

1.0 INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) initiated a corridor study for the KY 321 corridor at Paintsville in Johnson County. The study limits (**Figure 1**) extend from its intersection with KY 321X (Broadway) at milepoint (MP) 7.061 in the south through the KY 40 intersection at MP 8.791 in the north.

The KY 321 corridor provides access to a significant portion of Paintsville, including a regional commercial hub, two schools, a hospital, and downtown homes and businesses. It is also the primary connection between town and US 23—the main north/south highway for much of eastern Kentucky.



Figure 1: Item 12-80116 Study Area

1.1 NEW JCHS HILLTOP CAMPUS

Concurrent with the Item No. 12-80116 corridor study, there are several other developments in the area influencing demands placed on the KY 321 corridor. Most notably, Johnson County High School is being reconstructed, shifting students to a new hilltop campus currently under construction. The school is expected to open for the 2027-2028 school year.

A site plan for the property is shown in **Figure 2**. Key elevations are noted in blue; the school property sits 60-185 feet above the surrounding highway network.

A traffic impact study (TIS) was completed in January 2020, projecting traffic patterns and impacts for a 1,200-student high school with three different potential connections. The TIS concludes that “the addition of a high school at the proposed site will further degrade the KY 321 corridor if the primary access is provided along KY 321. The existing corridor has the existing high school and will be converted to another school based on discussions with the administration so traffic will not be reduced along the route...it is recommended that the primary access to the school use the existing entrance to Highland Elementary School.”

