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Safety Barrier Design Standard & Relevance to the Fencing Retrofit Programme

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TII Fencing Retrofit Programme Workshop
Tullamore, January 15th 2019

Agenda...

1. VRS Design – Relevant Standards

- 03034 / 03036 / 03079

2. Principles

- Forgiving Roadsides
- Hazard Mitigation
- Defined Hazards
- Hazard Ranking
- Clear Zone
- Terrain Class
- Length of Need

3. VRS Risk Assessment

Relevant Standards...

Before We Start...

- **You won't be necessarily designing VRS** for this Fencing Retrofit Programme...
- **You will be assessing and referring** locations which require VRS design or hazard mitigation to TII for design / implementation under other programmes...
- VRS should only be designed **by those** who have completed the **TII VRS Designer Training Course**

Relevant Standards...

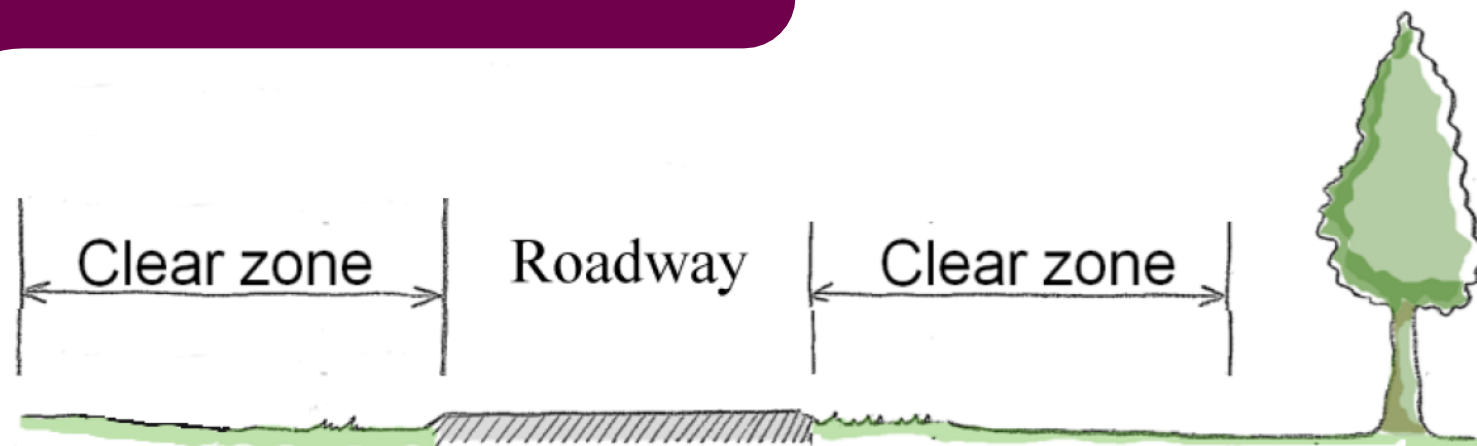


| | Current Version... | Expected 2019 Revisions... |
|---|--|---|
| <p>DN-REQ-03034: Safety Barriers [2015] <i>[2019 - Design of Road Restraint Systems (Vehicle & Pedestrian)]</i></p> | <ul style="list-style-type: none"> • Forgiving Roadsides • Hazards • Clear Zone • Terrain Classes • Risk Assessment | <ul style="list-style-type: none"> • Hazards • Hazard Ranking • Operational Speeds |
| <p>DN-REQ-03079: Guidance for Retrofitting VRS on the Single Carriageway National Road Network [2017] <i>[2019 - Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings)]</i></p> | | <ul style="list-style-type: none"> • Clear Zones v Operational Speeds • Risk Assessment |
| <p>DN-GEO-03036: Cross Sections & Headroom [2017] <i>[2019 - Cross Sections & Headroom]</i></p> | <ul style="list-style-type: none"> • Forgiving Roadsides | <ul style="list-style-type: none"> • Forgiving Roadsides • Hazards • Clear Zone • Terrain Classes |

VRS Design Principles...

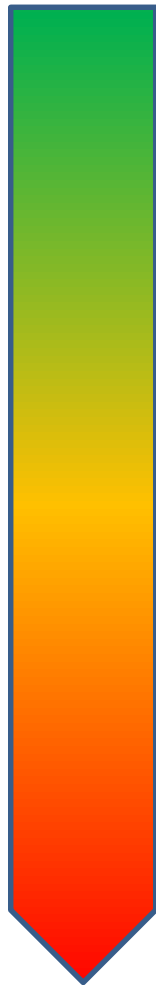
(relevant to Fencing Retrofit)

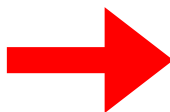
Forgiving Roadsides



VRS Design Principles...

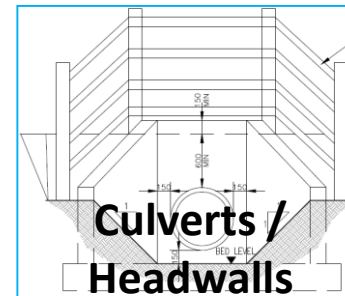
Hazard Mitigation



- a. **Remove**
- b. **Relocate**
- c. **Re-design** hazard (e.g. passive)
- d. **Revise** road layout or cross section to lower risk
- e. **Reduce** Impact Severity (e.g. breakaway features, flush profiles)
- f. **Provide** suitable barrier  **LAST RESORT**

VRS Design Principles...

