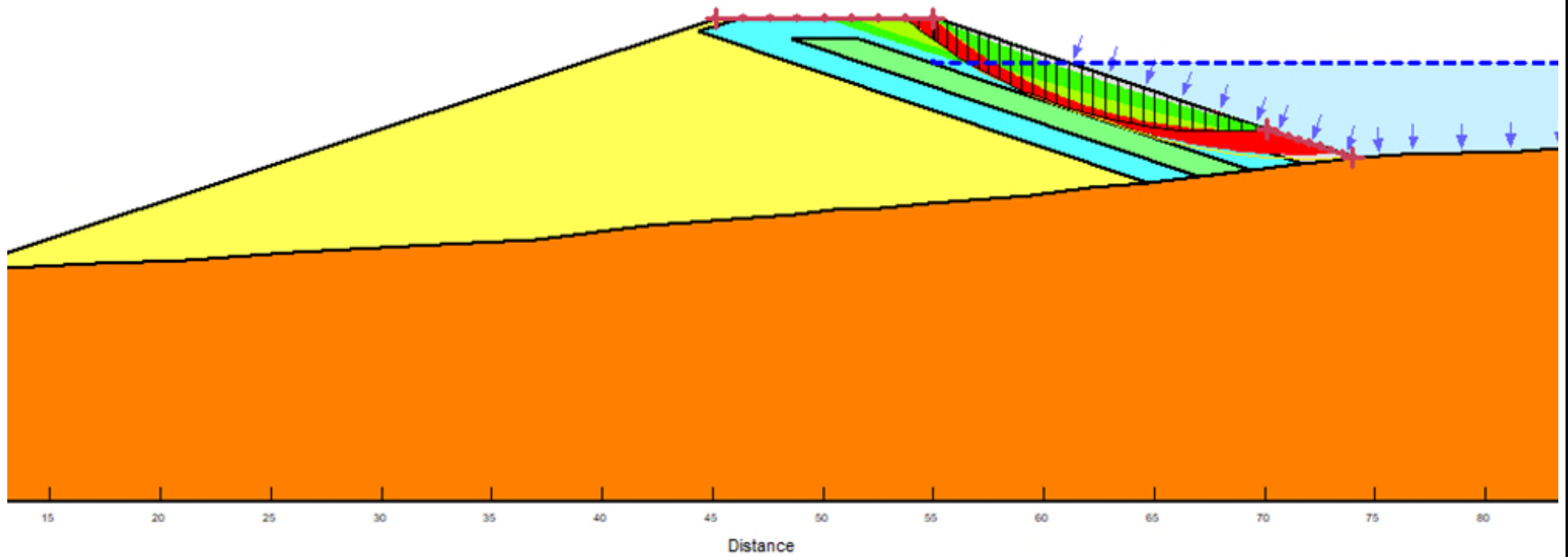


FIGURE
6.2

Color	Name	Effective Friction Angle(°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rodfill	41	

