Dam Safety Regulatory Advisory Panel
Tuesday, September 17, 2024
Department of Environmental Quality, Piedmont Regional Office, Glen Allen, Virginia

TIME AND PLACE

The meeting of the Dam Safety Regulatory Advisory Panel (RAP) took place at 9:00 a.m. on Tuesday, September 17, 2024, at the Department of Environmental Quality's Piedmont Regional Office in Glen Allen, Virginia.

DAM SAFETY REGULATORY ADVISORY PANEL MEMBERS PRESENT

Ellen Egen, substitute for Lisa Ochsenhirt, AquaLaw
Andrew Hammond, Department of Transportation
David Krisnitski, AMT Engineering
Amanda Lothes, Newport News Waterworks
Elfatih Salim, Fairfax County
Adrienne Shaner, Hazen and Sawyer
Laura Shearin-Feimster, substitute for Maridee Romero-Graves, Schnabel Engineering

DAM SAFETY REGULATORY ADVISORY PANEL MEMBERS NOT PRESENT

Jacob Compton, Department of Wildlife Resources
James Lang, Pender & Coward

DCR STAFF PRESENT

Chris Armstrong, Enforcement/Compliance Manager
Darryl Glover, Deputy Agency Director
Taylor Melton, Executive Assistant to the Director's Office
Brent Payne, Dam Safety Regional Engineer
Andrew Smith, Chief Deputy Director
Christine Watlington Jones, Policy and District Services Manager
Charles Wilson, District Dam Engineer

OTHERS PRESENT

Wheeler Wood, Virginia Commonwealth University

WELCOME AND INTRODUCTIONS

Mr. Glover welcomed members of the RAP and opened the meeting.

MEETING NOTES FROM BOTH AUGUST 27, 2024 STAKEHOLDER MEETINGS

Mr. Glover highlighted the key discussions from the previous RAP meeting, including the proposed tier system for low hazard dams, the distinctions between the simplified studies conducted by the Department and dam break inundation zone maps, and adding a requirement to notify, at minimum, the local emergency services coordinator as part of the dam owners' emergency preparedness plans. The Dam Safety Act Workgroup, meanwhile, discussed the need for an amendment to the law to implement the proposed tier system. Mr. Glover stated that the Workgroup would discuss how to streamline the enforcement process to ensure actions were taken to address the safety concerns in a more timely way than is currently established.

INCREMENTAL DAMAGE ANALYSIS

I. 4VAC50-20-45 (Hazard Potential Classifications Based on Low Volume Roadways) – Moderators

Mr. Glover read 4VAC50-20-45(A) which states that "all impacted public and private roadways downstream or across an impounding structure shall be considered in determining hazard potential classification". Currently dams are considered low hazard if the impacted roadways are used by 400 vehicles or less per day, per 4VAC50-20-45(D). He also highlighted 4VAC50-20-45(B) which states that "if a roadway is found to be impacted in accordance with subsection A of this section, and other factors such as downstream residences, business, or other concerns as set forth in this chapter that would raise the hazard potential classification do not exist, such classification may be adjusted in accordance with the section dependent on vehicle traffic volume, based on AADT" (Average Annual Daily Traffic).

Mr. Glover asked about the traffic count as it relates to the distinction between significant and high hazard dams, or whether the road classification, i.e. interstates, primary, secondary roads, etc. is the most appropriate factor for determining hazard classification. RAP members suggested that it was sensible to use the road classification to determine hazard classification; however, some secondary roads receive more vehicle traffic than primary roads which shows the importance of better delineating traffic counts between low and significant hazard dams.

Mr. Wilson supported using road classification because, he argued, using traffic counts would make the hazard analysis unnecessarily complex. Mr. Payne countered that VDOT's road classification system was not developed with flood resiliency in mind, and that this was a good reason to use traffic counts as the sole determining factor. Mr. Wilson noted that traffic counts can change over time which could lead to a lot of issues with the engineering studies provided to the Department. Mr. Krisnitski suggested setting an upper traffic threshold to determine high hazard. Ms. Watlington-Jones expressed concern that using traffic counts would result in owners having to conduct traffic studies on roads that might not have a known traffic count. Mr. Krisnitski responded that traffic counts can be generated using VDOT tools and residence figures.

The RAP discussed modifying the language in 4VAC50-20-45 so that high-volume and low-volume roadways are more clearly defined. Mr. Wilson said that having a definition for high-volume roadways would allow the Department to classify secondary roads as high-volume, when necessary. Mr. Payne suggested using the U.S. Army Corps of Engineers' (USACE) "persons-at-risk" statistical concept as a metric in defining high-volume roadways. After additional discussion, Ms. Watlington-Jones recommended deferring this item until the next meeting, and the RAP members collectively agreed to do so.

II. 4VAC50-20-52 (Incremental Damage Analysis) and 4VAC50-20-320 (Acceptable Design Procedures and References) – Brenton Payne, DCR

Mr. Payne gave a presentation titled "Review and Recommendations for SDF Reduction Procedures" (see Attachment A), which detailed proposed changes specific to reducing the spillway design flood (SDF) using an incremental damage analysis (IDA). He stated that in the context of dam safety, "incremental" is the difference in a given breach and non-breach scenario and serves as a measurement of the dam breach contribution to a flood event. He presented two IDA approaches for consideration. The South Carolina Method establishes the new spillway design flood as the flood event that does not cause a change to high danger due to dam breaches from flooding greater than the proposed SDF. Currently, Virginia's approach allows dam owners to identify flood levels where the incremental change in flooding due to dam breach is not significant.

The proposed regulatory change would permit the final spillway design flood to be selected from either IDA method. The owner would have the option of selecting which method would provide the most cost-effective approach to spillway sizing. Potential changes to the language in 4VAC-50-20-52(B) are detailed in the attached presentation.

After the presentation, several clarifying questions were addressed from the group, and the group was asked for feedback on the proposal. Mr. Wilson suggested that further research was needed on how the new method would affect current processes and procedures. Mr. Krisnitski added that it could potentially create new issues for dam owners. It was decided that the RAP would defer this conversation and the Department would conduct some real-life examples to support the discussion.

PUBLIC COMMENT

None.

NEXT MEETINGS

Mr. Glover stated that the panel will meet again October 29, 2024, and November 12, 2024, and that both meetings will be held at the same location.

ADJOURNMENT

There being no further business, Mr. Glover adjourned meeting at 11:02 a.m.

Review and Recommendations for SDF Reduction Procedures

Brent Payne, PE, CFM

9/17/2024

Incremental Damage Analysis (IDA)

- Functionally, an IDA is an analytical process used to determine the causes of a dam breach relative to a specific flood event.

- Virginia permits two IDA processes under 4VAC50-20-52

1. Hazard Class Reduction
   I. ACER-11
2. Spillway Design Flood (SDF) Reduction
   I. "Rule of Seven"

This presentation will focus on SDF Reduction.

Remember:

- The proposed changes are specific to reducing the Spillway Design Flood (SDF) using an Incremental Damage Analysis (IDA).
- The proposed changes do not include Hazard Classification Reduction/Identification using an IDA. Hazard Classification IDA's are completed by strictly following ACER-11 or similar federal processes.
- The following discussion will reference ACER-11 for definitions and graphics but keep in mind that we are not proposing to use the ACER-11 process for SDF Reduction.

Incremental Process (ACER-11)

Thus, when the dam-break plus PMF flood results in a hazard classification higher than that for a "sunny day" failure assumption, it becomes necessary to determine the incremental effects of a dam-break flood combined with an inflow flood on the downstream flooding. The reason for this is to separate the flooding due to a dam failure from that due to a natural flood. That is, if a natural runoff flood can occur such that a situation is a borderline hazard, then would the additional (incremental) flooding resulting from a dam failure cause the "borderline hazard" to become a hazard?

Incremental (FEMA P94 – IDF Selection Procedures)

- *"The incremental increase in downstream water surface elevation between the with-failure and without-failure conditions should then be determined, i.e., how much higher would the water downstream be if the dam failed than if the dam did not fail?"* PDF Page 23
- *"It is important to remember that the incremental increases should address the differences between the nonfailure condition with the dam remaining in place and the failure condition."* PDF Page 52

- Note IDF = Inflow Design Flood, which is equivalent to SDF in VA

Incremental is Breach minutes NonBreach

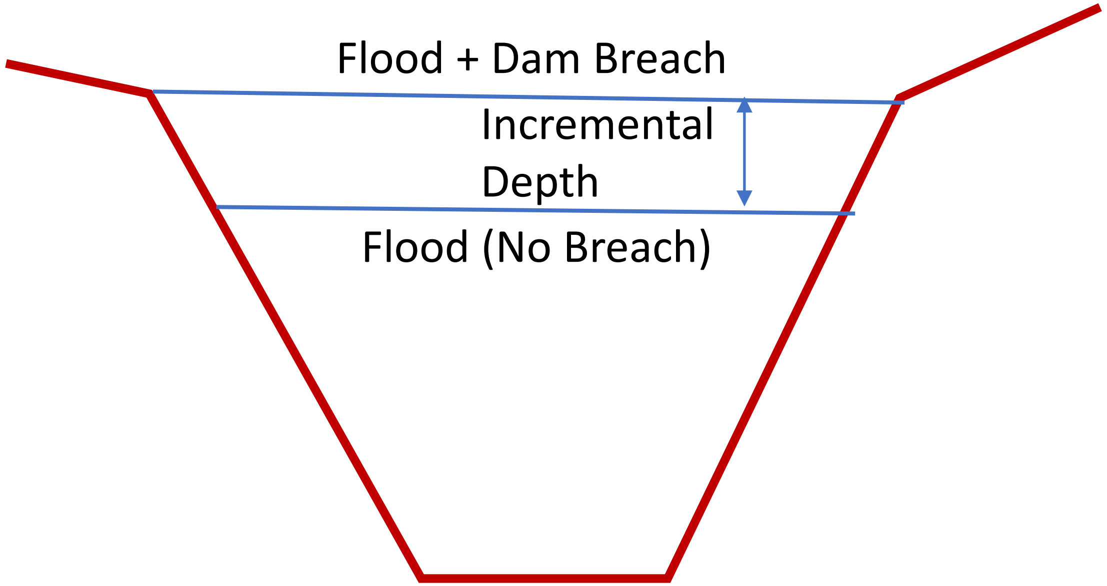
- Incremental Depth = Breach Depth – NonBreach Depth

