Curb Ramp Guidelines

Your Destination...Our Priority

October 2010

Version 1.0

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Disclaimer:
The guidance contained herein does not constitute a standard and shall be used in conjunction with existing Mn/DOT design standards and documentation

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INTRODUCTION

The Curb Ramp Guidelines provide designers and inspectors with current "best practices" and help them achieve successful curb ramp design and installations. As more information is gathered and better practices are revised the document will be altered accordingly. The goal of the document is to share experience and gain consistency in pedestrian ramp design and construction throughout Mn/DOT. This document is broadly available, but external users are advised that the information is geared to the needs of Mn/DOT's Trunk Highway System.

The information follows Public Rights of Way Accessibility Guidance (PROWAG) requirements and is based on Mn/DOT design requirements, designs presented in the Public Rights of Way Accessibility Advisory Committee's (PROWAAC) Special Report, and field experience. The Curb Ramp Guidelines address retrofit and alterations situations where existing obstacles and limited project scopes preclude some fixes readily achieved on new construction. The guide emphasizes the accessibility and usability of curb ramp designs in addition to compliance.

The guidelines should be used in concert with the following primary design resources:

- Mn/DOT Road Design Manual 11-3
- Standard Plate 7036
- Standard Plate 7038
- State Aid Rules
- Mn/MUTCD
- Public Rights of Way Accessibility Guidance (PROWAG)

All ADA and PROWAG specific dimensions are absolute.

DEFINITIONS

APS (Accessible Pedestrian Signal): Signal that communicates information about the WALK phase in audible and vibrotactile formats.

Blended Transition: Blended transitions are transitions to the street that have a grade less than 5%. Depressed corners and fans are considered blended transitions. In the past, the term blended transition typically referred to the design now known as depressed corners.

Bump-out: An extension of the curb line in a bulb-like rounding radius that incorporates curb ramps. Its purpose is to shorten the crossing distance for pedestrians as they travel through an intersection, and to provide space to implement a curb ramp with all the necessary components.

Combined Curb Ramp: Any combination of two curb ramps placed perpendicular to the centerline of the roadway that share a common landing. ***See Figure 3 and 4.***

Cross Slope: The slope measured perpendicular to the direction of travel. A steep cross slope increases the potential for wheeled users to tip and greatly increases the physical effort required by manual wheeled users to maintain a direct route.

Depressed Corner: Depressed corners gradually lower the level of the sidewalk, through an almost undetectable change in slope, to meet the grade of the street. Depressed corners are often designed as an expanded diagonal curb ramp that extends around the entire corner at the intersection. A depressed corner is a type of blended transition since it has a running slope of less than 5%. ***See Figure 8.***

Detectable Warnings: A surface feature built in or applied to the walking surface to indicate an upcoming change from pedestrian to vehicular way. Also known as truncated domes.

Diagonal Curb Ramp: A single, typically 4 ft. width, curb ramp that is located at the apex of the corner. The alignment of the ramp directs users into the center of the intersection, rather than the crosswalk, and should be used as the last option in curb ramp design. ***See Appendix page 45.***

Fan: A variation of a Depressed Corner that has the first 3 ft. to 4 ft. of the ramp sloped up to 8.3% through the detectable warning portion with a flat 4 ft. x 4 ft. landing at the top. ***See Figure 9.***

Median: A strip of concrete or grass down the center of a road that separates lanes of traffic traveling in opposite directions.

Mid-block Crossing: Pedestrian crossing that does not occur at a road intersection.

Paired Ramps: Two ramps with a minimum distance of 5.5 ft. between the inside legs of each ramp measured at the curb. ***See Figure 3 and 4.***

Parallel Ramp: A parallel curb ramp has two ramps leading toward a center level landing at the bottom. The ramp is oriented so that the path of travel on the ramp is parallel to the vehicular path of travel on the adjacent street as well as the user's path of travel on the sidewalk. ***See Figure 7.***

Pedestrian Access Route: Also known as PAR. The Pedestrian Access Route is a continuous and unobstructed walkway within a pedestrian circulation route that is specifically designed for ADA-accessible pedestrian travel.

Pedestrian Landing: A 4 ft. x 4 ft. minimum level area of walkway at the top or bottom of a ramp that allows wheeled users a space to orient their direction before and after using a ramp.

Perpendicular Ramp: A curb ramp that is aligned so that the ramp is generally perpendicular to the centerline of the roadway, and users will generally be traveling perpendicular to traffic when they enter the street at the bottom. ***See Figure 2.***

Pork Chop (a.k.a. Island): Raised concrete refuge usually found between right turns and through-fare travel lanes. Typically in the shape of a triangle or a "pork chop."

Return Curb: Curb line that follows an approximately perpendicular alignment to the flow line and takes the place of curb ramp flares.

Rollover: The algebraic difference between the grade of the ramp and the in slope of the gutter.

Running Slope: The grade measured along the direction of travel.

BASIC CURB RAMP COMPONENTS

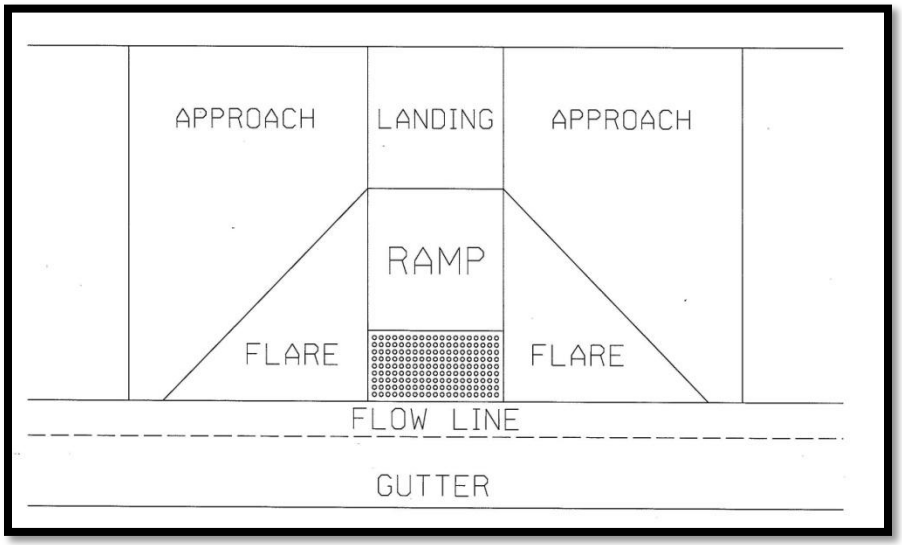


Figure 1: Curb Ramp Components

1.) ***Definition.*** PROWAG's definition of a curb cuts includes two distinct facility types based on slope. According to PROWAG, a ramp must have a running slope between 5% up to a maximum of 8.3%. A ramp slope with less than 5% running slope is defined as a "blended transition." There is a large practical benefit to this definition because blended transitions do not require a landing at the top. Keeping ramp and sidewalk running slopes below 5% not only simplifies the design but also makes the final product much more user friendly. Using slopes under 5% follows the Universal Design principles of making grade transitions gradual and should be implemented wherever practical. If a ramp grade needs to be greater than 8.3%, consideration should be given to a "switchback" style design or whether or not the scenario might be considered maximum extent feasible.

2.) ***Landings.*** A minimum 4 ft.x4 ft. landing with a maximum 2% cross slope in all directions must be provided at the top of a ramp and/or whenever a ramp changes direction so that wheelchair users maintain stability while turning.

3.) ***Ramp Slopes.*** Running slope (a.k.a. running grade) is the grade measured along the direction of travel (i.e. the difference in elevation from point A to point B with point B being the top of the ramp and point A being the gutter flow line). Curb ramp running slopes need to be less than 1 in. vertical for every 1 ft. of horizontal run or an equivalent 8.3% slope. Running slopes less than 5% are preferred. The length of the ramp is based on the vertical height traversed by the user with the gutter flow line as the starting point.

Cross slope is the grade measured perpendicular to the direction of travel. The cross slope of the PAR (see Pedestrian Access Route) must be a maximum of 2%. Cross slopes of concrete boulevards can be steeper if the boulevard is not considered part of the PAR.

4.) ***Tying into the existing sidewalk slope.*** The difference in elevation between existing sidewalk and the flow line should be horizontally separated by the corresponding horizontal offset. When constructing an 8.3% (1:12) ramp there is a 1 in. vertical difference for every 1 foot horizontal difference. Generally, it is recommended to round up to the next full sidewalk panel when determining removal limits to ensure the desired running slope can be achieved in construction.

Occasionally surrounding conditions will necessitate a design that requires the sidewalk to "chase the grade" up a hill. In "chasing the grade" situations the ramp will be longer in length than anticipated and must be checked at any proposed tie in locations. Conversely, if a ramp connects to a downhill slope, it will be considerably shorter than anticipated. Ramps that match into steep uphill/downhill grades should be as short as possible (8.3% maximum), so the approaching walk is not steeper than it needs to be.

Determining the appropriate curb ramp length is an iterative process, but essential to achieving the correct running slope. A curb ramp with a running slope between 5% and 8.3% cannot be longer than 15 ft. without a landing. The suggested curb ramp length for most situations is 4 ft. to 6 ft. A 4 ft. to 6 ft. ramp length provides the user with a shorter overall crossing distance while providing good sight distance for both oncoming traffic and pedestrians.

A secondary ramp rising from the first ramp's landing will quite often provide the required grade change to make the design compliant and usable. When chasing a grade to connect into the existing sidewalk it is reasonable to extend the run of the secondary ramp up to 15 ft. consistent to the maximum curb ramp length of 15 ft. Utilizing the maximum 15 ft. does not necessarily determine the maximum extent feasible and if a compliant running slope can be achieved by going further than 15 ft., this should be considered to avoid a "stepped" sidewalk design. Based on field experience, grades should be evaluated up to 50 ft. from the flow line and made compliant if the grade can be properly negotiated over 30 ft. of sidewalk reconstruction. If the grades cannot be made compliant within 30 ft. of the flow line, then a straight grade ramp up to 15 ft. in length would be the maximum extent feasible. Other components of maximum extent feasible will be discussed in subsequent sections.

5.) ***Flares.*** Concrete flares on the sides of the ramp are relevant when the surface adjacent to the sides of the ramp is a paved surface where pedestrians are likely to walk. The maximum slope for flares is 10% (or 1:10). When the sides of ramps are adjacent to a turf or landscaped surface (or other areas that won't be traversed such as a signal pole base), the 1:10 flares and the corresponding 1:10

transitions on the curb cut openings to match the existing curb height are not critical to meeting PROWAG requirements. Other factors should receive consideration such as ease of constructability, impact to surrounding terrain, and long term maintenance concerns.

6.) ***Curb cut width.*** When possible a 6 ft. wide curb cut / ramp width, exclusive of flares, is preferred over a 4 ft. width in new and major reconstruction. The wider width is often impractical on retrofit projects but is a key consideration on signalized intersections (see APS guidelines) and at locations that serve consistently large pedestrian volumes or deal with event clearance. The ramp width / detectable warning should match the existing trail or sidewalk widths whenever feasible to facilitate convenient travel.

7.) ***Perpendicular Grade Breaks.*** Grade Breaks are a critical element for all curb ramp designs and should allow users to smoothly transition from the sidewalk to the ramp and the ramp to the street. Grade breaks are required at the top and bottom of any ramp and must be perpendicular to the running slope of the ramp. Abrupt or improperly placed grade breaks create a tipping hazard for wheelchair users and a tripping hazard for blind and low vision users.

8.) ***Pedestrian Access Route (PAR).*** A continuous and unobstructed Pedestrian Access Route must be maintained for paths of travel including around corners. The PAR must be 4 ft. wide, with passing zones of 5 ft. x 5 ft every 200 feet, with a maximum 2% cross slope. Consideration must be given to all directions of travel when planning PARs around radii.

9.) ***Orientation.*** The orientation of curb ramps has historically been placed on the 45 degree "corner" of the radius (diagonal curb ramp). This orientation is not desirable because it directs pedestrians into the middle of the intersection rather than into the crosswalk. Diagonal curb ramps should be avoided whenever possible. The decision process to orient a ramp diagonally will receive increased scrutiny and must be documented in the project file.

Pedestrian ramps should be oriented in line with the preferred path of travel, which is usually a line between the approaching sidewalk and the ramp that is on the other side of the road. If ramps across from one another are not aligned, it will result in a skewed crosswalk. Straight crosswalks are preferred. Depending on the scope of a retrofit project, obstacles such as catch basins, signal poles, and/or steep gutter grades can complicate ramp orientation.

PEDESTRIAN RAMP TYPES

PROWAG identifies three broad categories of pedestrian curb ramps, perpendicular, parallel, and blended transition, creating the foundation of describing for basic curb ramp types and providing basic design parameters. Based on guidance found in PROWAG, the PROWAAC special report, and feedback for from Mn/DOT and local designers, these guidelines have identified variations of the base types with detail design and construction guidance:

1. Perpendicular curb ramps
    a. Combined Perpendiculars - ***See Figure 3 and 4.***
    b. One-way directional - ***See Figure 5 and 6.***
    c. Standard Ramp – ***See Figure 2***

2. Parallel curb ramps
    a. Parallel - ***See Figure 7.***
    b. Tiered ramps
3. Blended Transition
    a. Depressed Corner - ***See Figure 8.***
    b. Fan - ***See Figure 9.***
    c. Any other "ramp" with a slope of less than 5%

Selecting ramp types

"The design and placement of curb ramps into existing developed streetscape is governed by many of the same considerations as roadway design: controlling horizontal and vertical geometries, surface conditions, and access to intersections, all at the scale of the pedestrian rather than the vehicle. In an alteration, a balance needs to be struck between pedestrian and vehicle users vying for travel space within a limited right of way already constrained by existing development. A good understanding of the rationale behind accessibility standards will help the designer integrate usability for pedestrians who have disabilities into agency decision making" PROWAAC 2007.

To select a design(s) that will work effectively within a given intersection the following process is recommended:

1. **Take a bird's eye view of intersection**

- Identify where pedestrian facilities are located and where pedestrian generators and destinations are.
- Identify potential barriers and right of way restrictions. Curb ramps may necessitate the relocation of various existing features such as street signs, mailboxes, telephone booths, newspaper dispensers or other obstacles interfering with the desired accessibility. Relocating major utility conflicts such as fire hydrants, light poles, utility poles and drainage inlets should be assessed on a project by project basis.
- Consider pedestrian sight distance; driver sight distance of pedestrians; and vehicle stopping locations when choosing curb cut locations. If a curb cut is too far from an intersection (particularly in built-up urban environments), drivers making a right turn may not see pedestrians who are waiting to cross the street. In line with traffic engineering preferences, pedestrians should be crossing in front of a marked (or implied based on stop sign location) stop bar so as to not direct users towards stopped vehicles.
- Before determining a treatment for a specific quadrant it is important to see how the entire intersection functions because a design that works well at one intersection quadrant may not coordinate well with the opposite side of the intersection.
- Designing curb ramps for alteration projects will generally be more difficult than for new construction projects because existing conditions such as buildings, walls, sidewalk gradients, right-of-way width, etc. may limit the space available to provide the desired or required accessibility. Specific curb ramp locations should be adapted to existing site conditions.

2. **Determine pedestrian access routes and truncated dome orientations where they cross curb lines.**

- The approach of the pedestrian access route will determine the directionality of the ramps, the location of the grade breaks, and the location of detectable warning.

3. **Locate landings for all ramps**

- Landings are typically the most critical design control in alterations because the ability to provide a compliant landing is impacted by right of way availability and how the pedestrian access route will be maintained through the corner. By identifying the landing location

you will be able to determine what ramp options will work best at a given quadrant.

4. **Verify elevation difference between existing curb flow lines and existing sidewalks to ensure that an acceptable grade can be met.**

   When constructing an 8.3% (1:12) ramp there is a 1 in. vertical difference for every 1 foot horizontal difference. Generally it is recommended to round up to the next full sidewalk panel when determining removal limits to ensure the desired running slope can be achieved in construction.

5. **Determine which ramp type works the best.**

   a. Once the ability to provide a landing and the PAR location are established, a curb cut type can be selected. Generally the hierarchy for curb ramps at un-signalized intersections is:

      i. Paired Ramp

         1. Two ramps with flares or returned curb, 2%-8.33% running slope located **at** the tangent section.

      ii. Combined perpendiculars - ***See Figure 3 and 4***

         1. Two ramps with flares or returned curb, 2%-8.33% running slope located **off** the tangent section

      iii. Parallel Ramp - ***See Figure 7***

         1. Ramp is parallel to the direction of travel. Typically used where there is 6 ft. or less sidewalk width.

      iv. Tiered Ramp

         1. Parallel ramp combined with other ramp types are **tiered ramps.** Typically implemented on free rights and sidewalk widths between 6 ft.-10 ft.

      v. Depressed Corners - ***See Figure 8***

         1. The entire radius of the corner is dropped from tangent point to tangent point and the running slopes are less the 2%

      vi. Fan - ***See Figure 9***

         1. The entire radius of the corner is dropped from tangent point to tangent point and has a slope between 2% -8.3% to make up grades faster and eliminate drainage concerns.

      vii. Diagonal Ramp - ***See Appendix***

         1. A 4 ft. wide ramp minimum with flares or returned curb, 2%-8.3% running slope located at the center of the radius

6. **Intersection Consistency**

   - Whenever possible it is desirable to have each quadrant in the intersection utilize the same design, but in no case should the lowest common design dictate the consistency (i.e. if one corner must be a depressed corner but the others can be built as paired perpendiculars than only the one quadrant should be built with the lesser design.)

PERPENDICULAR CURB RAMPS

COMBINED PERPENDICULARS

Purpose

Any combination of two curb ramps placed perpendicular to the centerline of the roadway and share a common landing. The ramps do not need to have a 90 degree orientation to be defined as perpendicular. There is no requirement for a minimum separation between the ramps, but as a general rule if a separation of at least 5.5 ft. at the curb line cannot be accommodated, a different design solution should be considered. The curb height between the two ramps should rise to a minimum of 3 in. before dropping back down towards the ramps.

Application

Combined perpendicular ramps are best used on retrofit projects in urban areas where the corridor is fully developed, ROW is limited, and sidewalks are laid out on a grid system. In limited spaces, there is often only enough room for one shared landing. Unlike diagonal ramps, combined perpendicular ramps can accommodate grade changes while offering accessibility for users.

Design elements

The dimensions provided below are the minimums (or maximums) to achieve accessibility under PROWAG. Designers are encouraged to read the subsequent sections that provide extensive discussion on the proper application of the dimensions to achieve the best design that is both accessible and constructible.