Defined Hazards



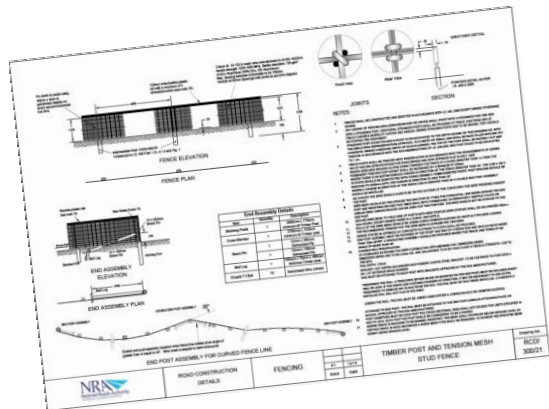
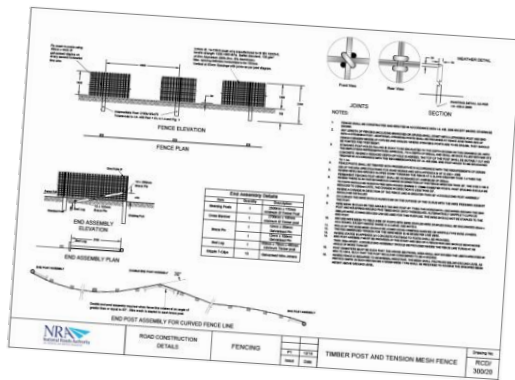
Defined Hazards (contd)...



All fences with rails even if used as road boundary = Hazards

Defined Hazards (contd)...

New CC-SCD-320 & CC-SCD-321 – Timber post and strained wire mesh fence



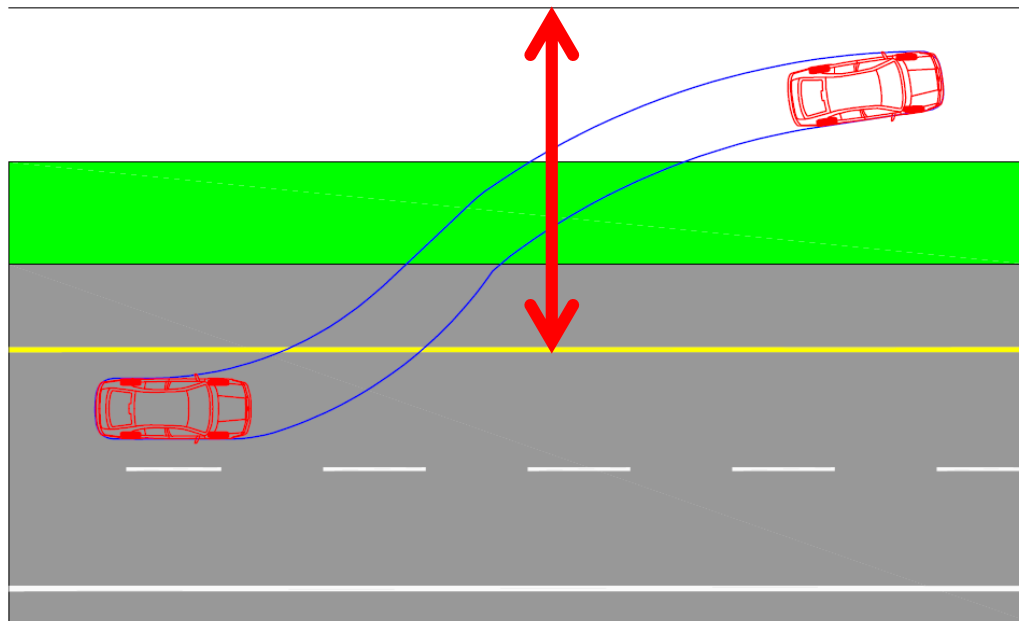
VRS Design Principles...

Hazard Ranking

APPENDIX D: HAZARD RANKING

| Hazard Ranking | Hazard Description |
|----------------|--|
| High | <ul style="list-style-type: none"> Lighting Columns that are not passively safe. Tubular Steel Signposts >80mm diameter by 3.2mm thick, or equivalent strength. Wooden Poles or Posts with Cross Sectional Area > 25,000mm² that do not have breakaway features. Trees having a girth 175mm or more measured at 1m above the ground. Concrete posts with Cross Sectional Area > 15,000mm². Play grounds/Monuments and other locations of high socio-economic value. Water of likely depth > 0.6m. Bridge Parapets, Bridge Piers, Abutments, Railing Ends, Gantry Legs Location where errant vehicle may encroach onto road/roadway which crosses or runs parallel to road. Substantial fixed objects e.g. walls extending above the ground by more than 150mm with projections or recesses > 100mm and running parallel to the road. Underbridges or retaining walls >0.5m high supporting the road, where a vehicle parapet or vehicle/pedestrian parapet of the required performance class is not provided. Buildings in danger of collapse. Industrial sites with potential for explosion or chemical spill. Rock cutting with rough face. Steep Embankment Slopes, steeper than 1:2 and ≥1.0m height. |
| Medium | <ul style="list-style-type: none"> Steep Embankment Slopes, steeper than 1:2 and between ≥0.5m and 1.0m height. Embankment Slopes between 1:2 and 1:3 (inclusive) and ≥2m height. Slopes to ditches. Drainage Items such as culvert headwalls and transverse ditches that are not detailed to be traversed safely. Hazardous topographical features outside the width defined in Table 4/1. Single cross culvert opening exceeding 1000mm measured parallel to the direction of travel. Culvert approximately parallel to the roadway that has an opening exceeding 600mm measured perpendicular to the direction of travel. Steep sided cuttings or earth bunds (steeper than 1:2) within the clear zone. Multiple cross culvert openings exceeding 750mm each, measured parallel to direction of travel. Linear V-ditches alongside the scheme. All fences (including timber post and rail fences) except those to RCD/300/20³ or RCD/300/21. Environmental Barriers. |
| Low | <ul style="list-style-type: none"> Shallow Slopes, between 1:3 and 1:5 gradient and ≥6m in height. Embankment Slopes between 1:2 and 1:3 (inclusive) and between 0.5m and 2m height. Substantial fixed objects e.g. walls extending above the ground by more than 150mm with projections or recesses ≤ 100mm and running parallel to the road. |

VRS Design Principles...