- Incremental Vel = Breach Vel – NonBreach Vel

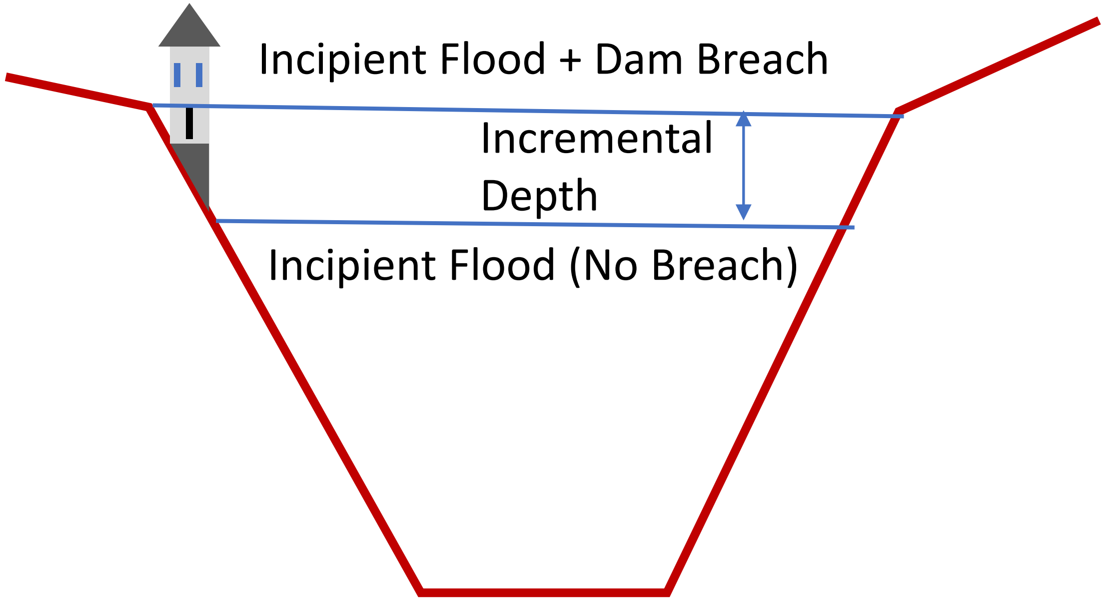
Definition of 'Incremental'

***"Incremental Damage Analysis"** means a comparative study of two floods of differing magnitude used to identify differential impacts for loss of human life and property damage in the zone above the lesser magnitude flood (incremental zone).* Colorado Department of Natural Resources 2 CCR402-1 4.2.17

In the context of dam safety, incremental is the difference in a given breach and non-breach scenario. It is a measurement of the dam breach contribution to a flood event.



Example A: Arbitrary Flood

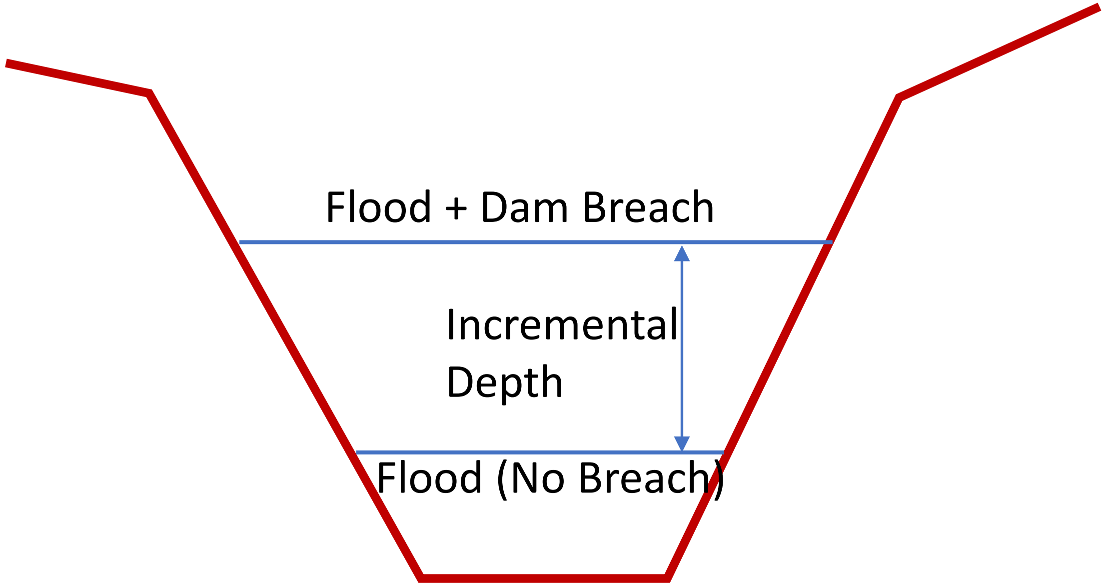


Example B: Incipient Flood

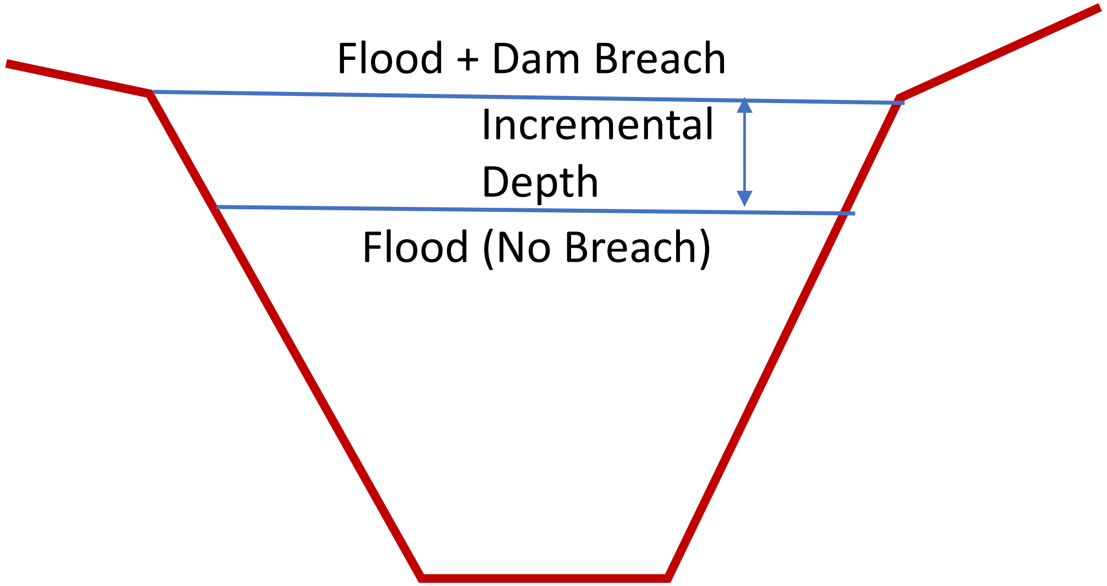
Incremental effects are not constant for all floods

Incremental effects for a given cross-section (location) on a river will change as flood intensity changes.

Typically, a stronger flood will result in weaker incremental effects. This is because the floodplain is trapezoidal and the amount of water released due to the breach does not increase with stronger upstream flooding.



Example C: Mild Flood



Example D: Intense Flood

Plotting Non-Breach Flooding

- The given example has a Nonbreach incipient (road begins to get wet) flood at 0.5PMF.
- As flooding increases, the depth and velocity increases as well.

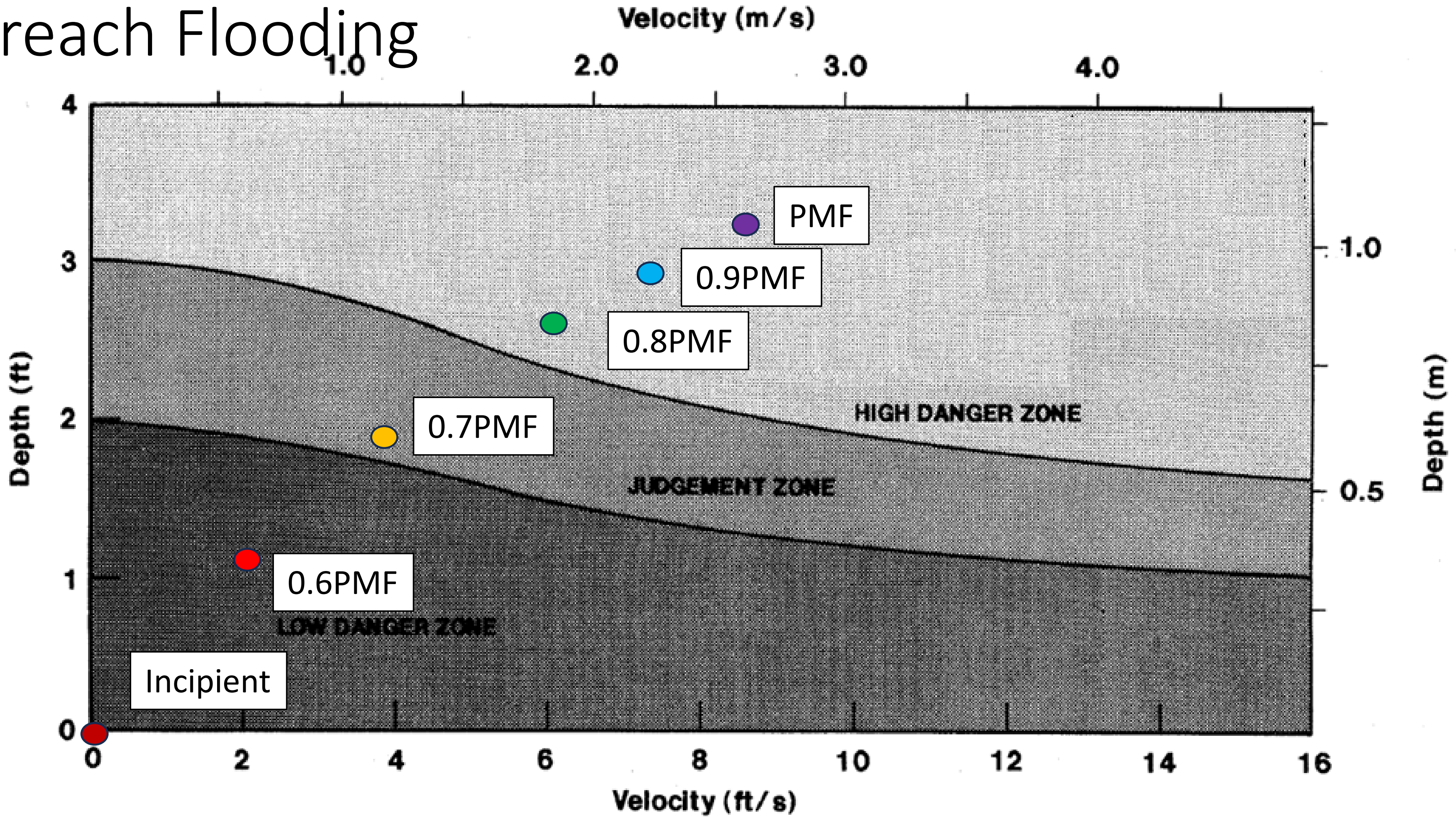


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

Plotting Flooding with Dam Breach

- Dam breach will add depth and velocity to the corresponding flood scenario.
- The yellow arrow represents the incremental depth and velocity.