51.33300, 140.83167 m

2.091



SLOPE STABILITY ANALYSIS

DYKE 6
STEADY STATE: UPSTREAM

 **ARCADIS**

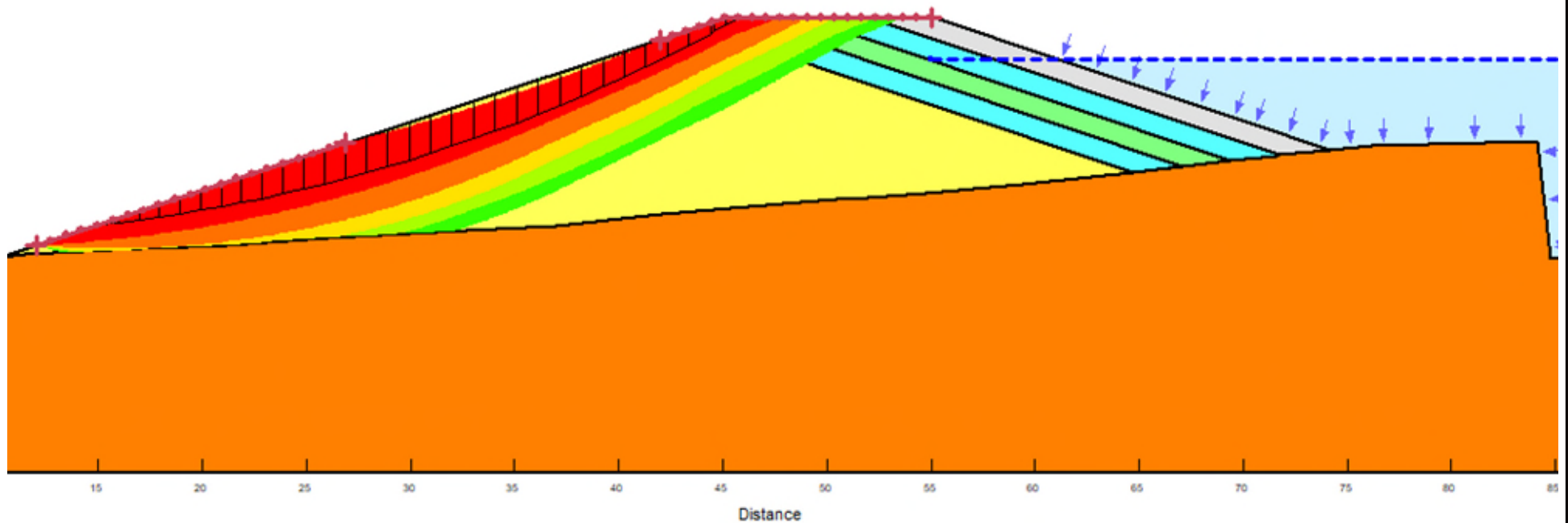
FIGURE
6.3

DRAFT

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rodfill	41	

64.81300, 136.83167 m

2.677



SLOPE STABILITY ANALYSIS

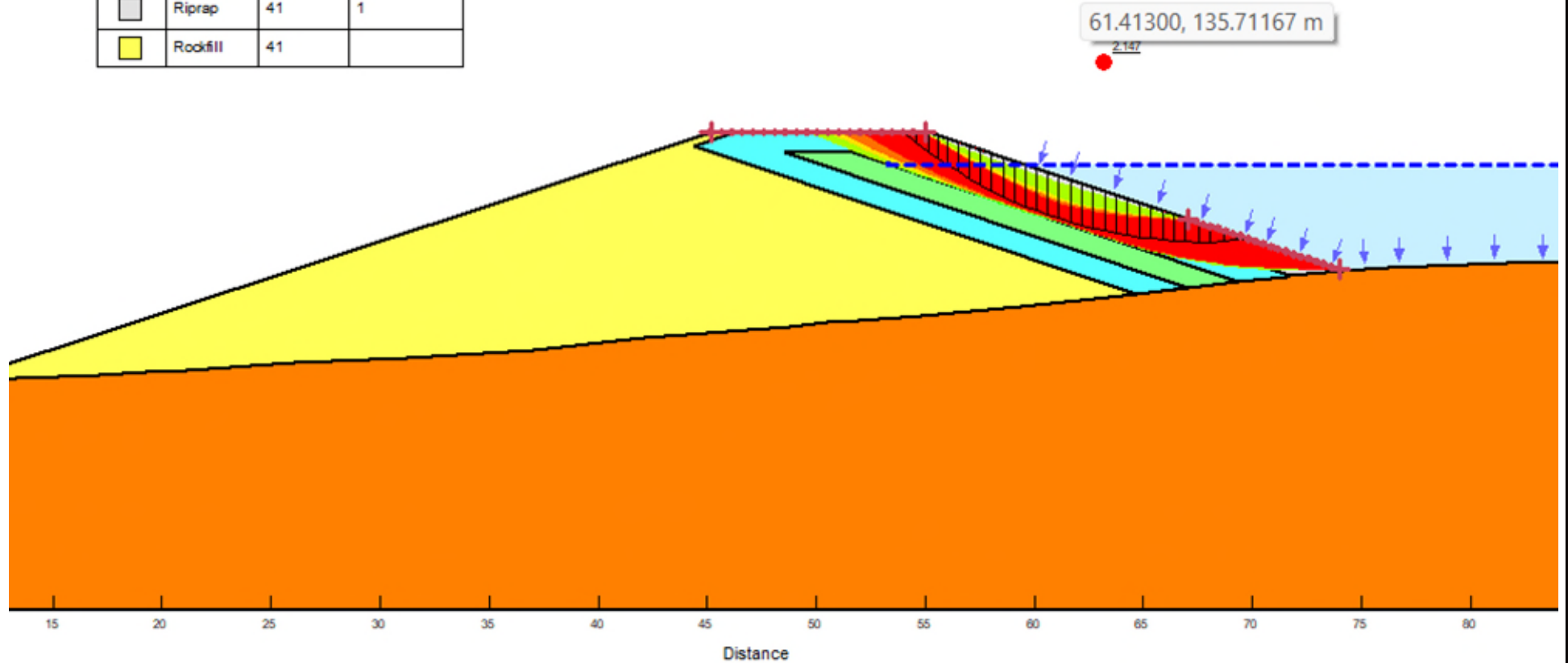
DYKE 6
STEADY STATE: DOWNSTREAM

