



# Vermont Agency of Transportation

## Statewide Guardrail Inventory

### Field Manual



Last Update: **In progress – May 2017**

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**(will need to be redone after document has had review and critique)**

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## INTRODUCTION

The Vermont Agency of Transportation (VTrans) owns and is responsible for the design, installation and maintenance of the guardrail systems. This system includes a number of different types of rail, posts and end treatments. The intent of the Statewide Guardrail Inventory (SGI) is to locate and catalog all of the runs of guardrail, assess their condition and identify critical runs in order to prioritize repairs and replacements. The SGI provides the framework for continued monitoring and condition assessments of all state owned runs of guardrail.

Several attempts had been made to develop a system wide inventory of guardrail, all of which were been plagued by similar pitfalls. Past inventories contained useful information but were one time assessments disconnected from maintenance activities and subsequent assessments. As the information was never maintained or updated, regularly these inventories became outdated and obsolete. The SGI has been designed to record location data, guardrail and end treatment type, and condition assessment. This data will then be integrated into the Managing Assets for Transportation System (MATS) used by the Operations Division. This critical link will ensure that any repairs or maintenance work will be associated with a specific run of guardrails and will in turn keep the inventory current.

This system will be used as a tool to prioritize and develop rehabilitation and replacement projects, in an effort to maintain our existing assets. The SGI provides the geospatial baseline that will allow for the utilization of the history recording, future planning and financial capabilities in the existing MATS system. This spatial inventory coupled with a consistently updated MATS database, will in turn provide useful data to the Project Development Division as well as the entire Agency. It is a first step in a commitment to periodically inspect and maintain guardrail conditions in an effort to increase the efficiency of the Agency while improving the safety of Vermont's infrastructure.

## DATA COLLECTION

Inspection teams should consist of two members, for safety reasons, with a third serving as a team leader but a single person can conduct this inventory if done in a safe manner. The first member will conduct the inventory while the second member will operate the vehicle. The team leader will coordinate inspection sites and upload data to the Agency's GIS server.

Prior to a day's field work the inspection team leader is responsible for all scheduling, weather cancellations in severe conditions, daily work plans and various other general issues that develop during the work day. The Roadway representative is also responsible for ensuring that the team is supplied with Personal Protective Equipment, and for acquiring the necessary resources for the day's field work including, **but not limited to**, the following:

- GPS Unit
- Statewide Guardrail Field Manual
- Weekly Inventory Sheet
- Tape Measure
- Writing Utensils

For your safety, the Agency policy is to ALWAYS wear your Personal Protective Equipment. When collecting inventory, the best practice is to walk behind the guardrail. Under ideal conditions it would be most efficient to collect and assess a guardrails condition and spatial information in sequence, while walking behind the guardrail.

To begin field work, the GPS unit should be powered on, and the data collection software opened. A new rover file should be created and named appropriately according to the date and the naming convention "GRMMDDYYYY", using the latest version of the "Guardrail" data dictionary, and always saving to the SD card.

At the specific beginning and ending points, pull down menus containing structural and conditional information for all the **data collection criteria** should be recorded. While the condition assessment is being performed, the spatial locations should be collected. At the end of the day the rover file should be saved and the GPS unit powered down.

(Add text regarding how to logically collect the data and average mile per day rate) ← unnecessary

~~Regardless of what strategy is chosen,~~ the roadway the inventory should operate as follows:

1. The data collecting team member should drive the road south to north (or west to east) if possible, **stopping each run of guardrail regardless of which side of the road the guardrail is on. Noting direction from the route signage. (this is contrary to data mining from as-built plans)**

2. The data collector ~~can~~ **should** approach the guardrail and measure from the ground to the top of the rail **panel**, not the **top of the** post. This measurement ~~will~~ **should** be recorded as the height.
3. At this point, the GPS shot can be taken. Once the GPS location has been stored, proceed through the data dictionary reporting ?? the ~~necessary~~ **required** attributes.  
<<discuss GID after review data collected so far>>

At the end of each week, the data needs to be uploaded for spatial corrections, and to limit the amount of data that could be lost due to equipment malfunction. The daily work log should also be turned in to the team leader.