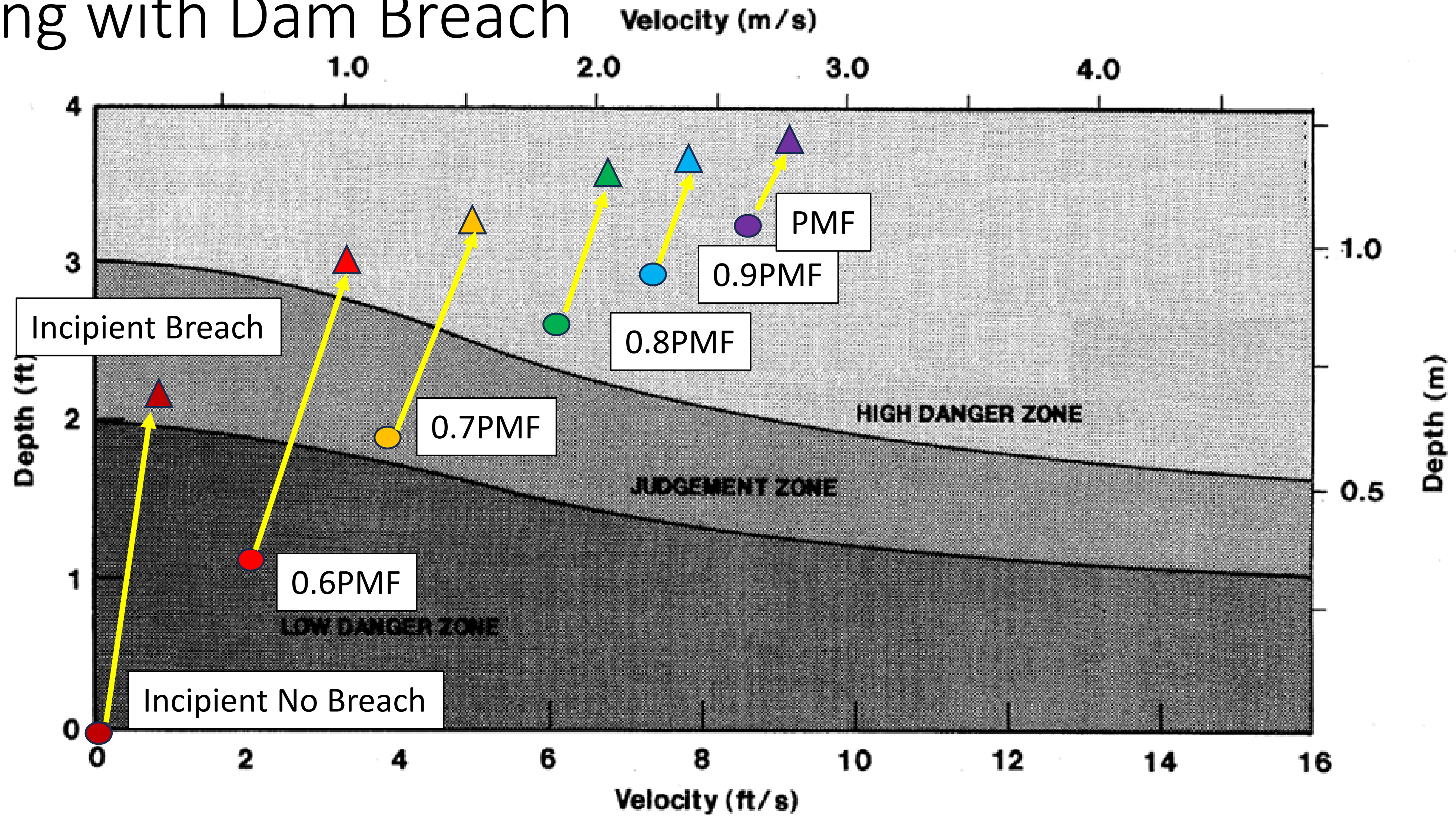


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

IDA Ideologies

- Federal IDAs, including ACER-11, tend to focus on depth and velocity differences between the breach and non-breach.
- Alternatively, South Carolina determines an upper limit of damage. Conceptually: if the structures is already a total loss then what are we trying to save?
  - For example, natural flooding with a dam breach inundates a home with 10 feet of water. The dam Breach adds an additional 4 feet of water. Is there a meaningful difference in structural damage between 10 and 14 feet of water depth or is the home floating away in both cases?

Two IDA approaches

- (1) If the dam breach for a flood does not trigger a high hazard, then the breach is not regarded as a hazard
  - South Carolina Method DSG501
- (2) If the dam breach adds a small amount of depth and velocity, then the dam breach is not regarded as a hazard.
  - Rule of Seven (Existing VA Method)

Dam Safety Program, Bureau of Water — dhec

Standard Operating Procedure (SOP) for Incremental Consequence Analysis to Establish Design Flood Level

DSG-501

IDA Method 1

- This method is substantially similar to the SDF reduction method identified in DSG501 Incremental Consequence Analysis utilized by the South Carolina Dam Safety Program.
- Method 1 establishes the new SDF as the flood event that does not cause a change to high danger due to dam breaches from flooding greater than the proposed SDF.

IDA Method 1

- The incipient scenario does not cross into a high danger zone.
- However, the 0.6PMF and 0.7PMF creates a high hazard when breaching.
- A high hazard already exists for the No-Breach scenarios of 0.8PMF and above.

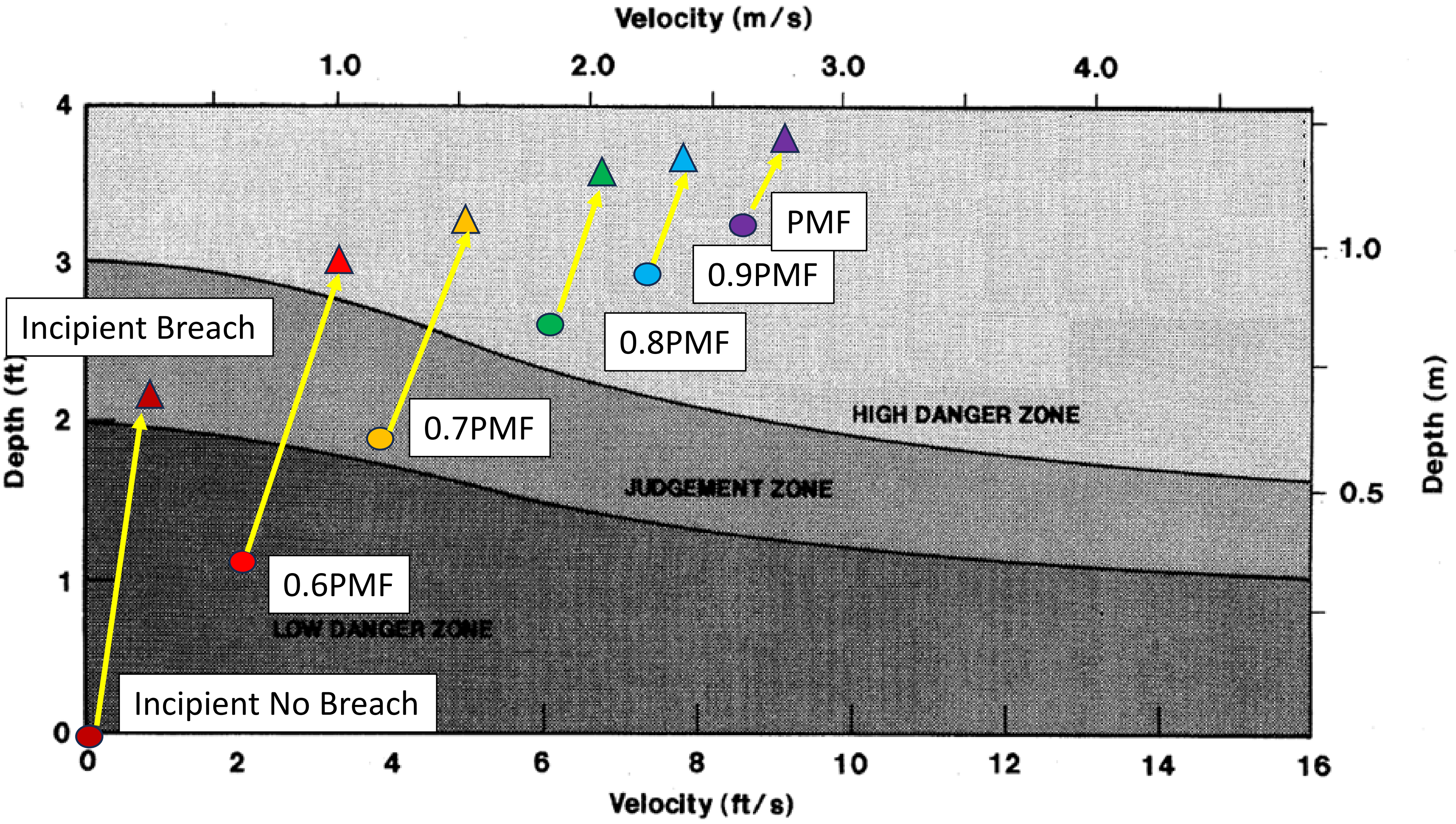


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

IDA Method 1 Continued

- Ultimately, we are trying to protect against all scenarios where the dam breach creates unsafe conditions.
- Because the 0.7PMF event creates an unsafe condition by crossing into the High Danger Zone, the SDF must be higher than 0.7PMF
- The 0.8 PMF event does not change hazard condition so the SDF may go lower.