DRAFT



FIGURE
6.4

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rockfill	41	



SLOPE STABILITY ANALYSIS

DYKE 6
IDF: UPSTREAM

DRAFT

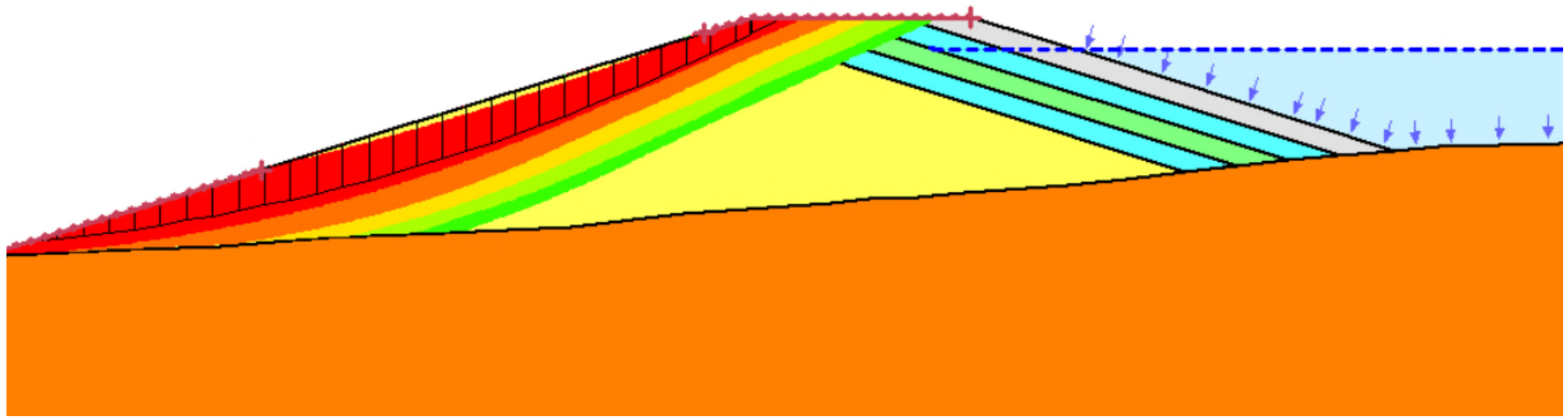


FIGURE
6.5

Color	Name	Effective Friction Angle (°)	Piezometric Surface
Orange	Bed Rock		1
Cyan	Cushion 1	35	1
Green	Cushion 2	32	
Grey	Riprap	41	1
Yellow	Rodfill	41	