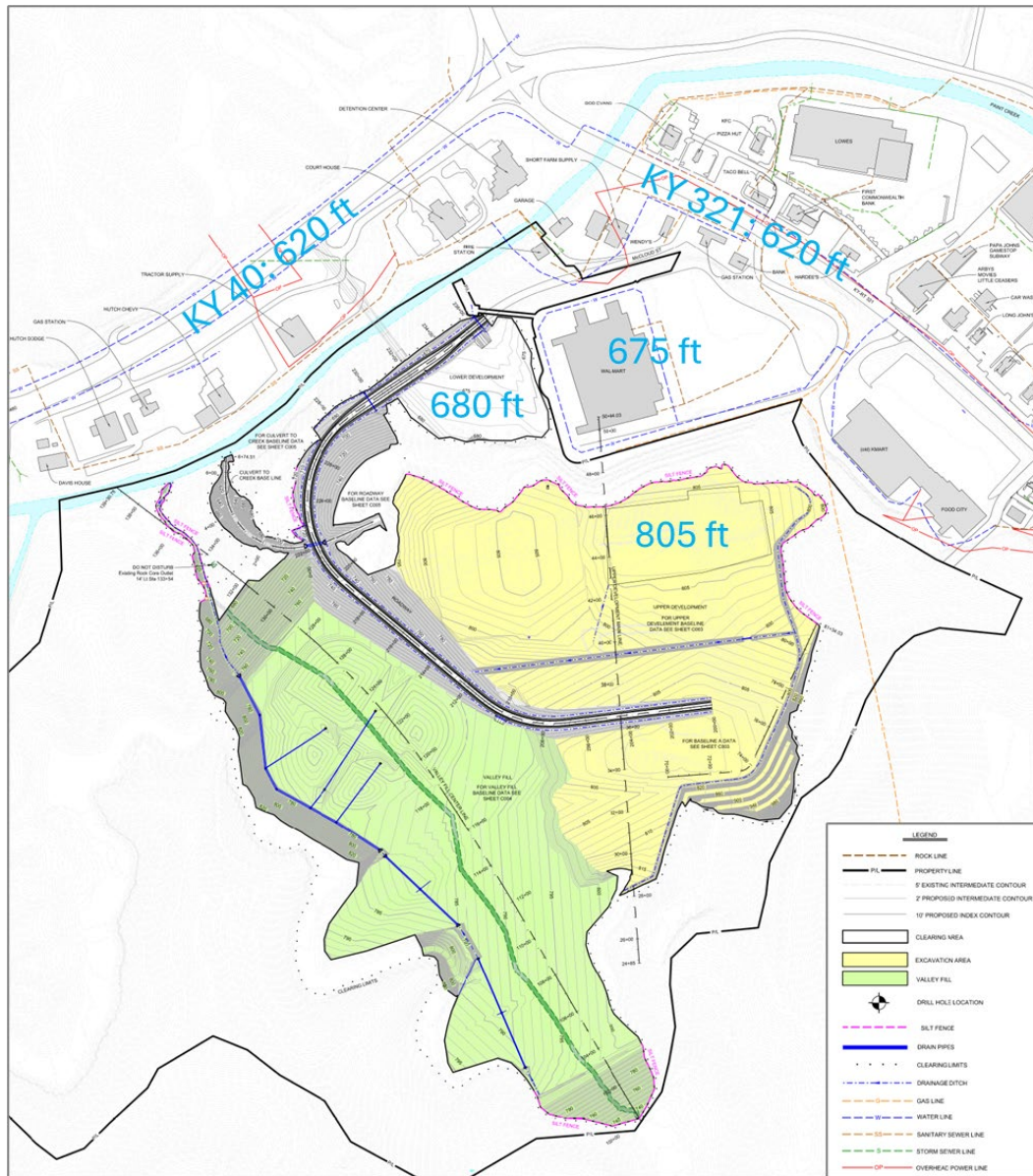


Figure 2: Site Plan for Hilltop JCHS Campus

Shown in **Figure 3**, construction access to the site is provided via a steep (approximately 10% grade) gravel road from McCloud Street, tying to KY 321 at MP 8.602 near Wendy’s. The existing intersection is stop-controlled for the minor approach with a frontage road connection paralleling KY 321. The KY 321/McCloud intersection is approximately 240 feet north of the signalized KY 321/Walmart intersection, with southbound KY 321 traffic regularly spilling back past McCloud during peak periods.



Figure 3: Topography and Construction Access via McCloud

2.0 BUILD CONNECTIONS CONSIDERED

Accordingly, the project team undertook an investigation of reasonable, feasible connections to provide access to the new hilltop school campus. *Kentucky's 2024-2030 Enacted Highway Plan* includes \$750,000 in right-of-way funding, \$350,000 for utility relocations, and \$2 million for construction in the budgeted biennium (utilizing state funds) plus \$8.6 million for construction in its "out" years.

Shown in **Figure 4**, an initial set of 12 Build concepts were considered, with the four most competitive options advanced for traffic microsimulation. New connectors were planned to tie to proposed roadways on the school site plan, connecting to an existing intersection along US 23, KY 40, or KY 321. **Table 1** compares engineering considerations for each of the initial concepts.