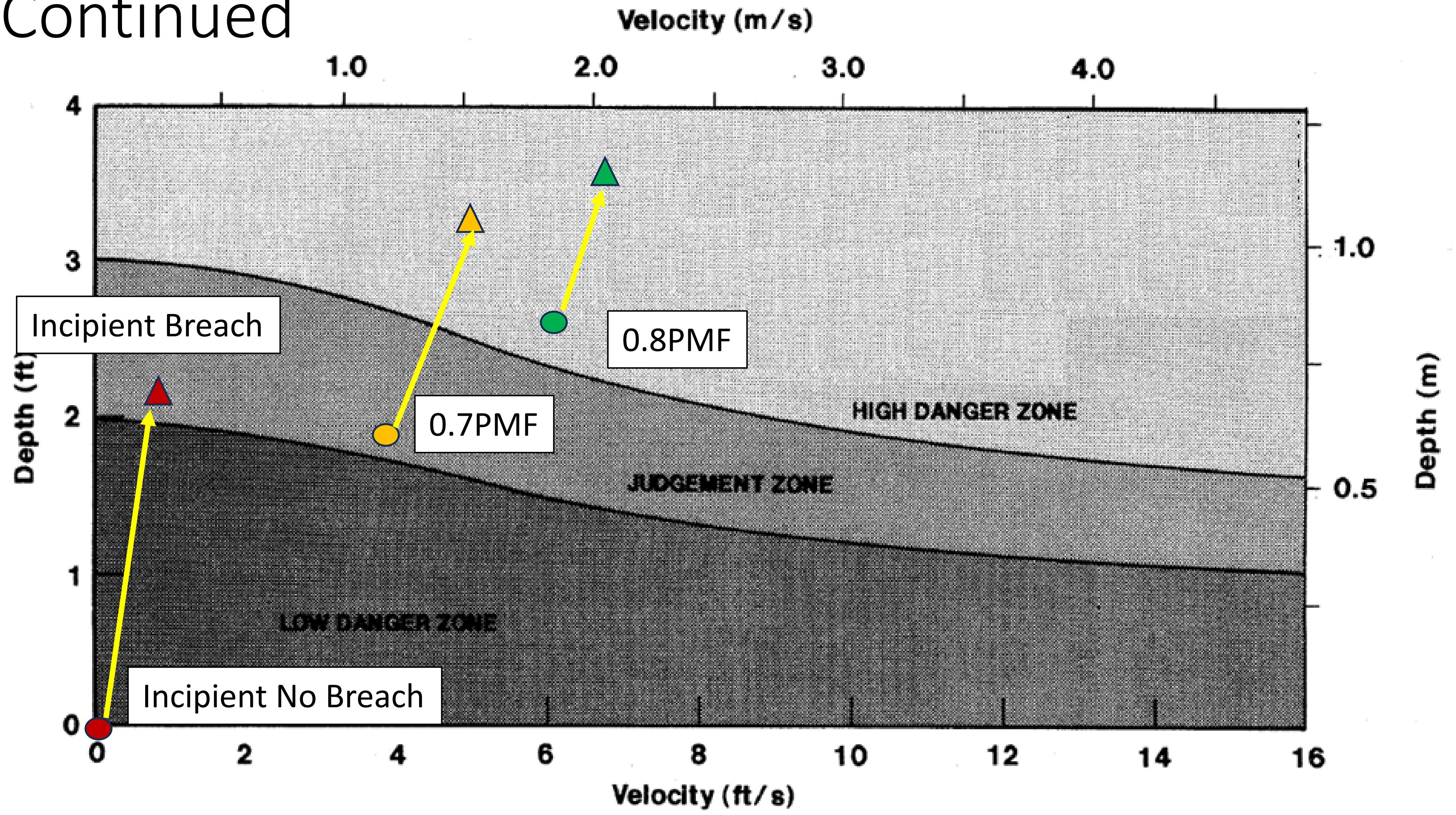


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

IDA Method 1 Continued

- The 0.77 PMF event has the breach and non-breach events both within the high hazard zone
- This is the lowest flood level where no new hazard is created by a breach of the dam.
- The spillway must be able to pass the 0.77PMF for an existing dam unless Method 2 can identify a lower SDF.

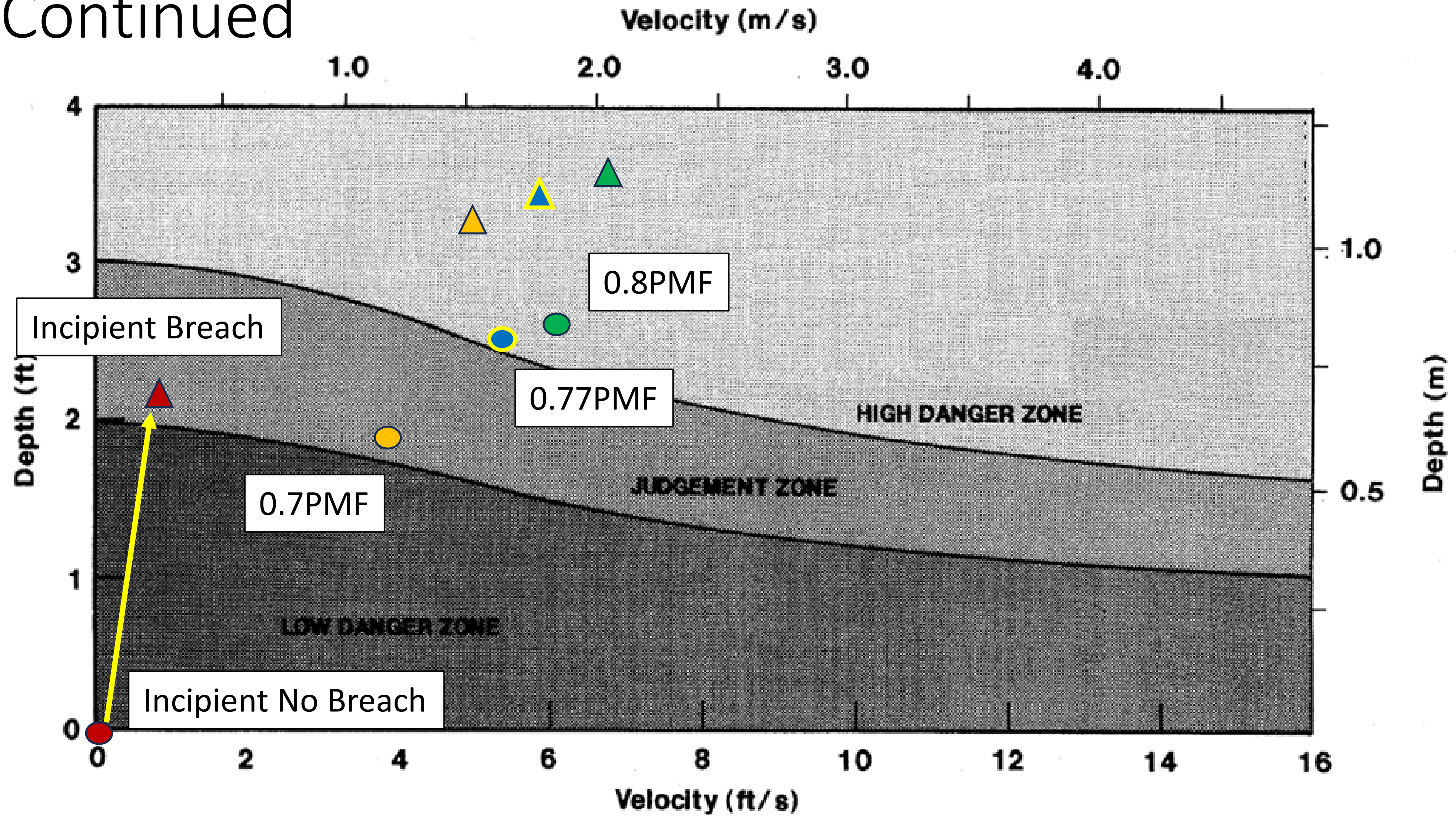


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

Method 2: Rule of Seven

- The Rule of Seven allows dam owners to identify flood levels where the incremental (Difference in breach and no-breach) change in flooding due to dam breach is not significant.

Method 2: Calculating Rule of Seven Values

- Provide a table indicating Incremental Depth and Velocity with supporting data from HEC-RAS output files.

	No-Breach Depth	Breach Depth	Incremental Depth	Breach Velocity	No-Breach Velocity	Incremental Velocity	Incremental DV
	HEC-RAS	HEC-RAS	Breach Depth Minus No-Breach Depth	HEC-RAS	HEC-RAS	Breach Vel. Minus No-Breach Vel.	Incremental Depth Multiplied by Incremental Velocity
Incipient (0.5PMF)	0.0	2.1	2.1	0.0	0.8	0.8	1.7
0.6PMF	1.1	3.0	1.9	2.1	3.1	1.0	1.9
0.7PMF	1.9	3.2	1.3	3.9	4.5	0.6	0.8
0.8PMF	2.6	3.4	0.8	6.0	6.4	0.4	0.3
0.9PMF	3.0	3.5	0.5	7.3	7.7	0.4	0.2
PMF	3.2	3.6	0.4	8.5	8.8	0.3	0.1

Method 2: Identifying compliant floods

- Identify the lowest flood events with incremental depths less than 2.0 Feet.
- Identify the flood events with Incremental DV less than 7.0.