- Shared Landing
  - Width of the pedestrian access route or 4 ft. x 4 ft. minimum
  - <2% cross slope in all directions
- Ramp
  - 2% - 8.3% running slope (2% - 5% no landing required 5% - 8.33% landing required)
  - <2% cross slope
  - 4 ft. width minimum
- Detectable Warning Surfaces
  - 2 ft. depth
  - 4 ft. wide or the width of the ramp, whichever is greater. (A gap of up to 3 in. is allowed on either side of a detectable warning for constructability.)
  - Detectable warnings shall be aligned to be perpendicular to the path of travel, but no portion of the domes may be greater than 5 ft. from the back of curb. If the approaching sidewalk is located at the back of curb (rather than having a boulevard for separation), the domes may need to be at the back of curb instead of directional to reduce the possibility for a user to bypass (i.e. walk in front of) the domes without noticing them.
- Ramp alignment
  - Combined perpendicular ramps are usually aligned with the curb ramp directly across the crosswalk, both of which have outside edges in line with the corridor ROW. A direct alignment is preferred for both wheeled and visually impaired users because they are not required to change direction while moving through the crosswalk.

Ramp Design

Landing Location and Elevation

Landing location and the landing elevation are the key control points in both the design and construction of combined perpendicular ramps. The design and construction must accommodate the intersection of two pedestrian ramps while maintaining the minimum 4 ft. x 4 ft. landing area with a cross slope of <2%. This common shared ramp area is critical to maintaining the Pedestrian Access Route. ***See Figure 2.***

After establishing the location of the landing area, the landing's elevation must be determined. The landing elevation is determined by the gutter flow line elevation of the controlling inside ramp leg. The controlling leg determination is controlled by two elements:

- Ramp leg length between back of curb and the landing
- Flow line elevation of the curb and gutter immediately in front of each of those ramp legs. As a rule, the leg with shortest distance will control, especially when the gutter flow line elevation is also lower on that shorter leg.

The calculation to establish the maximum landing elevation is based on the lowest controlling running slope**.** Once the running grade is established for the most complex leg, the other legs of the ramp will be compliant.

Ramp Running Slope

- The running slopes applied to combined perpendicular ramps is determined by the slope of the existing sidewalks and surrounding terrain. The first slope from the curb cut to the shared landing is the primary controlling grade. In flatter situations these should be less than a 5% running slope and in areas with significant elevation change an 8.3% ramp is likely the best option.
- A ramp maintaining a running slope at or below 5% is always preferable to using 8.3% slopes. Some major deciding factors in determining the running slope are: matching into existing sidewalks in front of commercial doorways, matching into private sidewalks, or any other off ROW impacts. It would never be appropriate to re-grade a ramp or sidewalk so as to create a new step to an adjacent property's doorway, but in cases where steps already exist one more could be added to make the sidewalk compliant. If there is a step onto Mn/DOT ROW the curb ramp should transition into a landing area through the step portion of the walk to avoid creating a slipping hazard when the sidewalk is icy.

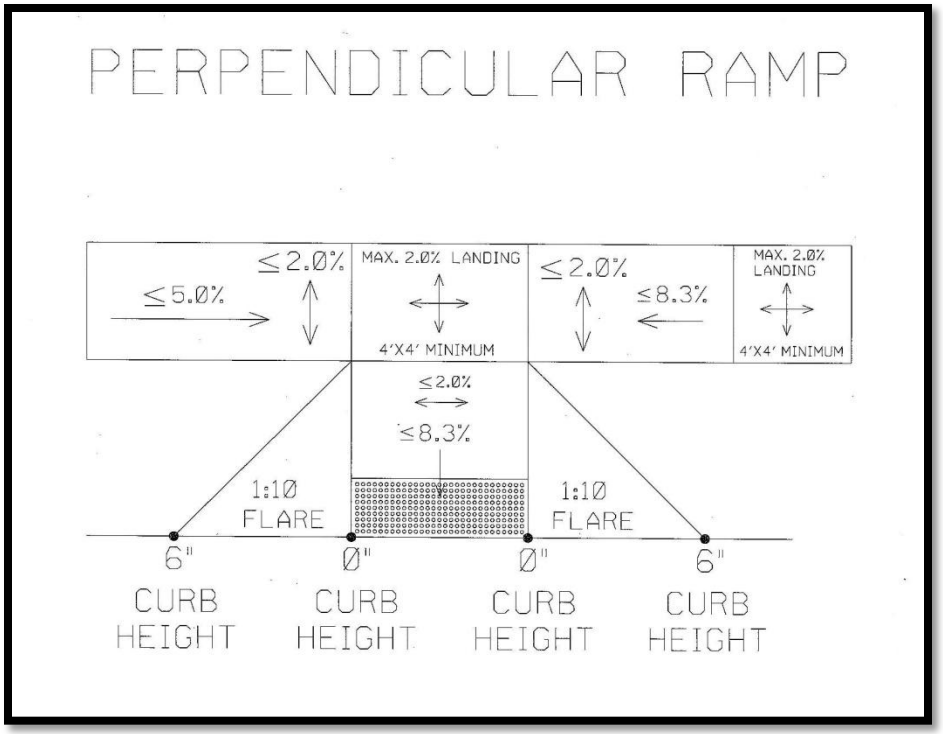


Figure 2: Perpendicular Ramp

- In alterations, the ideal running slope will sometimes elevate the landing 3 in. or 4 in. above the overall grade and secondary ramps will need to be constructed to connect to the shared landing and ascend the remaining vertical distance required to match into existing sidewalks without chasing the grade.
- When a secondary ramp is needed to connect the shared landing into the existing sidewalk(s) the ramp grade should be less than 5% to eliminate the need to have another landing at the top of the secondary ramps before the existing sidewalk match is made. If the slope of the secondary ramp is between 5% and 8.3%, a landing at the top of the ramp is required.

Grade Breaks

Aligning ramps with the crosswalk and the ROW line provides adequate directionality but since they can rarely be located on a tangent section the grade break concept applies. The grade break should be perpendicular to the ramp slope and the crosswalk alignment with a 2% triangular area at the bottom of the ramp. There needs to be some flexibility in the grade break criteria since steep existing gutter flow line grades will control the adjacent ramp cross slopes near the bottom of the ramp.

Design Variations

Adjacent to Walkable Surface

When combined perpendicular ramps are constructed adjacent to paved walks, concrete side flares with 1:10 slope are required. If the 2% ramp cross slope is maintained throughout the ramp all the way to the bottom of the interior leg the grade break necessary to achieve accessibility will be accomplished. Detectable warnings shall not be set back more than 2 ft. from the curb line. ***See Figure 3.***

Adjacent to Non-Walkable Surface

When combined perpendicular ramps are constructed adjacent to a non-walkable surface such as turf, a concrete side flare is not needed on the side adjacent to the non-walkable surface. A V-curb would be an appropriate solution. A concrete side flare with 1:10 slope is required on the other side however. If the 2% ramp cross slope is maintained throughout the ramp all the way to the bottom of the interior leg the grade break necessary to achieve accessibility will be accomplished. Detectable warnings shall not be set back more than 5 ft. from the curb line. ***See Figure 4.***

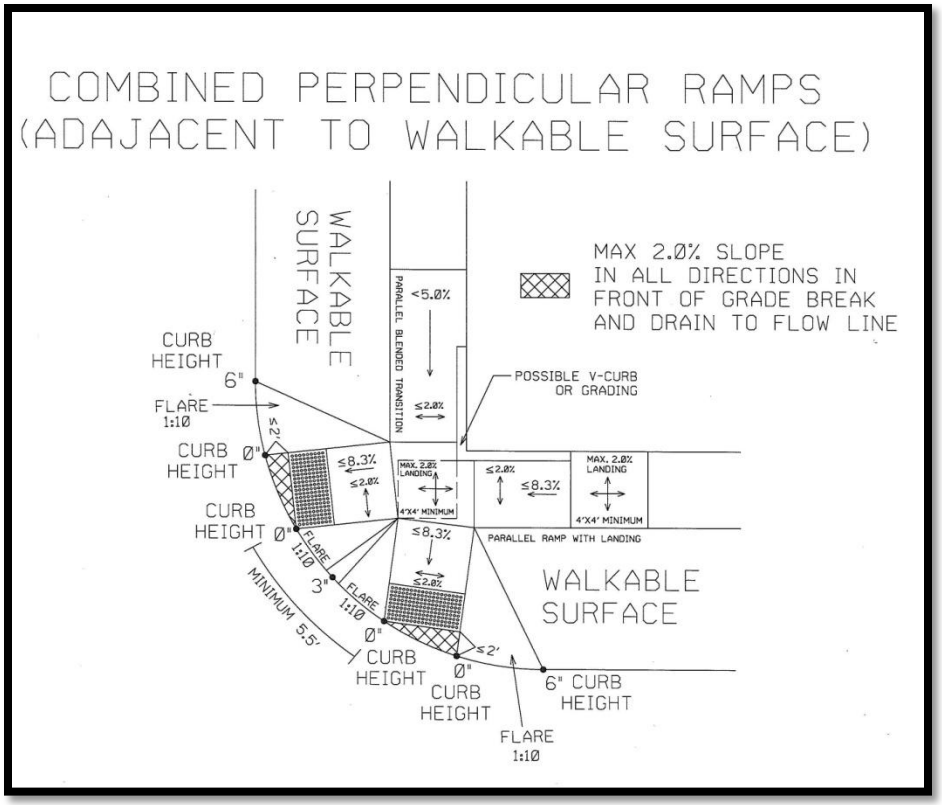


Figure 3: Combined Perpendicular Ramps Adjacent to Walkable Surface

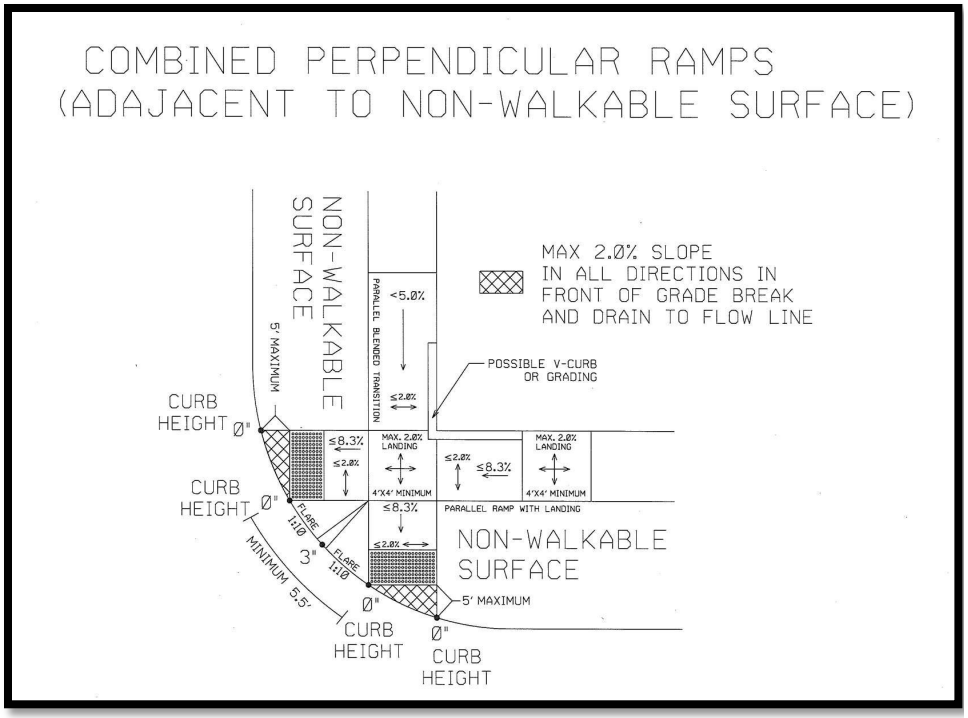


Figure 4: Combined Perpendicular Ramps Adjacent to Non-Walkable Surface

Flared "Bump" in the Middle

It is preferable to have two distinct curb cut openings / individual curb ramps for each quadrant but on smaller radii the 1:10 curb transitions are so short it becomes questionable if there really is a detectable curb edge. Developing a minimum 3 in. curb height for a minimum 6 in. width is the minimum recommended dimensions to provide visually impaired users an indication they are leaving the sidewalk and entering the street. Regardless of those minimal dimensions the "bump" still starts to transition from 0 in. at each curb cut so for the first 2 ft. of each transition there is negligible curb height to detect.

In constrained ROW, 1:10 curb ramp flares could be increased to create a more pronounced vertical "bump" between the ramps or to install a vertical curb. Both designs present a tripping hazard as well as maintenance concerns. A bollard system is a potential option to protect the corner apex area from being accidently traversed, but would not work in most high speed applications. However, these solutions seem to potentially have more adverse impacts than the problem they attempt to solve.

When there is insufficient room to develop a meaningful curb height (less than 5.5 ft. between curb cuts) detectable warnings provide the best measure of delineating the edge of sidewalk and should be utilized. PROWAG recognizes this open design as a "fan" ramp and dome orientation where a maximum 8.3% ramp grade is wrapped around a shared landing with radial domes ringing the radius. The design mimics the radial dome orientation of a depressed corner (see Figure 7), but is an option of last resort.

"Fan" type ramps are useful when vertical grades cannot be met by any other ramp type because, like a diagonal ramp, they rise vertically from the flow line to a common landing without any controlling short legs and any wasted grade break areas.

ONE WAY DIRECTIONAL

Application

A directional ramp is used when there is only one pedestrian access route approaching the intersection and only one direction to cross the intersection. Directional ramps provide superior directionality for all users with no adverse impacts. Typical design situations are:

- One sidewalk or trail approaching the intersection
- Inner legs of intersections at diamond interchanges
- Bridges

- Traversing cross streets with limited main line highway crossings
- "T" intersections.

Directional Ramps should not be used in a "grid system" of walkways where sidewalks approach the intersection from both the mainline and the cross street.

One way directional ramps can be used when the pedestrian access route is adjacent to the curb and gutter or when there is a boulevard.

Design and Construction Considerations

It is important that the top of the curb slope match the proposed slope of the ramp. The controlling slope begins at the grade break at the bottom of the detectable warnings and continues to the match point of the existing curb.

Directional ramps are rarely placed at the tangent of a radius so the grade break must be constructed perpendicular to the ramp slope at the bottom of the ramp to allow wheelchair users to maintain contact with the ramp surface with all four wheels. When perpendicular grade breaks are not provided, a wheelchair user will have one front wheel strike the extended portion of the ramp first, causing the opposite front tire to lift off the ground resulting in user instability and discomfort.

The detectable warnings of directional ramps shall be aligned perpendicular to the running slope of the ramp and line up with the crosswalk direction. The leading (a.k.a. closest) edge of the domes (not just one corner) must be within 5 ft. of the back of curb. Aligning the detectable warnings perpendicular to the path of travel of wheeled users minimizes discomfort. A perpendicular detectable warning alignment also must coincide with the orientation of the crosswalk orientation. When detectable warnings are aligned perpendicular to the path of travel in a directional ramp design there is the additional benefit of providing a directional cue for blind and low vision users, but this benefit should not be a considered a controlling design factor.

Directional Ramp with Sidewalk Adjacent to Curb and Gutter

As stated earlier, the top of curb paralleling the ramp controls the sidewalk / ramp surface. ***See Figure 5.***

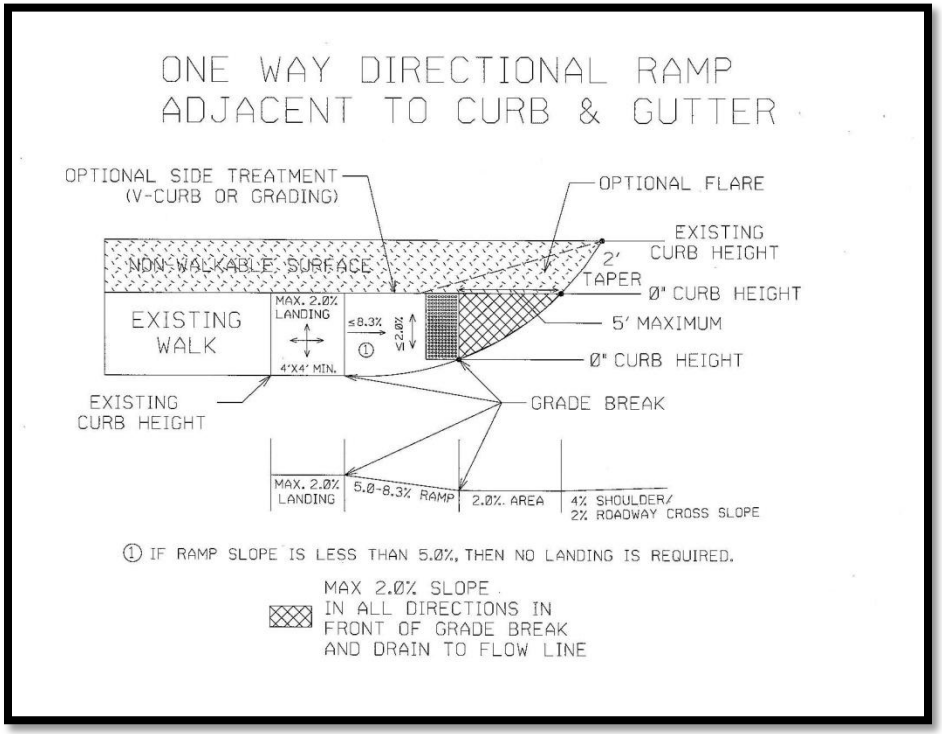


Figure 5: One Way Directional Ramp Adjacent to Curb and Gutter

Directional Ramp with Adjacent Non-Walkable Surface

There is more flexibility with the top of curb elevation but it is still good practice to construct the curb height lower or equal to the adjacent slope of the sidewalk when possible so the boulevard drains to the curb. ***See Figure 6.***

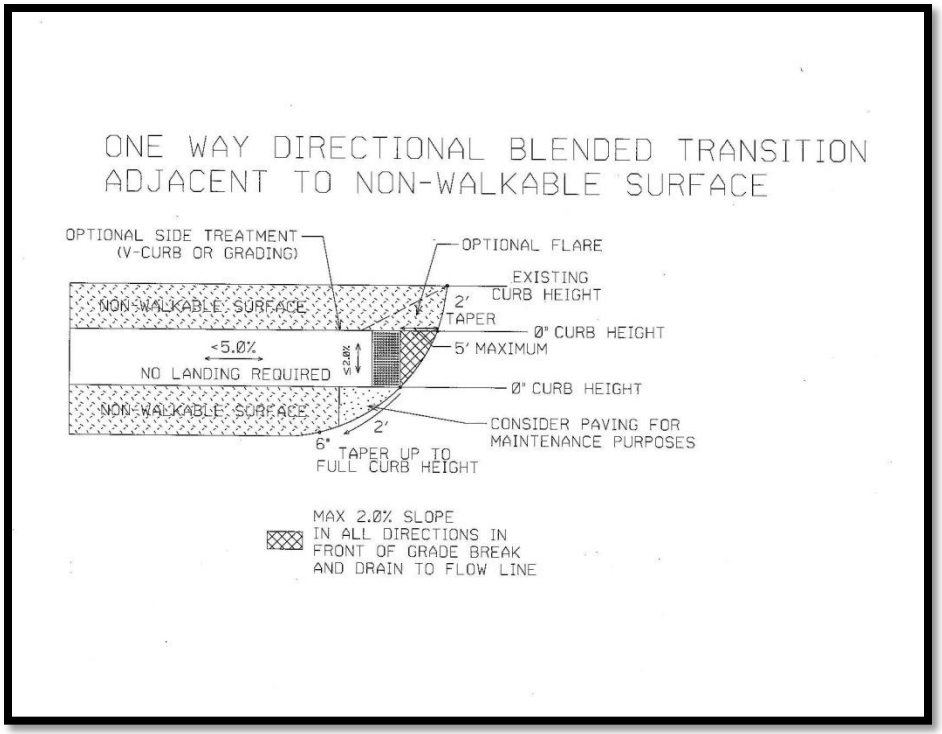


Figure 6: One Way Directional Ramp Adjacent to Non-Walkable Surface

PARALLEL RAMPS

PARALLEL RAMP

Parallel Ramps are recognized in PROWAG and are a good design to consider at T-intersections and in tight ROW situations where a narrow sidewalk (4 ft. minimum width) is adjacent to the back of the curb.

