ATTACHMENT C

"S" CURVE ALTERNATIVE PLAN

S-Curve Alternative Plan

Ravenna Planning Study

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CR 74 S-CURVE ALTERNATIVE PLAN

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CR 74 S-CURVE ALTERNATIVE PLAN

Existing Conditions

The CR 74 S-Curve is a combination of two horizontal curves on CR 74 where the Norfolk Southern railroad crosses over CR 74 via an old railroad bridge. The S-Curve is near the intersection of CR 74 (South Prospect Street) and Summit Road on the south side of Ravenna Township (See **Exhibit 1**). In this area, CR 74 functions as an urban minor arterial and is the main north/south connector between I-76 and Downtown Ravenna. CR 74 is a two-lane roadway that varies in speed between 25 mph and 55 mph. The posted speed limit at the S-Curve is 45 mph; the speed limit is reduced to 25 mph at the southern corporation limit of the City of Ravenna, located just under 0.5-mile north of the S-Curve (See **Exhibit 2**). The existing degree of curvature for both curves is approximately 50 degrees.

Existing signage includes chevrons, vertical delineators, vertical clearance warnings, directional arrows, and warning signs for the approaching S-Curve (See **Exhibit 3**). Traffic counts performed in 2011 at locations along Summit Road and South Prospect Street measured an average daily traffic (ADT) of 6,320 vehicles along Summit Road and an ADT of 10,340 vehicles along CR 74. In addition, this corridor is widely used by trucks servicing the area. The railroad which passes over the S-Curve is double wide and owned by Norfolk Southern Railroad. The extent of the property owned by Norfolk Southern extends approximately 35 ft from the edge of the outermost rail lines. (See **Exhibit 4**). While the railroad is active, but there is limited information available about its usage.

Identified Issues

At this section of CR 74, several safety-related issues were identified (the standards used in this evaluation came from ODOT's Location & Design Manual):

- **Substandard Horizontal Curves**
  There are two back-to-back horizontal curves on either side of the railroad overpass, that form an 'S.' For a speed of 45 mph, each of the horizontal curves should have a maximum degree of curvature of 8 degrees; instead the existing degree of curvature is approximately 50 degrees, which is appropriate for a design speed of 22 mph (as per ODOT L&D Manual).

- **Substandard Roadway Lateral Clearance**
  The roadway underpass of the rail line is very narrow – there are only a couple feet of clearance on either side of the roadway. ODOT standards require an arterial with an ADT greater than 2,000 to have a minimum lateral clearance of 8 feet on either side of the roadway.

- **Substandard Horizontal Sight Distance**
  With the horizontal curves and narrow bridge, the horizontal sight distances are substandard for this roadway. This situation causes potential problems for the drivers on CR 74 and for the drivers attempting to navigate the nearby intersections of Hayes Road and Summit Road. The offset from the lane of travel to the edge of the view obstruction around the curves for this roadway, assuming drivers are traveling 25 mph should be about 20 feet. The existing offset is approximately 20 feet. However, for a 45 mph road, the offset should be 260 feet.

- **Substandard Vertical Clearance**

The existing vertical clearance of the railroad bridge is 13 feet, which is 3.5 feet below the minimum required 16.5 feet for an arterial roadway (as per ODOT L&D Manual).

- **CR 74/Hayes Road Skewed Intersection**
  The existing CR 74/Hayes Road intersection is a T-intersection. Hayes Road connects with CR 74 at an approximately 50 degree angle along a curved section of CR 74.

Case Studies

Research was performed to determine how these types of bridges and horizontal curves have been addressed in other locations around the U.S.

For the bridge, the main types of treatments that have been used in other locations included:

- **Raising the Bridge and Raising/Widening the Roadway**
  One alternative that is often considered when addressing railroad overpass issues is raising the railroad tracks and widening the underlying roadway. Underpasses in general can cause drainage issues and dangerous driving conditions for the underlying roadway. In this event, one proposed solution is raising both the roadway and railroad to eliminate the amount of water runoff. Widening the roadway assists in improving drainage of the water runoff, as well as improving visibility around the underpass. Several projects have considered such measures like US 14 in Barrington, IL, and 53rd Street in Corvallis, OR. Both communities avoided these measures, however, largely because of the collaboration that would be required of the railroad companies and the increased noise and visibility from the increased elevation of the railroad tracks.

- **Relocating the Overpass**
  In the case of US 14 in Barrington, IL, the town decided to move forward in considering a shifting of the road. The option was considered in an effort to accommodate higher loads of traffic. Increased widths necessitate right-of-way acquisitions, which can often require homeowner displacement. Shifting an overpass can ease the acquisitions and result in little to no displacement. While still under review, other cases often disregard this method based on the high cost of the project and the increased level of cooperation required from the railroad companies.

