A roadside hazard is
- any roadside object or feature
- with a diameter greater than 100mm
- located on or near the roadway
- likely to create a danger to occupants / riders of any vehicle leaving the carriageway
POINT HAZARDS

- Point hazards are individual hazards or roadside hazards of limited length. They include:
  - trees (over 100 mm diameter),
  - bridge end posts,
  - large planter tubs,
  - monuments,
  - landscape features,
  - non-breakaway sign posts (over 100 mm diameter),
  - interchange supporting piers,
  - driveway headwalls,
  - culvert headwalls,
  - utility poles (more than 100 mm diameter),
  - solid walls, and
  - pedestrian overpass piers and/or stairs.
Continuous hazards extend for a considerable length along a road:

- rows and forests of large trees
- uncovered longitudinal drains
- retaining walls
- steep embankments
- rock cuttings
- cliffs
- areas of water (such as lakes, streams, channels over 0.6 m deep)
- unshielded hazards (such as cliffs) beyond clear zone, but within reach of an errant vehicle
- curbs with a vertical face more than 100 mm high on roads with operating speeds above 80 km/h
- fences with horizontal rails that can spear vehicles.
FORGIVING ROADSIDE CONCEPT

• Drivers (or riders) will make mistakes
• Forgiving roadsides minimize severity of driver’s mistakes
• Safe design principles include provision of forgiving roadsides - vehicle runs off road
• Roadside designed to minimize possibility of occupant of an errant vehicle being seriously injured or killed
RECOVERY AREA

• Part of the roadside in which an errant vehicle could be expected to come to rest safely or pass through before rejoining traffic lane
  – Primarily dependent on traffic speed
  – On high speed, open roads with flat side slopes, between 80-85% of vehicles recover within 9m from edge of carriageway
  – However, the distance a vehicle travels after leaving the carriageway depends on speed, adjacent slope and horizontal and vertical alignment at that point
Clear Zone

A traversable area that starts at the edge of the traffic lane, includes the shoulder, and extends laterally a sufficient distance to allow a driver to stop or return to the road before encountering a hazard or overturning.
Clear Zone for Straight Roads

- Clear zone width measured from the edge of the traffic lane (meters)
- One-way AADT (approach volume)

- >50,000 (adopt 13 m)
- 30,000 (adopt 11 m)
- 10,000
- 5,000
- 4,000
- 3,000
- 2,000
- <1,000 (vehicles/day)

Operating Speed (km/h)
Clear Zone Adjustment Factors for Curves

Note: For radii > 1,000 meters use $F_c = 1.0$

Example:
On a 700 meter radius curve with an operating speed of 100 km/h, the graph suggests an $F_c$ of 1.15.

$F_c =$ curve correction factor, km/h = kilometer per hour.

CLEAR ZONE: SLOPE ADJUSTMENT

• Recoverable slopes (1V:4H or flatter) - no adjustment to the clear zone width
• Non-recoverable fill slopes (steeper than 1V:4H and flatter than 1V:3H) - clear zone distance excludes width of the non-recoverable embankment slope and continues beyond bottom of slope
• Critical fill slopes (exceeds 1V:3H)
  – cause an errant vehicle to roll over
  – need to be flattened or shielded with safety barrier, if slope is within clear zone
EFFECTS OF SIDE SLOPES ON CLEAR ZONE WIDTHS

ECZ = CZ
Flat batter included in effective clear zone width

ECZ Case 2(b)

CZ - W₁ ≤ WB/₂
ECZ = W₁ + 2 (CZ - W₁)

Case 2(a) if

CZ - W₁ > WB/₂
ECZ = CZ + WB/₂
or ECZ = W₁ + WB + W₂

where

W₂ = CZ - W₁ - WB/₂

Batter slope 1 on 6 or flatter

Hinge point

Traffic lane

ECZ

Traffic lane

WB/₂

W₁

CZ

WB

W₂

Case 2(b) if

W₂

Batter slope 1 on 4 to 1 on 6

ECZ Case 2(a)
EFFECTS OF SIDE SLOPES ON CLEAR ZONE WIDTHS

![Diagram showing the relationship between ECZ width required and various components like W2, WB, and W1, with ECZ calculated as W1 + WB + W2, where W2 = CZ - W1.]

Notes:
1. CZ is the clear zone width determined from Figure 3 adjusted for horizontal curve where necessary.
2. ECZ is the effective clear zone width.
3. W1 is the width from edge of through lane to hinge point.
4. WB is batter width.
5. W2 is width from toe of batter.
6. S is batter slope (m/m).
7. Provide batter rounding to all batter top and toe hinge points.