## SAFETY

The intent is to obtain a location and condition assessment of all guardrails; however the inspection team should ~~not~~ **never** compromise their own safety. Please follow the following safety precautions.

- Park your vehicle **well** off the road so that it does not become a hazard. If you are using a private vehicle, be sure to display your AOT placard. If you are using a crossover on a limited access highway, you must use an amber light and follow the procedures in the Safety Manual for using crossovers.
- Once you leave the vehicle, you are required to wear the standard AOT **reflective** vest (**or jacket**) an orange cap, **full length** pants, and **Agency approved** footwear.
- **Always attempt to** walk behind the guardrail.
- Please be aware that there is a lot of poison ivy, **and other noxious plants**, around the roadways.
  - **Please contact the VTrans Occupational Safety Coordinator with any questions or concerns. Construction Section (802) 828-3565 (I checked this number)**
  - **~~Charles Mayhood~~ don't use name.**

## Data Dictionary

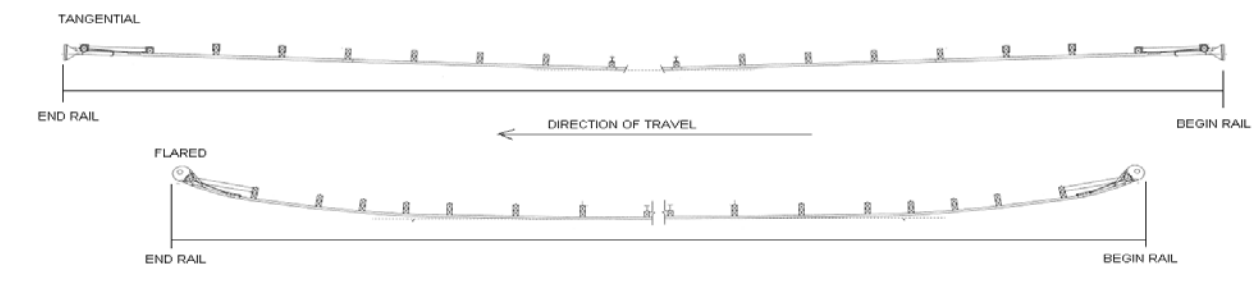
There are specific sections of guardrail that serve different purposes. A “run” of guardrail is the overall end to end length, regardless of how many different “sections” it contains. The individual “sections” are described in more detail below;

1. A Terminal Section (or End Treatment Section) – The initial section at the beginning, or ending of a contiguous run of guardrail. Examples of Terminal Sections can be found in this document under Appendix A.
2. A Transition Section – The section of guardrail that is usually found between the Standard Section of guardrail and Bridge Rail Section. This Transition Section generally will be the same rail type as the Standard Section, but will likely have closer post spacing.
3. A Standard Section – The section of guardrail with normal post spacing. Usually found between two Terminal Sections, or between a Terminal Section and a Transition Section, if there is a bridge within the guardrail run.
4. Bridge Rail Section – The guardrail on the bridge. Bridge Rail types are not to be included as part of Asset Management’s data collection.

For Asset Management collection purposes in ArcMap tables, both the Terminal Sections & the Transition Sections should both be combined with the Standard Sections. Examples;

1. A run of roadside guardrail with no bridge, and no curb board. – The entire run is treated as one segment (ArcMap record), with a beginning point, and an ending point.
2. A run of roadside guardrail with no bridge, but with curb board on part of the run. – This run would be broken into three (3) separate segments. From the beginning point of the run to the beginning of the curb board is the first segment. The second segment is from the beginning of the curb board to the end of the curb board. The third segment is from the end of the curb board to the end point of the run. At the point where the segments connect, the treatment option is “join”.
3. A run of guardrail with a bridge. - This run would be broken into two (2) separate segments. From the beginning point of the run to the beginning of the bridge rail is the first segment. The second segment is from the ending of the bridge rail to the end of the run. At the point where the segments connect, the treatment option is “join”.

If there are runs with both a bridge and curb board, the number of segments will increase. I don’t like this example, as the tangential terminal is shown flared ↓



## Begin Rail

### GID (numeric)

Unique identifier used to link the beginning point and ending point of the guardrail ~~run~~ (record) section.