Clear Zone

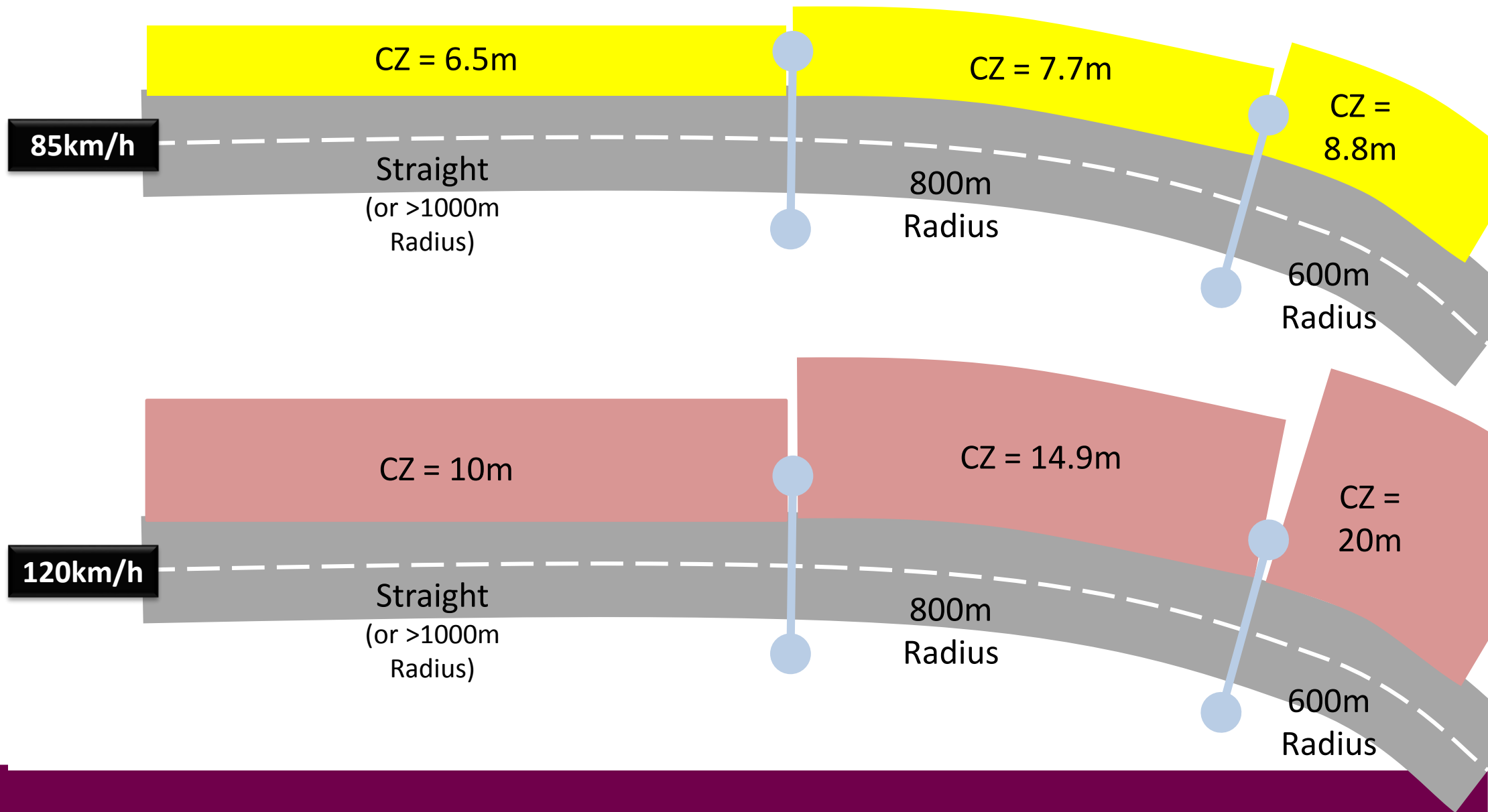
- Width of traversable land to be clear of unprotected hazards
- Measured from the nearest edge of trafficked lane
- May include the road boundary and land beyond
- Influenced by speeds, horizontal curvature, and terrain profile

Clear Zone (contd)...

DN-REQ-03034 Table 4/1 – Required Clear Zone Widths

| | Design Speed (km/h) | | |
|--------------------------------------|----------------------------------|------------|-------------|
| | 85 | 100 | 120 |
| Horizontal radius (m) | Required Width of Clear Zone (m) | | |
| Inside of bend or Straight | 6.5 | 8.0 | 10.0 |
| Outside of bend $\geq 1,000\text{m}$ | 6.5 | 8.0 | 10.0 |
| “ 900m | 7.1 | 8.8 | 12.4 |
| “ 800m | 7.7 | 9.6 | 14.9 |
| “ 700m | 8.3 | 10.4 | 17.5 |
| “ 600m | 8.8 | 11.2 | 20.0 |
| “ 500m | 9.4 | 12.0 | |
| “ 400m | 10.0 | 12.8 | |
| “ 300m | 10.6 | | |