- **Rerouting Intersecting Roads**
  Historic US 61 at Rock Creek used to travel north and make a sharp turn west to cut under a railroad before turning north again. A bypass, which generated a gentler curve nearly a half mile before and after a new overpass was constructed, eliminating the curves so close the previous overpass. The new road alignment resulted in a straight road intersecting the railway, resulting in safer driving conditions.

Due to the high-costs and uniqueness of project sites, cost/benefit studies have not been able to yield any verifiable results as of yet so as to decide which method is the most effective.

For horizontal curves, the main types of treatments included:

- **Delineators**
  Post-mounted delineators provide drivers tracking information both in the curve approach and throughout the action of maneuvering the curve. A Report by the National Cooperative Highways Research Program indicated that post-mounted

delineators can reduce off-road crashes by as much as 15%, while the Federal Highway Administration has calculated numbers as high as 25%-58%. Researchers in Virginia studied various delineation treatments and found that drivers responded better to chevrons for curves, like the one at CR 74 and Summit Road, that exceed 7 degrees. Various other studies performed in Montana, and Kansas yielded similar reductions in crashes by a minimum of 33% and 25% respectively.

- **Raised Pavement Markers**
  A study in Georgia in the 1970's on curves greater than 6 degrees yielded crash reductions of 9%. This includes a 22% greater reduction in crashes at night over daytime equivalents at the same site. A 1990's study in New York showed that the raised pavement markers were responsible for reducing crashes by 7%, with a 26% decrease in nighttime crashes and a 33% decrease in wet weather, nighttime crashes. Most notably, there was a 23% reduction in crashes related to guidance errors; head-on collisions, encroachments, sideswipes, and off-road crashes.

Identified Solutions

From the case study research and from evaluation of the existing conditions, alternatives have been developed for this study. These alternatives address the identified issues in varying degrees of effectiveness and are described below. In addition, a planning-level analysis was performed on these alternatives to identify the degree of positive benefits and negative impacts, comparatively between the alternatives (See **Exhibit 5**).

The solutions are grouped into three categories:

- **Low-Cost Solutions** include options to address some of the identified issues without structural modifications to the railroad bridge or roadways.
- **Medium-Cost Solutions** include options to address some of the identified issues with structural modifications to either the railroad bridge or roadways.
- **High-Cost Solutions** include options to address all of the identified issues with structural modifications to both the railroad bridge and the roadways.

➢ Low-Cost Solutions

These alternatives (except the No Build) address some of the identified issues to a minor degree, and they avoid impacts to the railroad bridge, right-of-way, and major roadway modifications. They are all low-cost solutions so could be implemented in the short-term, depending on funding availability.

1. **No Build**
   This option is listed for comparison purposes. All of the identified issues would remain with this alternative, but there would be no impacts to the bridge, roadways or right-of-way. The only costs associated with this alternative would be the ongoing maintenance of the roadways and bridge.

2. **Speed Limit Reduction**
   As shown in **Exhibit 2**, the posted speed limit is 45 mph in this area. Less than 0.5 mile north of this location at the southern corporation limits of the City of Ravenna, the posted speed limit is 25 mph. Thus, this alternative proposes to reduce the posted speed limit from the southern corporation limit of the City south to just south of Timber Run to 35 mph. This will not only assist in reducing the speed of the traffic well before approaching the S-Curve but will also offer a more incremental transition between the

45 mph section and the 25 mph section of CR 74. There are numerous residences and residential streets within this area, so a lower speed limit would also be more compatible with these land uses.

Impacts: This alternative would not have any impacts to the bridge, roadways, or to right-of-way. The only costs associated with this alternative would be with the purchase and installation of the speed limit signage.

3. **Install/Update Signage & Pavement Markings**

As shown in **Exhibit 3**, there is existing signage on both approaches to the S-Curve section that address the horizontal curves and the bridge. This alternative proposes to install additional signage and to update some of the existing signage and pavement markings in order to more clearly warn vehicles of the horizontal curves.

Flashing Warning Signage: Additional horizontal curve warning signage with flashing beacons could be installed on both approaches to the S-Curve. A variation to this option would be to install flashing beacons to the top of the existing vertical clearance warning signage or the directional arrow signs. The flashing beacons would be an additional method of making vehicles aware of the need to slow down for the horizontal curves.

Chevron Signage: Currently, there are three directional chevron signs installed on the southern curve for northbound vehicles on CR 74. For a bigger visual impact, additional chevron signs could be placed in this location to create a larger visual impact along the curve for northbound traffic. In addition, there are no chevron signs north of the bridge, so new chevron signs could be installed that guide southbound vehicles on CR 74 as they approach the northern curve.

Retroreflective Signage Retrofits: Existing and new signs should be installed with high-intensity retroreflective sheeting for better visibility during nighttime driving conditions.

Raised Pavement Markers: Raised pavement markers add delineation qualities to the horizontal curves and provide additional benefits to nighttime driving conditions. Raised pavement markers can also be retroreflective (reflect light back to the source) to enhance their visibility in the dark.