### Direction (text menu)

Traveling direction base on the Route's signage

(Should we base this on the direction of Mapping's LRS centerline)

### Side (text menu)

Which side of the road the guardrail is on, based on the Route's signage.

(Should we base this on the direction of Mapping's LRS centerline)

### Begin Treatment (text menu)

Begin Treatment refers to the approach End Treatment of a section of guardrail, based on the direction of vehicular traffic. It can be a guardrail terminal, such as a G-1d or a MELT, it could be an adjacent section of guardrail with curb board, or it could be a connection point with bridge rail. Note: Bridge rail is not collected as part of Asset Management data collection criteria.

**Begin Flare** (text menu) A flared guardrail terminal **diverges** away from the road, while the tangential guardrail terminal **remains** parallel with the edge of the road. See **detail** above.

### Comments

This is a space to put any other relevant comments, such as erosion or other unexpected rail conditions

## End Rail

### GID (numeric)

Unique identifier used to link the begin and the end of the guardrail **run**.

### Direction (text menu)

Traveling direction base on the Route's signage. (Should we base this on the direction of Mapping's LRS centerline)

### Side (text menu)

Which side of the road the guardrail is on. (Should we base this on the direction of Mapping's LRS centerline)

### Overall Condition (text menu)

- **Excellent** Rail appears to have no visible damage.
- **Good** Rail may have some damage (up to 10% of rail), but it does not impair the safe functioning of the rail itself.
- **Fair** Rail has significant damage (up to 50% of rail), or damage that severely limits its functionality.
- **Poor** Rail is heavily damaged (over 50%), and/or is unable to function.

### Post Type (text menu)

- **Wood**
- **Steel** (there is a heavy steel post, and a light steel post)
- **Steel with Wood Approach** (the beginning and end sections will have wood posts and spacers)
- **Weathered**

**Spacer:**

- **Steel**
- **Steel with Wood Approach** (the beginning and end sections will have wood posts and spacers)
- **Wood**
- **Composite**
- **Mixture**
- **None**
- **Other-Comment?? How**

**End Treatment** (text menu)

End Treatment refers to the trailing End Treatment of a section of guardrail, based on the direction of vehicular traffic. It could be a guardrail Terminal Section, such as a G-1d or a MELT, it could be an adjacent Standard Section of guardrail with Curb Board, or it could be a connection point with bridge rail. Note: Bridge rail is not collected as part of Asset Management data collection criteria.

**End Flare** (text menu)

refer to begin flare text from the “Begin Rail” subsection.

**Curb Board** (text menu)

YES/NO Curb Board is Treated Timber Curbing. It is pressure treated planking attached to the guardrail posts, and a bituminous concrete pavement fillet is installed against it, creating a barrier against the erosive effects of flowing water. It channels the rainfall along a section of guardrail, and often ends at a drop inlet. See photo below.



**Comments:**

This is a space to put any other relevant comments, such as erosion or other unexpected rail conditions.



## Rail Types

### **Galvanized Steel Beam Guardrail**

Steel Beam Guardrail is often referred to as W-Beam Guardrail due to its shape. The standard section length is 12' -6". The W-beam panels do not have slots, as does the Slotted Rail Terminal shown in the photo.



### **Weathered Steel Beam Guardrail**

Weathered Steel Beam Guardrail has the same characteristics as does Galvanized Steel Beam Guardrail, but the rust prevention coating has been omitted.



### **Box Beam Guardrail**

Box Beam Guardrail is a 6" x 6" closed steel tube mounted on light steel posts. In the photo on the right the material for both the rail and posts is of weathered steel.



## 2 Cable Guardrail – Wood Post

2 Cable Guardrail on Wood Posts are not being used on new installations, but can still be found in many locations across the state.



## 3 Cable Guardrail – Steel Post

3 Cable Guardrail on Steel Post installations have three  $\frac{3}{4}$ " steel cables. The steel posts are 3" x 2  $\frac{1}{2}$ " and are driven into the ground. They are most likely found on the Interstate system.



## 3 Cable Guardrail – Wood Post

3 Cable Guardrail on Wood Posts installations have three  $\frac{3}{4}$ " steel cables. The wood posts are 5" in diameter, and are driven into the ground.



