

# FrontRunner Forward Technical Memorandum

To: Utah Transit Authority  
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Date: May 18, 2023  
Subject: FrontRunner Forward Corridor Level Traffic and Safety Analysis

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## **Introduction**

This technical memorandum contains a traffic analysis for the FrontRunner Forward program and evaluates the impact of the proposed FR service increase from 30-minute headway to 15-minute headway during peak periods. The focus of analysis is on the peak hour for traffic volumes at each of the existing at-grade FrontRunner train crossings. There are 69 at-grade crossings along the corridor, comprised of 59 public and 10 private crossings; one of the public crossings is for pedestrians only. In addition, there are 79 grade-separated crossings where FrontRunner either passes over or under the cross street.

An initial screening process brought forward eight crossings to undergo a more detailed traffic evaluation. Detailed evaluation of crossings includes analysis of existing and future queue lengths, school bus routes, emergency services routes and pedestrian safety. The FrontRunner crossing locations also serve Union Pacific (UPRR) trains, however this analysis focuses on the impacts of increasing frequency of FrontRunner trains only, as UPRR train events are longer and would overshadow any FrontRunner train impacts. The potential for consecutive FrontRunner train crossing events is also considered. The screening process is discussed further in the next section.

The 2050 peak hour queue lengths are projected to be over 1,000 feet at four of the crossing locations, but each of these is programmed for a future grade-separation project, which would fully mitigate queues at the crossings. Two of the analysis crossings will have projected 2050 queues which extend beyond the nearest major intersection. Increasing FrontRunner train frequency to 15-minute intervals during peak periods is not expected to increase the lengths of existing or projected 2050 queues at any of the crossings evaluated in detail as the queues will have sufficient time to dissipate between train crossing events, although the queues that result from a FrontRunner train crossing will occur twice as often. The possibility of a consecutive FrontRunner train event was also analyzed at two crossings, and the results showed that projected queues would be able to dissipate within two to three minutes of a consecutive train crossing event.

The increased FrontRunner train frequency may cause some minor impacts to school routes and emergency services due to an increased potential for any given vehicle to get stopped at the crossing. However, emergency service providers likely have alternate route plans at each crossing due to the existing UPRR trains causing a worse condition than is projected from the increase in FrontRunner train

frequency. Pedestrian facilities already feature sidewalks on one or both sides at all eight crossings and pedestrian safety is not expected to be impacted with increased train frequency.

### **Screening Process**

An initial screening process was performed to review traffic conditions for each at-grade crossing on the FrontRunner corridor using existing information provided by Utah Transit Authority (UTA) and the PMSC (Program Management Services Consultant). There are 69 at-grade FrontRunner crossings that were evaluated from Ogden to Provo. The screening process identified thresholds to screen crossings not anticipated to be substantially impacted by increased rail services frequency.

### **Thresholds**

Screening thresholds were based on roadway traffic volume and proximity to intersections and driveways. The analytical emphasis for the thresholds were on crossings that have higher volumes, higher delays, and proximity to other significant transportation facilities. Crossings that exceeded the thresholds were advanced to detailed analysis.

The primary screening threshold was based on existing AADT (Annual Average Daily Traffic) per lane at the crossing location. (*Source: 2019 Utah Department of Transportation AADT*). AADT per lane was chosen to make a fairer comparison between roads with two lanes and roads with four lanes rather than just using total AADT of the roadway at the crossing. AADT per lane at the crossing locations ranged from a high of 8,500 vehicles per day per lane to less than 100 vehicles per day per lane. An AADT of 4,500 vehicles per day per lane was determined as an initial screening threshold. Crossing locations above this threshold were candidates for further evaluation. The threshold was chosen because an AADT of 4,500 vehicles per day per lane correlates with a predicted 95<sup>th</sup> percentile vehicle queue length of 350 feet or greater at the crossing during a crossing event in the PM peak hour (5:00-6:00 PM). The 350-foot queue length was determined to be a conservative threshold at which queues from a crossing event might begin to cause congestion to the surrounding road network since most block sizes in Utah are 400 feet or less.

### **95th Percentile Queue Lengths**

To calculate queue lengths at the crossings, PM peak hour volumes at the crossing were first estimated as ten percent of the existing AADT. To account for directional splits during the PM peak hour, each of the crossing locations were evaluated in one direction with an assumed 60 percent of total two-way volume directional split therefore providing a conservative estimate of queues at the crossing.