The key construction element to a parallel ramp is constructing the curb transition to be the same slope as the proposed ramp surface. Another way of saying this is the ramp surface/sidewalk grade will be constructed to match the top of the previously constructed curb and gutter sections. The top of curb grade needs to be exactly the same grade as the parallel ramp grade. (As before, the running slope cannot exceed 8.3%). ***See Figure 7.***

As in any ramp design, a 6 ft. wide opening is preferred for crossing the street and the extra width generally presents fewer obstacles than encountered with other ramp types. In very tight situations the detectable warnings can be considered a part of the landing area but if possible the landing area should be provided behind the detectable warnings.

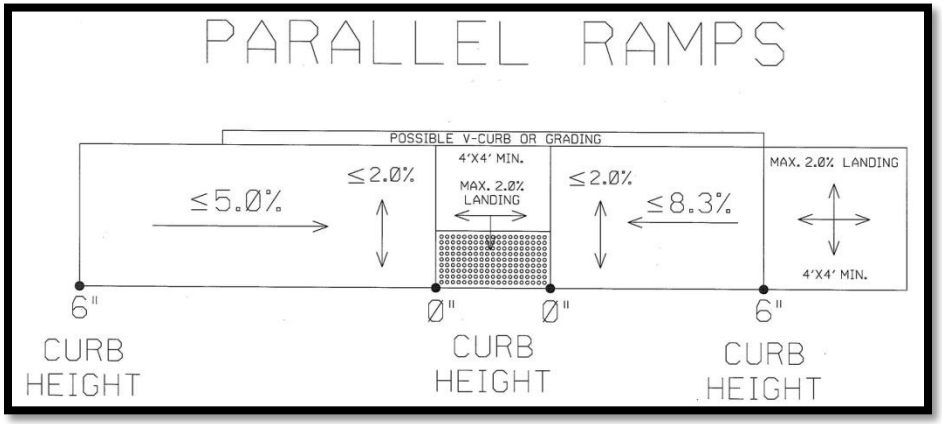


Figure 7: Parallel Ramps

Tiered Ramps

Parallel ramps are often a useful component when combining ramp types. All secondary ramps can be classified as a parallel ramp whether it rises out of a Depressed Corner, rises out of a Combined Perpendicular, transitions curb and gutter from B6 to B4, or transitions out of a standard ramp when there is insufficient sidewalk width (usually less than 10 ft). It is unnecessary to produce standard layouts for all these situations but be aware combining parallel ramps into a "tiered" manner provides great flexibility and can result in creative solutions to challenging areas.

BLENDED TRANSITIONS

DEPRESSED CORNER

Depressed Corners are useful when the ROW at the radius area is very limited and a single landing area at the bottom is the most feasible option.

Depressed Corners basically act like one large landing with the entire area meeting both the landing and PAR criteria. They can also be called "Flat Landings" at signalized intersections on rural sections of roadway.

Depressed Corners should be used sparingly without APS since they provide limited directionality for visually impaired users. The benefit of depressed corners over a diagonal ramp is it allows all users to continue their straight path of travel when crossing the street and may be easier for winter maintenance. Depressed Corners may also be used at quadrants where there is not enough space to construct two individual ramps. The determination to use a Depressed Corner versus two ramps is made by measuring the distance along the gutter flow line between the interior ramp legs/inside edges of the crosswalk. The separation between the two ramps should be a minimum 5.5 ft. at the curb in order to develop a compliant 1:10 flare with a minimum 3 in. curb height between any pair of proposed ramps. ***See Figure 8.*** Depressed Corners should also be considered when a dedicated landing cannot be provided or there is a barrier such as a building immediately at the back of the sidewalk.

Depressed corners provide a very good barrier free ramp for wheeled users and are maintenance friendly. Safety considerations need to be evaluated so users are not pinched in an isolated street level area in close vicinity to traffic. A smaller opening should be utilized to discourage vehicle tracking into the landing.

In retrofits, this design requires more concrete removal and replacement to chase grades and needs to be evaluated for potential drainage concerns. The size of the Depressed Corner should be minimized for various reasons. Generally the larger the depressed area the more cautious one should be of existing drainage patterns and unwanted ponding.

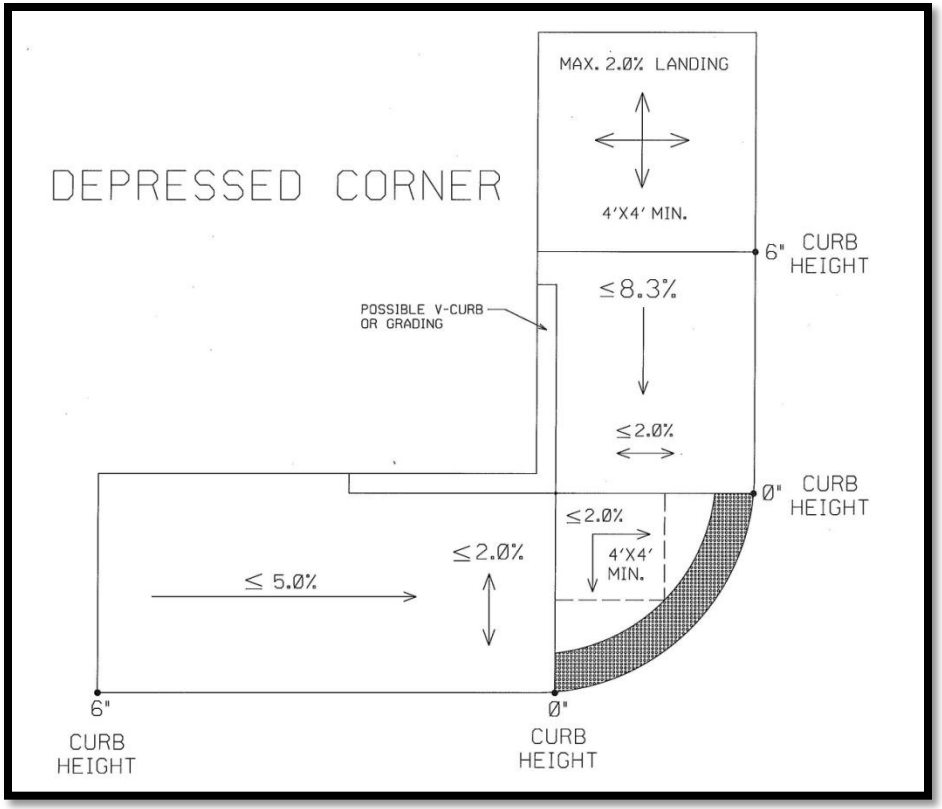


Figure 8: Depressed Corner Detail

Depressed Corner Specifics

The controlling construction element is to come off the gutter flow line at a minimum 1.5% to a maximum 2% slope to the interior corner of the depressed landing.

The corner area should be kept to a minimum since larger areas have an increased chance of the curb flow line either warping the cross slope beyond the 2% maximum grade or creating unforeseen ponding in the landing area due to that warping. A 1.5% minimum slope is recommended to discourage ponding. If the flow line exceeds 2% it should be flattened and constructed so that the cross slope of the crosswalk does not exceed

the 2% maximum allowable within the PAR. However, any flow line adjustment must maintain positive water flow away from the crosswalk(s).

Larger depressed corners will likely require significant removals since maintaining a maximum 2% slope over a larger area does not achieve much grade rise. As a result, all elevation change occurs beyond the corner in the connecting parallel ramps.

Depressed corners are challenging in areas that have a lot of elevation change. It is difficult to maintain the 2% maximum cross slope for the entire landing area when the roadway grade or existing terrain quickly rises. A parallel ramp is needed to chase the grade up adjacent sidewalks. This grade chasing is compounded by the fact that the landing is basically at street grade and the secondary parallel ramps need to also transition into the existing roadway curb heights.

This chasing grade and curb transitioning can lead to some very minimal curb heights that transition to full height over long distances. An example of this would be an 8.3% ramp chasing a 5% sidewalk grade. The curb transition from 0 in. curb to 6 in. curb would be 16.7 ft. The math works algebraically but can be difficult to build and even more importantly will not provide a very good detectable edge of sidewalk for much of the transition.

One solution can be to hold the sidewalk cross slope at 2% throughout. The parallel curb height will be higher than the sidewalk ramp slope for the first few feet. Drainage will not be trapped since the ramp itself has positive drainage. Stored snow could have minor ponding impacts. The better solution to this problem may be the "Fan" design discussed below.

Consideration also needs to be given to historical drainage concerns in any particular area. Even if a depressed corner is constructed perfectly an undersized drainage system that historically has frequently surcharged or presented problems during spring freeze thaws may present problems. The "Fan" design discussed later may be a good option.

Since the depressed corner is constructed at or near gutter grade deposited sediment and debris can collect in the landing area. A "Fan" may be a solution to this as well.

Radial domes should be used for best dome coverage. There is a 4-6 week lead time for ordering radial detectable warnings. Therefore the designer needs to provide accurate radius dimensions and lengths of detectable warnings needed at each quadrant in the plans.

With the depressed corner design there is a potential for vehicle tracking over the depressed corner area because of the zero inch curb height that runs around the radius. In situation where the project will not allow for modification of the turning radius to minimize tracking a concrete thickness should be 6 in. in depth should be used to mimic driveway thickness.

FANS

Fan type quadrants are a variation of a Depressed Corner with the main difference being that the first 3 ft. to 4 ft. of the ramp is sloped up to 8.3% through the detectable warning portion with a flat 4 ft. x 4 ft. landing at the top. These fan type designs are much more efficient at chasing grades and alleviating drainage concerns since the landing is 2 in. to 4 in. above the flow line. Fans more closely mimic the grade rise of a diagonal ramp but open up completely to both directions of travel like a Depressed Corner.

Similar to Depressed Corners, Fans should only be used when the distance between inside edges of the crosswalk/interior ramp legs is less than 5.5 ft. apart measured on the flow line. If the distance is greater than 5.5 ft., use two separate ramps. ***See Figure 9.***

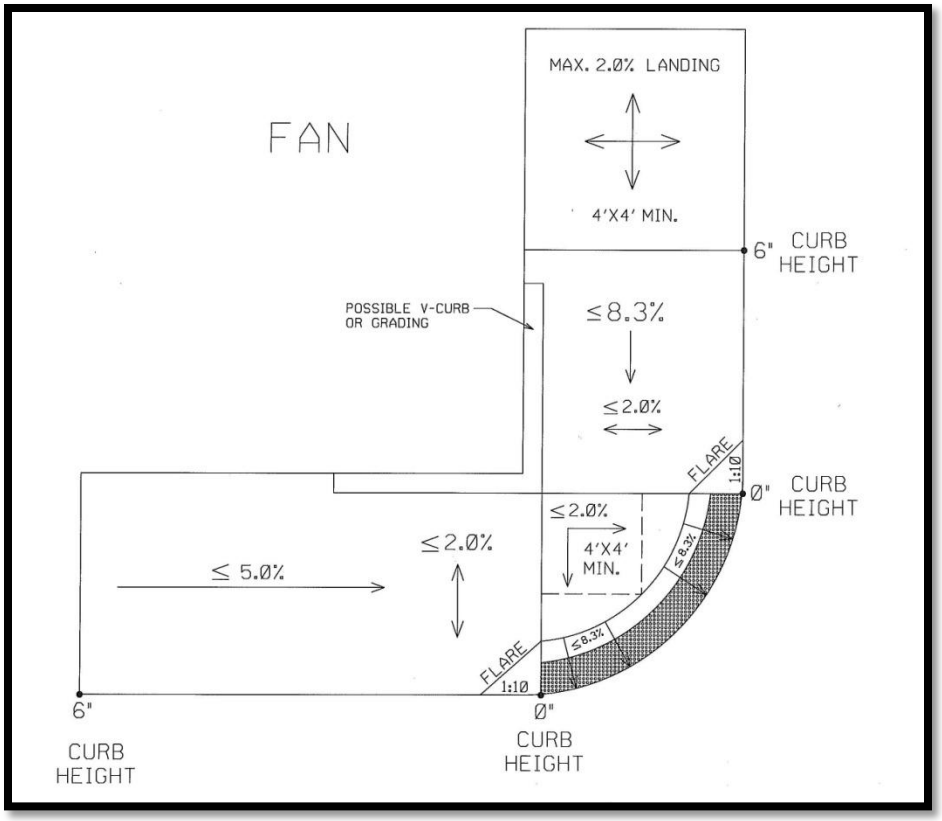


Figure 9: Fan Detail

The key construction element of a fan is to come off the lowest flow line elevation and implement the maximum desired grade from that point. The fan should be constructed with a uniform ramp length around the entire radius with the acceptable variable ramp slopes being blended into the flat triangular landing area at the top (maximum 2% cross slope in all directions).

Unlike a Depressed Corner, Fans allow for a short 1:10 flare on either side of the ramp up to the proposed landing height with parallel ramps transitioning beyond. These flares allow for a standard detectable curb transition height.

The current drawback to Fans can be a contractor's ability to properly construct the required grades. Two pours may be necessary or other appropriate internal contractor grade control measures. As contractors become familiar with Fans, their usefulness will increase.

DETECTABLE WARNINGS SURFACES (Truncated Domes)

Purpose

The purpose of a detectable warning surface is to provide a tactile equivalent of a visible curb line that can be easily detected underfoot. Well placed domes provide an appropriate warning to users that are blind or low vision through a perpendicular dome alignment that minimizes the impact to wheeled users.

The placement and directionality of detectable warnings must balance the needs of blind and low vision users against the need of wheeled users. From the perspective of the wheeled user, the domes should be placed perpendicular to the path of travel to ensure their wheels can smoothly track through the spaces between the domes and to provide the required perpendicular grade break that maintains wheelchair stability. Directional dome placement can also provide directional cues to blind and low vision users by aligning them with the crosswalk.

Application

Detectable warnings are required at all curb cuts. Warning surfaces need to be placed in a continuous 24 in. depth anywhere the curb height is 0 in. It is recommended that all conflicting surface utilities be relocated outside of the dome area.

General requirements for truncated dome placement

Alignment. The rows of truncated domes in a detectable warning surface shall be aligned perpendicular or radial to the grade break between the ramp, landing, or blended transition and the street.

Location on Parallel Ramps, Depressed Corners, and Fans. The detectable warning surface shall be located on the bottom landing or blended transition within 3 in. of the back of curb.

Perpendicular Curb Ramps. Where both ends of the bottom grade break are 5 ft. or less from the back of curb, the detectable warning surface shall be located on the ramp surface at the bottom grade break.

When curb ramp designs include a flare or curb returns, the side edges of the domes should abut the flares or return. To minimize any potential non-detectable curb openings, the edge of the domes should never be more than 3 in. from the edge of the flares or return. When no concrete flares or curb returns are present the edge of the detectable warning surface should be 3 in. from the edge of the concrete landing/pad to provide a long term serviceable dome installation. These dimensions will require care and planning on the part of the contractor to ensure that curb ramp and formed concrete walks meet required construction tolerances.

Aligning domes

When ramps are located on a curved radius, the placement of the detectable warning is driven by two design factors: ramp type and location of the grade break. On curb cuts with a diagonal or radial orientation detectable warnings must always be placed immediately behind the curb line. Landings, directional or perpendicular ramps built along the tangent section of the curb shall place the detectable warning immediately behind the curb line.

When a directional or perpendicular ramp is located along the curve radius and not on the tangent section of the curb, design flexibility is required to determine the optimal placement of the detectable warning. Without customized detectable warnings, the dome alignment will not be perpendicular to the path of travel or the grade break, thus requiring additional effort by wheeled users navigating the ramp. In addition, the directionality cue of the ramps, for blind and low vision users, is further compromised when the domes are no longer perpendicular to the path of travel.

To accommodate the placement of detectable warnings perpendicular to the path of travel, PROWAG allows for the exterior corner of the domes to be placed up to 5 ft. from of the back of the curb. ***See Figure 10.***

The 5 ft. setback works well when the ramp is adjacent to turf or other protected surfaces but can pose potential safety risks for blind users when the adjacent surface is paved and walkable. Extra care and judgment should be used by the designer in situations where a blind user could potentially pass in front of the detectable warning therefore not detecting the edge of roadway.

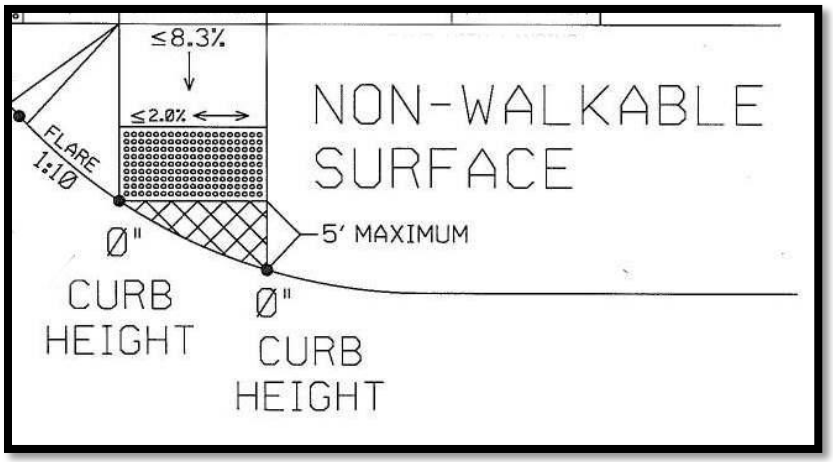


Figure 10: Dome Setback Adjacent to Non-Walkable Surface

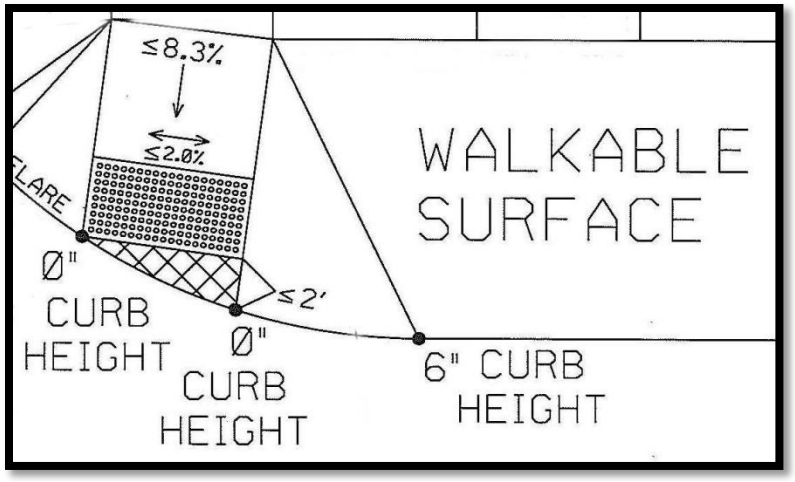


Figure 11: Dome Setback Adjacent to Walkable Surface

When detectable warning are placed perpendicular to the path of travel the leading edge of the domes is the grade break transitioning to the street.