Impacts: This alternative would not have any impacts to the bridge or to right-of-way. Temporary minimal impacts to the roadway would occur during installation of the signs and raised pavement markings related to maintenance of traffic activities. The costs associated with this alternative would be the purchase and installation of the signage and raised pavement markers.

4. **Aesthetic Treatments**

Another opportunity to address the railroad bridge in a low-cost way is to 'celebrate' the historic nature of the bridge and to allow it to serve as a type of gateway for the City of Ravenna. The more the bridge is highlighted, the more likely vehicles are to slow down and notice it, thus navigating the S-Curve more safely. Several options could be explored for this alternative in the form of landscaping, paint, and a mural. A comparative example of these treatments is shown in the **below images**.

Landscaping: The foliage on both sides of the bridge could be cleared out and replaced with aesthetically-pleasing, low-maintenance landscaping.
Paint: Both sides of the bridge structure could be painted to improve the look and condition of the bridge.

Mural: A mural representative of the City of Ravenna could be painted on one or both sides of the bridge in lieu of painting it a solid color. A design competition for local artists could be held, and the public could be involved by voting on the finalists.


Existing Railroad Bridge


Williamsport, MD (Gilbert 2011)

Impacts: This alternative would not have any permanent impacts to the bridge, roadway or right-of-way. Temporary minimal impacts to the bridge and roadway could occur during the painting process while workers are accessing the bridge structure. And temporary impacts to railroad-owned right-of-way could occur during the clearing and landscaping efforts. The costs associated with this alternative would include labor and purchase of landscaping and painting materials.

5. Install Stop Signs and a Signal at Intersections

As shown in **Exhibit 6**, the two nearby intersections to the S-Curve (CR 74/Summit Road and CR 74/Hayes Road) could be converted to a signalized intersection (at Summit Road) and a three-way stop-controlled intersection (at Hayes Road). Such an application would slow down vehicles in advance of the S-Curve so they could more safety navigate it. In addition, this alternative would address sight distance issues for vehicles navigating the intersections because traffic would be slower and would have to stop prior to moving through the intersections. In fact, the Portage County Engineer plans to install a traffic signal at the Summit Road intersection in addition to left turn lanes on CR 74 at both the Summit Road and Hayes Road intersections.

Impacts: This alternative would not have any impacts to the bridge and minor impacts to right-of-way and the roadway during the conversion to the signalized and three-way stop-controlled intersections related to widening the roadway for the left turn lanes, maintenance of traffic, and some impacts to traffic flow would occur as a result of the

conversions since vehicles on CR 74 would now have to stop at these two intersections. The costs associated with this alternative would include new pavement, installation and materials of advanced signage for the intersections, stop signs, signal, and related pavement markings.

- **Medium-Cost Solutions**

These solutions are a balance between the low-cost and high-cost solutions. They address the identified issues as much as possible while restricting impacts to only the bridge or only the roadways, but not both. Depending on final cost estimates and funding availability, these alternatives could be constructed in near-, medium-, or long-term timeframes.

6. **Raise & Widen Railroad Bridge**

As shown in **Exhibit 4** and discussed in the identified issues section, the lateral clearance on either side of CR 74 under the bridge is too narrow and the vertical clearance is too low to meet minimum standards. This alternative proposes to raise the railroad bridge from 13 feet to 16.5 feet, in addition to widening the bridge from the approximate two-foot lateral clearance to eight-foot lateral clearance on either side of the roadway to meet minimum standards. However, the limited sight distances would not be addressed with an eight-foot lateral clearance, so the bridge could be widened an additional amount to improve sight distances through the S-Curve.

Impacts: This alternative would not address the substandard horizontal curves or the skewed CR 74/Hayes Road intersection, but it would effectively address the vertical clearance and narrow underpass issues, in addition to moderately addressing the sight-distance issues. For negative impacts, this alternative would impact the rail lines and the bridge and have high costs associated with reconstructing the bridge and the associated grading work. Temporary impacts to the roadway would occur during the bridge construction related to maintenance of traffic, and but no additional direct roadway impacts should be incurred. And minor strips of right-of-way may be required with the increase in the bridge footprint but no full right-of-way takes should be needed.

7. **Lower CR 74**

To address the vertical clearance issue without major disruption to the rail line operation or bridge, CR 74 could be lowered 3.5 feet. Due to the already narrow lateral clearances, the bridge would need some structural work for reinforcement and retaining walls would be needed.

Impacts: This alternative would address the vertical clearance issues but none of the other issues. For negative impacts, this alternative should not impact the rail line operations, but would impact the supporting structure of the bridge. Impacts to the roadway would occur from excavation and regrading, and minor strips of right-of-way may be required but no full right-of-way takes should be needed. In addition, flood control measures would need to be introduced due to the frequent flooding of the existing roadway. The costs would be moderately high for lowering the roadway, reinforcing the bridge structure, and installing retaining walls.