Based on observed data, it was assumed that an average FrontRunner train crossing event takes 60 seconds from the beginning of the flashing lights and the gate lowering, to the gates raised back up and the end of the flashing lights sequence. Queue lengths were measured based on the 60 seconds of closure for each crossing event using Synchro/SimTraffic, a traffic engineering software program published by Trafficware. Table 1 shows the AADT and queue length ranges used to determine the AADT per lane threshold.

**Table 1. Screening Process AADT and Queue Length Ranges**

| EXISTING AADT/LANE | PEAK HOUR VOLUME (1-WAY) | 60% DIRECTIONAL SPLIT PEAK HOUR VOLUME (1-WAY) | 95TH PERCENTILE QUEUE (FT) |
|--------------------|--------------------------|--|----------------------------|
| 2,000              | 200                      | 240  | 135                        |
| 3,000              | 300                      | 360  | 215                        |
| 4,000              | 400                      | 480  | 305                        |
| <b>4,500</b>       | <b>450</b>               | <b>540</b>                                     | <b>360</b>                 |
| 5,000              | 500                      | 600  | 415                        |
| 6,000              | 600                      | 720  | 555                        |
| 7,000              | 700                      | 840  | 725                        |
| 8,000              | 800                      | 960  | 945                        |
| 8,500              | 850                      | 1,020  | 1,085                      |

**Proximity to Major Intersection**

A secondary screening threshold was determined based on distance to a major intersection from a crossing location. If a crossing AADT was at or above 4,500 vehicles per day per lane *and* had a major intersection (signal, roundabout, interchange, adjacent rail crossing) within 500 feet or a minor intersection (city-maintained roadway) within 100 feet, it was advanced to detailed traffic analysis.

**Crossings Advanced to Detailed Analysis**

Through the screening process, eight crossing locations were advanced for more detailed analysis. The eight crossing locations (City – Cross Street) are as follows:

1. Roy – 4800 South
2. Sunset – 1800 North (SR-37)
3. Layton – Gentile Street
4. North Salt Lake – Center Street
5. Murray – 4800 South
6. Murray – 5900 South
7. Lehi – Main Street
8. Provo – 820 North

Table 2 shows AADT and distance to major or minor intersections at each of the crossing locations that advanced to detailed analysis. A full list of the 69 at-grade crossings with initial screening results is included in the appendix.

**Table 2. Crossing Locations Advanced to Detailed Analysis**

|    | CROSSING LOCATION               | EXISTING AADT | DISTANCE AND DIRECTION TO MAJOR INTERSECTION (FT) | MAJOR INTERSECTION TYPE | DISTANCE TO MINOR INTERSECTION (FT) |
|----|---------------------------------|---------------|---|-------------------------|-------------------------------------|
| 1. | Roy – 4800 South                | 15,000        | 1,000 ft West                                     | Roundabout              | 25 ft West                          |
| 2. | Sunset – 1800 North (SR-37)     | 16,000        | 1,250 ft East                                     | Signal                  | 75 ft East                          |
| 3. | Layton – Gentile Street         | 11,000        | 400 ft East                                       | Signal                  | 20 ft West                          |
| 4. | North Salt Lake – Center Street | 17,000        | 200 ft East                                       | Off-ramp                | n/a                                 |
| 5. | Murray – 4800 South             | 11,000        | 450 ft East                                       | UTA TRAX Xing           | 200 ft West                         |
| 6. | Murray – 5900 South             | 12,000        | 500 ft East                                       | Signal                  | 240 ft West                         |
| 7. | Lehi – Main Street              | 9,200         | 400 ft West                                       | Roundabout              | 75 ft East                          |
| 8. | Provo – 820 North               | 9,400         | 325 ft East                                       | UP RR Xing              | n/a                                 |

**Detailed Traffic Analysis**

Following the initial screening process, a detailed traffic analysis at each of the eight crossings was performed. Each of the crossings were evaluated for existing and future 2050 conditions during the PM peak hour, with 95<sup>th</sup> percentile queue lengths as the primary traffic measurement. Potential effects to roadway and intersection performance for facilities in the vicinity of the crossing due to expected increases in rail services frequencies were evaluated. Impacts to school/bus routes, emergency services, and pedestrian safety were also evaluated.

**Methodology**

The latest available Utah Department of Transportation (UDOT) AADT for each of the cross-streets at each crossing location was used to perform the existing traffic analysis. As with the initial screening analysis, 95<sup>th</sup> percentile queue lengths were measured for the PM peak hour and PM peak hour volumes at the crossing were assumed to be ten percent of the existing AADT. To account for directional splits during the PM peak hour at each of the crossing locations, crossing locations were evaluated in one direction with an assumed 60 percent of total two-way volume directional split, therefore providing a conservative estimate of queues at the crossing.