Taking the above considerations into account, it is preferable to orient the domes in a directional manner perpendicular to the ramp running slope. In general directionality provides the best overall product for all users when used appropriately though care must be taken to provide safety for blind users when domes are adjacent to walkable surfaces.

To minimize the likelihood that a sidewalk would allow blind and low vision pedestrians to pass in front of the detectable warning, Mn/DOT recommends that the maximum distance for the leading edge of the dome to be set back is 2 ft. in situations where the facility is not a directional ramp. ***See Figure 11.***

Installation

General

Mn/DOT requires the use of cast iron detectable warnings from the preapproved products list in all projects. Cutting pre-fabricated detectable warnings to achieve a proper fit is not allowed without approval from the Construction Engineer. Cast iron domes have a strengthened rib/frame on the underside near the edges of all domes. When the dome panels are cut and the rib is removed panel adhesion to the concrete walk is reduced and the unsupported dome surface panel is more likely to warp creating difficulty for winter maintenance operations.

When setting domes in a concrete walk, excess concrete surfaces through the air vents to eliminate any air pockets that could fill with water and cause dome separation. There must be enough downward pressure placed on the domes and sufficient concrete fluidity for this to take place. If too much pressure is placed on the dome panels or the concrete is starting to set up a slight concrete swell or bubble often is created around the edges of the dome panels. This swell often can be more than the allowable ¼ in. vertical deflection and must be screeded/struck off before final finishing/brooming.

The following detectable warning setback guidance is for constructability and long term serviceability once the directional dome placement decision has been made. Quite often detectable warnings are placed on the corner radius. It is good construction practice to keep a minimum 3 in.-4 in. setback from the back of the curb to allow for a clean flush concrete finish and joints (less than ¼ in. vertical deflections). This provides a slightly larger and durable section of concrete versus small slivers of concrete. When the detectable warnings are placed on a tangent section of curb, the warning surface should have no offset and touch the back of curb so that there are no deflections, concrete bubbles or slim slivers/sections of concrete.

Radial

Radial detectable warnings must be ordered 4 to 6 weeks in advance; contractors must be informed well in advance which intersection quadrants will require radial detectable warnings. They also need to know the current design radius of each quadrant as well as the length of domes needed to delineate between outer edges of crosswalks.

Manufacturers can produce radial detectable warnings in most 5 ft. radius increments. If they cannot produce the exact radius necessary for a particular quadrant, they typically mix and match various sizes in a "best fit" shop drawing process between the supplier and the contractor. It is best to keep the shop drawing process in the contractor's hands. The supplier should be expected to keep the front edge of all domes within 3 in.-6 in. of the back of the curb, primarily for aesthetic reasons. The contractor should be given some leeway if necessary to slightly modify the curb radius (2 ft.-3 ft.) to ensure the radial detectable warning fit is more uniform.

Throughout a project, the contractor must use the same manufacturer for all warning surfaces and a uniform panel connection system (either bolted or hinged). Do not cut panels unless approved by the Construction Engineer. Contractors should tie as many dome panels as feasible for a more durable warning surface, but they sometimes cannot attach all panels together because of the resulting weight (this happens most often on blended transition ramps with radial domes). Generally this is approximately an 8 ft. length of panel.

CURB AND GUTTER

A curb and gutter cross section detail is not referenced on the curb ramp standard plate but is critical to providing a gradual transition between the pedestrian ramp and the street and should be used in almost every application.

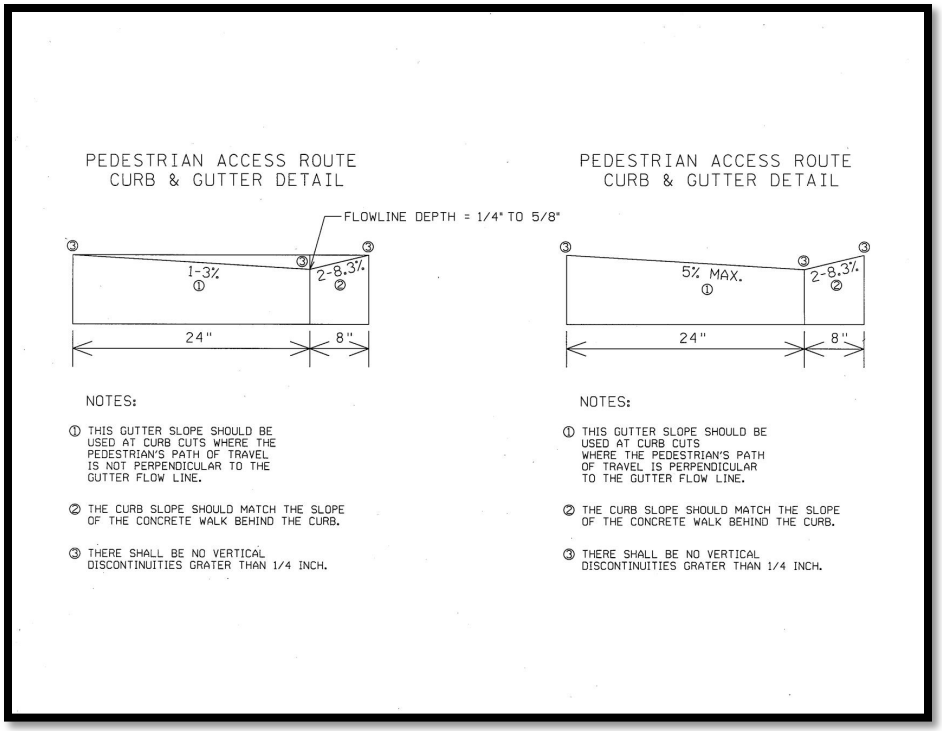


Figure 12: Curb and Gutter – Standard and Pedestrian Access Route

This detail provides a smooth ride for wheeled users and complies with the maximum ¼ in. vertical and ½ in. tapered discontinuity thresholds. In the past, contractors have added a slight 1/2 in. curb height to maintain drainage in the gutter flow line which presents a conflict with usability. All curb ramps constructed with this older style curb and gutter are non-compliant.

The PROWAAC report *Accessible Public Rights – of – Way Planning and Designing for alterations* state the maximum roll over criteria between a pedestrian ramp and the street is 11%. If a maximum 8.3% pedestrian ramp is constructed with the typical curb and gutter section containing 6% gutter inflow it would violate this roll over criteria: (8+6=14;; 14>11).

The appropriate C&G cross section to be used in Figure 11 is determined by the proposed ramp type. If a ramp tangent to the gutter flow line is proposed then the max 5% counter slope is allowable. In this case the wheeled user will maintain stability by having all 4 wheels in contact with the walk surface at all times. This is because there is a defined travel path that is directly perpendicular to the gutter flow line. In all other ramp types the PAR is not directly perpendicular to the gutter flow line so the detail with a 1%-3% gutter counter slope should be used. This greatly reduces adverse cross slopes created by traversing the gutter flow line at a skew. In any case a flatter curb and gutter section is always more usable to wheeled users.

Contractors need to maintain acceptable flow lines along with existing gutter inflows or outflows. There will be minimal grade adjustments necessary where the flatter gutter face matches in to the existing street surface. These minor grade adjustments can be made up in the bituminous patching needed to replace the old curb and gutter section. Even with these minor gutter face elevation adjustments needed with the new curb and gutter section, the irregular condition of the in place bituminous roadway surface usually governs the drainage conditions.

There could be an instance such as tying into a concrete paved roadway surface where there will not be any bituminous patching to blend into, so the gutter flow line may need to be adjusted slightly in order to maintain positive drainage.

The only instance when the new pedestrian access route detail should not be utilized is on a downhill gradient ramp that has a considerable concentrated flow passing by the curb cut. The flow could be routed down the sidewalk and not contained by the curb. In this situation a case could be made to keep a minimal curb height but even in these cases drainage should be maintained through a brief positive ramp grade transitioning into the negative gradient ramp.

If feasible, catch basins should be considered upstream of all pedestrian ramps to avoid draining into the into the pedestrian access route.

FLARES, V-CURBS, BEAVER TAILS, AND SLOPED TURF

There are multiple options for finishing the side of ramps on non-walkable surfaces. A V-Curb in straight alignment with the edge of a crosswalk can provide a directional cue to visually impaired users and should be considered in high-volume pedestrian areas and in locations where the crosswalk needs to be skewed to line up with opposite pedestrian ramp. Other than the directional cue of a V-curb, the primary drivers of these side treatments selections are not accessibility driven. The driving factors are ease of constructability, how the surrounding terrain is affected, ROW considerations, and long term maintenance issues.

Using a V-Curb is a good choice when adjacent to grass, other landscaping, or a building front (but not a building doorway) if ROW is limited or if no temporary easement is allowed to re-grade the adjacent ground to match into the new lower ramp elevation. If a V-curb is used, consideration needs to be made for snow plow operations. If the V- curb ties into the existing curb on the downstream side of the snow plow there is likely no concern. If the V-curb ties into the upstream side of plowing operations a modified beaver tail similar to a median snow plow nose should be considered. ***See Figure 13.***

If there are obstacles that cannot be moved such as trees, underground vaults, or other utilities and minor re-grading is not feasible, then a V curb could be a good option to avoid impacting those features. If topsoil stripping and minor grading can easily be achieved and the adjacent surface is grass or other landscaping, this is likely a better option to reduce construction costs and also easy maintenance for adjacent property owners.

If minor re-grading is chosen, the curb transitions can occur over a shorter distance such as a standard 2 ft. beaver tail that will minimize curb and gutter removals and placement.

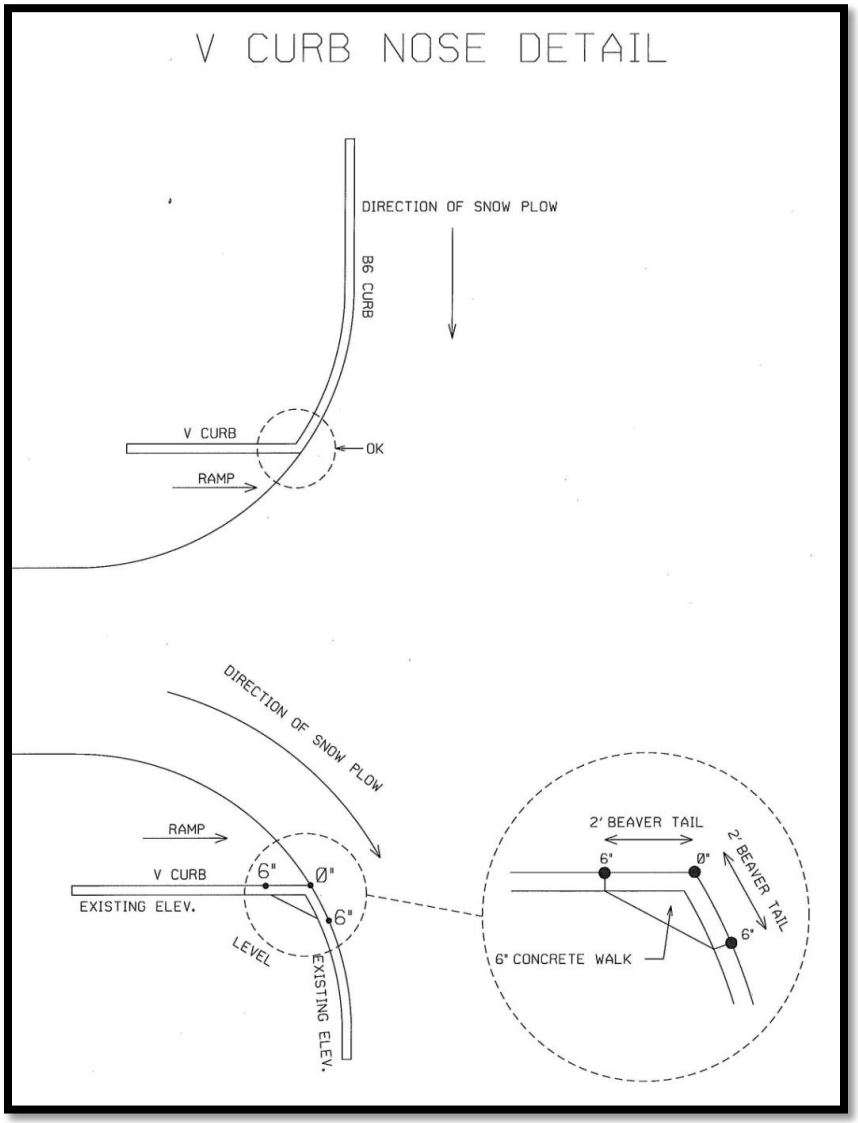


Figure 13: "V" Curb Nose Detail

Finally, concrete side flares on the standard plate have been the most common side treatment application in the past regardless if the adjacent surface was concrete or turf. This is acceptable though not required in PROWAG. As ramps get longer to meet required grades these side flares get longer as well and tend to look large and unwieldy. It is primarily an aesthetic consideration but thought should be given to putting a maximum flare length on longer ramps. It also may be difficult to consistently maintain a 10% walking surface on these unusually long flares. Uneven flare lengths can be appropriate when one leg of a ramp is considerably longer than the other.

If the adjacent surface is concrete or paved and there are no obstacles as defined above, concrete flares should be constructed instead of V-curb because the V-curb would create a potential tripping hazard.

This is the type of information that makes a standard detail very difficult to make "standard". These are primarily field decisions that are made after a pedestrian ramp type selection is made, utilities are accounted for, and removal limits are marked.

SIGNALIZED INTERSECTION AND ACCESSIBLE PEDESTRIAN SIGNALS

Overview

The Minnesota Manual of Uniform Traffic Control Devices (MN/MUTCD) has three criteria for placement of pedestrian push buttons that are part of an APS system and PROWAG has one additional criterion. ***See Figure 14.*** Push buttons should:

1. Be within a maximum 5 ft. offset of the projected outer edge of the crosswalk but preferably in line with the projected outer crosswalk edge. (MN/MUTCD)
2. Be within 4 ft. to 6 ft. of the back of the curb, with exceptions from 1.5 ft. up to 10 ft. from the back of curb. (MN/MUTCD)
3. Contain a minimum 10 ft. separation between adjacent crosswalk push buttons on the same corner. (MN/MUTCD)
4. Be located on a 4 ft. x 4 ft. landing with maximum 2% cross slope in any direction. (PROWAG)

There is a lot of discussion regarding the best setback to use under Criteria #2. Even though the 1.5 ft. setback is preferred by visually impaired users to provide the shortest street crossing distance, placing pedestrian stations too close to the road presents snow and ice operational difficulties and turning movement conflicts.

A 4 ft. minimum setback is recommended for snow and ice winging operations. A larger setback is often appropriate depending on the quadrant's design radius and the likelihood that turning trucks will track over the curb section and destroy the push button station.

Snow and ice sidewalk clearing operations are also a factor. ADA requires a 4 ft. minimum PAR distance around the pedestrian stations and ramps but to accommodate sidewalk snow clearing operations a 6 ft. clear minimum width maintenance path is recommended.

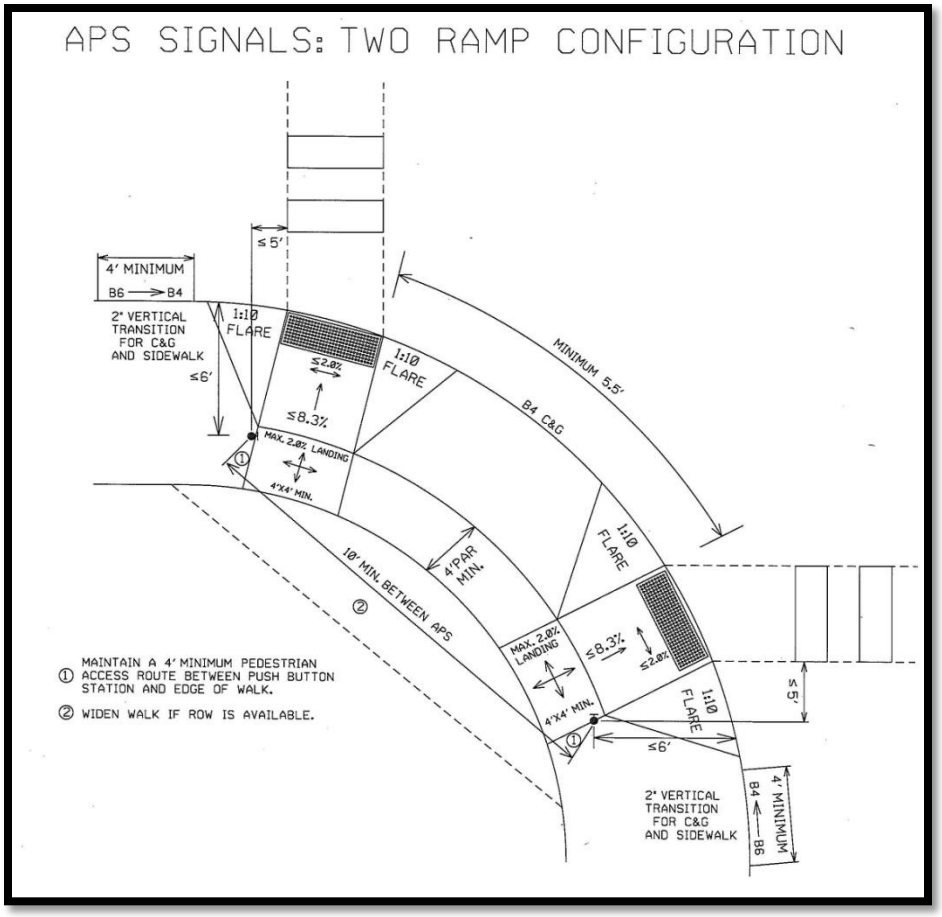


Figure 14: Accessible Pedestrian Signal

When the above factors are present they should be documented to accomplish the optimum push button placement up to a 10 ft. set back from the back of curb. Caution must be used when exceeding the required setback criteria. Practicality must be balanced with user need. The farther a push button is set back the more it loses it value to visually impaired users. If the criterion is not met the installation is considered non-compliant and the intersection needs to remain on the ADA Transition Plan for a more comprehensive future solution.