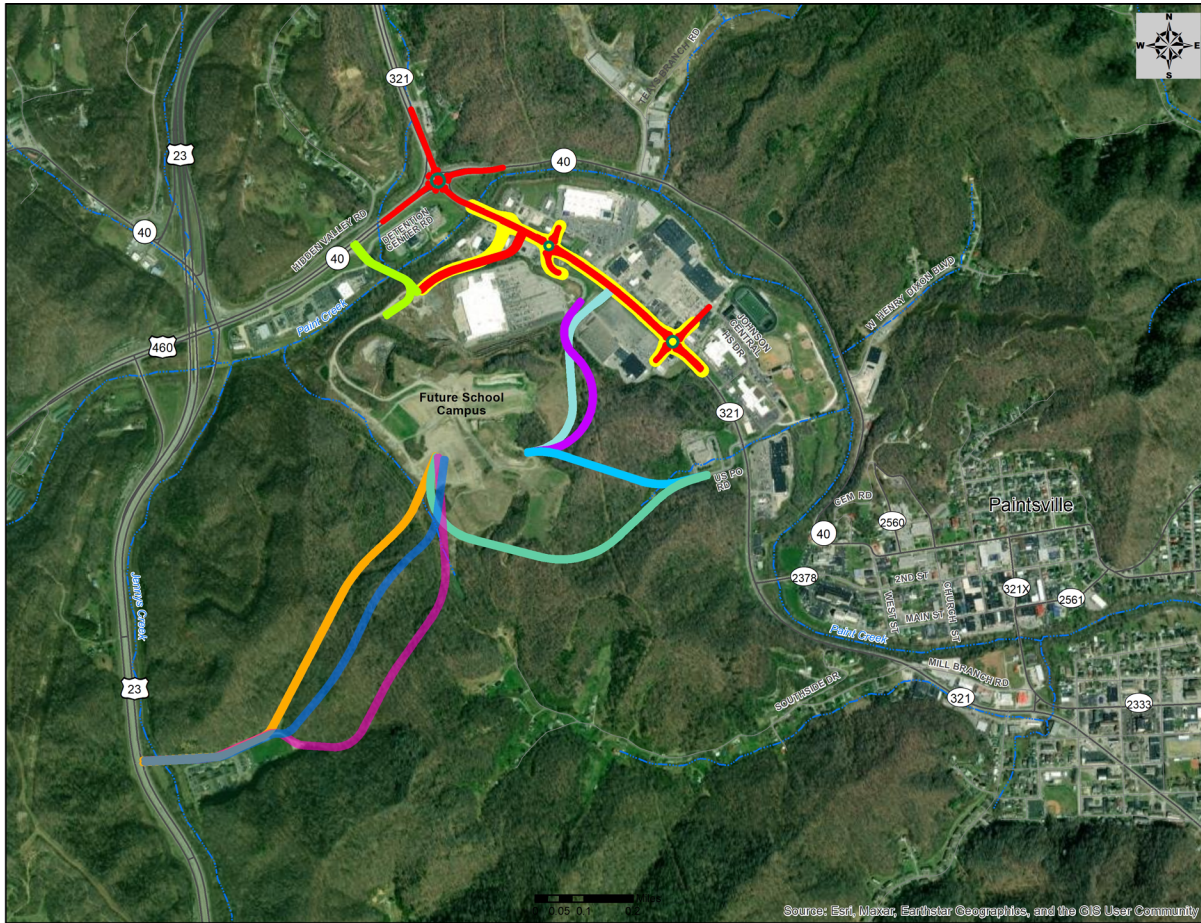


Figure 4: Range of School Connectors Considered

Table 1: Key Metrics for School Connectors Considered

| Connector | Max Grade | Cut (CU YD) | Fill (CU YD) | Design Speed | Length |
|---------------------|-----------|-------------|--------------|--------------|--------|
| Highland Entrance 1 | 12.0% | 1.6M | 0.6M | 30 | 4080' |
| Highland Entrance 2 | 9.4% | 1.6M | 0.7M | 25 | 4870' |
| Highland Entrance 3 | 7.7% | 3.4M | 0.5M | 25 | 4230' |
| Kmart | 8.7% | 0.5M | 1k | 15 | 2230' |
| Walmart | 9.3% | 0.5M | 55k | 30 | 2200' |
| McCloud | 6.2% | 19k | 2k | 25 | 1310' |
| Tractor Supply | 12.5%* | 3k | 28k | 15 | 870' |
| Tractor Supply 2 | 10.0%* | 26k | 14k | 25 | 1210' |
| USPS | 10.0% | 1.3M | 2 | 45 | 2000' |
| USPS Long | 7.6% | 2.1M | 0.5M | 45 | 3970' |
| Roundabouts 40 | 10.3% | 0.1M | 60k | 45 | 9170' |
| Roundabouts McCloud | 10.3% | 35k | 23k | 45 | 7800' |

* Max bridge grade of 4%

A connection to US 23 near Highland Elementary School (MP 5.928) was recommended in the 2020 TIS but results in the longest lengths and most earthwork. The existing US 23 intersection lies inside a curve with a narrow bridge (30 feet curb to curb) immediately east; however, all impacted properties are owned by the school system, simplifying the acquisition process.

A gas transmission line increases costs and impacts for options with connections to Kmart, Walmart, or USPS.

Options with roundabouts help address queuing and safety concerns at the McCloud intersection, roughly 240 feet from the current Walmart signal, but lead to capacity concerns with anticipated volumes.

Right-of-way acquisition, complex maintenance of traffic plans, or massive construction efforts increase risk, a consideration given the aggressive timeline to have a new connection open to traffic in time to serve the inaugural class.