## Brifen Wire Rope Safety Fence

This installation of Brifen Wire Rope Safety Fence utilizes four  $\frac{3}{4}$ " steel cables. Other installations may use fewer cables. The top cable passes through a slot in the post. The remaining cables are woven alternately from front face of post to back face of post. The posts are set into sockets in concrete foundations. There are black polyethylene caps on the posts.



## Steel Backed Timber Guardrail

Steel Backed Timber Rail is shown in both photos. The wood post is 10" x 12". The timber rail is 6" thick x 10" tall, and is backed by a 6" tall by 3/8" thick steel plate. The wood offset block is 9" x 10" x 4" thick.



## Thrie-beam Guardrail



## Concrete Median Barrier

Are we collecting concrete median barrier under guardrail features? It is usually a bridge railing. I suggest adding it to the pull down list, just in case.



**W-Beam median barrier**



**Thrie-Beam median barrier**



## Guardrail Terminal Types



**Breakaway Cable Terminal (G-15)** - The Breakaway Cable Terminal is a flared end terminal. The identifying features are posts 1 & 2 are 6" x 6" steel tubes. It has a steel cable connecting post 1 to the W-beam panel. There is no strut between posts 1 & 2. It always has



**FLEAT 350** - The FLEAT 350 Terminal is a (Flared Energy Absorbing Terminal). Identifying features are a square impact head, a steel cable connecting post 1 to the W-beam panel, and a strut between posts 1 & 2. Posts 1 & 2 have steel foundation tubes. Posts 1 thru 8 are weakened wood posts (3 ½" holes at ground line)



**FLEAT SP** - The FLEAT SP Terminal is a (Flared Energy Absorbing Terminal). The FLEAT SP end terminal is built with steel posts



**G1-D** – The G-1D end terminal is a single W-beam 12'-6" panel, shop bent to a 16' radius. It has an anchor rod which connects to a buried anchor. It has a rounded W-beam End Section (know as a "boxing glove", in this case, open style).





**MELT** – The MELT is a Modified Eccentric Loader Terminal, and is a flared end terminal. Identifying features are a diaphragm plate inside the End Section (boxing glove). There is a steel cable connecting post 1 to the W-beam panel, and a strut between posts 1 & 2. Posts 1 & 2 have steel foundation tubes. Posts 1 thru 6 are weakened wood posts (3 ½” holes at ground line). It always has wood posts. The “boxing glove is a closed style.



**SRT 350 8'** - The SRT is a Slotted Rail Terminal, and is a flared end terminal. The first and second w-beam panels have been slotted to weaken them. It has an open style “boxing glove”, a cable, and a strut. The SRT 350 8’ end terminal is built with wood posts



**SRT-27 and SRT-31** - The SRT is a Slotted Rail Terminal, and is a flared end terminal. The first and second w-beam panels have been slotted to weaken them. It has an open style “boxing glove”, a cable, and a strut. The SRT-27 and SRT-31 end terminals are built with steel posts. The SRT-31 does not have offset blocks.



**Texas Twist** – The Texas Twist is a flared end terminal. The first and second w-beam panels (25') are without posts. The end of this 25' connects to a buried anchor. It is usually found on one way roads, on the trailing end of a run of guardrail.



**Trailing End Terminal** – The Trailing End Terminal is a tangential end terminal. The anchor and “boxing glove” are the same as the G-1D terminal, except the panels are not bent to a 16' radius. Due to its potential for spearing oncoming vehicles, it is only found on one way roads, and only on the trailing end of a run of guardrail. The “boxing glove” is open style.



**SKT 350** – The SKT (Sequential Kinking Terminal) is an energy absorbing tangent terminal. The SKT is 50'-0" long and has 8 posts. The SKT 350 is made with wood posts. The end piece is more square-shaped than the FLEAT end terminal.



**SKT SP** – The SKT (Sequential Kinking Terminal) is an energy absorbing tangent terminal. The SKT is 50'-0" long and has 8 posts. The SKT SP is made with steel posts. The end piece is more square-shaped than the FLEAT end terminal.