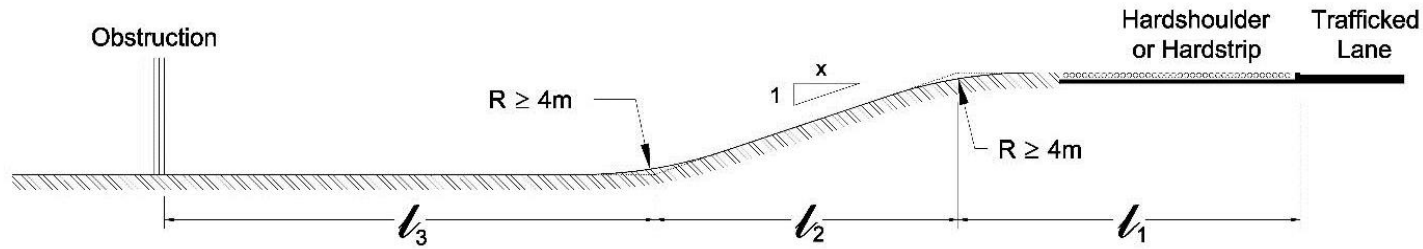
Clear Zone (contd)...



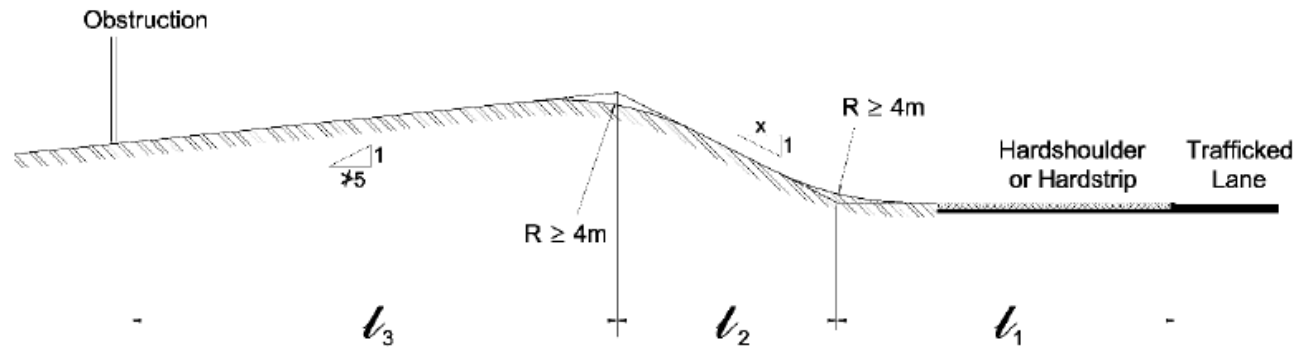
Clear Zone (contd)...



Terrain Class (contd)...