These criteria are difficult to implement in congested areas. To allow flexibility in location, it is generally recommended to utilize an independent push button station or pedestal for each direction of travel and not rely on the signal mast for a push button location. It is acceptable to use the mast as a button location, if it is located appropriately. Because of the pole's octagonal shape a shim may be needed to provide true directional alignment of the APS button if the crosswalk contains any skew. Mast pole foundations may need to be relocated during construction due to utility conflicts with the deep footings, which could place the push button out of the appropriate range, and a push button station would have to be added. Finally, mast pole foundations have a much larger diameters than the pedestrian push button stations so the horizontal reach distance is greater (9.5 in. from button to edge of base), which presents even more difficulty in snow and ice conditions when access is compromised.

Using APS at signalized intersections provides directional indications through both the tactile orientation of the push button and through an audible indication. Therefore, providing directionality through truncated dome orientation provides minimal additional benefit to visually impaired users. Due to the fact the signalized intersections commonly have sidewalk adjacent to the sides of the pedestrian ramp, the truncated dome orientation should be at the back of curb and as a result they do not provide directionality. As always, when grass or furniture is adjacent to the ramp the 5 ft. maximum truncated dome set back is beneficial from a wheeled user standpoint in order to provide dome alignment and a directional grade break.

The signal contractor should be cognizant of the proposed ramp design and use grade control to ensure signal bases and push button foundations are within horizontal and vertical tolerances. Push buttons are to be 42 in. high but can range +/- 2 in. on retrofit projects. All push buttons need to be immediately adjacent to a 4 ft. x 4 ft. paved landing with maximum 2% cross slope in any direction. The push button should be centered front to back on the landing at two feet. The maximum horizontal reach distance to the push button is 10 in. The push button orientation should be lined up in precisely the same direction as the crosswalk alignment so visually impaired users can properly navigate the intersection using audible cues.

Crosswalk Placement

Crosswalks should be perpendicular if possible, skewed if necessary, and avoid being kinked. If kinked, the change of direction needs to occur within a median cut through or median refuge.

There are some conflicts between desirable curb ramp and crosswalk positioning and how vehicles function in signalized intersections. According to PROWAG, the preferred locations for curb ramp placement are the tangent points of an intersection radius. Often moving the crosswalks to tangent points becomes very difficult when larger radii are needed to accommodate larger vehicular turning movements. Unfortunately, vehicles often stop closer to the intersection than these points and block crosswalks. Placing the median nose away from the intersection can be one way to encourage vehicles to stop before the crosswalk. When changing crosswalk locations an additional consideration is vehicle loop detector location to ensure the crosswalk does not encroach into / cover the loops which would interfere with signal operation. Both design and construction staff should consult district signal design and signal operations personnel when laying out crosswalks and APS locations.

Ramp Designs

The most common ramp configurations for APS installations consist of using two individual ramps (including the required landing) or using a Depressed Corner.

Conventional Two Ramp Configuration

When crosswalk placement allows for adequate separation at the radius and sufficient ROW is available two individual ramps are preferred. ***See Figure 3 and 4.*** These ramps need to include a 4 ft. x 4 ft. landing at the top with maximum 2% cross slope in any direction. This design allows for

distinction between the two crosswalks by providing an individual ramp for each direction. The ramps should be constructed with the running slope perpendicular to the back of the curb in a "radial" manner. Directionality for visually impaired users is provided through APS and is not provided with detectable warning. Again, directionality of the domes is beneficial from a wheeled user standpoint if the curb ramp is adjacent to grass and appropriate grade break is considered.

Signalized locations generally have higher pedestrian volumes and are more likely to have pedestrian passing needs. Therefore, a 6 ft. wide curb opening and dome width that aligns with the 6 ft. crosswalk width is preferred, but a 4 ft. wide curb opening is acceptable as long as it falls within the crosswalk.

To meet the 6 ft. APS push button setback requirement, it is highly recommended to transition into B4 curb and gutter throughout the radius so shorter 4 ft. ramps can be constructed with the button positioned an additional 2 ft. back into the landing. When constructed in this fashion, one landing provides dual roles for the button and the top of the ramp. The curb and gutter transition from B6 to B4 should occur well beyond the limits of the curb ramps so the connecting sidewalks can gradually taper down 2 in. vertically.

When using this design and all other designs with multiple landings, a minimum 4 ft. wide sidewalk / PAR should be utilized to connect all existing sidewalks and landings in a continuous route. This additional area also provides users a comfortable refuge from traffic.

When determining feasibility of this design, ROW needs to be assessed to accommodate the landings as does providing adequate separation between the two ramps. A minimum distance of 5.5 ft.-7 ft. should be provided between the curb cuts so the 1:10 flare taper can be developed to a 3 in.-4 in. height over 40 in. of run for each ramp.

Depressed Corner

When adequate distance cannot be achieved between crosswalks or ROW is limited a depressed corner can be used. This design requires the entire ramp and landing area to have a maximum 2% slope with the connecting sidewalks ramping up to existing grades beyond the intersection. It allows for a more flexible placement of push button pedestals since the entire area acts as a landing. As depicted in the details, radial domes are the preferred option in this APS configuration. See Figure 8.

In retrofits, this design requires more concrete removal and replacement to chase grades and needs to be evaluated for potential drainage concerns. The size of the Depressed Corner should be minimized for various reasons. A smaller opening should be utilized to discourage vehicle tracking into the landing. Generally the larger the depressed area the more cautious one should be of existing drainage patterns and unwanted ponding. The controlling construction element is to come off the gutter flow line at a minimum 1.5% to a maximum 2% slope to the interior corner of the depressed landing. Without APS, these designs provide limited directionality to visually-impaired users and should be paired with APS whenever possible.

Other APS Considerations

Pork Chop

Pork chops can present directional challenges for visually impaired users since they contain no defined PAR. Ramps and landings should be oriented in a symmetrical manner to create a logically intersecting path that facilitates direct pedestrian movements and minimizes obscure warping in the pork chop sidewalk itself. Generally a B4 curb is preferred in all pork chop designs in order to shorten ramp distances in congested areas and to minimize sidewalk warping.

Drainage can be a primary concern on pork chop ramp designs. A quick survey should confirm the controlling ramp leg on a pork chop and verify sidewalk (PAR) routes between the ramps. It is often the case that a ramp has negative grade so a short 2 ft. positive grade ramp may be needed to contain existing drainage which is then connected to a landing, which in turn is connected to a negative grade sidewalk to the opposite ramps.

Signalized pork chop locations generally have higher pedestrian volumes and are more likely to have pedestrian passing needs so a 6 ft. wide curb opening and dome width that aligns with the 6 ft. crosswalk width is preferred, but a 4 ft. wide curb opening is acceptable as long as it falls within the crosswalk. To help with congestions in median areas PROWAG reduces the minimum separation distance between pedestrian push button stations to 5 ft. from the usual 10 ft.

Rural Intersection Designs

Rural signalized intersections require a unique approach to meet user needs. ***See Figures 15 and 16.*** Flat landings with a maximum 2% cross slope in all directions provide a fairly simple design while being maintenance friendly. Proper truncated dome placement is the critical element of these flat landings. The domes need to be placed the entire length of the landing wherever it touches the edge of the roadway to provide detection for visually impaired users. The landing edge adjacent to the roadway should be granular to provide a differing surface type. That gravel surface will help prevent vehicles from utilizing the pedestrian landing area as an expanded free right turn.

The edge of the detectable warning should be no more than 6 in. from the edge of the concrete landing (in order to provide a continuous detectable edge) with a preferred distance of 3 in. to 4 in. from the landing edge for long term serviceability.

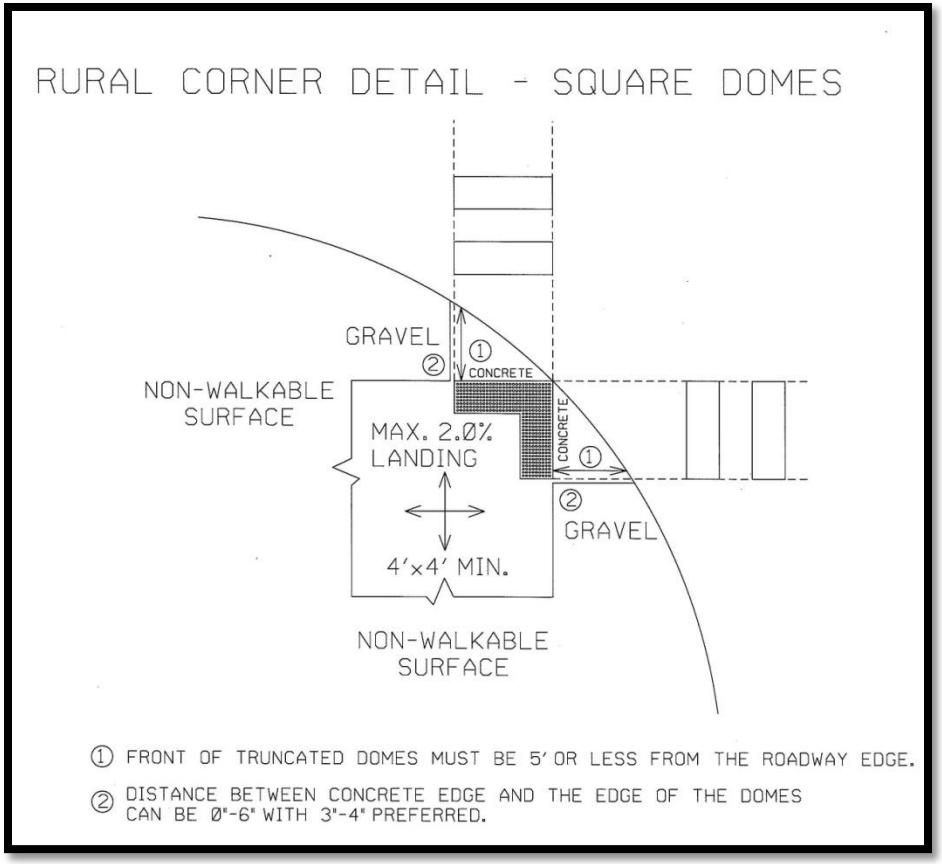


Figure 15: Flat Landing with Directional Domes

The concrete landing must be formed correctly to meet these construction tolerances and the crosswalks need to be properly located as well. The last 2 ft. of the concrete landings should radially tie into the edge of the roadway to prevent a pointed tip of concrete that will ultimately crack.

Radial domes are the preferred truncated dome option. ***See Figure 16.***

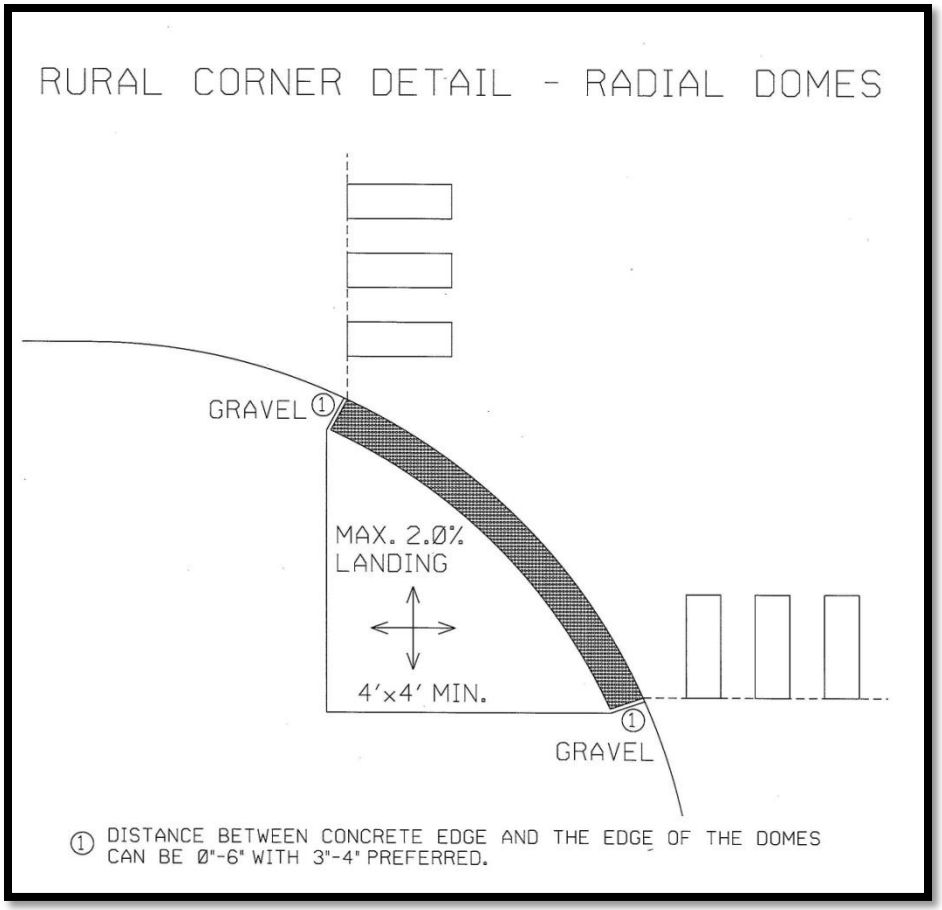


Figure 16: Flat Landing with Radial Domes

Median Cut Throughs

Median cut throughs are not preferred since traffic has a tendency to stop at the median nose and therefore block the curb cut opening. Feasibility of moving the median nose back should be considered so vehicles stop behind the crosswalk. If median cut throughs are used the curb cut opening should be 6 ft. wide to match the crosswalk. A minimum 2 in. raised elevation/ramp is also recommended so cut through area drains properly and does not gather debris.

Detectable warnings should be placed at the back of the curb if 6 ft. or greater median width is provided from back of curb to back of curb. If less than 6 ft. median width is provided the median area should not be considered a safe refuge and crosswalk striping should be placed through the median. When there is no refuge, the pedestrian cycle time must allow for crossing the entire street. ***See Figure 17.***

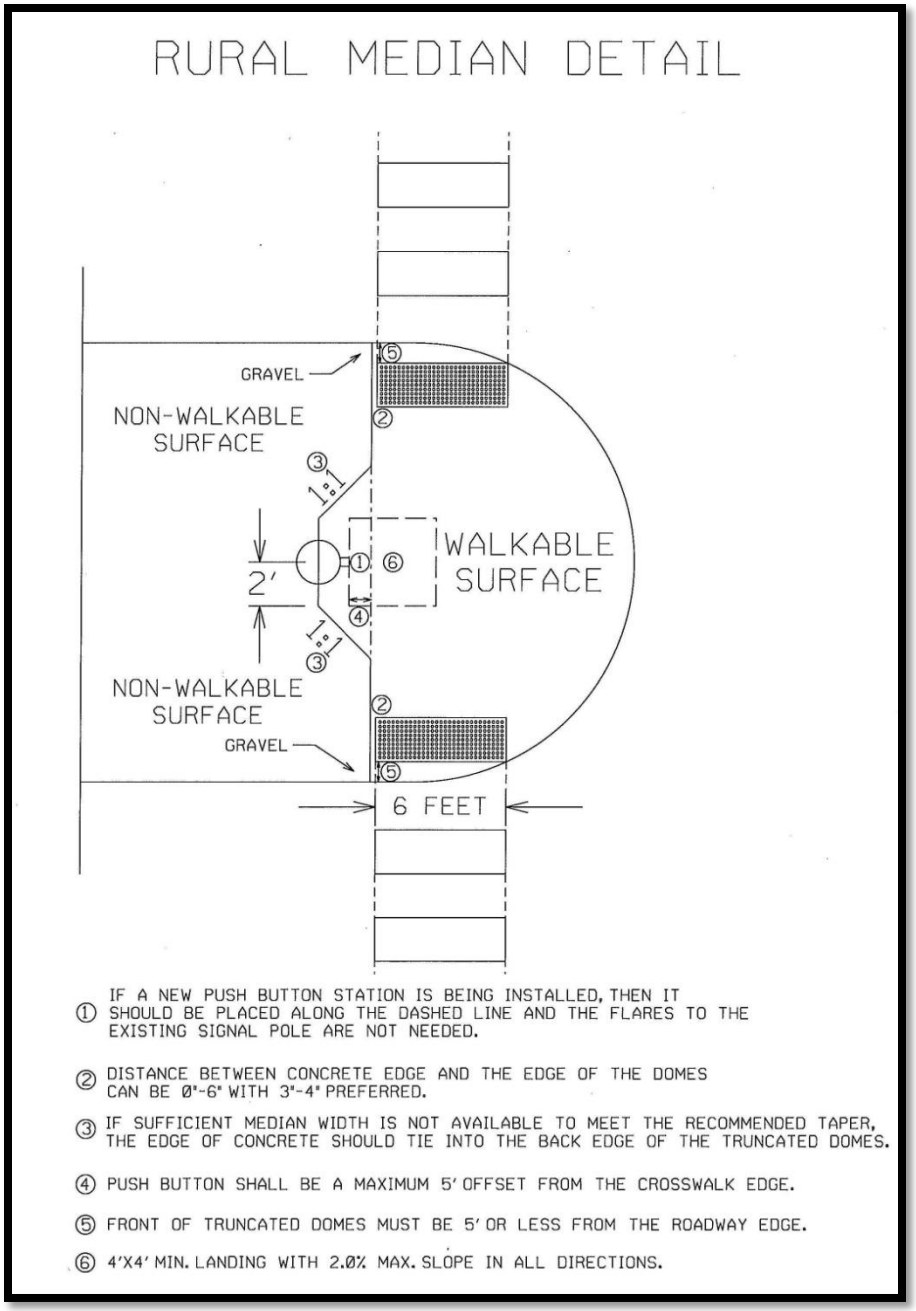


Figure 17: Rural Median Detail

Crosswalks in front of Medians

When a crosswalk passes in front of a median, the crosswalk must be perpendicular to the median and the portion of the crosswalk adjacent to the median shall have a defined edge for the visually impaired. The edge perpendicular to the median could be a median bull nose along a raised median or a grassed edge on a depressed median; however the edge perpendicular to the median should not be defined with detectable warnings.

When the adjacent median is more than 6 ft. wide it should contain detectable warnings perpendicular to the path of travel (i.e. perpendicular to crosswalk orientation) and aligned so the leading edge is no more than 5 ft. from the travelled roadway surface. If possible the median APS push button should be on the outside of the crosswalk in order to be clear of snow plow operations and to be consistent with the primary push button locations.

APS Considerations on Shared Use Trails

This topic will be discussed in subsequent revisions of this document. The following is interim guidance.

The center of the push buttons station should not encroach more than 2 ft. into the shared use trail. Since the signal is a stopped condition for bikes the 2 ft. clear distance from trail edge will likely have an exception at the signal to accommodate ADA push button criteria.

Detectable warning should extend full width of the trail / curb opening. The maximum 5 ft. setback criteria should be implemented in an effort to provide truncated dome alignment for wheeled users. A flat landing is required at the push button pedestrian stations. A perpendicular grade break should be implemented in the direction of travel so the ramps don't turn into one big diagonal ramp.