8. **Install Roundabouts**

This alternative proposes to install roundabouts at the CR 74/Summit Road intersection and CR 74/Hayes Road intersection (see **Exhibit 7**). This alternative is similar to Alternative 5 (Three-Way Stop-Controlled Intersection Conversions) because it slows

down traffic prior to the S-Curve and allows for vehicles to more easily navigate the two intersections. However, it is a much more effective solution because it allows for a continuous flow in traffic on CR 74 and it addresses the CR 74/Hayes Road skewed intersection. The roundabouts shown in the exhibit were designed with 130-foot diameters, which is the minimum width needed for a standard single-lane roundabout that can be used by all typical vehicle types at a design speed of 20-25 mph (as per FHWA's Roundabout Technical Guidance, 2010); however, please note that smaller diameters (down to 90 feet) could be used if all vehicle types do not need to be accommodated.

Impacts: This alternative would address all of the identified issues in varying degrees except for the vertical clearance issue – it will reduce traffic speeds, thus allowing for safer driving of the horizontal curves, shorter needed sight distances, and less of an issue for the narrow underpass and it would realign the skewed intersection. For negative impacts, this alternative would not impact the rail line operations or the bridge. Impacts to the roadway would occur at the two intersections for installation of the roundabouts. Some permanent right-of-way would be required to account for the larger roundabout footprint as compared to the existing intersections; however, no total right-of-way takes should be needed and the roundabouts can be situated to minimize right-of-way impacts. There would not be any costs associated with the bridge but there would be a moderately high cost for installing the roundabouts. **Please note that the goal of this alternative was to maximize addressing the identified issues as much as possible while completely avoiding impacts to the railroad bridge and rail line operations.**

- **High-Cost Solutions**

These alternatives address all of the identified issues. However, they also have the highest costs because they involve structural modifications to both the railroad bridge and nearby roadways. These alternatives are most likely long-term solutions due to their high costs and high impacts.

9. Straighten CR 74 S-Curve

This alternative straightens the S-Curve on CR 74 to meet minimum horizontal curve standards for a 35 mph roadway (see **Exhibit 8**). It also addresses the skewed CR 74/Hayes Road intersection so that it would be at a 90 degree angle. The railroad bridge would be reconstructed to account for the new alignment of CR 74 and appropriate lateral clearances, sight distances, and vertical clearances. This alternative addresses all of the identified issues while essentially leaving CR 74 in the same location and keeping the roadway network connectivity the same.

Impacts: This alternative would fully address all of the identified issues, but it results in substantial impacts and costs. The rail line operations and bridge would be impacted while the bridge is rebuilt. The roadways would be impacted due to realignment of CR 74. Permanent right-of-way would be required to account for realignment of CR 74 and possibly the larger bridge footprint; however, no total right-of-way takes should be needed. As a result there would be high costs associated with the bridge, the roadway, and possibly the right-of-way acquisition.

10. Connect Summit Road to Hayes Road

Instead of attempting to fix the identified issues "in place" as in Alternative 9, this alternative identified a different roadway network connectivity that will address all of

the identified issues. This alternative proposes to abandon the current S-Curve location and create a new east-west connection between Summit and Hayes roads. (see **Exhibit 9**). As shown in the exhibit, the S-Curve would be abandoned by motorized vehicles with the option to retain the old route but convert it to multi-use path for pedestrians and bicyclists. All roadways would be straight with 90 degree connections to intersecting roadways. A new railroad bridge would be constructed to the south of the existing one to account for the new connection and would include appropriate lateral clearances, sight distances, and vertical clearances. This alternative addresses all of the identified issues by changing the roadway network connections.

Impacts: This alternative would fully address all of the identified issues, but it results in substantial impacts and costs. The rail line operations would be impacted while the new bridge is built. The roadway network would be impacted due to the new connections but maintenance of traffic may be easier since the existing CR 74 alignment could be maintained during construction of the new bridge and associated connections. Permanent right-of-way would be required to account for the new connection of Summit and Hayes roads and the new bridge; however, no total right-of-way takes should be needed. As a result there would be high costs associated with the bridge, the roadway, and possibly the right-of-way acquisition.

- **High-Cost Solution Comparisons:**
  - ✓ Traffic Flow: Alternative 9 offers a continuous trip along CR 74, but it has horizontal curves designed for a 35 mph roadway, not a 45 mph roadway. Alternative 10 would require vehicles to turn at two T-intersections to travel along CR 74, but both intersections are at 90 degrees and there are no substandard horizontal curves.
  - ✓ Bridge: Alternative 9 would reconstruct the railroad bridge in essentially the same location while Alternative 10 requires a new location. However, the new bridge for Alternative 10 has the option to become an over or underpass and would not need to be as long of a span because the roadway would cross at 90 degrees.
  - ✓ Maintenance of Traffic: Alternative 10 would more easily be able to maintain and detour traffic because the existing CR 74 alignment could be retained during construction of the new connection. Alternative 9 would require less convenient detouring alongside roads.
  - ✓ Right-of-Way: Alternative 10 would have slightly less right-of-way impacts. Both alternatives will impact railroad right-of-way, but Alternative 9 is shifting a longer section of CR 74 outside its existing footprint.
  - ✓ Cost: The bridge for Alternative 9 is modifying the existing bridge in place, however that bridge has to be wider than the bridge for Alternative 10 due to its skewed crossing, so the bridge costs may be similar. The roadway and right-of-way costs may be a little higher for Alternative 9 due to the greater amount of new pavement and right-of-way than for Alternative 10.