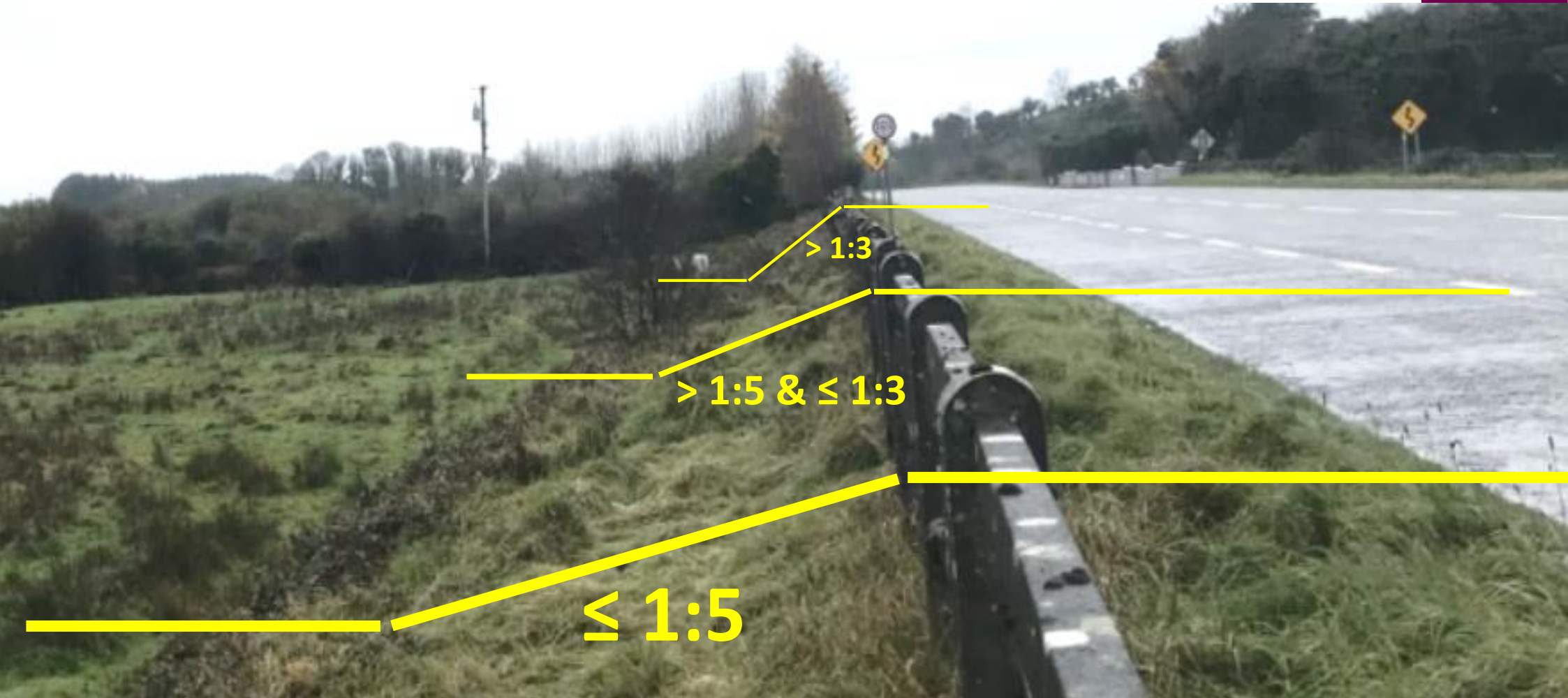


| Embankment or Falling Terrain | Terrain Class | Clear Zone Width |
|-------------------------------|---------------|-------------------|
| Slope flatter or equal to 1:5 | 1 | $l_1 + l_2 + l_3$ |
| Slope between 1:5 and 1:3 | 2 | $l_1 + l_3$ |
| Slope steeper than 1:3 | 3 | l_1 |



| Cutting or Rising Terrain | Terrain Class | Clear Zone Width |
|---------------------------------|---------------|-------------------|
| Slope shallower or equal to 1:2 | 1 | $l_1 + l_2 + l_3$ |
| Slope steeper than 1:2 | 3 | l_1 |

Terrain Class (contd)...



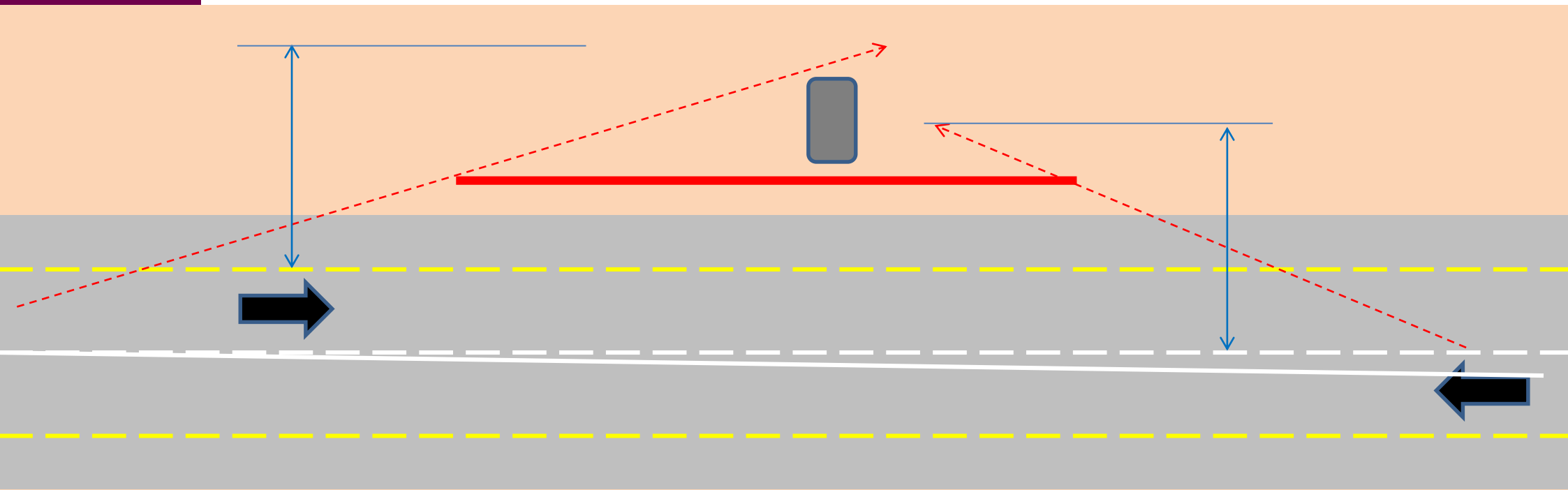
Terrain Class (contd)...



VRS Design Principles...

Length of Need

>> The length of a barrier which provides the full level of protection required for a particular hazard <<