**BIB-BURIED** – The BIB-BURIED terminal is a W-Beam end section that goes into the earth.



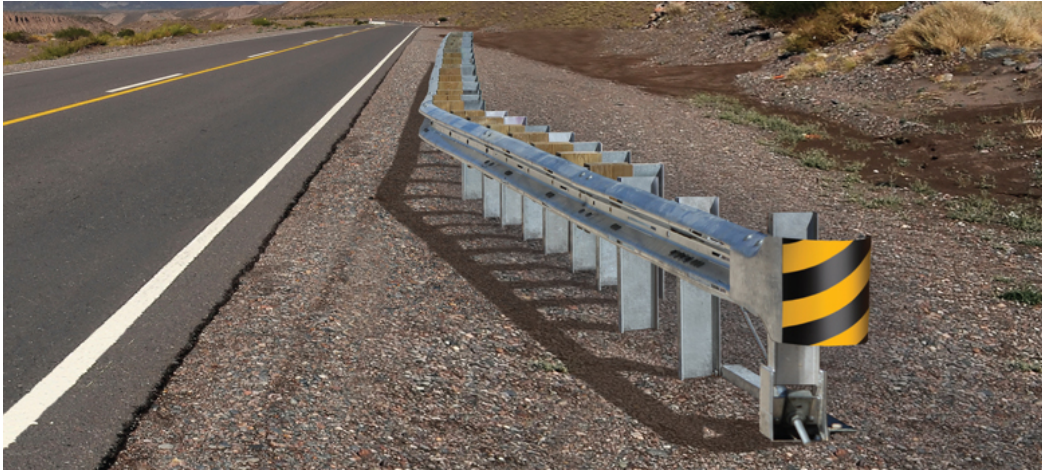
**ET-PLUS** – The ET-PLUS is an energy absorbing Guardrail end treatment. The ET-PLUS is can be from 25' to 50' long and can have up to 9 posts. The ET-PLUS can be installed with steel or wood posts. The end piece is more rectangular shaped than the FLEAT and SKT end terminals.



**X-Lite** – More information needed



**SoftStop** – More information needed



**SRT M10** – More information needed

**SRT-275P** – More information needed



**MSKT**– More information needed



**STBBT**– Slotted Thrie-Beam Bullnose Terminal



**Bridge Connections:**





**A Thriebeam bridge approach terminal installed with wood posts**



**BOX BEAM END SECTIONS:**



**G1-B** – Common end treatment for box beam guardrail.



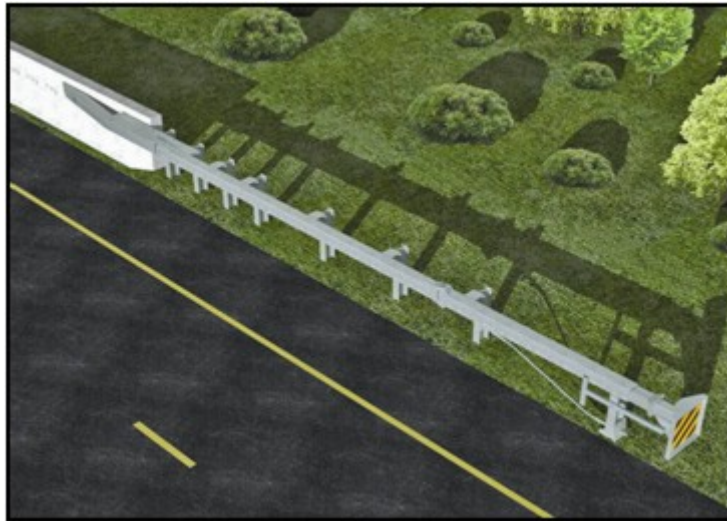
**A W-BEAM to BOXBEAM guardrail connection**



**BEAT** – The BEAT is an energy absorbing Guardrail end treatment for 6" x 6" box beam guardrail. (VTrans uses 6" x 6" Boxbeam)



**BEAT MT** – The BEAT-MT is an energy absorbing Guardrail end treatment for 6" x 8" box beam guardrail. (VTrans uses 6"x 6" Boxbeam)