68.53300, 138.52501 m

2.895



SLOPE STABILITY ANALYSIS

DYKE 6
IDF: DOWNSTREAM



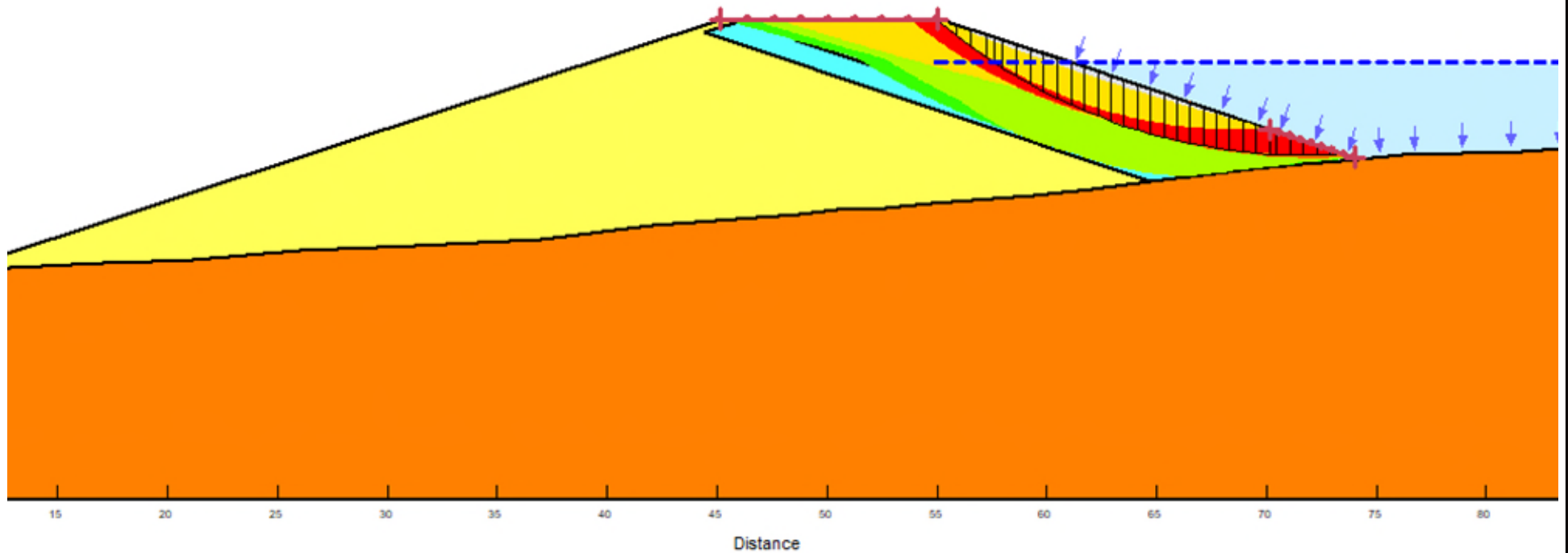
FIGURE
6.6

DRAFT

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Light Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