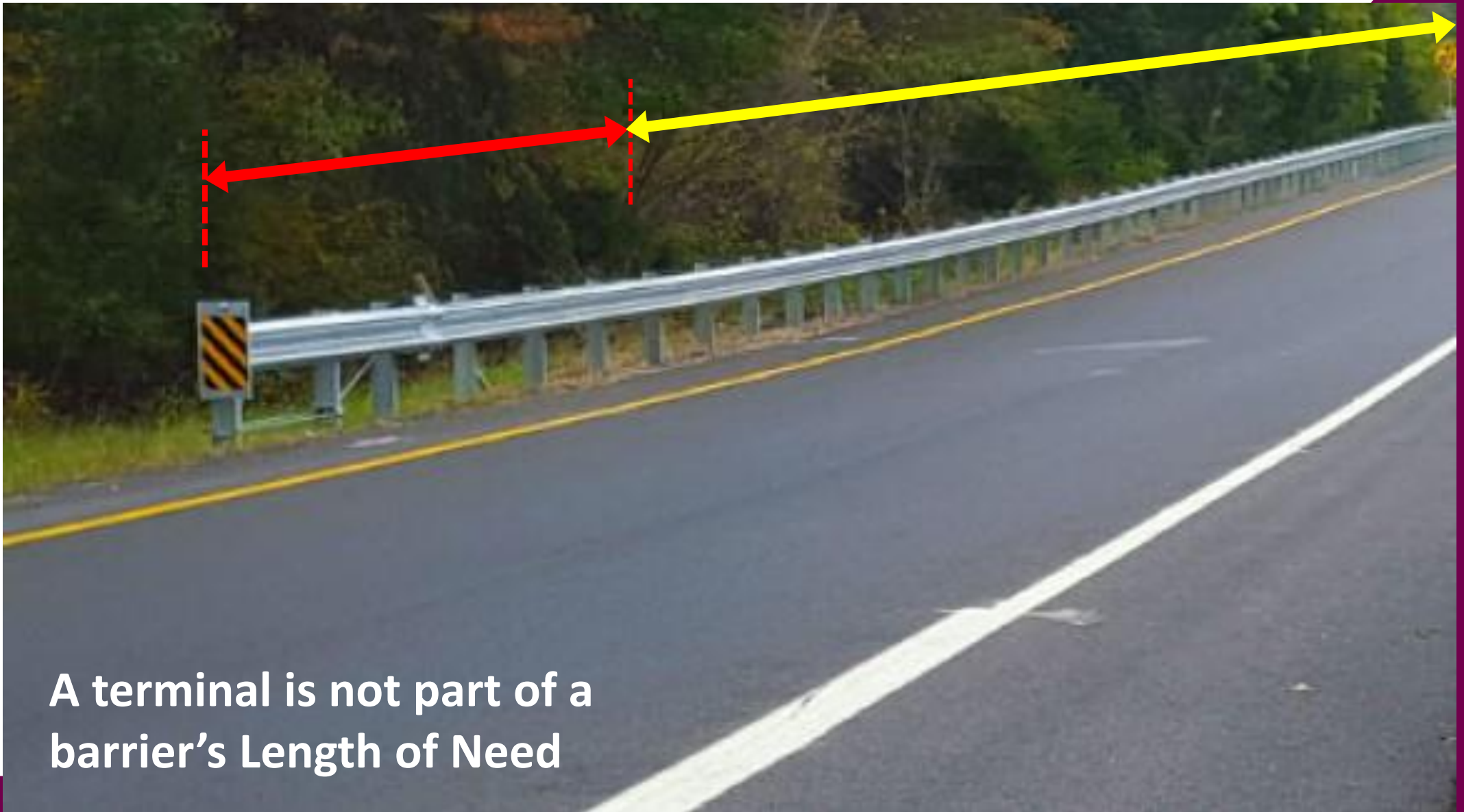
Length of Need (contd)...



Length of Need (contd)...



Length of Need (contd)...



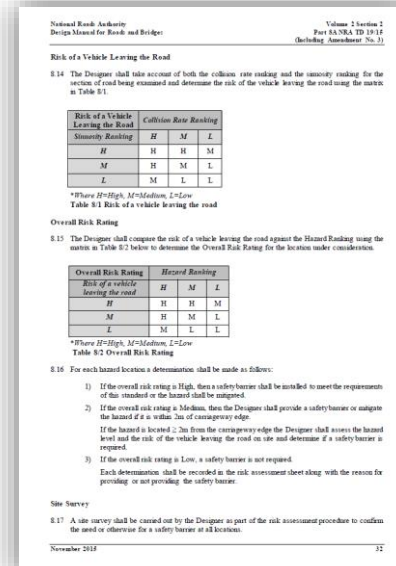
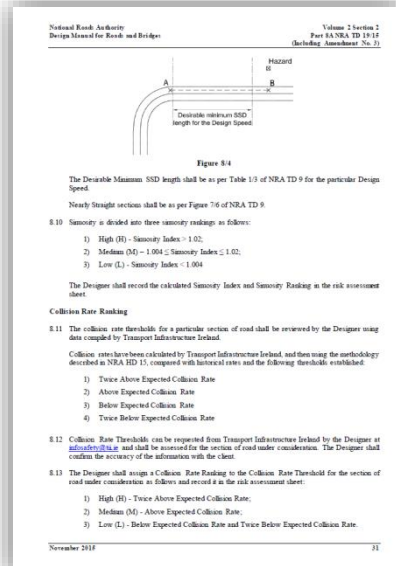
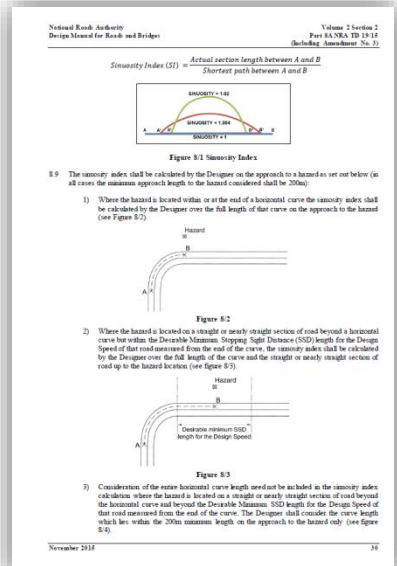
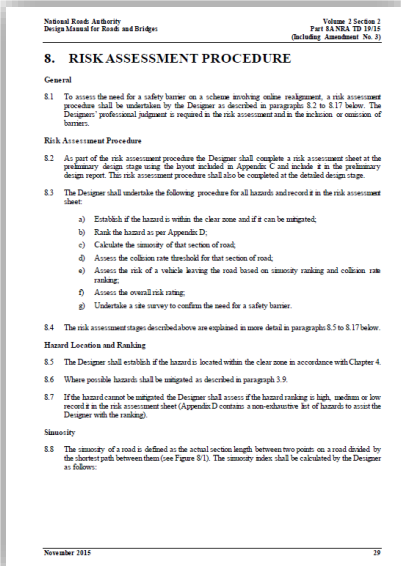
A terminal is not part of a barrier's Length of Need

Length of Need (contd)...



VRS Risk Assessment Procedure...