Following coordination with the project team and other KYTC leadership, four concepts were advanced for detailed study (**Chapter 4.0**): one option each at Highland, USPS, Tractor Supply, and McCloud.

3.0 2023 TRAFFIC

As documented in the 12-80116 report, video-based peak period turning movement counts were conducted at key intersections within the study area during March 2023. Analysts collected field data on peak period travel speeds and queue lengths. Existing (2023) average daily traffic volumes along KY 321 range from 11,400 to 15,100 vehicles per day (vpd)—shown in red in **Figure 5**. Stars denote intersections where turning movement counts were conducted.

All traffic analyses for the 12-80250 school connectors focused on current year (2023) traffic, with no future year planning horizon. The larger 12-80116 study will also examine year 2045 traffic flows.



Figure 5: Average Daily Traffic and Turning Movement Counts

Created from this data collection effort, Vissim microsimulation networks were created to analyze AM and PM peak hour operations along the KY 40 and KY 321 corridors. Each model was calibrated around turning movement volumes, key queue lengths, and travel speeds then used to test performance for the detailed study connectors. Build models reflected 2023 traffic, incorporating trip generation and distribution assumptions from the 2020 TIS.

3.1 SCHOOL TRAFFIC

Currently, three main driveways serve the school campus abutting KY 321.

- The southernmost driveway opposite the USPS post office (MP 7.987) is the primary entrance for all middle school traffic and buses to the high school. Middle school parents also exit via this driveway following pick-up/drop-off.
- JCHS Drive (MP 8.100) is the central driveway, serving as the entrance for high school drivers and exit for middle school buses.
- The northern driveway (approximate MP 8.18) is the exit for high school bus traffic while high school parents/drivers exit to the Plaza parking lot behind McDonalds.

Based on March 2023 counts, 30% of traffic accessing the current schools is to/from the south and 70% is to/from the north. The largest distribution—nearly 40%—comes from areas further north or

west along US 23 and US 460. These distributions were applied for each of the Build access points tested in the microsimulation network.

3.2 NETWORK PERFORMANCE

South to north, **Table 2** presents key metrics for existing traffic operations at KY 321 study intersections during the AM and PM peak hours. For simplicity, KY 321 is considered to run north/south with its intersecting cross-streets running east/west. The right column reports turn movements approaching or over capacity in either peak hour. As shown, thru trips along KY 321 generally operate smoothly, but turns from minor cross-streets can experience longer delays and Level of Service (LOS) E performance.

Table 2: Existing KY 321 Traffic Operations during AM (PM) Peak Hours

| Cross Street | MP | Control | LOS | Delay (sec) | LOS E Moves |
|--------------------|-------|------------|-------|-------------|--------------------|
| J. S. Trimble Blvd | 7.715 | Signal | A (A) | 7 (8) | WBL |
| Save A Lot | 7.893 | Signal | A (A) | 2 (2) | WBL |
| Post Office Rd | 7.987 | Signal | B (B) | 11 (11) | EBL, WBL, WBT |
| JCHS Dr | 8.100 | 1-way Stop | - | 3 (2) | - |
| McDonalds | 8.231 | Signal | B (C) | 19 (22) | EBT |
| Burger King | 8.330 | 1-way Stop | - | 5 (8) | - |
| Mayo Plaza | 8.390 | 2-way Stop | - | 2 (2) | - |
| Hardees | 8.450 | 1-way Stop | - | 2 (2) | - |
| Walmart | 8.537 | Signal | B (C) | 10 (22) | EBL, EBT, WBL, WBT |
| McCloud St | 8.602 | 2-way Stop | - | 4 (4) | - |
| KY 40 | 8.791 | Signal | C (C) | 27 (31) | SBL, SBT, EBL, WBL |

4.0 DETAILED STUDY SCHOOL CONNECTORS

4.1 HIGHLAND CONNECTOR

A new alignment connection to Highland Elementary School was modeled (**Figure 6**), a refined version of the Highland 2 option in **Table 1**. With a total length of 1.1 miles, the concept is entirely contained on school-owned properties. Layouts are based on a 25-mph design speed, with a max grade of 10% and minimum horizontal radius of 200 feet.