	No-Breach Depth	Breach Depth	Incremental Depth	Breach Velocity	No-Breach Velocity	Incremental Velocity	Incremental DV
	HEC-RAS	HEC-RAS	Breach Depth Minus No-Breach Depth	HEC-RAS	HEC-RAS	Breach Vel. Minus No-Breach Vel.	Incremental Depth Multiplied by Incremental Velocity
Incipient (0.5PMF)	0.0	2.1	2.1	0.0	0.8	0.8	1.7
0.6PMF	1.1	3.0	1.9	2.1	3.1	1.0	1.9
0.7PMF	1.9	3.2	1.3	3.9	4.5	0.6	0.8
0.8PMF	2.6	3.4	0.8	6.0	6.4	0.4	0.3
0.9PMF	3.0	3.5	0.5	7.3	7.7	0.4	0.2
PMF	3.2	3.6	0.4	8.5	8.8	0.3	0.1

Method 2: Selecting the new SDF

- Identify the lowest flood event that has less than 2.0 feet of flood depth **and** less than 7.0 Incremental DV.
- The 0.6PMF may be selected as the new SDF.

	No-Breach Depth	Breach Depth	Incremental Depth	Breach Velocity	No-Breach Velocity	Incremental Velocity	Incremental DV
	HEC-RAS	HEC-RAS	Breach Depth Minus No-Breach Depth	HEC-RAS	HEC-RAS	Breach Vel. Minus No-Breach Vel.	Incremental Depth Multiplied by Incremental Velocity
Incipient (0.5PMF)	0.0	2.1	2.1	0.0	0.8	0.8	1.7
0.6PMF	1.1	3.0	1.9	2.1	3.1	1.0	1.9
0.7PMF	1.9	3.2	1.3	3.9	4.5	0.6	0.8
0.8PMF	2.6	3.4	0.8	6.0	6.4	0.4	0.3
0.9PMF	3.0	3.5	0.5	7.3	7.7	0.4	0.2
PMF	3.2	3.6	0.4	8.5	8.8	0.3	0.1

Final SDF Selection

- The final Spillway Design Flood may be selected from either Method 1 OR Method 2:
- Method 1 SDF: 0.77 PMF
- Method 2 SDF: 0.6 PMF

- The 0.6PMF may be selected as the most cost-effective approach to spillway sizing.
- If the existing capacity is greater than 0.6, then the SDF becomes the existing capacity.

4VAC50-20-52B (DRAFT)

- The proposed spillway design flood for the impounding structure may be lowered based on the results of an incremental damage analysis. Once the owner's engineer has determined the required spillway design flood through application of Table 1, further analysis may be performed to evaluate the limiting flood condition for incremental damages. Site-specific conditions should be recognized and considered. In no situation shall the allowable reduced level be less than the level at which the incremental increase in water surface elevation downstream due to failure of an impounding structure is no longer considered to present an additional downstream threat. This engineering analysis will need to present water surface ~~elevations~~ depths and velocities at each structure that may be impacted downstream of the dam. An additional downstream threat to persons or property ~~is presumed to~~ exists ~~for~~ when:
- Water depths exceed two feet or when the product of water depth (in feet) and flow velocity (in feet per second) is greater than seven.
- or
- The proposed spillway design flood scenario without breach of the dam is plotted in the High Danger Zone of the corresponding ACER-11 Figure.

Questions?

Example 1

- $D_{NB} = 2.6$
- $D_B = 3.6$
- $V_{NB} = 5$
- $V_B = 7.8$

- $D_{Inc} = 1$
- $V_{Inc} = 2.8$
- $DV_{Inc} = 2.8$

- SC: High
- 2FT: <2
- Ro7: <7

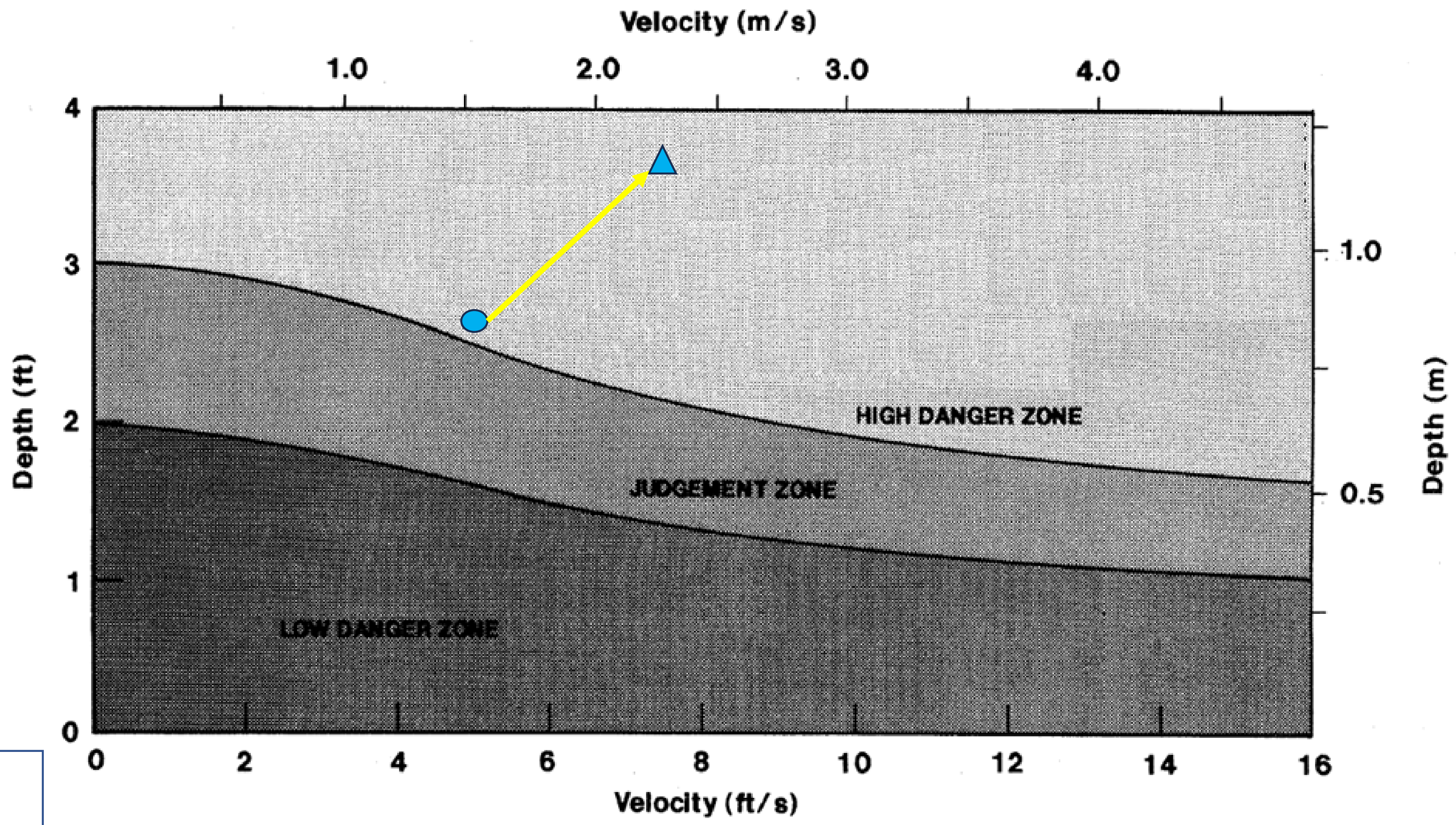


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May Reduce SDF to proposed Flood

Example 2

- $D_{NB} = 2.3$
- $D_B = 5.0$
- $V_{NB} = 8.1$
- $V_B = 12.1$

- $D_{Inc} = 2.7$
- $V_{Inc} = 4.0$
- $DV_{Inc} = 10.8$

- SC: High ✓
- 2FT: >2 ✗
- Ro7: >7 ✗

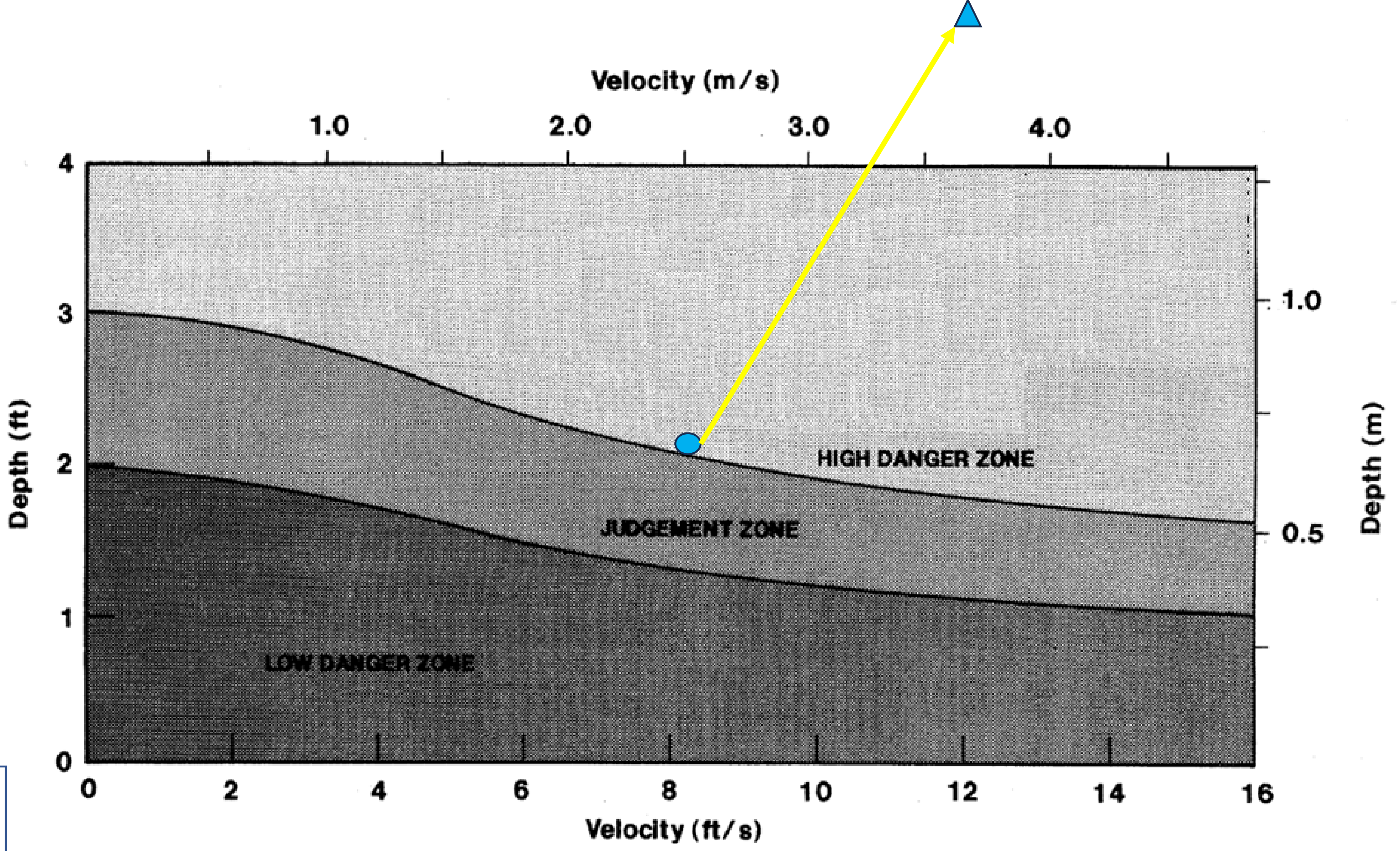


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May Reduce SDF to proposed Flood (SC Method Satisfied)