- Used by Designers to assess risk
- Involved Designers' professional judgment
- Aids decision to provide or omit VRS



Risk Assessment Procedure...



1. Is hazard within **clear zone**? **Mitigate?**



2. **Rank** the hazard (App D)



3. Calculate **sinuosity**



4. Assess **collision rate** threshold



5. Assess **risk of vehicle leaving the road** (**sinuosity** & collision rate ranking)



6. Assess **overall risk rating**



7. Undertake **site survey** to confirm VRS needed

Risk Assessment Procedure...

1. Clear zone



2. Rank hazard



3. Sinuosity



4. Collision Rate



5. Assess risk



6. Risk rating



7. Site survey

Is it a hazard?

- Physical obstruction? List in Ch.3 of 03034
- May result in injury to occupants of errant vehicle?



Within Clear Zone?

- Width to be kept clear of hazards
- Table 4/1 of 03034
- Speed, geometry

| Horizontal radius (m) | Design Speed (km/h) | | |
|----------------------------|---------------------|------|------|
| | 85 | 100 | 120 |
| Inside of bend or Straight | 6.5 | 8.0 | 10.0 |
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| “ 400m | 10.0 | 12.8 | |
| “ 300m | 10.6 | | |

Hazard Mitigation?

- Remove?
- Relocate?
- Redesign?
- Revise layout?
- Reduce impact severity?

-
- a. Remove
 - b. Relocate
 - c. Re-design hazard (e.g. passive)
 - d. Revise road layout or cross section to lower risk
 - e. Reduce Impact Severity (e.g. breakaway features, flush profiles)
 - f. Provide suitable barrier → **LAST RESORT**

Risk Assessment Procedure...

1. Clear zone



2. Rank hazard



3. Sinuosity



4. Collision Rate



5. Assess risk



6. Risk rating



7. Site survey

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Assuming hazard cannot be mitigated...

Assess hazard ranking from Appendix D of 03034

as

(VH), H, M, L

Risk Assessment Procedure...

1. Clear zone



2. Rank hazard



3. Sinuosity



4. Collision Rate



5. Assess risk



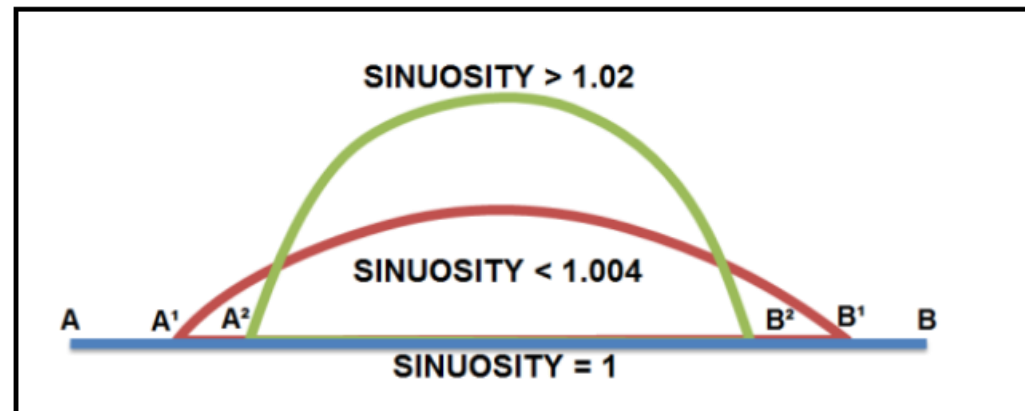
6. Risk rating



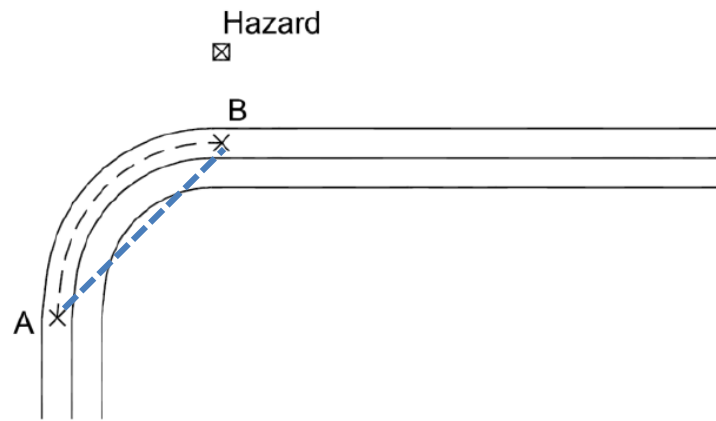
7. Site survey

- Calculate Sinuosity **on the approach** to a hazard
- **Minimum approach length** to the hazard considered shall be **200m**

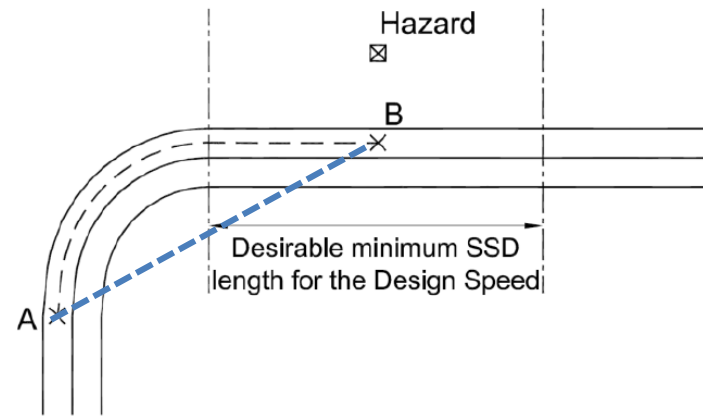
$$\text{Sinuosity Index (SI)} = \frac{\text{Actual section length between A and B}}{\text{Shortest path between A and B}}$$