Bridge 058C00051N carries the Highland driveway over Jennys Creek, 120 feet east of US 23. With 30 feet of horizontal clearance, the bridge limits queue space to extend separate westbound turn lanes. The bridge is assumed to be replaced with a wider structure in the Build scenario.

Forecast turn movements at the US 23/Highland driveway are presented in the green inset in **Figure 6** for the AM and PM peak hour.

From a traffic perspective, the new connector at Highland would have minor impacts on KY 321 performance: average delay at 10 of 11 modeled intersections is within 2 seconds of the Existing scenario in both peak hours. The signalized intersection at McDonalds improves by 6-8 seconds overall as turns to/from the school shift to thru movements.

Increased traffic at the US 23 intersection was modeled as a one-way stop (current condition) and a signalized Continuous Green-T for comparison. Stop controlled, left turn movements are over capacity, with the westbound left demonstrating a 2.9 volume-to-capacity ratio (v/c) in the AM peak.

As a Green-T, all movements operate at LOS C or better during both peak hours with adequate queue storage space.



Figure 6: Highland Connector Option with AM (PM) Traffic

Table 3: Highland Connector Comparison

| Strengths | Weaknesses |
|---|--|
| <ul style="list-style-type: none"> - Consistent with 2020 TIS recommendations - No new right-of-way needed - Does not increase congestion along KY 321 | <ul style="list-style-type: none"> - Existing driveway inside horizontal curve - Funnels all school traffic to single intersection - Substantial earthwork required - WBL over capacity with stop-control - Reconstruct existing Jennys Creek bridge - Most expensive connection studied |

4.2 KY 40 CONNECTION NEAR TRACTOR SUPPLY

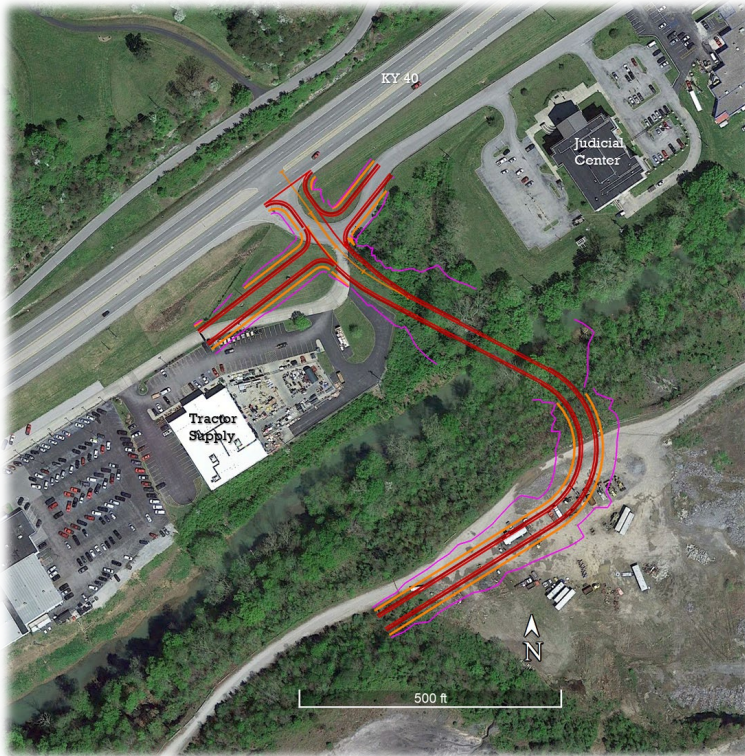


Figure 7: Tractor Supply Connection Option

Another Build option considered a new access point to KY 40 near MP 8.85 at Tractor Supply and the judicial center (**Figure 7**). A quarter mile long, the layout is based on a 25-mph design speed, with a max grade of 8% and minimum horizontal radius of 150 feet. This Build option requires a new bridge over Paint Creek, assumed to have a max 4% grade and be around 190 feet long. An intersection with the frontage roads is 140 feet from KY 40 in a horizontal curve and will require consideration during subsequent design phases to accommodate traffic. To the west, another stop-controlled intersection with KY 40 serves the frontage road but this is the only access point serving the judicial and detention centers.