FIVE-STEP ROADSIDE HAZARD MANAGEMENT

Five options to treat each identified hazard:

• keep vehicles on the road
• remove the hazard
• relocate the hazard
• modify the hazard
• shield the hazard
Determine the clear zone distance

Are there any hazards within the clear zone?
- Yes: Can hazard be removed?
  - Yes: Remove hazard
  - No: Can hazard be relocated at least to edge of clear zone?
    - Yes: Relocate, preferably beyond CZ
    - No: Can hazard be modified to reduce its crash frequency and/or crash severity risk to road users?
      - Yes: Modify or redesign hazard to remove or reduce the danger.
      - No: Can hazard be shielded with safety barrier?
        - Yes: Install an approved safety barrier (or impact attenuator)
        - No: Has everything been done to “keep vehicles on the road” with delineation, tactile edge lines, paved shoulders, and guideposts?
          - Yes: Move on to the next run-off-road problem location
          - No: Keep vehicles on the road by signs, improving delineation, installing tactile edge lines, paving shoulders, installing guideposts

No action required
KEEP VEHICLES ON ROAD

• Safe road design
• Signs and guideposts
• Width markers, hazard markers, and chevron alignment markers
• Pavement markings
SAFE ROAD DESIGN

- Lane widths
- Road shoulders
- Horizontal alignment and localized curve widening
- Vertical alignment
- Sight distance
- Road surface
SIGN AND GUIDEPOSTS

- guidance, information, and knowledge about the road ahead
  - changes in road alignment, including curves and severity of those curves
  - visibility or where it is unsafe to overtake
  - need to slow down or stop at intersections
  - changes to the lane configuration or width of road
  - temporary changes to the road conditions, including road works
PAVEMENT MARKINGS
SIGNS AND GUIDEPOSTS
WIDTH MARKERS, HAZARD MARKERS, AND CHEVRON ALIGNMENT MARKERS
REMOVE THE HAZARD

• Remove all existing roadside objects that are fixed and are 100 mm in diameter or larger within the clear zone
• Reduces consequences of crash
• When designing a new road, avoid locating any new hazardous objects within the clear zone
RELOCATE THE HAZARD

• Relocating further from edge of road or relocating from outside of a curve to a location on a straight section of the road
• relocation of even a few meters will reduce risk, even if it is not possible to place it outside the clear zone
• Trees - not practical to relocate
  – most common hazards along highways
  – three choices:
    • remove it (albeit with environmental issues)
    • shield it (with suitable barrier)
    • do all possible to keep the vehicles on the road at that point
MODIFY THE HAZARD

• alter (or redesign) roadside hazard to reduce its potential for severe injury or death during a crash

• Includes
  – modifying open longitudinal drains by piping them or covering them with a drivable cover
  – modifying end walls of driveway culverts to make them drivable
  – redesigning rigid sign posts to provide frangible (breakaway) posts
  – designing frangible posts that break away, if struck;
  – redesigning rigid street lighting columns to provide frangible columns
  – flattening a steep fill slope to make it drivable.
MODIFY THE HAZARD

Covering drains within the clear zone can give a smooth drivable and more forgiving area.

Impact-absorbent poles (such as this one which has been struck) help to minimize injuries to the vehicles’ occupants.
• protect the occupants of errant vehicles from striking hazards by the installation of safety barriers
• Safety barriers designed to redirect an impacting vehicle and dissipate crash forces in a controlled manner
SHIELD THE HAZARD

• factors considered for selecting / designing safety barriers
  – need for a barrier
  – crash performance requirements - operating speed and types of vehicles
  – design requirements,
    • offset from traffic lanes
    • clearance from hazard
    • slope and condition of surface in front of barrier
    • any restrictions imposed by vertical or horizontal geometry
  – length of barrier required to effectively shield a hazard
  – type of barrier required
  – terminals for ends of the barrier so they are not hazardous
  – maintenance requirements and issues
SHIELD THE HAZARD

• three categories of safety barriers
  – flexible barriers
  – Semi-rigid barriers
  – rigid barriers
There are several approved wire rope safety barriers in use. They are the most forgiving of the three groups of barriers.

Semirigid barriers have been widely used for decades. They deflect by up to 1 meter when struck. Therefore, they should be at least 1 meter from the hazard they are shielding, and offset by (at least) 4 meters from the road (if the cross-section permits) to allow safe stopping.

Rigid barriers (concrete) do not deflect, and are well suited where width is limited and deflections cannot be tolerated.
Many roadside hazards
No delineation
No delineation
Incorrect direction of overlap
Hazardous terminals
Roadside debris
Unprotected terminals
Inadequate clear zone
Incorrect transition
Inadequate transition
Adequate transition
IMPACT ATTENUATORS
IMPACT ATTENUATORS
SAFER TERMINALS
SLIP BASE COLUMNS
FRANGIBLE LIGHTING COLUMNS

- Impact
- Vehicle continues with a small reduction in speed
- Road lighting pole falls behind vehicle
- Vehicle comes to rest, with lighting pole on ground
- Slip base pole

- Impact
- Controlled deceleration
- Vehicle at rest
- Impact-absorbing pole

Thank you