➢ **Combinations, Variations & Phasing**

- Combinations:
  - ✓ Alternatives 2 (Speed Limit Reduction), 3 (Signage & Pavement Markings) & 4 (Aesthetic Treatments) could be combined with any of the other alternatives for a low cost addition.
  - ✓ Alternatives 6 (Raise/Widen Bridge) or 7 (Lower CR 74) could be combined with Alternative 8 (Roundabouts) to address the bridge issues.

- Variations:
  - ✓ Roundabouts could be considered at intersections other than just for Alternative 8 (the roundabout alternative).
  - ✓ The new bridge in Alternative 10 (New Roadway Connections) could potentially be a railroad overpass or a roadway overpass.

- Phasing: One or more of the low-cost alternatives could be implemented in the short-term while funding is pursued for the medium- or high-cost alternatives so that some improvements to this area are completed now.

Conclusions & Recommendations

Overall, there are quite a few options that could be implemented in this area to address the identified issues. The final selections depend on preference, priorities, and funding availability. The more expensive alternatives address a high number of the issues more effectively, but some low-cost alternatives could be the preferred solution, at least for the short-term.

If a medium or high-cost solution can be funded, Alternatives 8, 9 and 10 are recommended because they are the alternatives that most effectively address the identified issues. If a low-cost solution is the preference, then a combination of Alternatives 2, 3 and 4 are recommended because they are the least expensive and are the most compatible with the area with the fewest impacts to traffic flow.

The main funding sources for these alternatives include the Portage County Engineer, AMATS, and CDBG.