Beyond school property, right-of-way is needed from one private property, largely following an existing city street.

The proposed MP 8.85 access point lies between two signals: KY 40 at the northbound US 23 ramps (MP 8.529) and KY 40 at KY 321 (MP 9.073). Microsimulation considered two traffic control scenarios: one-way stop control or a signal. Forecast AM and PM hourly volumes at the entrance are shown with a screenshot of the model in **Figure 8**.



Figure 8: Tractor Supply Build Traffic for AM (PM) Peaks

- With a one-way stop, the maximum queue lengths¹ are 350 feet for the westbound left turn from KY 40, compared to 250 feet of available storage today. Exiting the school, northbound maximum queues reach 650 feet in the AM peak with both left and right turn movements operating at LOS F.
- With a signal, all turn movements operate at LOS C or better in both peak hours. Maximum queue lengths reach 200 feet for the northbound driveway and 250 feet for the westbound left from KY 40.

While the existing westbound turn lane could be extended within the raised median, doing so reduces available length for weave maneuvers between southbound KY 321 and the westbound left to the schools. Roughly 100 cars make the southbound right in the AM peak hour, with about 40% assumed to head to the school.

A new connector at Tractor Supply would have minor impacts on KY 321 performance overall: average delay at 10 of 11 modeled intersections is within 2 seconds of the Existing scenario in both peak hours. The signalized intersection at McDonalds improves by 6-8 seconds overall as turns to/from the school shift to thru movements.

Table 4: Tractor Supply Connector Comparison

| Strengths | Weaknesses |
|---|--|
| <ul style="list-style-type: none"> - Among shortest/least expensive Build options considered - Does not increase congestion along KY 321 - Minimal right-of-way or utility impacts | <ul style="list-style-type: none"> - 1,100 feet from existing KY 321/KY 40 signal, limiting queue/weave lengths - Requires new bridge over Paint Creek |

4.3 USPS CONNECTION

Shown in **Figure 9**, another Build option considered a new link to KY 321 at the signalized USPS intersection (MP 7.987)—a variation of the USPS Long concept in **Figure 4**. With a total length of 0.8 miles, the layout is based on a 45-mph design speed, with a max grade of 7.6% and minimum horizontal radius of 590 feet. An estimated 7.5 acres of additional right-of-way would be required plus a “land bridge” to cross above a gas line.

Forecast turn movements are presented in the green inset for the AM and PM peak hours.

¹ Maximum queue length is the greatest backup over the analysis period; it could last only a second before cars begin moving again. Average queue lengths are substantially shorter.