APPENDIX

Figure 2: Perpendicular Curb Ramp

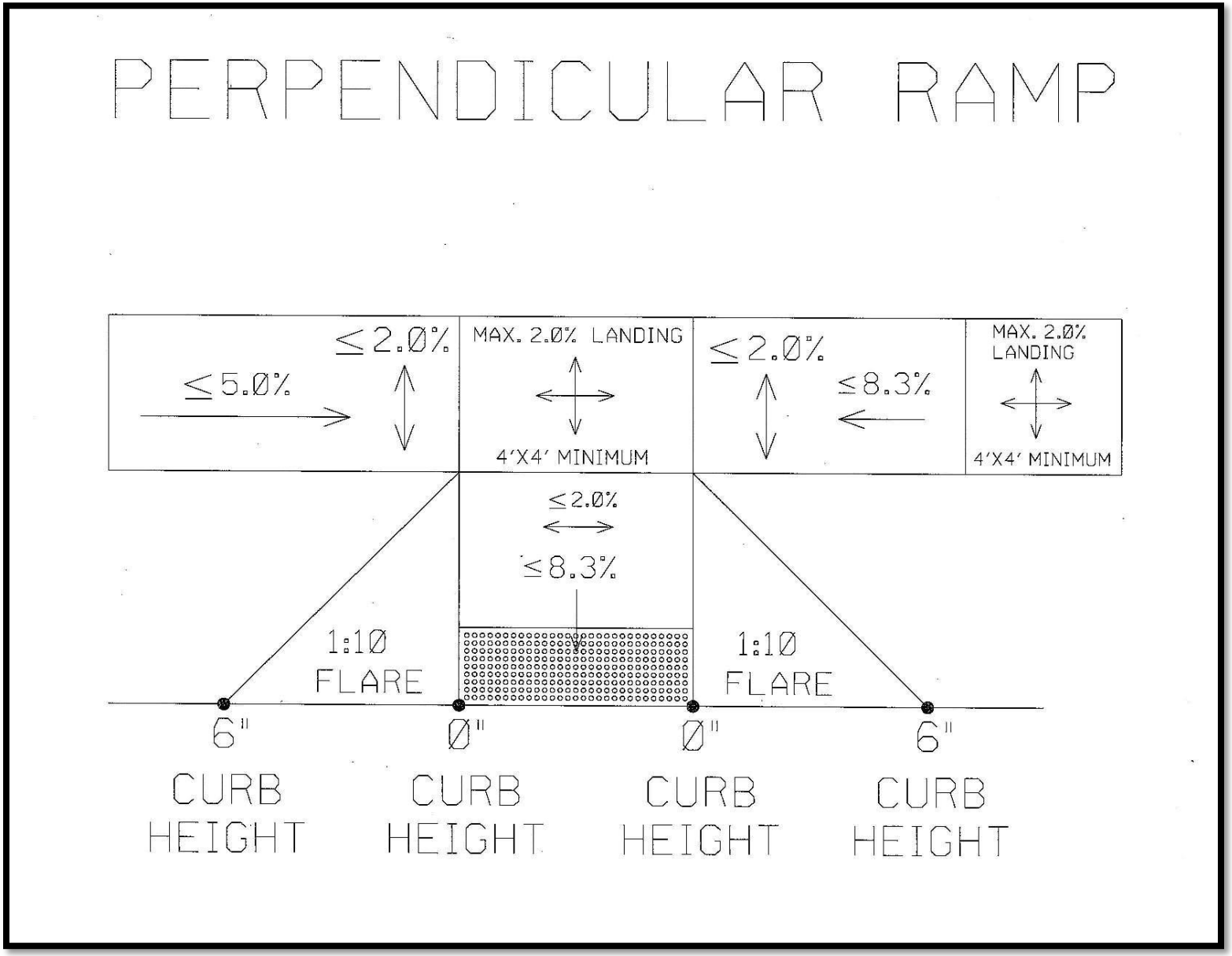


Figure 3: Combined Perpendicular Ramps Adjacent to Walkable Surface

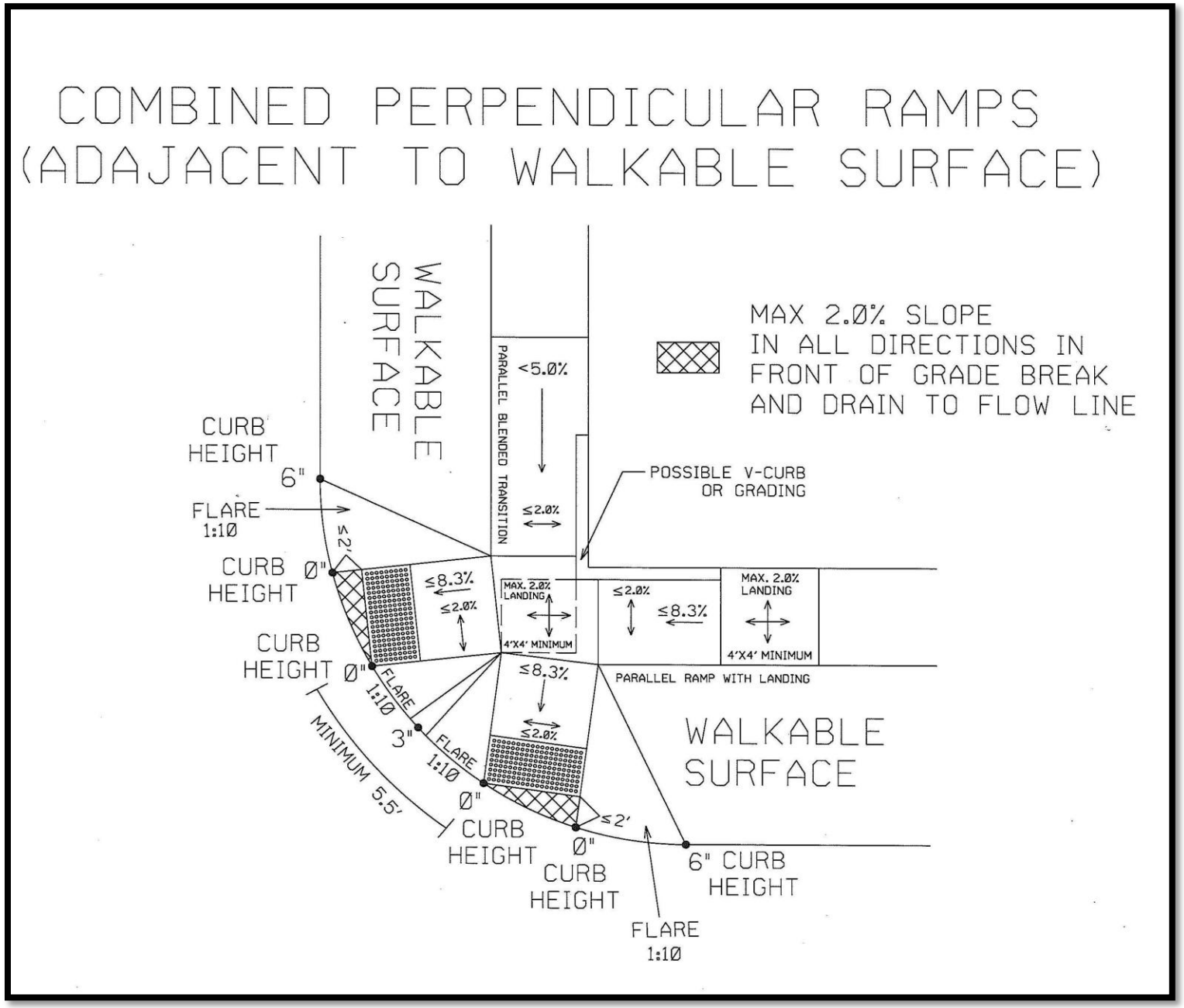


Figure 4: Combined Perpendicular Ramps Adjacent to Non- Walkable Surface

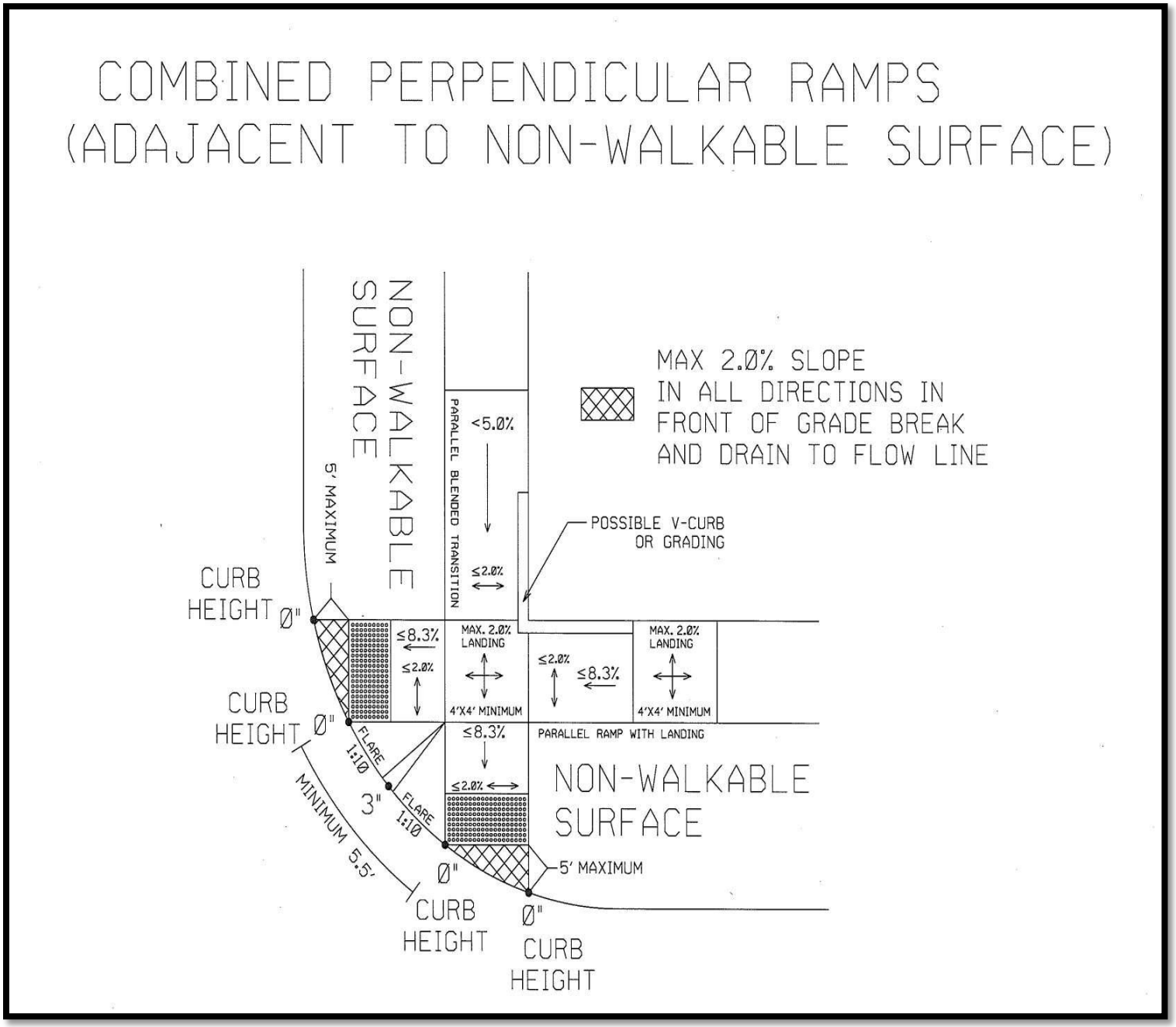


Figure 5: One Way Directional Ramp Adjacent to Curb and Gutter

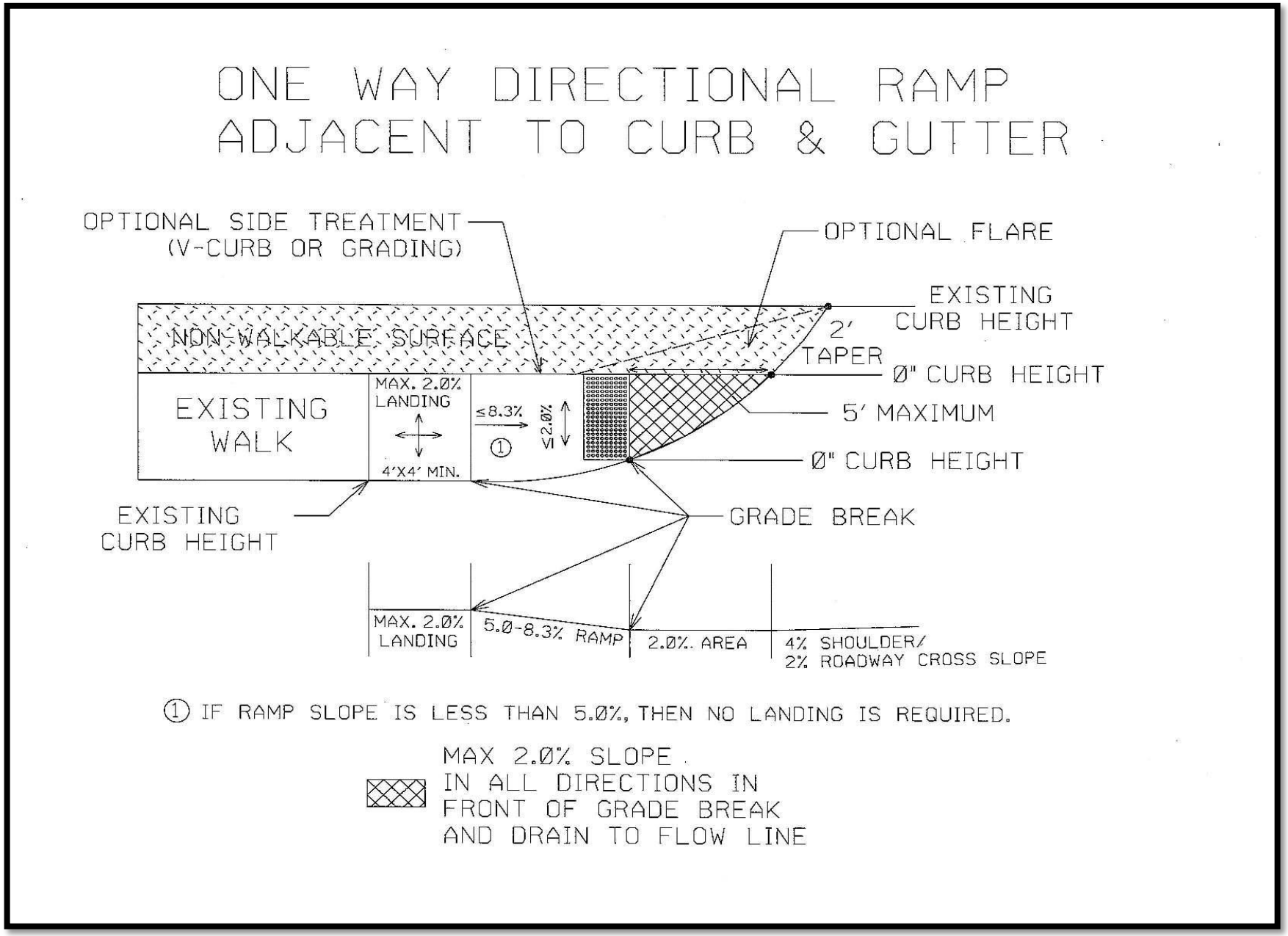


Figure 6: One Way Directional Ramp Adjacent to Non-Walkable Surface