Exhibit 1 - CR74 S-Curve Project Location

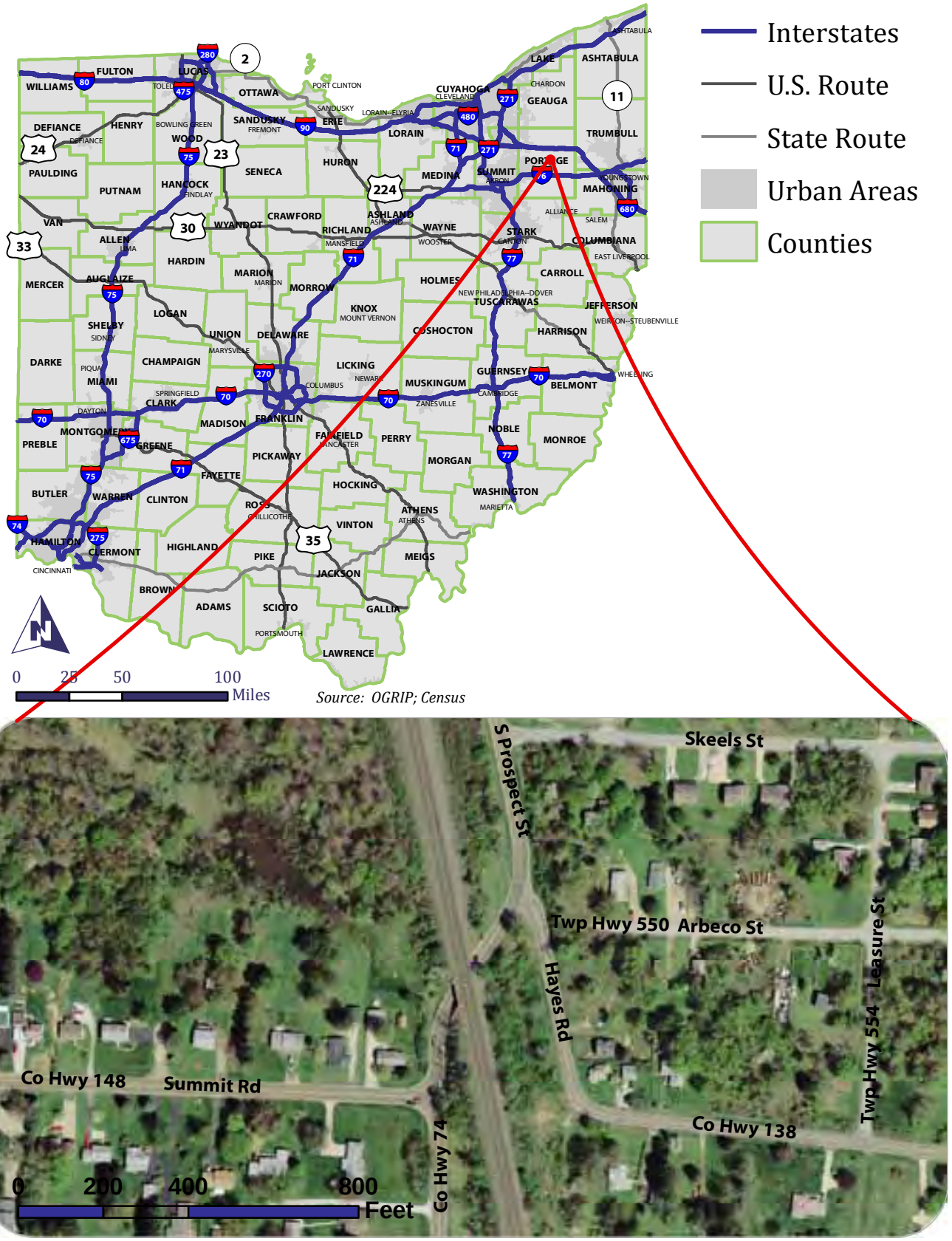


Exhibit 2 - Posted Speed Limits/Traffic Count Locations

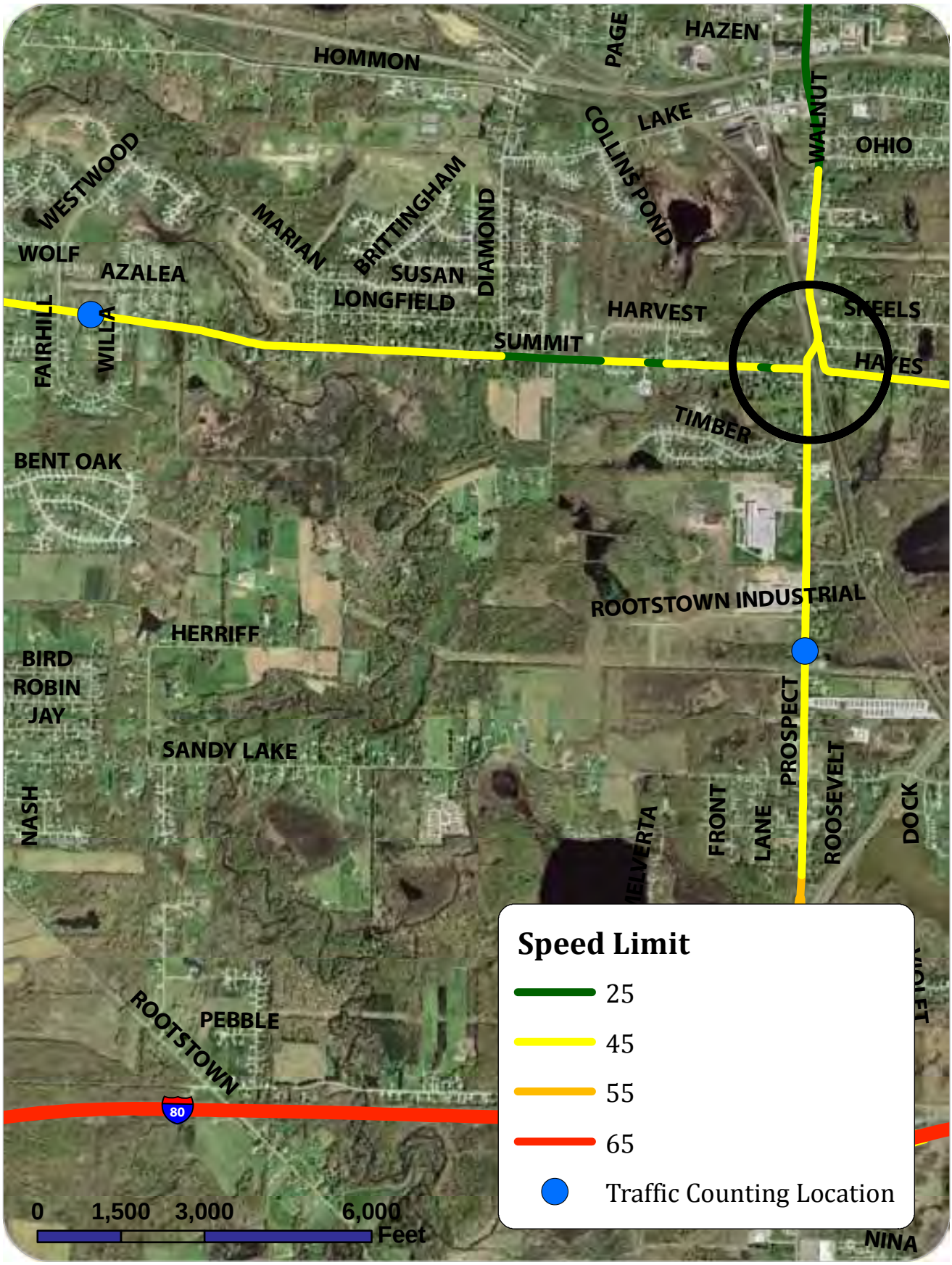