39.69300, 137.52501 m

1.126



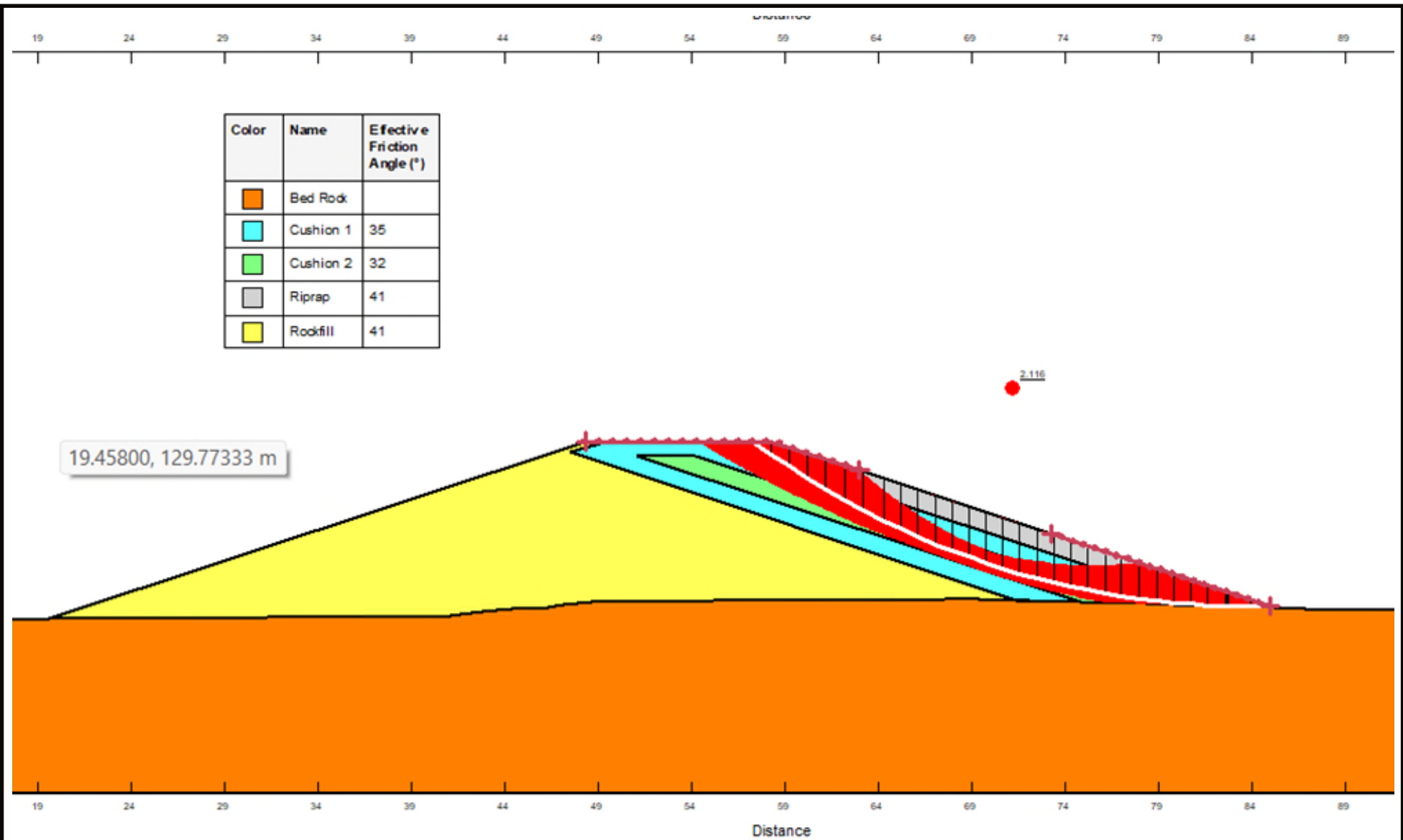
SLOPE STABILITY ANALYSIS

DYKE 6
SEISMIC: UPSTREAM



FIGURE
6.7

DRAFT



SLOPE STABILITY ANALYSIS

DYKE 8
END OF CONSTRUCTION: UPSTREAM

 | FIGURE 7.1

DRAFT

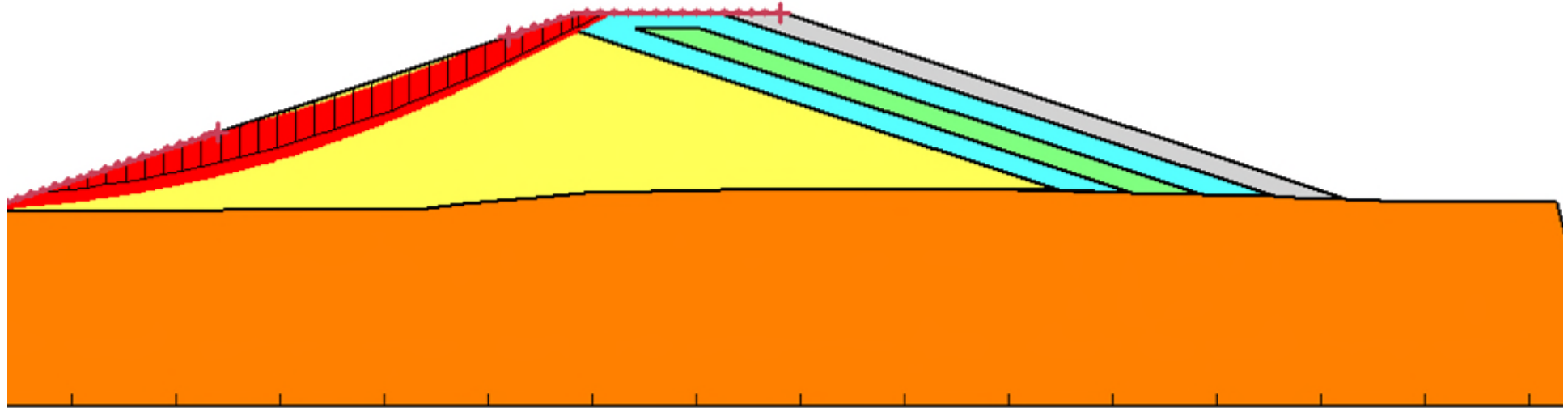
Distance

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle(°)
	Bed Rock	
	Cushion 1	35
	Cushion 2	32
	Riprap	41
	Rockfill	41