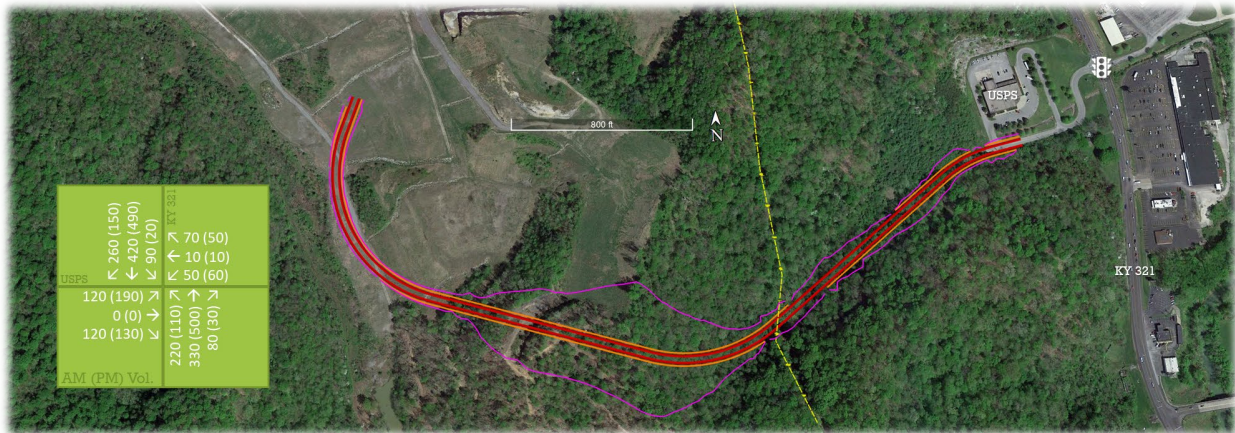


Figure 9: USPS Connector Option with AM (PM) Traffic

From a traffic perspective, the new connector at USPS would have minor impacts on KY 321 performance: average delay at 9 of 11 modeled intersections is within 2 seconds of the Existing scenario in both peak hours. The signalized intersection at McDonalds improves by 9-10 seconds overall as turns to/from the school shift to thru movements. Delay at the signalized USPS intersection increases with the additional traffic but is still projected to operate at LOS C or better overall in both peak hours. While average queue lengths are manageable, maximum queue lengths exceed available storage space at two intersections: northbound and southbound at both the USPS and Walmart signals.

Table 5: USPS Connector Comparison

| Strengths | Weaknesses |
|-----------------------------------|---|
| - Meets KY 321 at existing signal | - Substantial earthwork required - Requires crossing gas line - New right-of-way beyond school-owned properties - Second most expensive construction costs |

4.4 McCloud Connection

Another Build option considered a new access point to KY 321 utilizing the construction access road at McCloud Street to reach KY 321. The proximity to the Walmart signal and frontage road connection pose challenges at this location; a variety of Build options were considered to find a viable solution. Forecast volumes for the AM and PM peak hours are summarized in **Figure 10**.

- The existing configuration (stop-controlled three-leg intersection without any eastbound turn restrictions) does not provide adequate capacity for school traffic. There are also safety concerns based on recent crash trends, exacerbated with increased traffic.

| | | KY 321 | AM (PM) Volumes |
|---------|--|---|--------------------|
| McCloud | ↖ 310 (220) ↘ 630 (570) | ↖ 40 (120) | |
| | 160 (260) ↗ 90 (100) ↘ | ↗ 190 (80) ↘ 400 (560) ↖ 10 (10) | |
| Walmart | ↖ 80 (150) ↘ 560 (430) ↗ 80 (90) | ↗ 50 (90) ↘ 10 (30) ↖ 20 (40) | |
| | 50 (160) ↗ 5 (20) → 70 (170) ↘ | ↗ 100 (180) ↘ 500 (400) ↖ 20 (40) | |

Figure 10: AM (PM) Forecast

- A right-in/right-out (RIRO) at McCloud, paired with a series of roundabouts along the KY 321 corridor to accommodate u-turns—including roundabouts at KY 40 and Walmart—does not provide adequate capacity for school traffic and requires greater right-of-way and utility impacts that are likely not compatible with the construction timeframe for the school. The Walmart roundabout itself operates well, but the high volume eastbound right turn from McCloud is over capacity (LOS F) in both peak hours, limited by the restrictive merge/weave distance between intersections.

- Shown in **Figure 11**, shifting McCloud north of Wendy's to increase spacing to the Walmart intersection and creating paired roundabouts at McCloud and Walmart does not provide adequate capacity for school traffic and requires greater right-of-way and utility impacts that are likely not compatible with the construction timeframe for the school. Operations are marginally better than the roundabout/RIRO combination discussed above but the eastbound right turn from McCloud remains over capacity in the AM peak hour.

Roundabouts reduce delay and simplify conflict points, providing both safety and mobility benefits for the KY 321 corridor. While a new school connection at McCloud does not appear to be practical with anticipated traffic volumes and resulting impacts to the developed commercial corridor, a similar Build solution may warrant consideration as part of the larger 12-80116 corridor study.