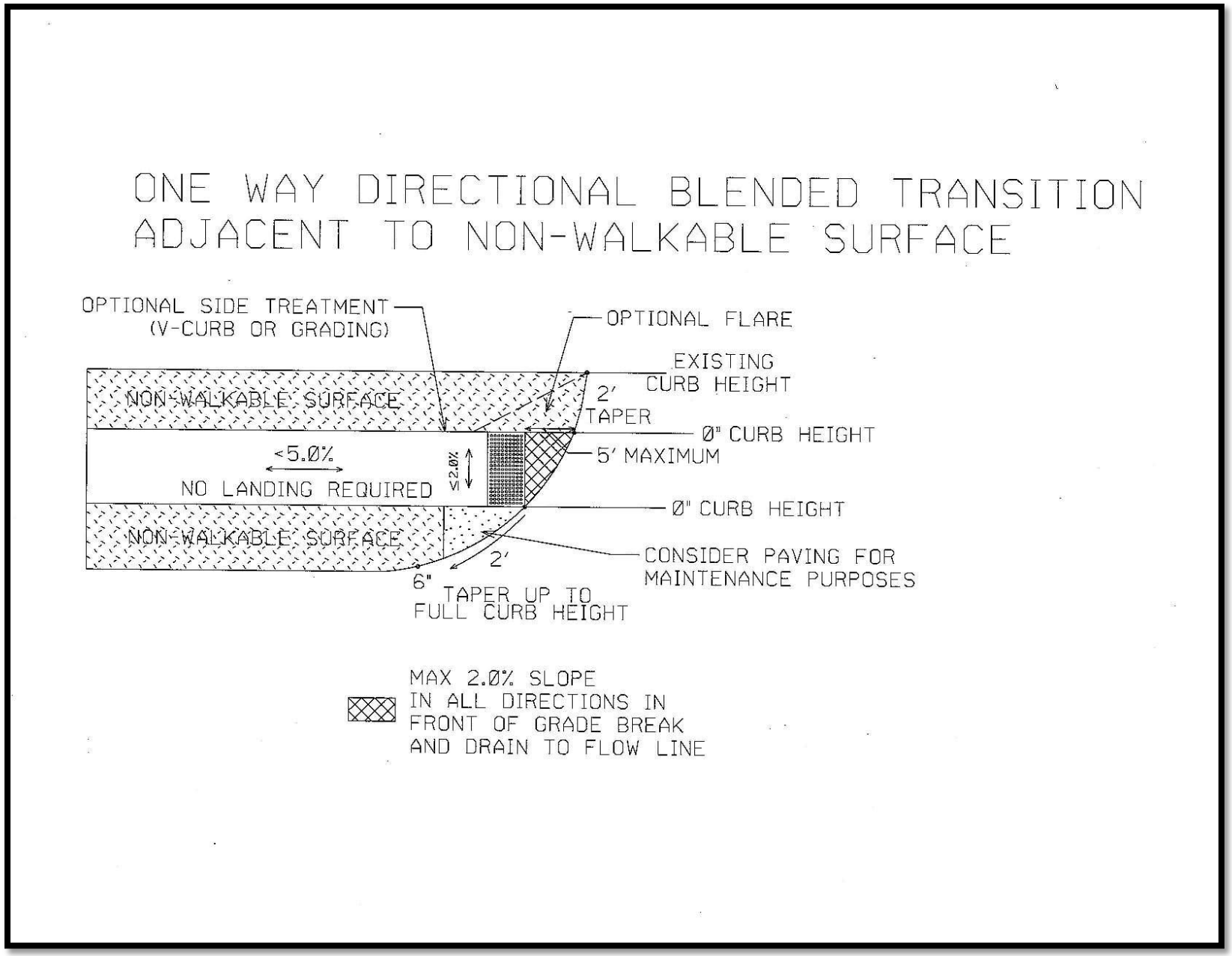


Figure 7: Parallel Ramp

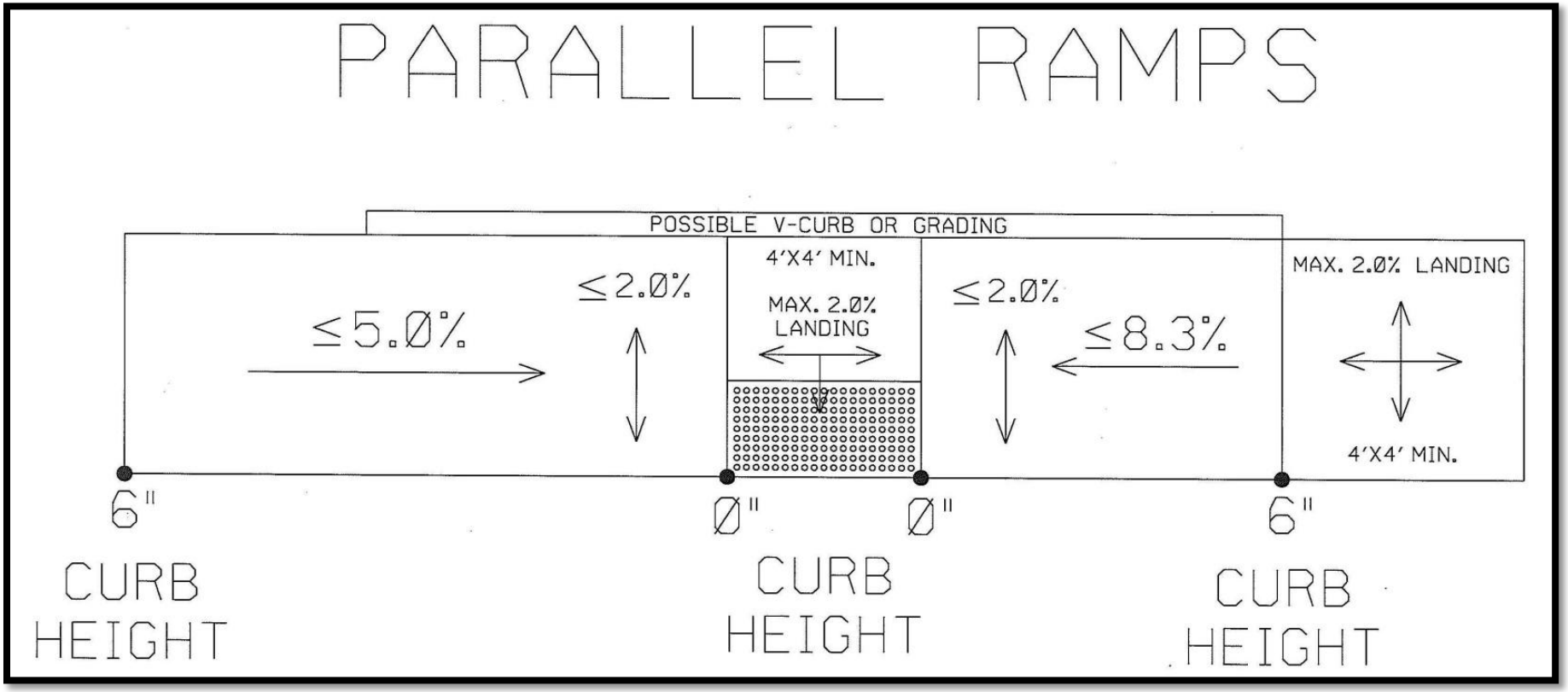


Figure 8: Depressed Corner

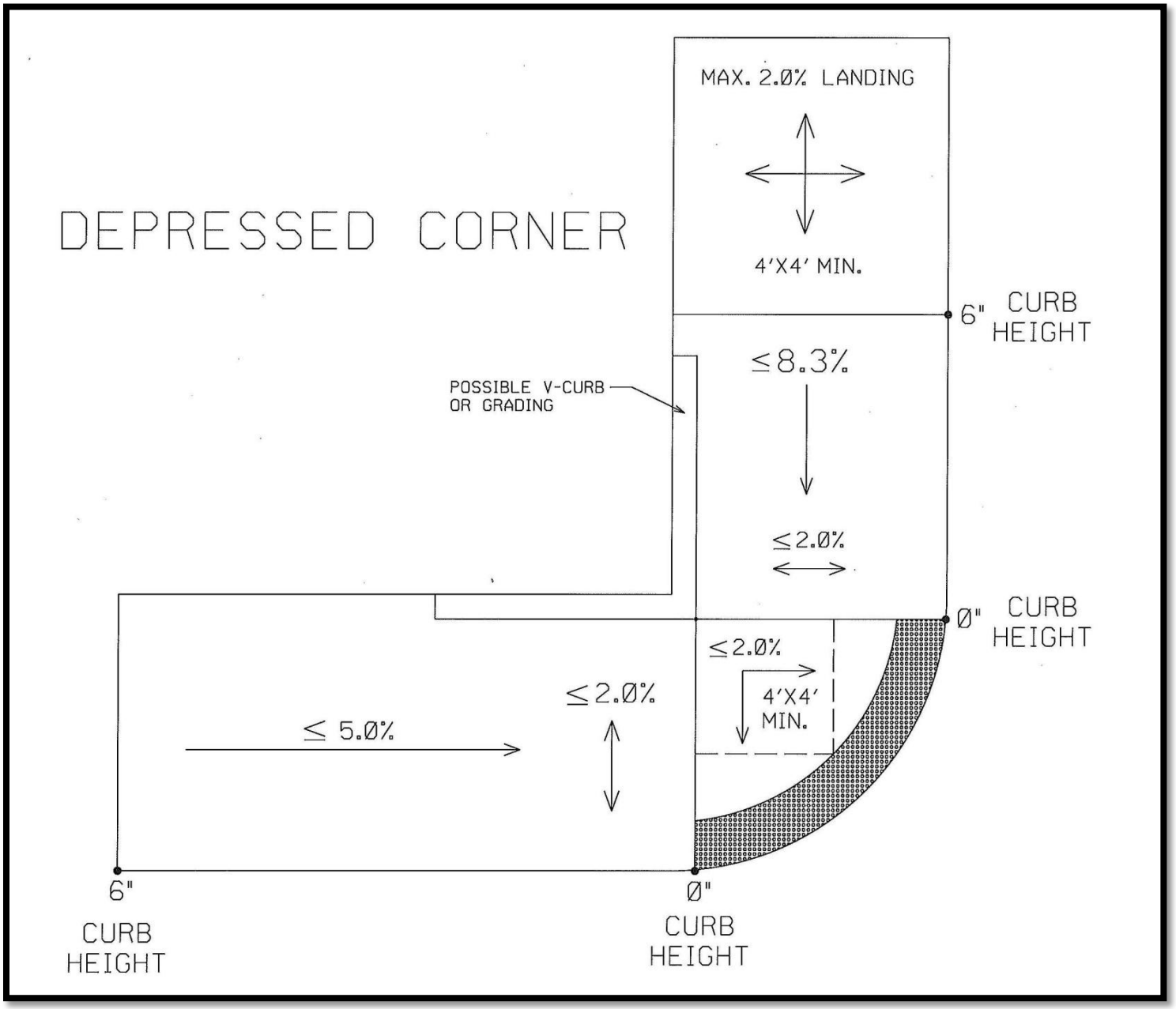


Figure 9: Fan Detail

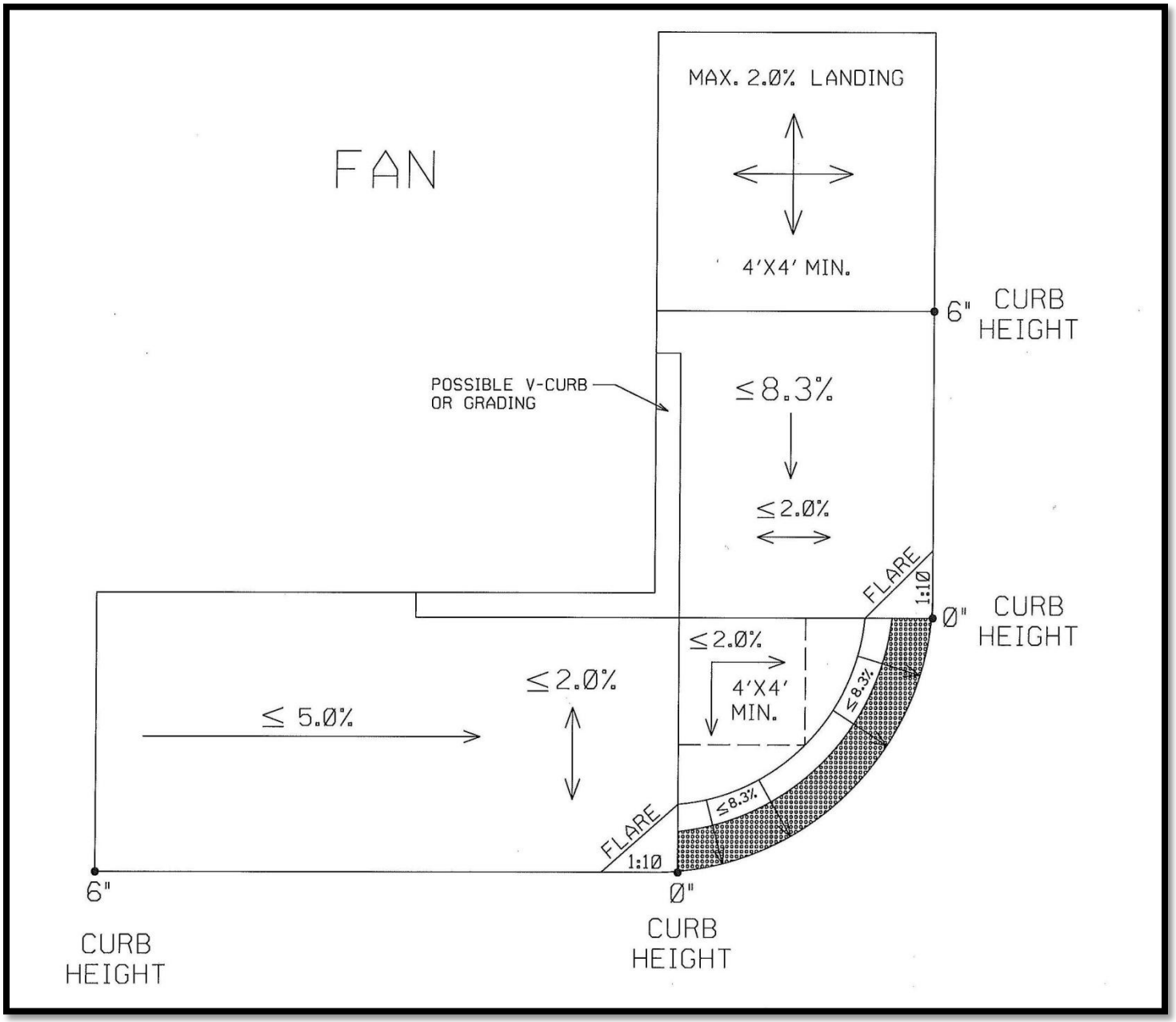


Figure 10: Dome Setback Adjacent to Non-Walkable Surface

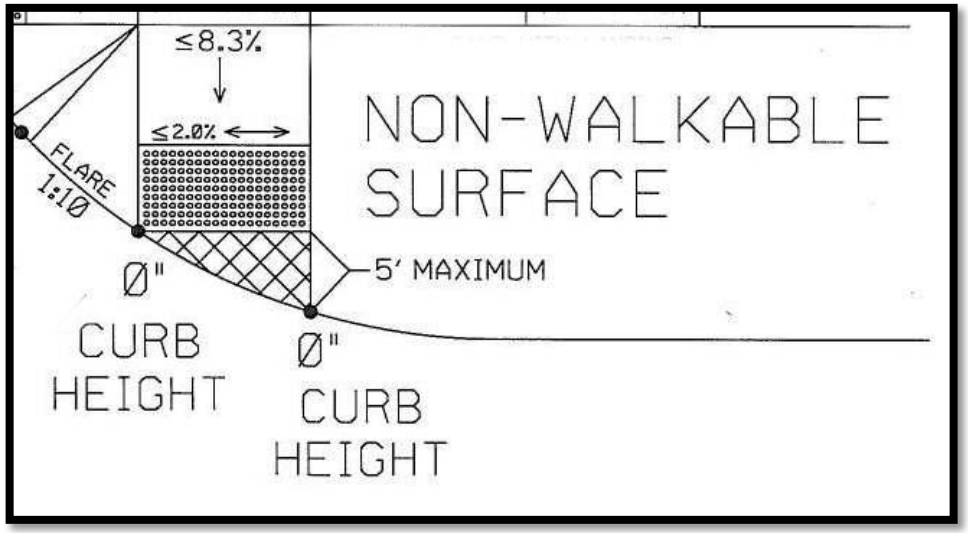


Figure 11: Dome Setback Adjacent to Walkable Surface

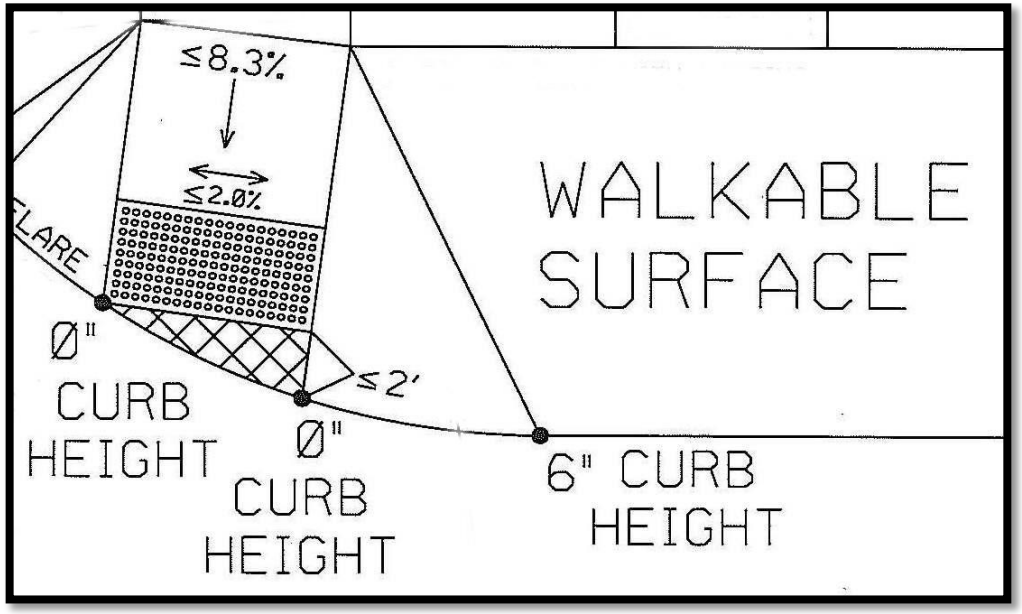


Figure 12: Curb and Gutter – Standard and Pedestrian Access Route