2.681

68.99967, 137.23167 m



24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Distance

SLOPE STABILITY ANALYSIS

DYKE 8 END OF CONSTRUCTION:
DOWNSTREAM



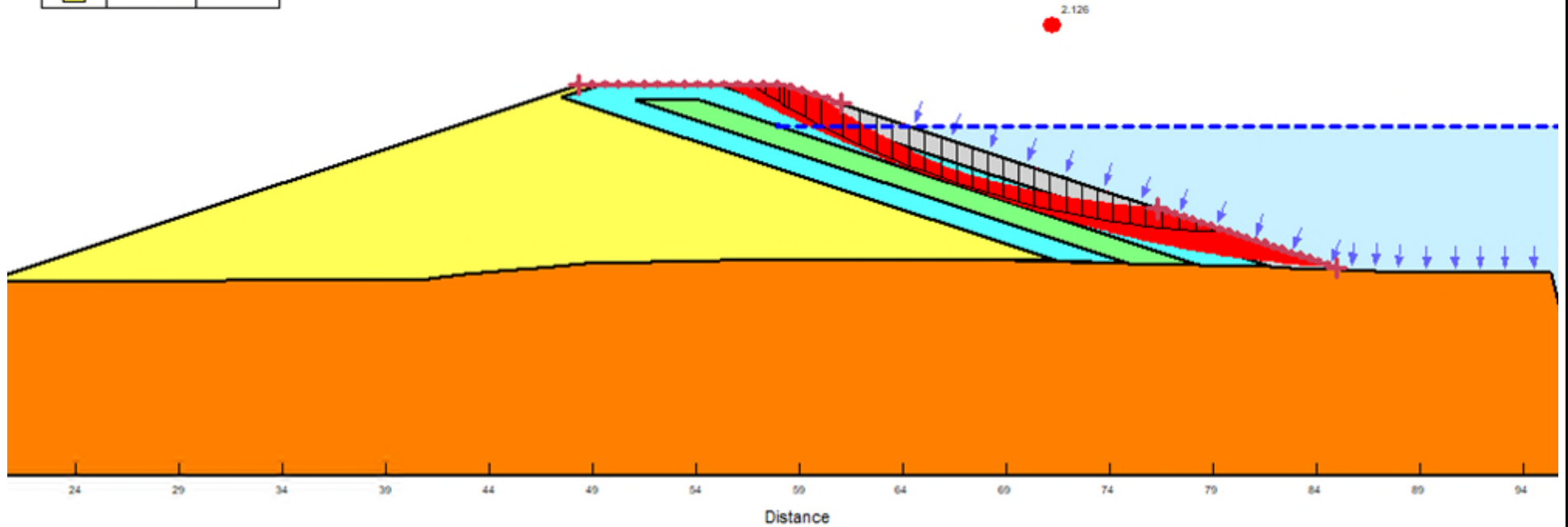
FIGURE
7.2

DRAFT
DRAFT

Distance

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rodfill	41



SLOPE STABILITY ANALYSIS

DYKE 8
STEADY STATE: UPSTREAM



FIGURE
7.3

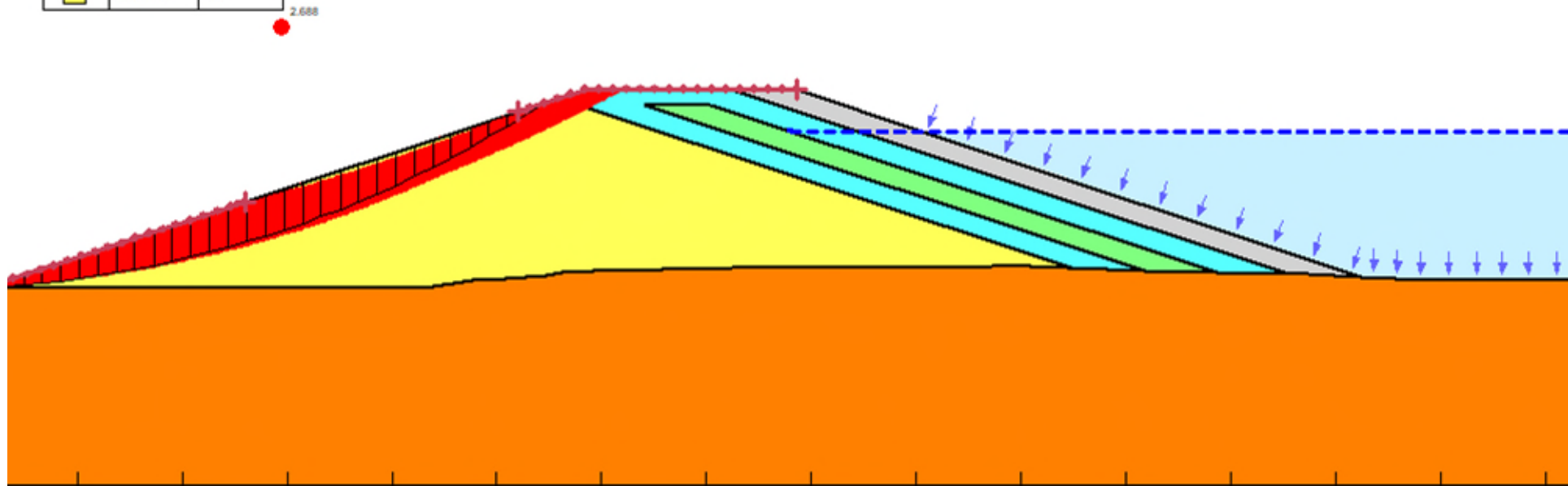
DRAFT

Distance

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rodfill	41

2.688