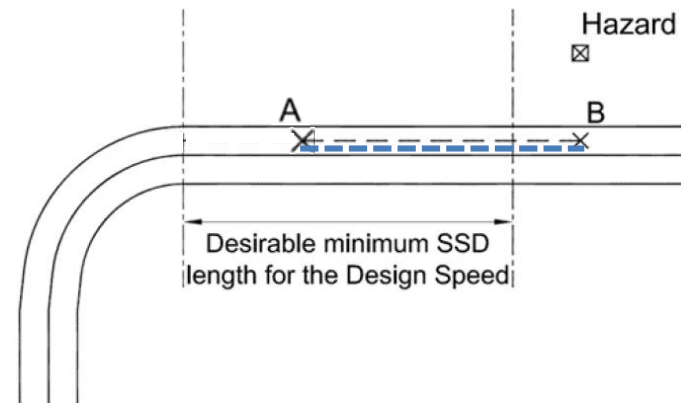
Hazard located on or at the end of a horizontal curve



Hazard located on straight beyond a horizontal curve but within the Desirable Minimum SSD



Hazard located on straight beyond horizontal curve and beyond the Desirable Minimum SSD





High (H)

Sinuosity Index > 1.02



Medium (M)

$1.004 \leq$ Sinuosity Index ≤ 1.02



Low (L)

Sinuosity Index < 1.004

Risk Assessment Procedure...

1. Clear zone



2. Rank hazard



3. Sinuosity



4. Collision Rate



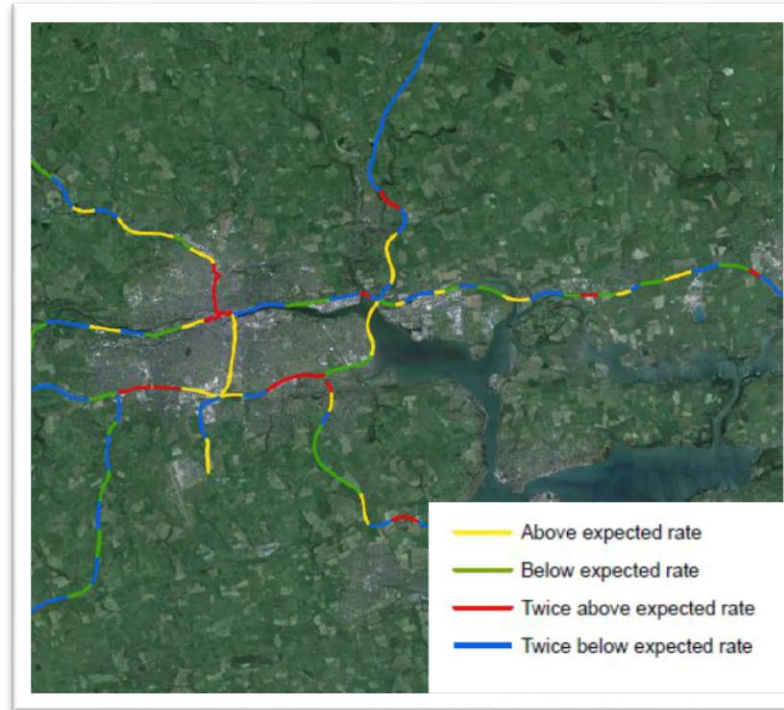
5. Assess risk



6. Risk rating



7. Site survey



Collision Rates available from TII and data.gov.ie (KML)

- Above Expected
- Below Expected
- Twice Above
- Twice Below

Twice Above Expected Collision Rate = **High (H)**

Above Expected Collision Rate = **Medium (M)**

Below & Twice Below Expected Collision Rate = **Low (L)**

Risk Assessment Procedure...

1. Clear zone
2. Rank hazard
3. Sinuosity
4. Collision Rate
- 5. Assess risk**
6. Risk rating
7. Site survey

Using both **Collision Rate Ranking** and **Sinuosity Ranking**, use matrix to determine the **risk of the vehicle leaving the road...**

| Risk of a Vehicle Leaving the Road | | Collision Rate Ranking | | |
|------------------------------------|---|------------------------|---|---|
| | | H | M | L |
| Sinuosity Ranking | H | H | H | M |
| | M | H | M | L |
| | L | M | L | L |

Risk Assessment Procedure...

1. Clear zone
2. Rank hazard
3. Sinuosity
4. Collision Rate
5. Assess risk
- 6. Risk rating**
7. Site survey

Using **Risk of Vehicle Leaving the Road** and **Hazard Ranking**, determine **Overall Risk Rating**...

| Overall Risk Rating | | Hazard Ranking | | |
|------------------------------------|---|----------------|---|---|
| | | H | M | L |
| Risk of a Vehicle Leaving the Road | H | H | H | M |
| | M | H | M | L |
| | L | M | L | L |

Interpreting Overall Risk Rating...

High VRS required (or hazard to be mitigated).

Medium If hazard within 2m of c/w edge, provide VRS (or mitigate).

If hazard \geq 2m from c/w edge, Designer to assess hazard level and risk of vehicle leaving the road on site and determine if VRS required.

Low VRS is not required.

Risk Assessment Procedure...

1. Clear zone
2. Rank hazard
3. Sinuosity
4. Collision Rate
5. Assess risk
6. Risk rating
7. **Site survey**

Designer **visits the site** as part of the risk assessment procedure **to confirm the need or otherwise** for VRS at all hazard locations considered.



Thank You