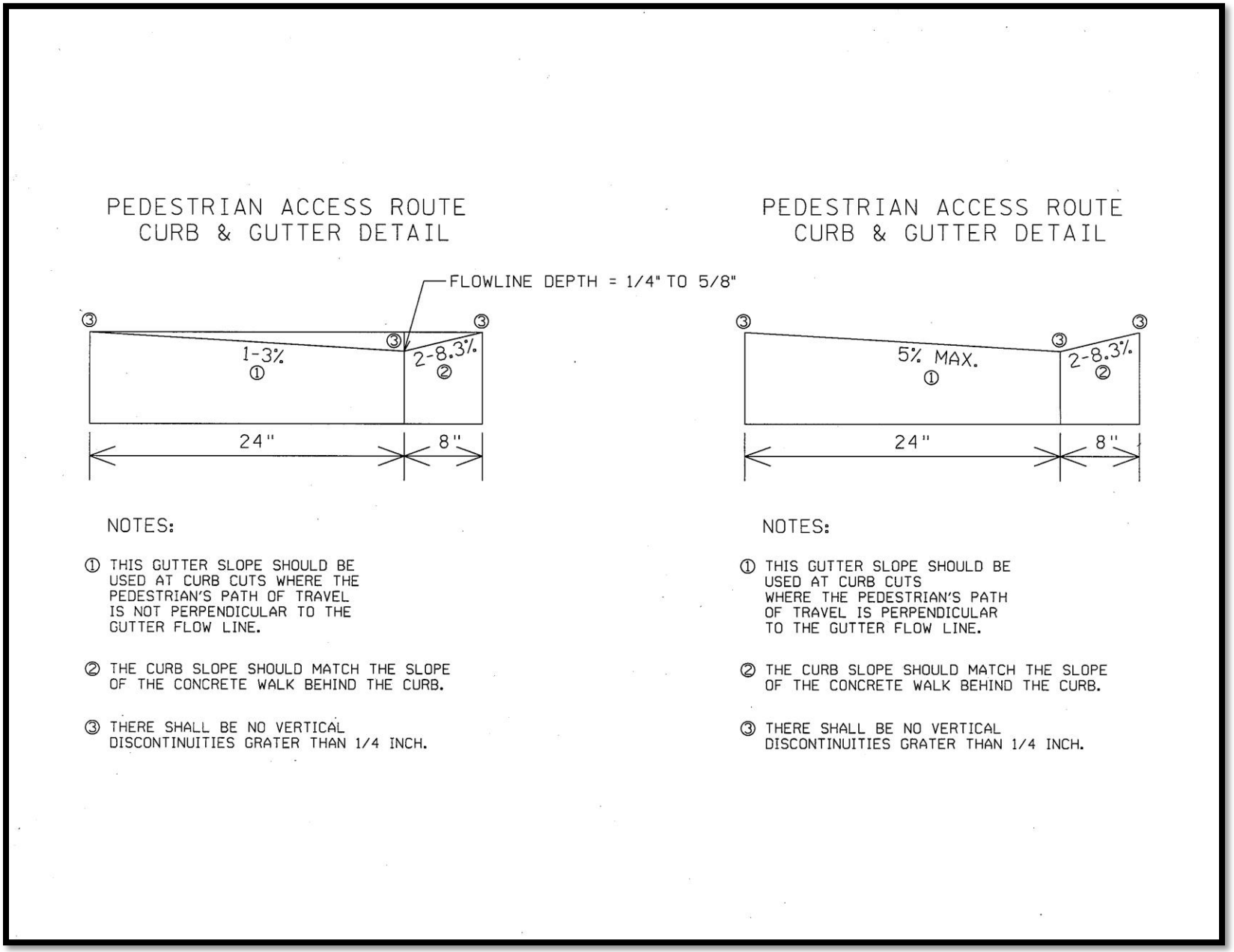


Figure 13: V-Curb Nose Detail

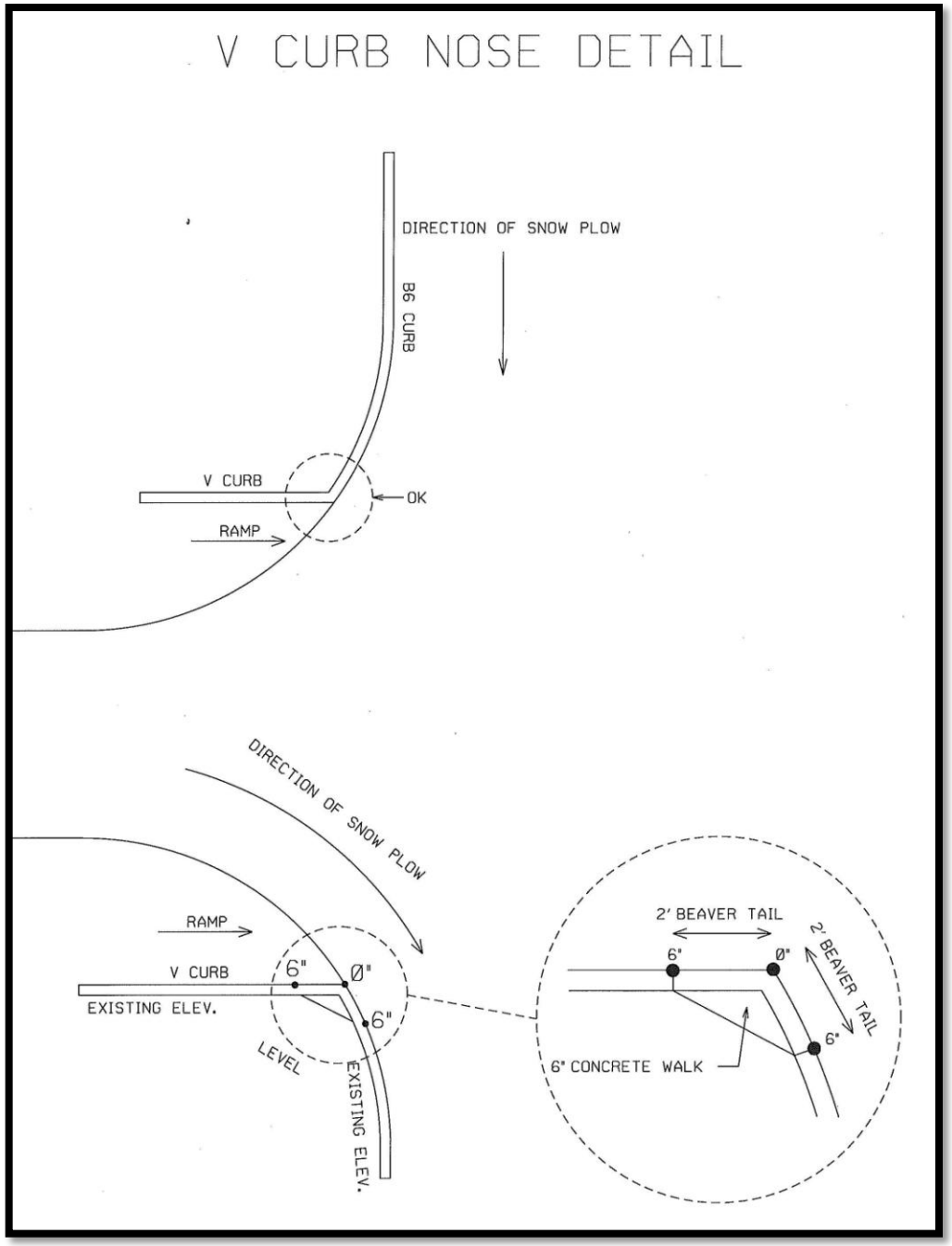


Figure 14: Accessible Pedestrian Signal

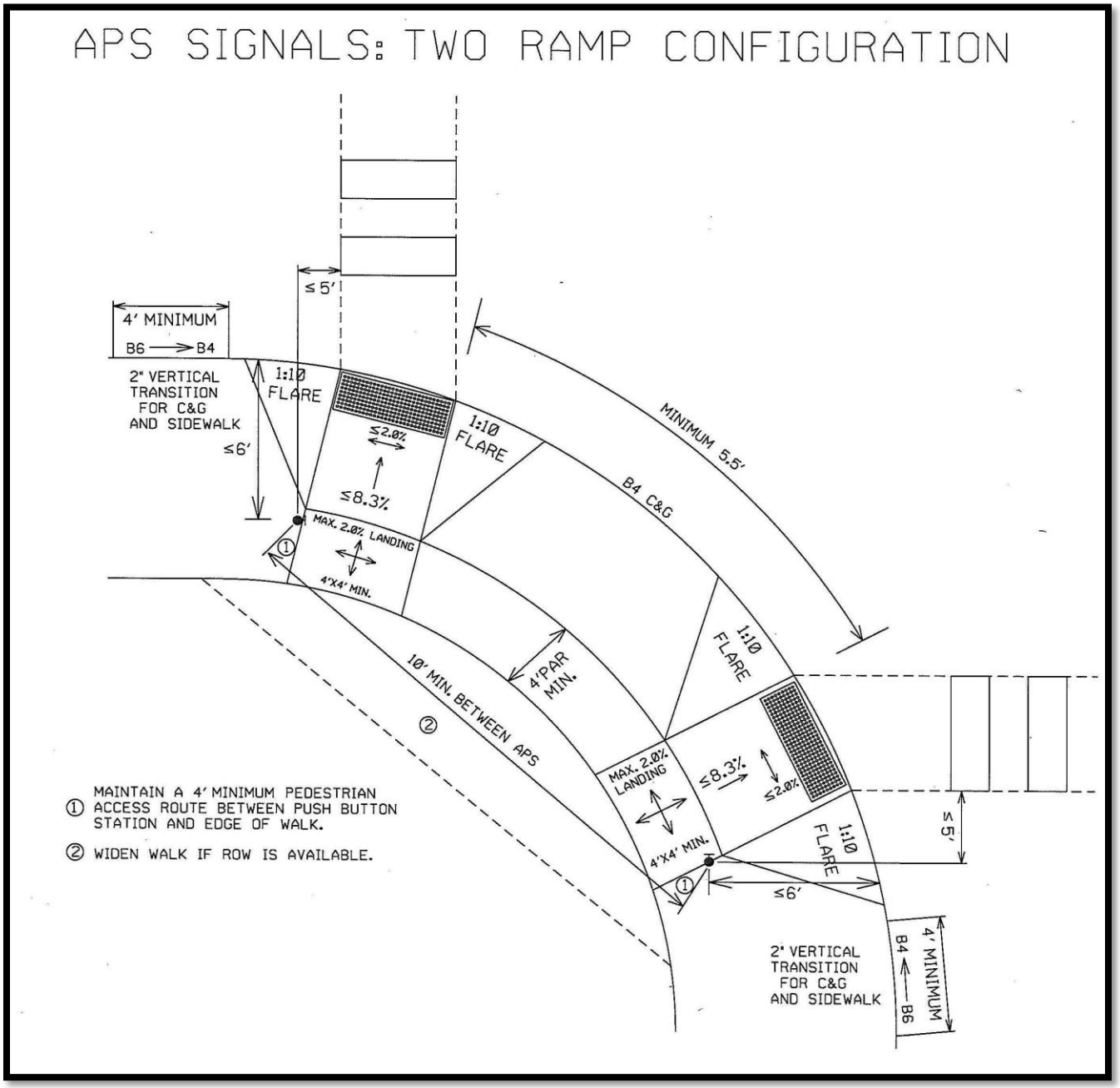


Figure 15: Flat Landing with Directional Domes

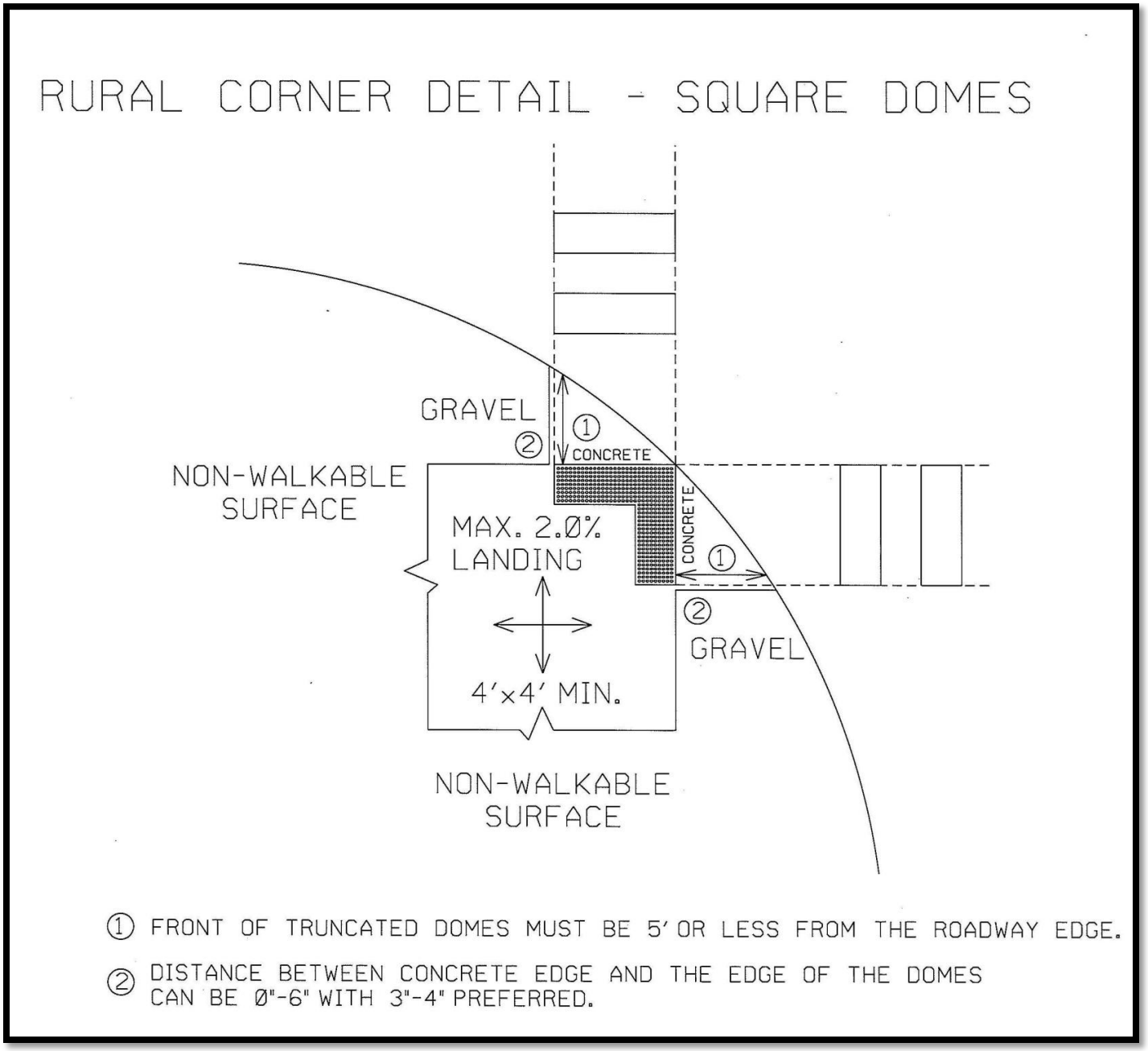


Figure 16: Flat Landing with Radial Domes

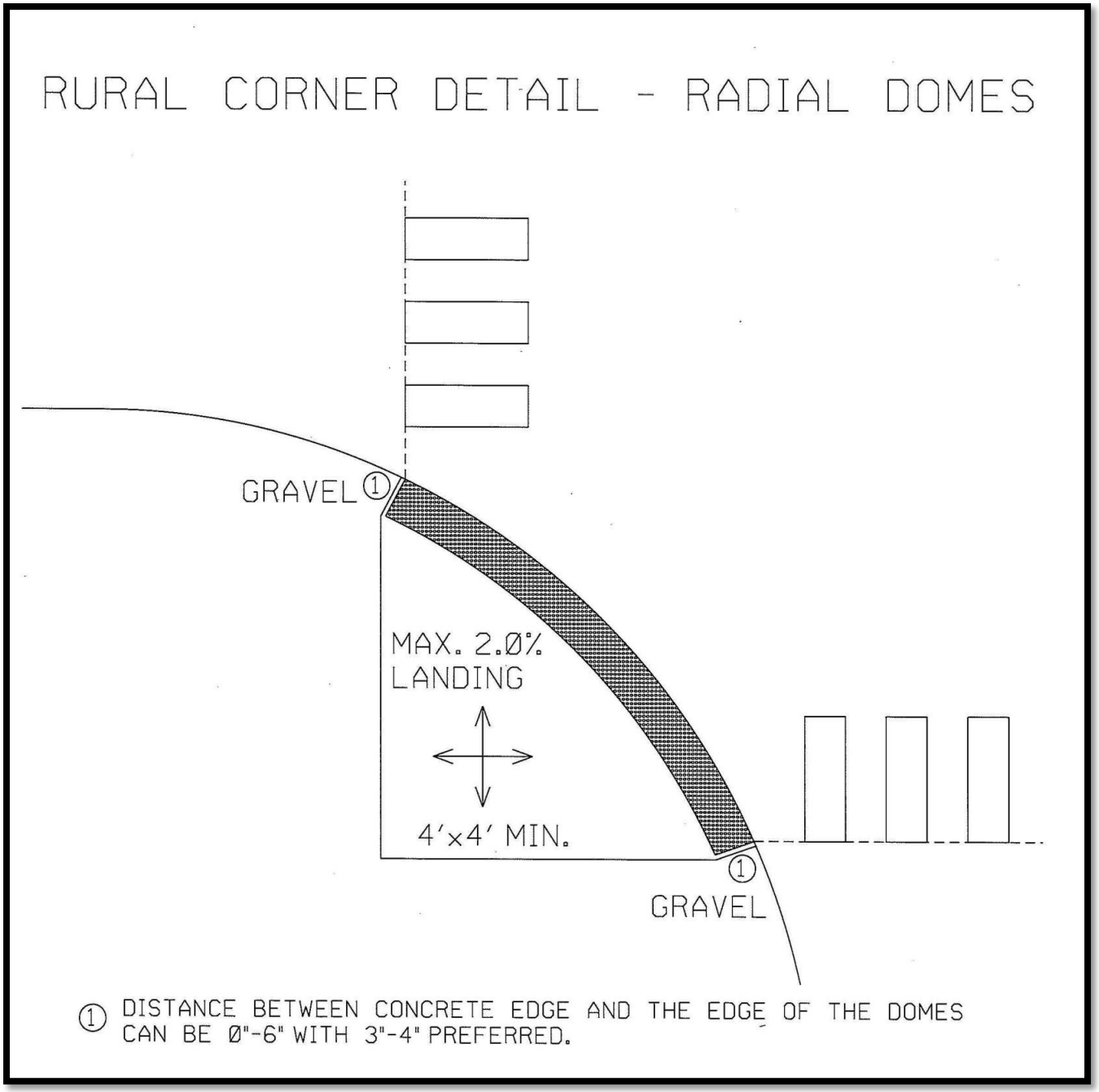
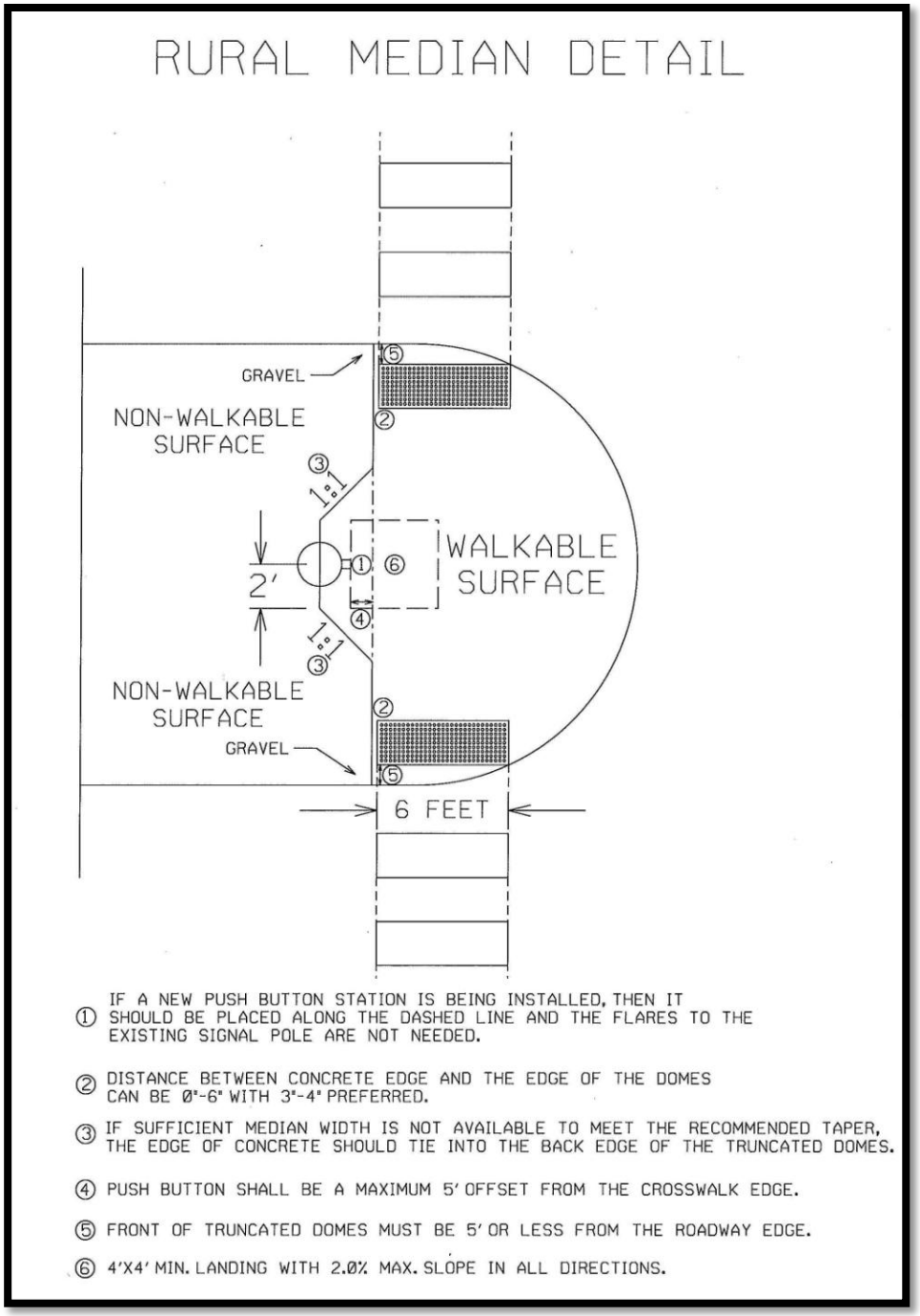


Figure 17: Rural Median Detail



Diagonal Ramp