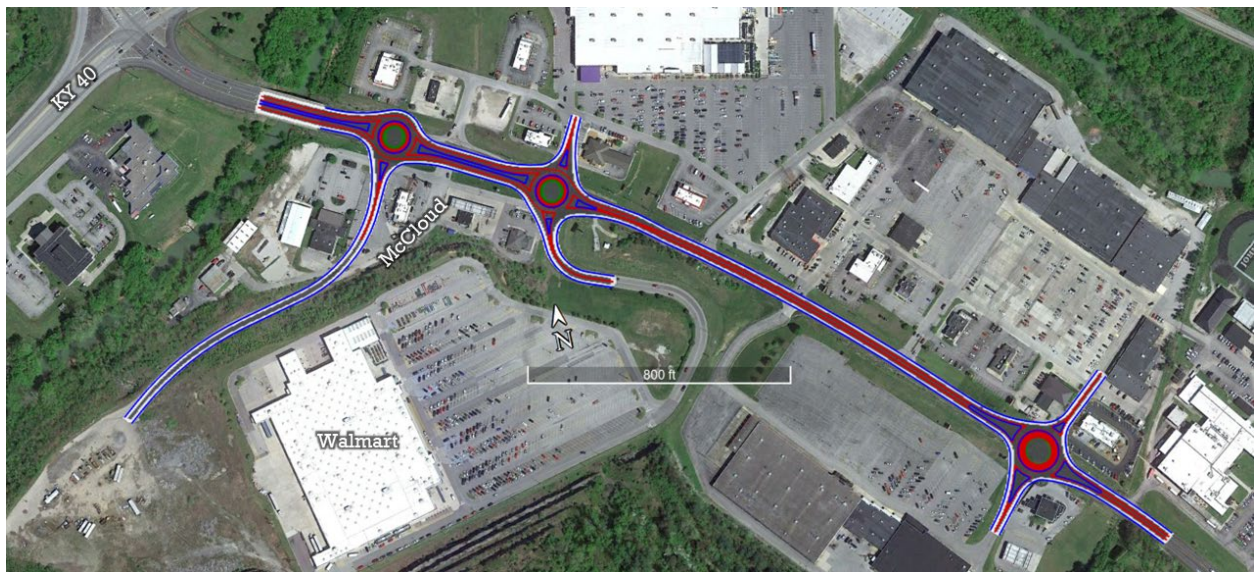


Figure 11: Shifted McCloud Connector Option

Table 6: McCloud Connector Comparison

| Strengths | Weaknesses |
|---|---|
| <ul style="list-style-type: none"> - Among shortest/least expensive Build options considered - Least earthwork needed | <ul style="list-style-type: none"> - Traffic capacity/queuing concerns - Right-of-way and utility impacts unlikely to be resolved on timeline for school opening - Local opposition to roundabouts |

5.0 COST ESTIMATES

Planning-level designs for Build concepts were used to estimate preliminary quantities of high-cost construction items including earthwork and pavement. Construction costs were tabulated using Bid Express² average unit bid prices for Johnson, Floyd, Pike, and Lawrence counties’ construction bids since January 2021. Parametric factors were applied to account for drainage, traffic control, mobilization, and miscellanea. A 30% contingency factor was also applied to construction cost totals. KYTC District 12 provided right-of-way and utility cost estimates based on conceptual modeled disturb limits, aerial imagery, approximate locations of property lines, and utility records.

Planning-level cost estimates by phase (i.e., design, right-of-way acquisition, utility relocations, and construction) are presented in **Table 7**, presented in 2022 dollars.

Table 7: Cost Estimates by Phase (2022 Dollars)

| Connector Concept | D | R | U | C | TOTAL |
|-----------------------------|--------|---------|---------|---------|----------------|
| Highland Elementary | \$5.4M | <\$0.1M | NA | \$54M | \$59 million |
| Tractor Supply | \$1.0M | \$0.6M | <\$0.1M | \$9.5M | \$11.1 million |
| USPS | \$4.9M | * | \$0.5M | \$48.9M | \$54 million* |
| Shifted McCloud Roundabouts | \$1.0M | \$0.5M | \$0.7M | \$7.9M | \$10.1 million |

* dismissed due to costs/impacts before right-of-way costs estimated

6.0 RECOMMENDATIONS

In light of high costs, earthwork quantities, and construction timeframes, the project team agreed to dismiss the Highland and USPS connections. A build option with roundabouts along KY 321 provides safety and capacity benefits, but is unlikely to be completed on the aggressive timeline required for the school’s opening date. An improved KY 321/McCloud Street intersection does not provide adequate capacity to be the sole school access point. Therefore, the Tractor Supply Connector was identified as the best-fit solution to advance for preliminary design.

² Online at <https://bidx.com/ky/main>