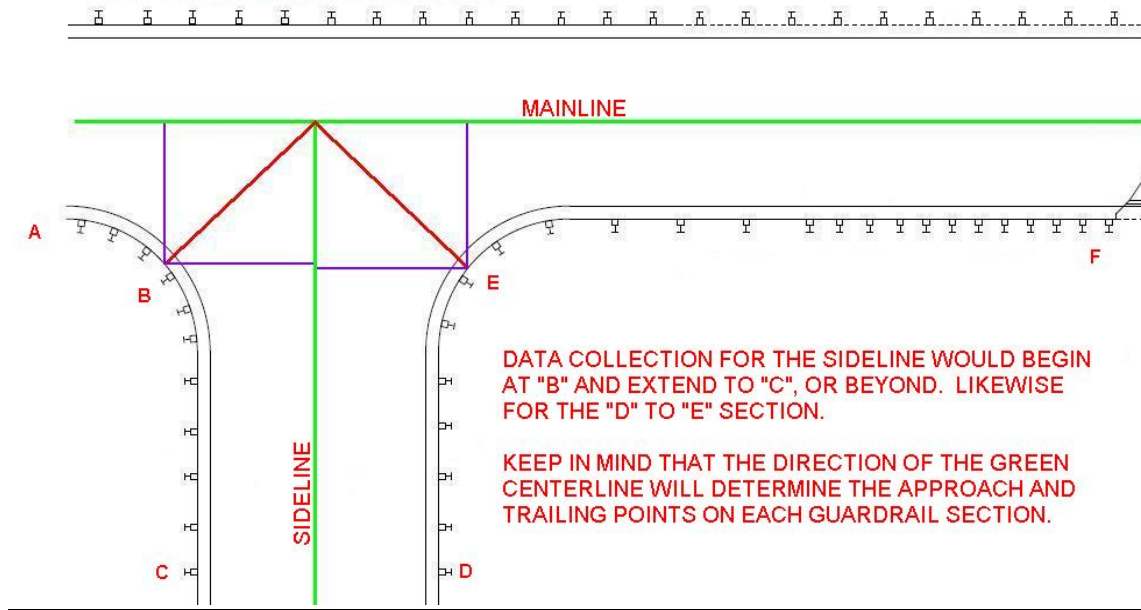
**BEAT-SSCC** – The BEAT-SSCC is an energy absorbing Guardrail end treatment for box beam guardrail. It is a BEAT end terminal used as an attachment to a rigid barrier.



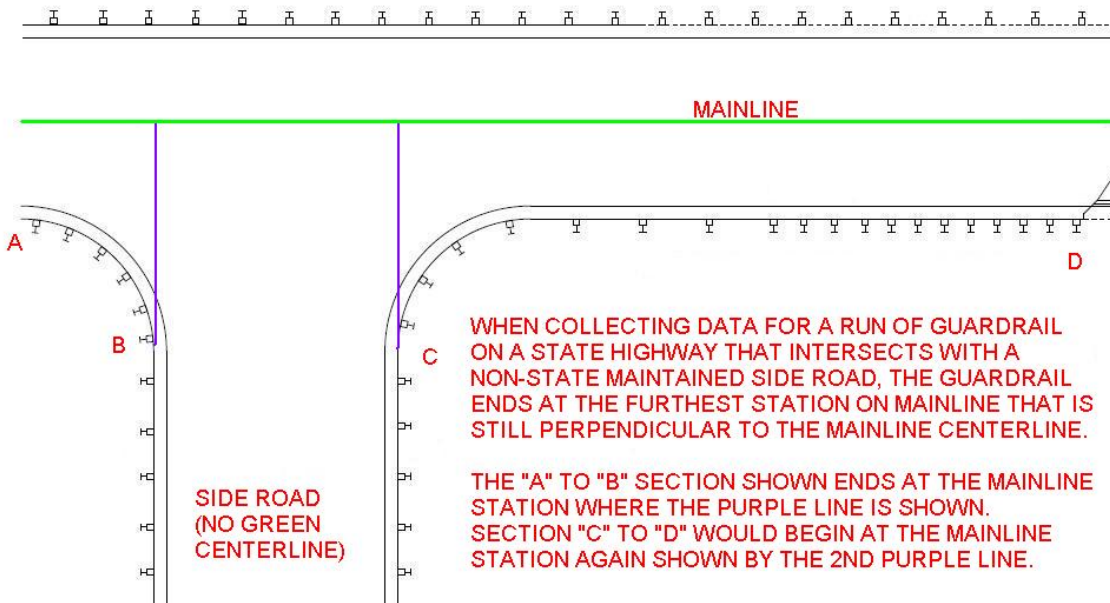
**WY-BET** – Wyoming Box Beam End Terminal