24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Distance

SLOPE STABILITY ANALYSIS

DYKE 8
STEADY STATE: DOWNSTREAM

DRAFT



FIGURE
7.4

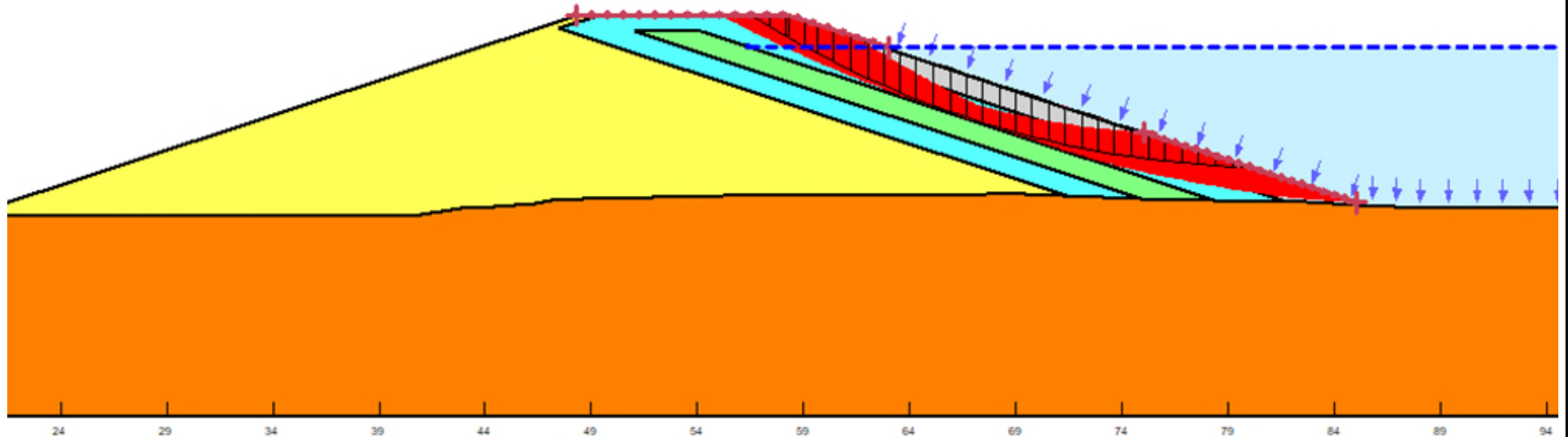
Distance

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

71.58300, 141.60667 m

2.166



SLOPE STABILITY ANALYSIS

DYKE 8
IDF: UPSTREAM

DRAFT



FIGURE
7.5

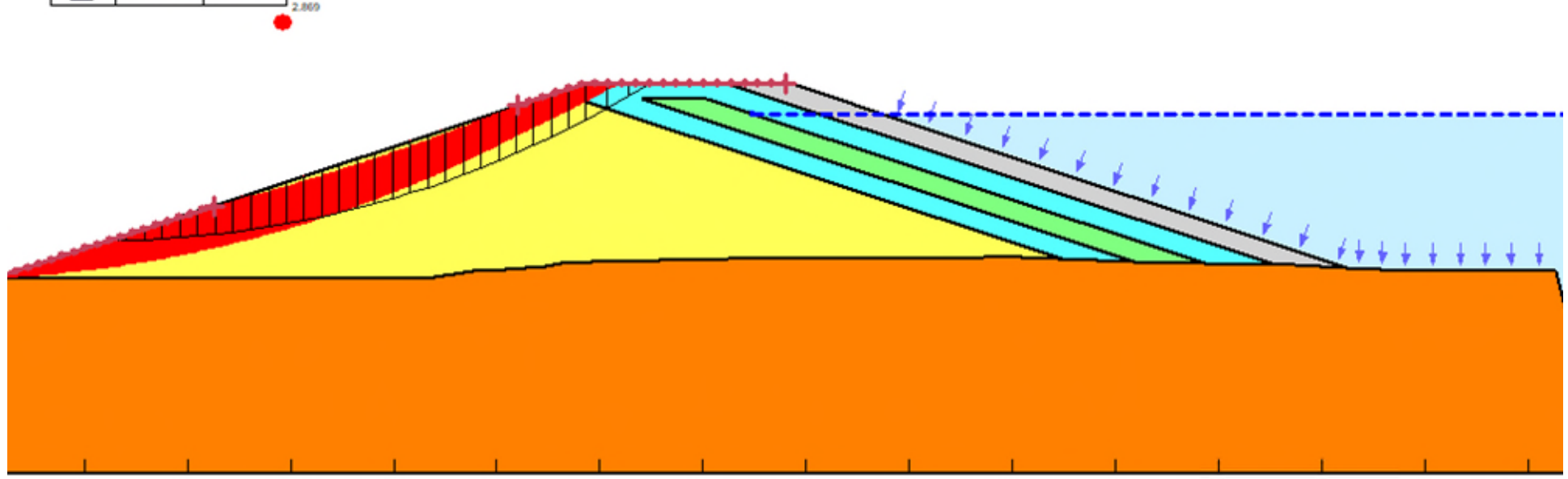
Distance

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle (°)
Orange	Bed Rock	
Cyan	Cushion 1	35
Green	Cushion 2	32
Grey	Riprap	41