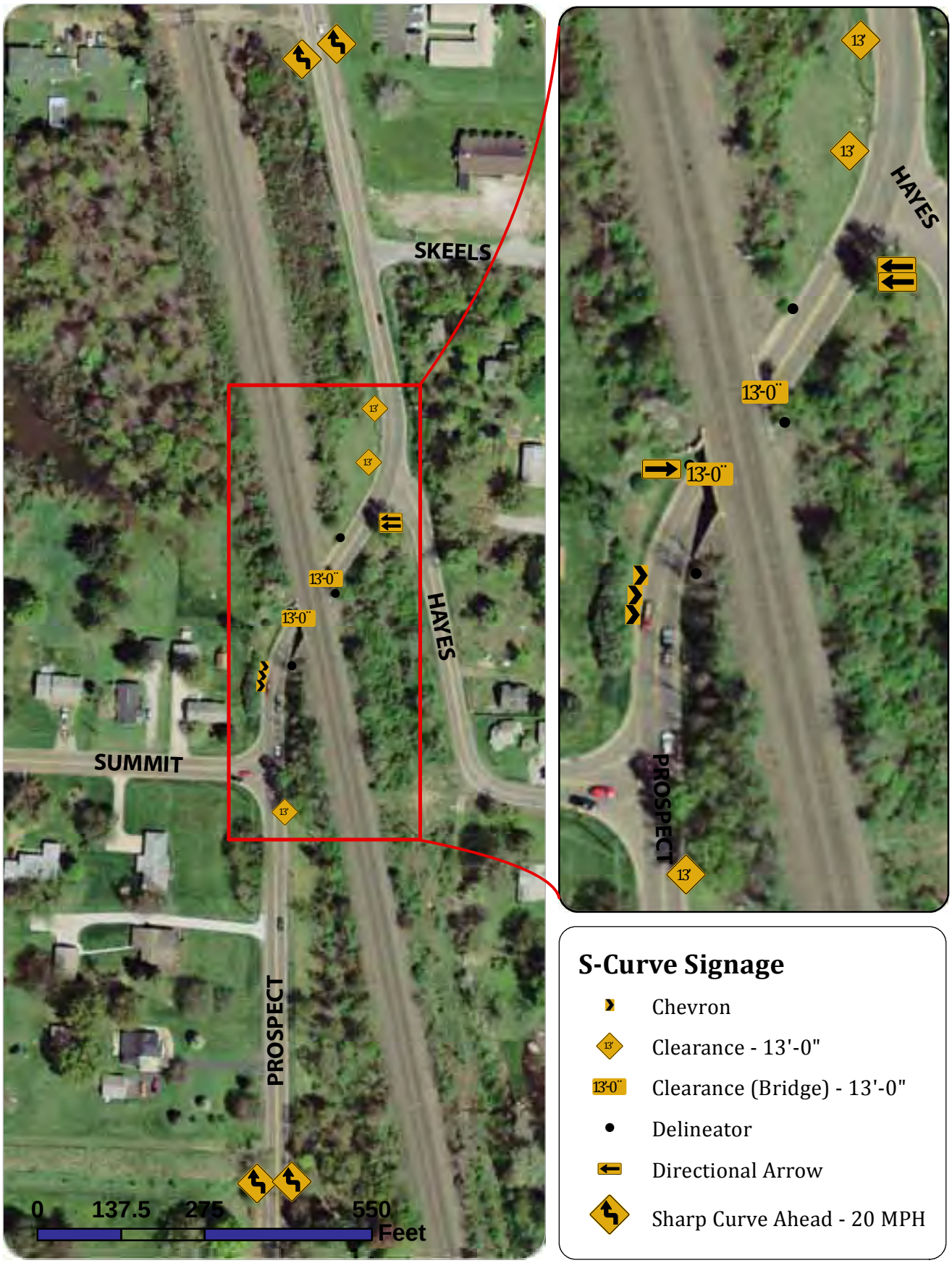


Exhibit 3 - CR74 S-Curve Signage



S-Curve Signage

- Chevron
- Clearance - 13'-0"
- Clearance (Bridge) - 13'-0"
- Delineator
- Directional Arrow
- Sharp Curve Ahead - 20 MPH