Example 3

- $D_{NB} = 1.0$
- $D_B = 4.0$
- $V_{NB} = 2.0$
- $V_B = 6.0$

- $D_{Inc} = 3.0$
- $V_{Inc} = 4.0$
- $DV_{Inc} = 12.0$

- SC: Low ❌
- 2FT: >2 ❌
- Ro7: >7 ❌

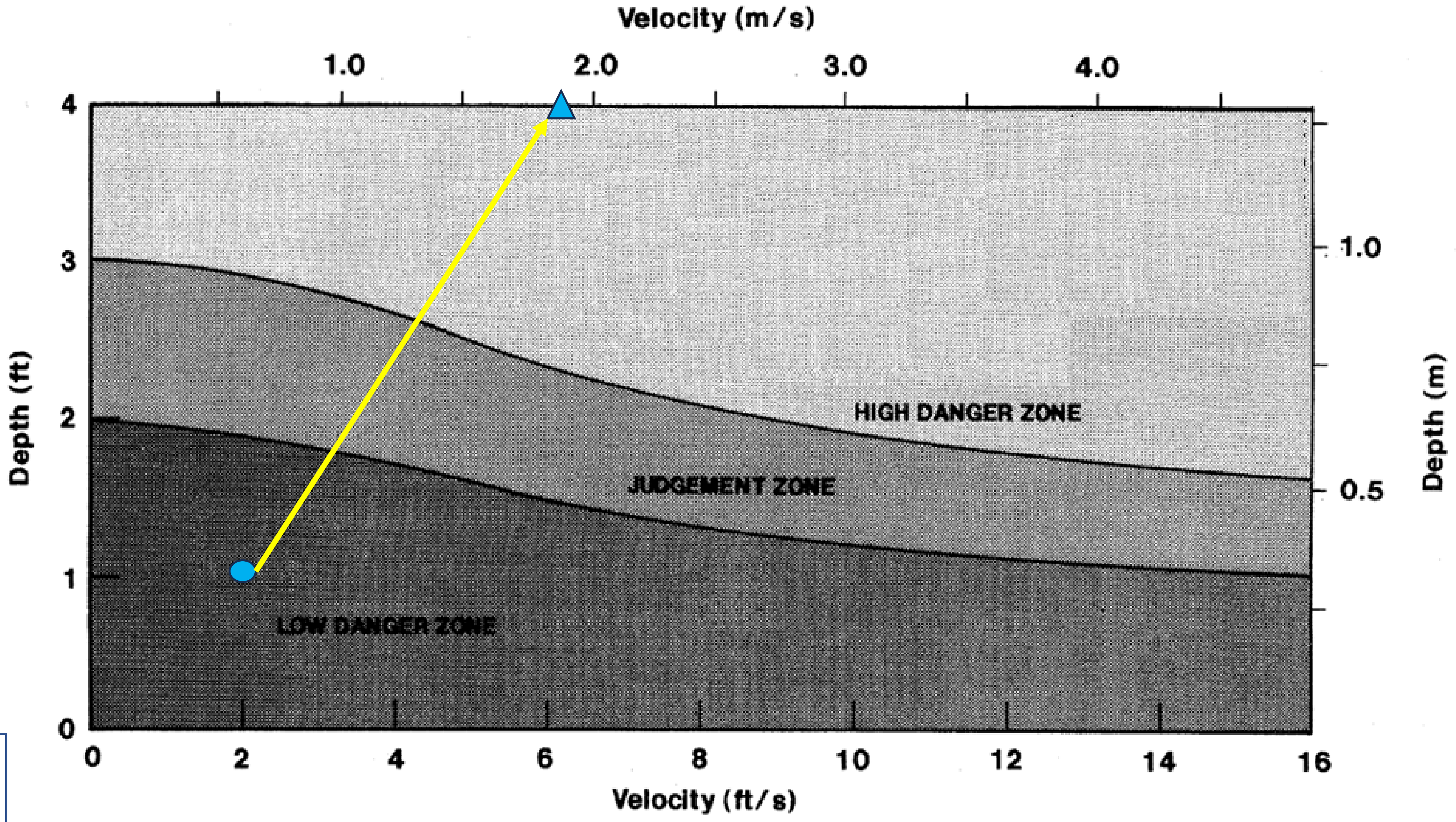


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May NOT Reduce SDF to proposed Flood

Example 4

- D_{NB} = 1.9
- D_B = 4.0
- V_{NB} = 2.0
- V_B = 6.0
- D_{Inc} = 2.1
- V_{Inc} = 4.0
- DV_{Inc} = 8.4
- SC: Judgement ✗
- 2FT: >2 ✗
- Ro7: >7 ✗
- **Conclusion**: May NOT Reduce SDF