## **Guardrail Data Collection Limits at Intersections**

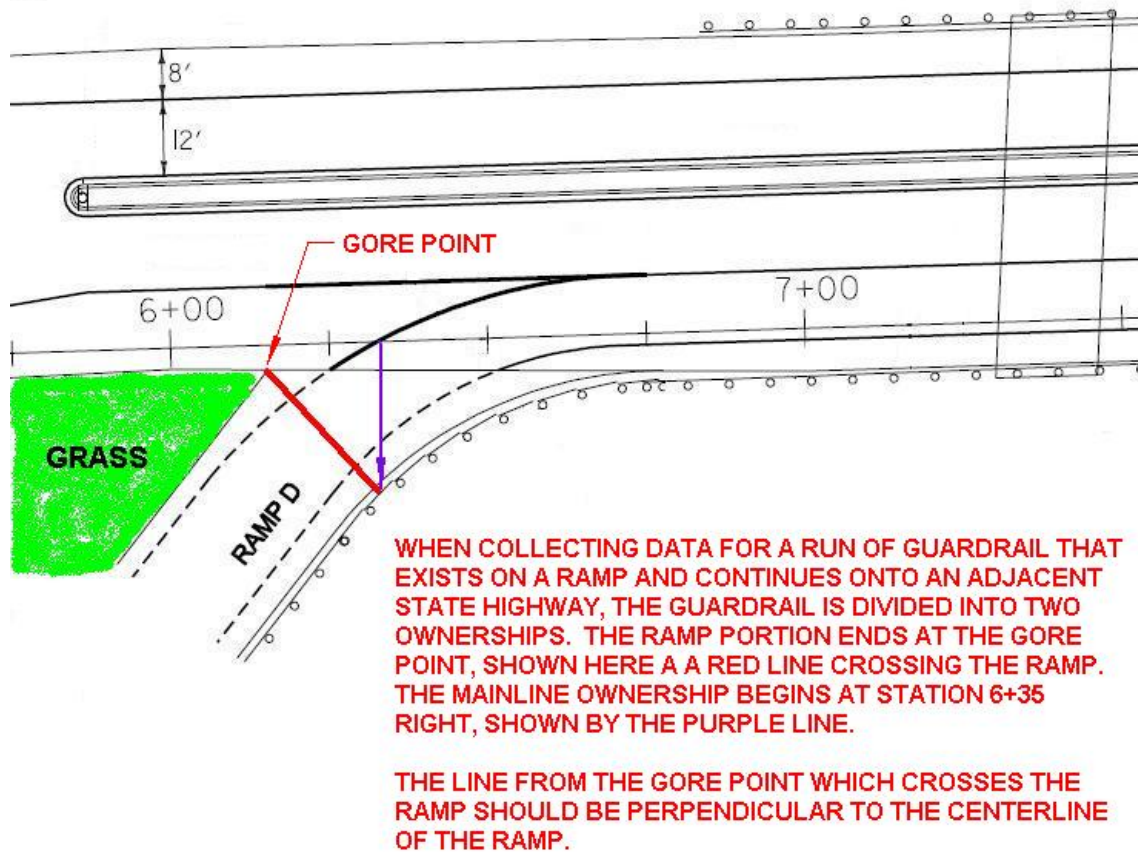
WHEN COLLECTING DATA FOR A RUN OF GUARDRAIL AT THE INTERSECTION OF TWO STATE MAINTAINED HIGHWAYS, THE GUARDRAIL IS DIVIDED INTO TWO OWNERSHIPS. THE GUARDRAIL ON MAINLINE 1 RIGHT WOULD BEGIN AT "A" AND END AT "B". A SECOND SECTION OF GUARDRAIL ON MAINLINE 1 WOULD BEGIN AT "E" AND COULD POSSIBLY END AT "F" WHERE BRIDGE RAIL BEGINS.



### Intersections with two State maintained highways



### Intersections with only one State maintained highway



**Intersections with a State maintained highway and a ramp**