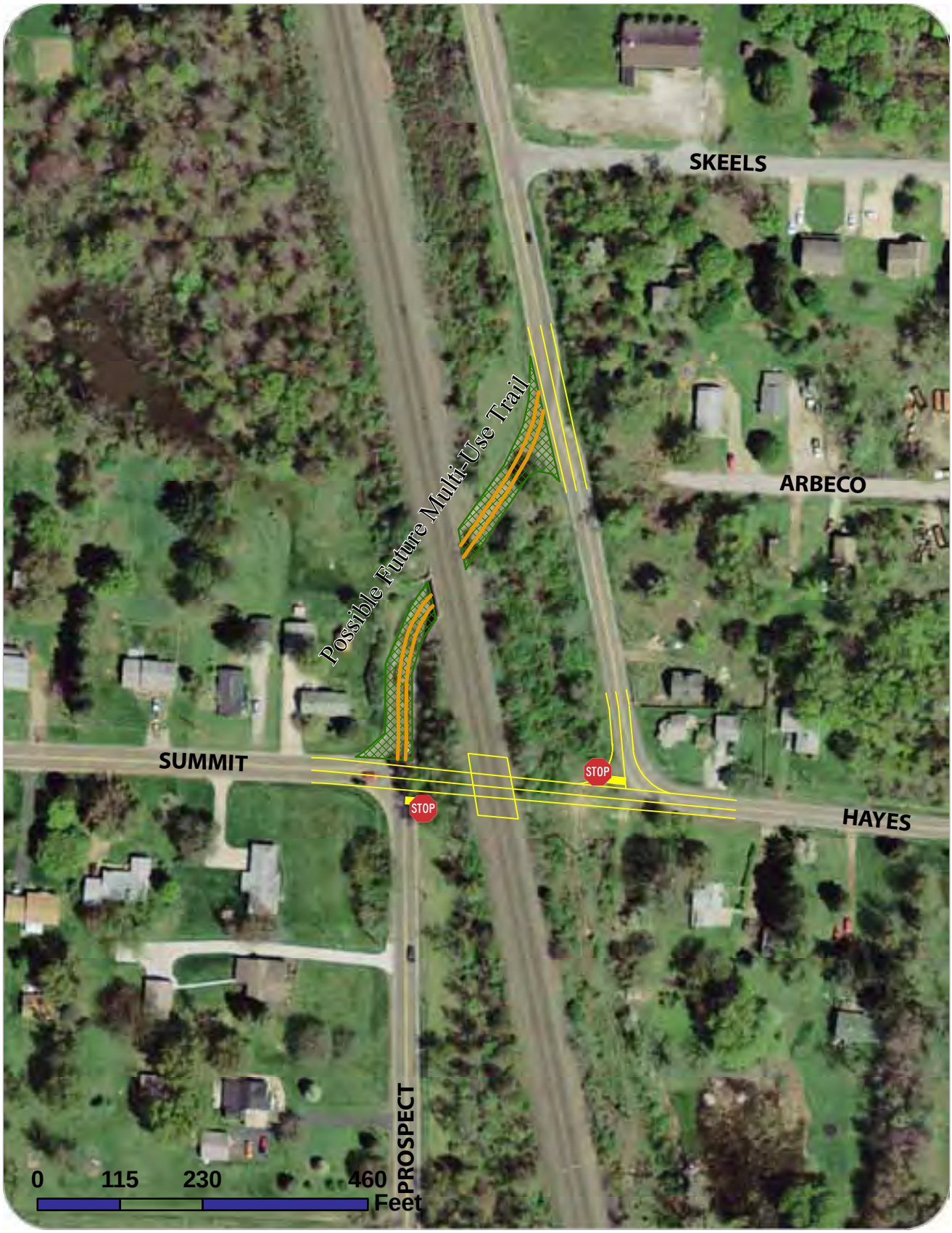
Exhibit 4 - Railroad Location and Extent of Property

Exhibit 6
Alternative 5: Stop Sign & Signal Installation

Exhibit 7
Alternative 8: Roundabouts

Exhibit 8
Alternative 9: Straighten the S-Curve

Exhibit 9
Alternative 10: New Roadway Connectivity



RAVENNA PLANNING STUDY
CR 74 S-CURVE ALTERNATIVE PLAN

Exhibit 5: Alternative Impact Matrix

	Positive Benefits					Negative Impacts		
	Horizontal Curves	Sight Distance	Vertical Clearance	Narrow Underpass	Skewed Intersection	Right-of-Way	Railroad Bridge	Cost
LOW-COST SOLUTIONS								
1. No Build	No	No	No	No	No	No	No	No
2. Speed Limit Reduction	Low	Low	No	Low	Low	No	No	Low
3. Signage & Pavement Markings	Low	Low	No	Low	Low	No	No	Low
4. Aesthetic Treatments	Low	Low	No	Low	Low	No	No	Low
5. Install Stop Signs at Intersections	Low	Low	No	Low	Low	No	No	Low
MEDIUM-COST SOLUTIONS								
6. Raise & Widen Bridge	No	Medium	High	High	No	Low	High	Medium
7. Lower CR 74	No	No	High	No	No	Low	Low	Medium
8. Install Roundabouts	Medium	Medium	No	Low	High	Medium	No	Medium
HIGH-COST SOLUTIONS								
9. Straighten S-Curve	High	High	High	High	High	High	High	High
10. Connect Summit to Hayes	High	High	High	High	High	Medium	High	High