Yellow	Rockfill	41

66.29133, 138.39833 m

2.869



24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Distance

SLOPE STABILITY ANALYSIS

DYKE 8
IDF: DOWNSTREAM

DRAFT

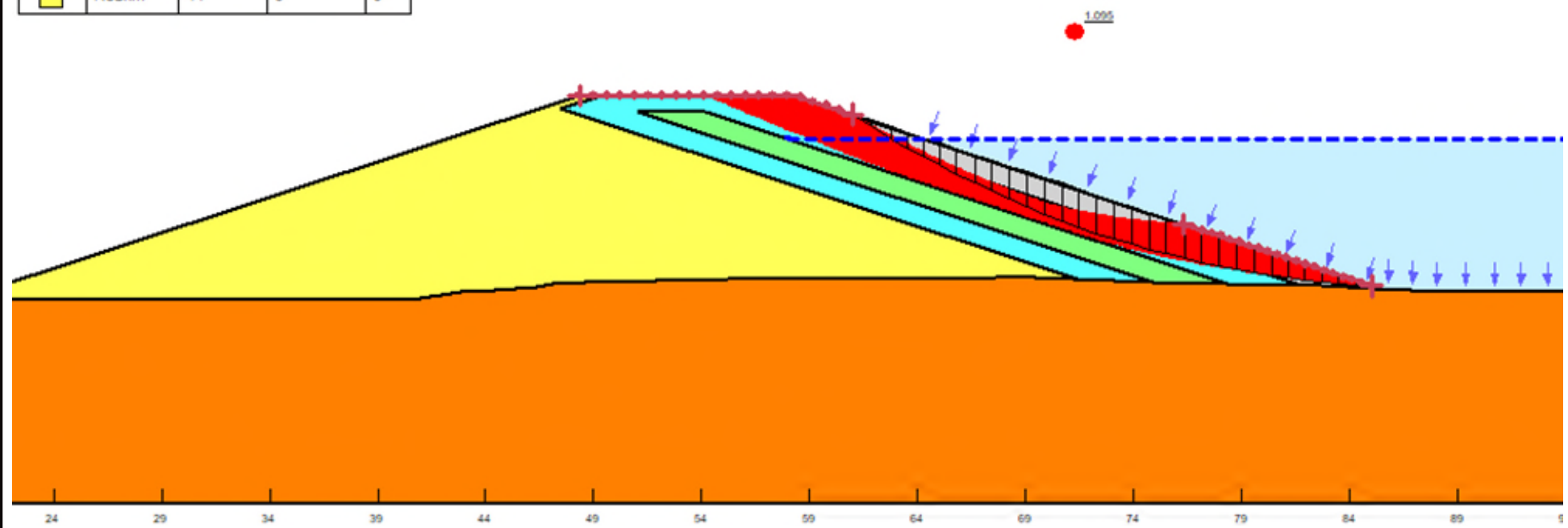


FIGURE
7.6

DISTANCE

24 29 34 39 44 49 54 59 64 69 74 79 84 89 94

Color	Name	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)
Orange	Bed Rock			
Cyan	Cushion 1	35	0	0
Green	Cushion 2	32	0	0
Grey	Riprap	41	0	0
Yellow	Rodfill	41	0	0



SLOPE STABILITY ANALYSIS

DYKE 8
SEISMIC: UPSTREAM



FIGURE
7.7

DRAFT