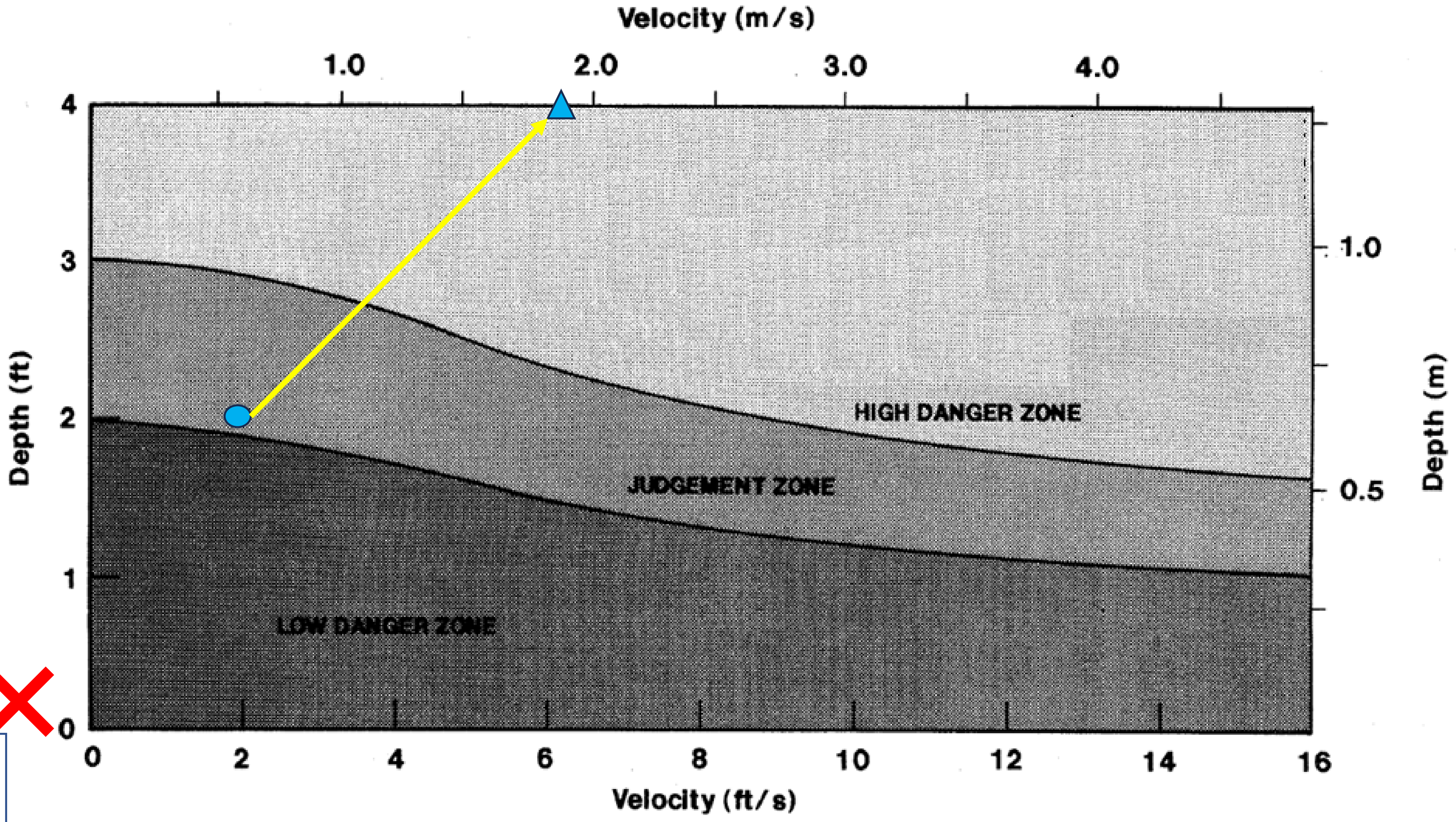


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

Example 5

- $D_{NB} = 0.0$
- $D_B = 2.3$
- $V_{NB} = 0.0$
- $V_B = 6.2$

- $D_{Inc} = 2.3$
- $V_{Inc} = 4.1$
- $DV_{Inc} = 9.4$

- SC: Low ✗
- 2FT: >2 ✗
- Ro7: >7 ✗

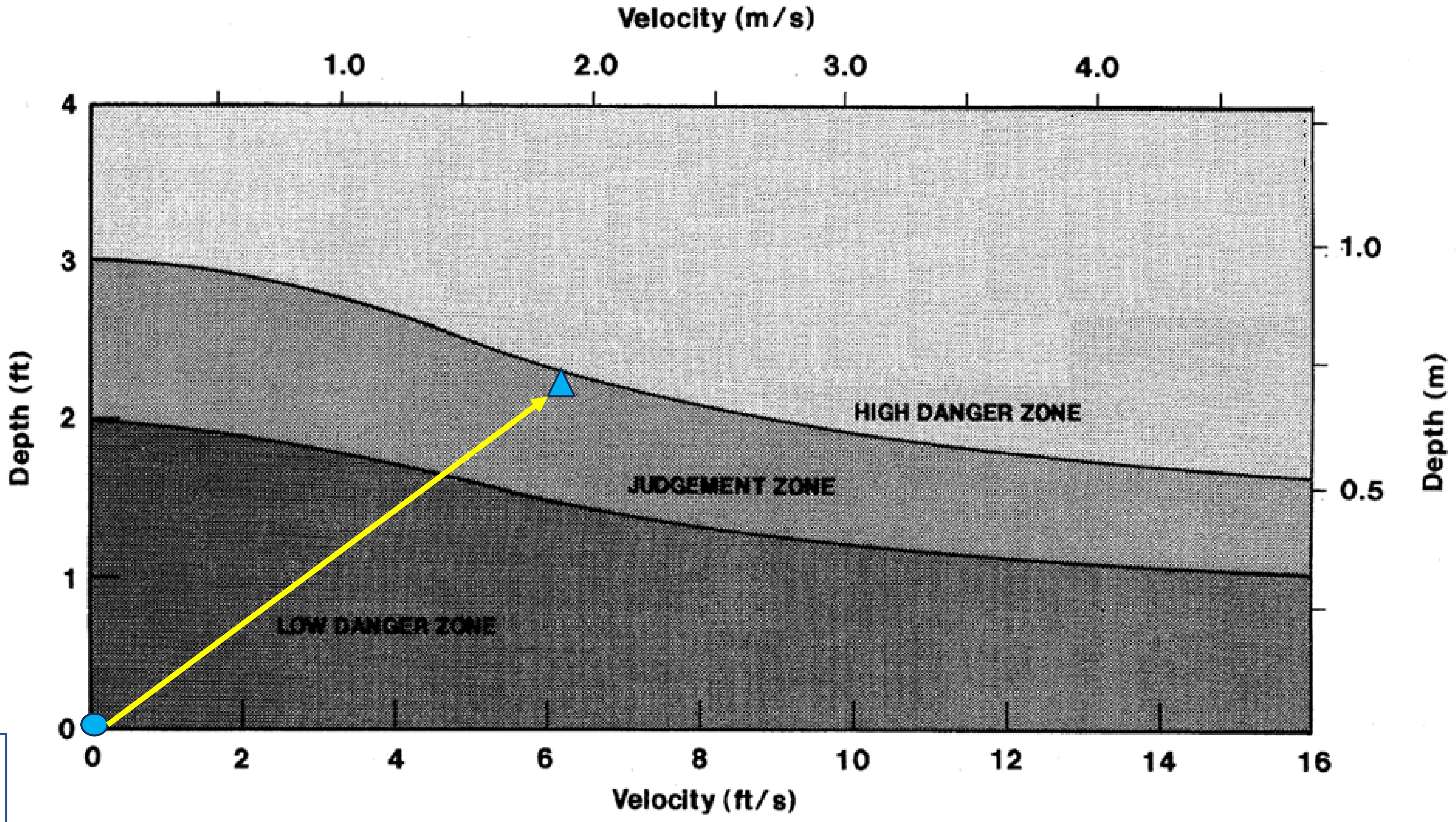


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May NOT Reduce SDF to proposed Flood

Example 6

- D_{NB} = 1.8
- D_B = 3.1
- V_{NB} = 2.0
- V_B = 2.6

- D_{Inc} = 1.3
- V_{Inc} = 0.6
- DV_{Inc} = 0.78

- SC: Low ✗
- 2FT: >2 ✓
- Ro7: >7 ✓

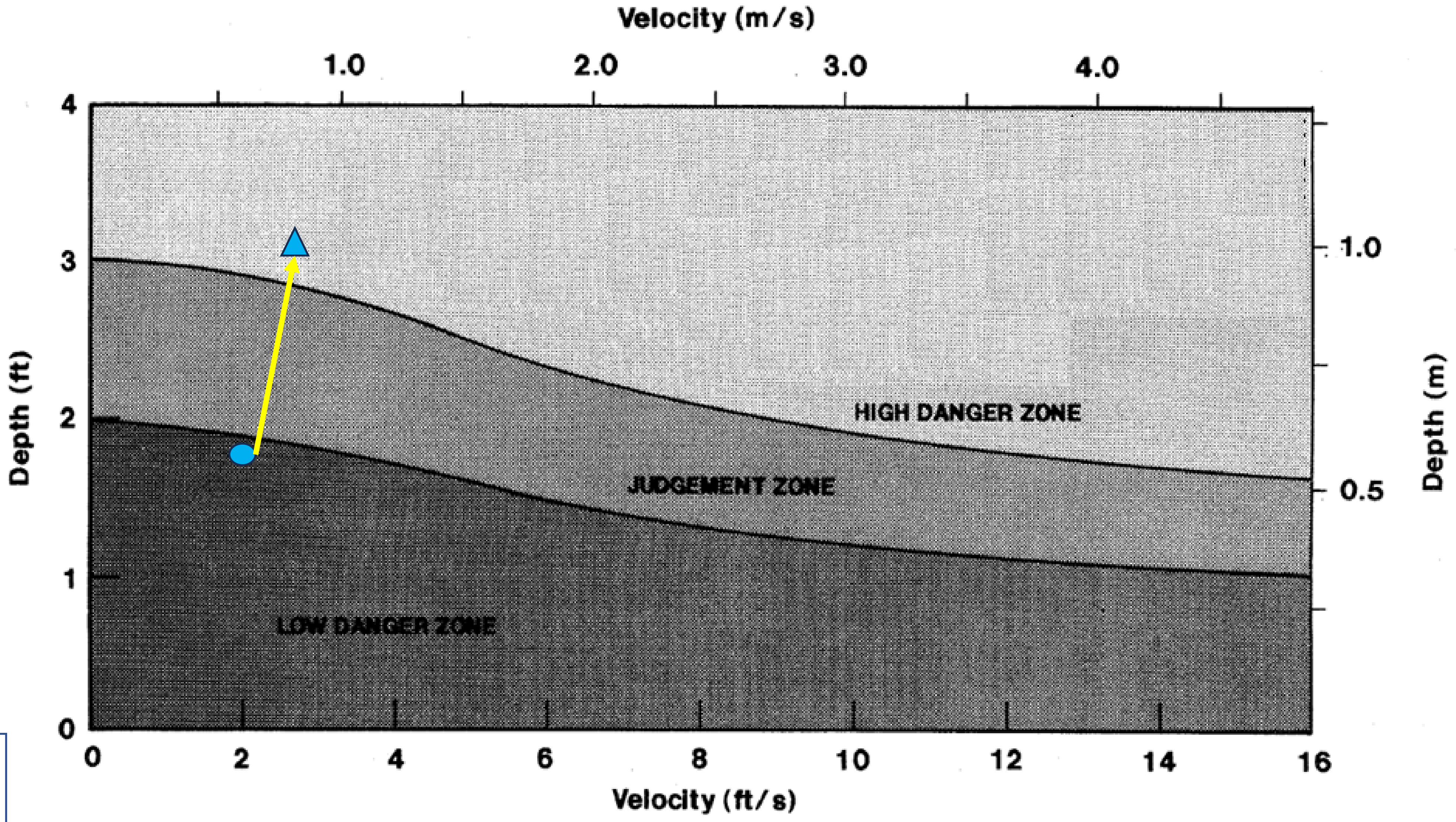


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May Reduce SDF to proposed Flood (2FT AND Ro7 Satisfied)

Example 7

- D_{NB} = 1.8
- D_B = 4.0
- V_{NB} = 2.0
- V_B = 2.6

- D_{Inc} = 2.2
- V_{Inc} = 0.6
- DV_{Inc} = 0.78

- SC: Low ✗
- 2FT: >2 ✗
- Ro7: >7 ✓

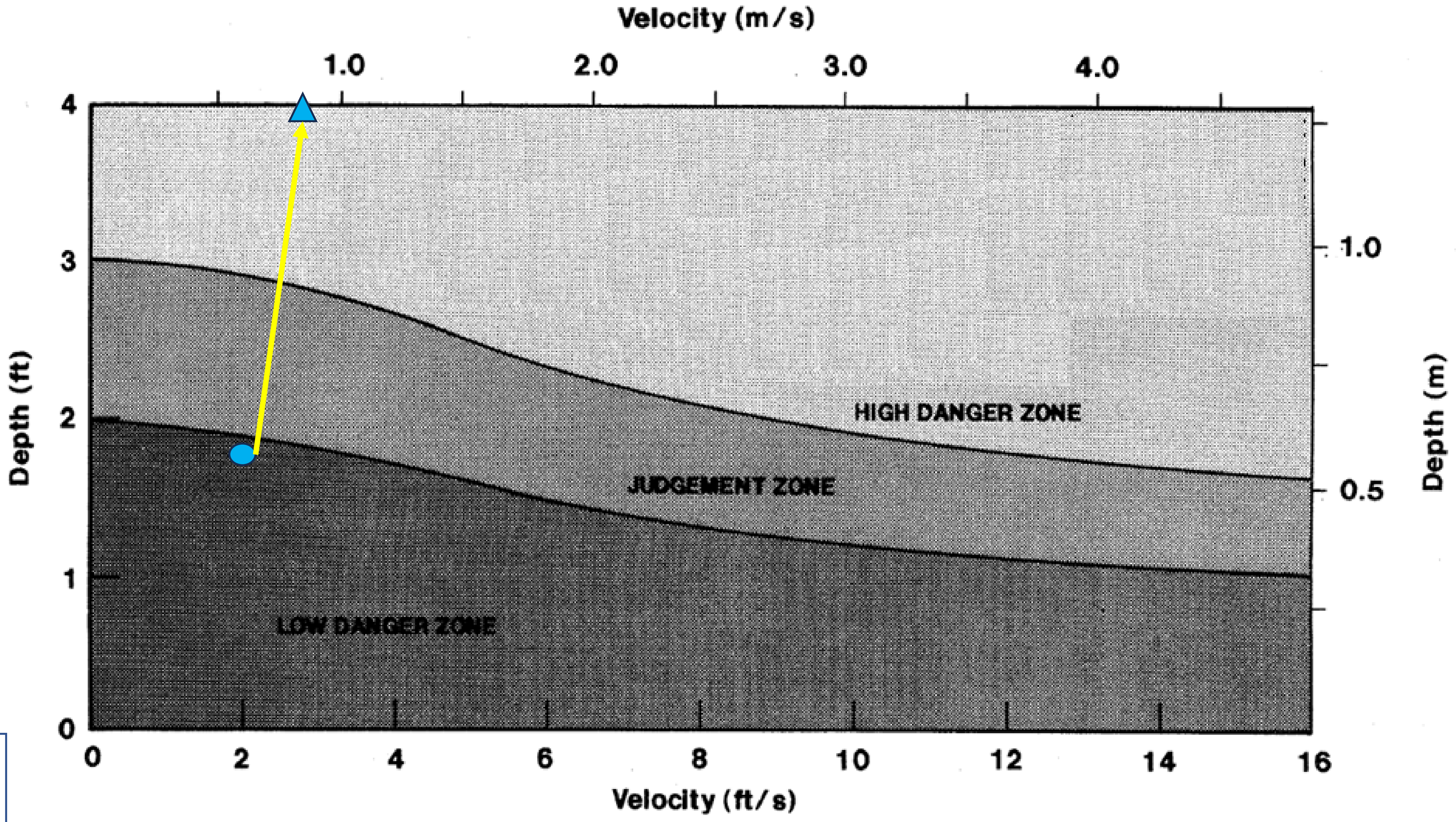


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May NOT Reduce SDF to proposed Flood(Both 2FT AND Ro7 Must be satisfied)

Example 8

- $D_{NB} = 1.8$
- $D_B = 3.0$
- $V_{NB} = 2.0$
- $V_B = 8.0$
- $D_{Inc} = 1.2$
- $V_{Inc} = 6$
- $DV_{Inc} = 7.2$
- SC: Low ✗
- 2FT: >2 ✓
- Ro7: >7 ✗

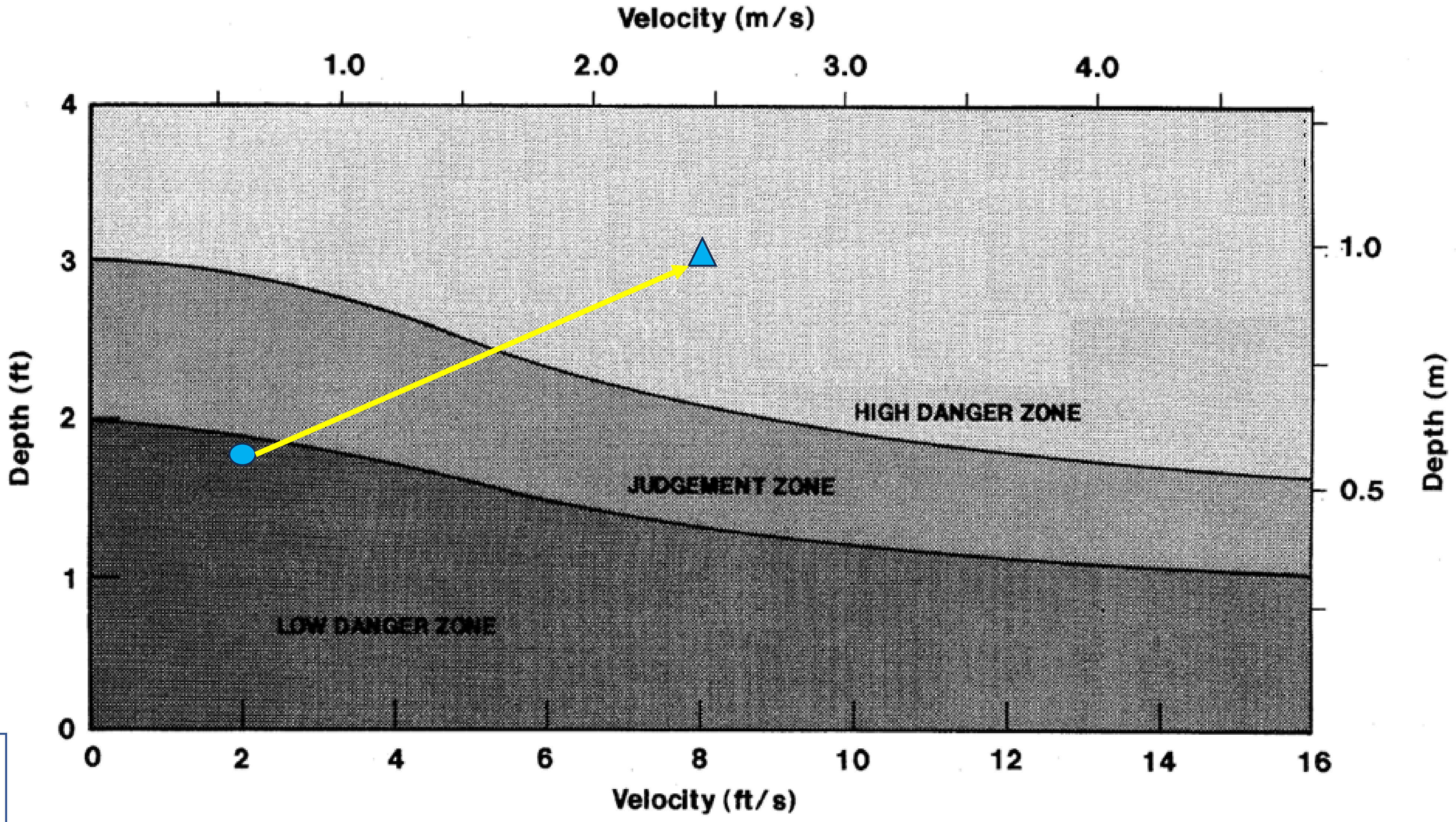


Figure 4. – Depth–velocity flood danger level relationship for passenger vehicles.

- **Conclusion**: May NOT Reduce SDF to proposed Flood(Both 2FT AND Ro7 Must be satisfied)

Example 9

- D_{NB} = 0.1
- D_B = 2.5
- V_{NB} = 0.0
- V_B = 3.0

- D_{Inc} = 2.4
- V_{Inc} = 3.0
- DV_{Inc} = 7.2

- SC: Low ✗
- 2FT: >2 ✗
- Ro7: >7 ✗

- **Conclusion**: May NOT Reduce SDF to proposed Flood

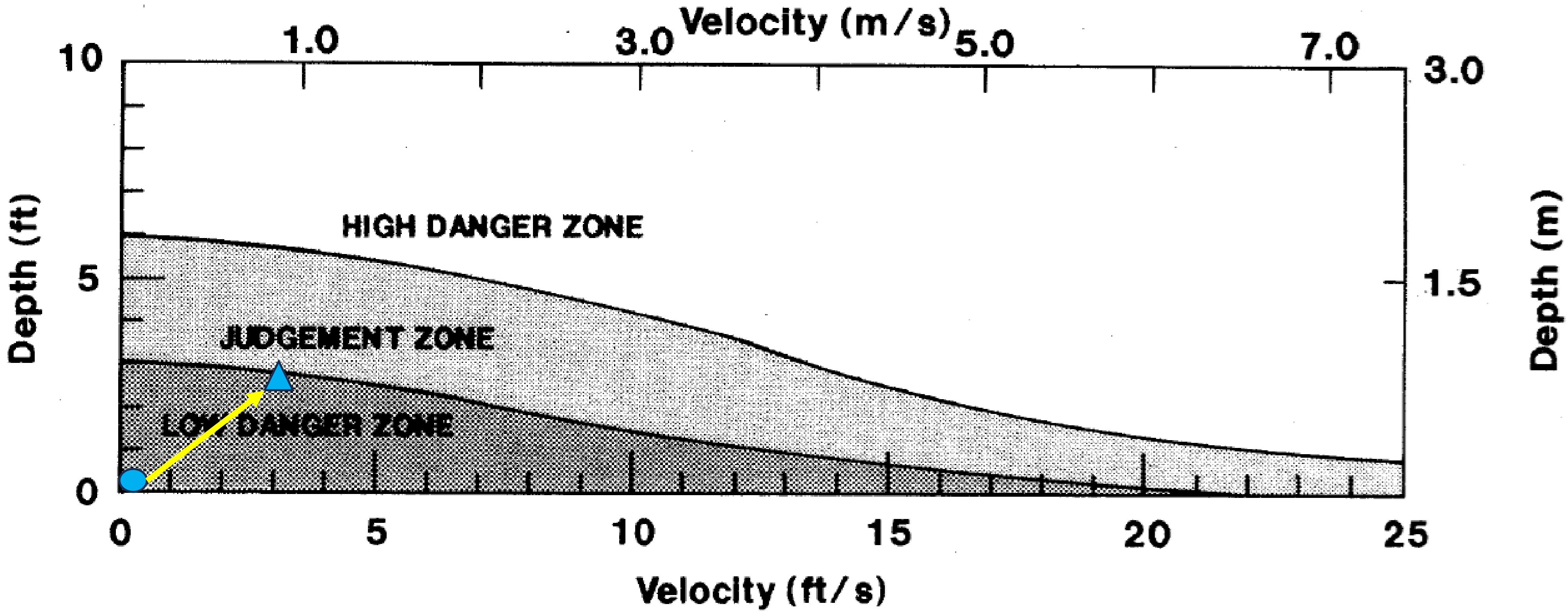


Figure 2. – Depth–velocity flood danger level relationship for houses built on foundations.