As with the initial screening analysis, it was assumed that an average FrontRunner train crossing event takes 60 seconds. Queue lengths were measured based on the 60 seconds of closure for each crossing event. For the detailed traffic analysis, queue lengths at each crossing location were evaluated using Synchro/SimTraffic, Table 3 shows existing AADT, AADT per lane, the peak hour one-way analysis volume based on a 60 percent directional split, and 95<sup>th</sup> percentile queue length for the PM peak hour.

**Table 3. Existing PM Peak Hour Queue Lengths**

|    | CROSSING LOCATION               | EXISTING AADT | AADT/LANE | EXISTING PM PEAK HOUR |                               |
|----|---------------------------------|---------------|-----------|-----------------------|-------------------------------|
|    |                                 |               |           | ONE-WAY VOLUME (VEH)  | 95 <sup>TH</sup> % QUEUE (FT) |
| 1. | Roy – 4800 South                | 15,000        | 7,500     | 900                   | 830                           |
| 2. | Sunset – 1800 North (SR-37)     | 16,000        | 8,000     | 960                   | 950                           |
| 3. | Layton – Gentile Street         | 11,000        | 5,500     | 660                   | 480                           |
| 4. | North Salt Lake – Center Street | 17,000        | 8,500     | 1,020                 | 1,085                         |
| 5. | Murray – 4800 South             | 11,000        | 5,500     | 660                   | 480                           |
| 6. | Murray – 5900 South             | 12,000        | 6,000     | 720                   | 550                           |
| 7. | Lehi – Main Street              | 9,200         | 4,600     | 552                   | 370                           |
| 8. | Provo – 820 North               | 9,400         | 4,700     | 564                   | 380                           |

As shown in Table 3, existing PM peak hour 95<sup>th</sup> percentile queue lengths for a 60 second crossing event range from 370 feet to 1,085 feet at the crossing locations. Detailed queue analysis for each crossing is discussed in the *Detailed Evaluation by Crossing* section.

**Future (2050) Analysis**

Future analysis of roadway operations were analyzed for each of the eight crossings. Future year (2050) traffic forecasts were obtained from the Wasatch Front Regional Council (WFRC)/Mountainland Association of Governments (MAG) regional travel demand model. The model was developed for each agency’s 2019 Regional Transportation Plan 2050 PM peak hour analysis assumes that peak hour volumes at the crossing are ten percent of the future year AADT. Table 4 shows projected 2050 AADT, the peak hour one-way analysis volume based on a 60 percent directional split and 95<sup>th</sup> percentile queue lengths for each of the eight analysis crossing locations. Table 4 also shows whether or not a crossing has a planned grade-separation project, and which phase the project is in the WFRC regional transportation plan or the MAG regional transportation plan.

**Table 4. 2050 PM Peak Hour Queue Lengths**

|    | CROSSING LOCATION               | 2050 AADT | AADT/LANE | 2050 PM PEAK HOUR    |                               | FUTURE GRADE-SEPARATION PROJECT? |
|----|---------------------------------|-----------|-----------|----------------------|-------------------------------|----------------------------------|
|    |                                 |           |           | ONE-WAY VOLUME (VEH) | 95 <sup>TH</sup> % QUEUE (FT) |                                  |
| 1. | Roy – 4800 South                | 17,500    | 8,750     | 1,050                | 1,160 ft                      | Yes, WFRC Phase 3                |
| 2. | Sunset – 1800 North (SR-37)     | 37,500    | 18,750    | 2,250                | >3,000 ft                     | Yes. WFRC Phase 1                |
| 3. | Layton – Gentile Street         | 10,000    | 5,000     | 600                  | 415 ft                        | No                               |
| 4. | North Salt Lake – Center Street | 23,000    | 11,500    | 1,380                | 2,780 ft                      | Yes. WFRC Phase 1                |
| 5. | Murray – 4800 South             | 12,500    | 6,250     | 750                  | 590 ft                        | No                               |
| 6. | Murray – 5900 South             | 14,000    | 7,000     | 840                  | 725 ft                        | No                               |
| 7. | Lehi – Main Street              | 14,000    | 7,000     | 840                  | 725 ft                        | No                               |
| 8. | Provo – 820 North               | 50,000    | 25,000    | 3,000                | >3,000 ft                     | Yes. MAG Phase 1                 |

As shown in Table 4, future queue lengths for a crossing event range from 415 feet to over 3,000 feet at the crossing locations. Each of the crossings with a future queue length over 725 feet have a planned grade-separation project. The future grade-separation projects and roadway improvements planned at each crossing location is discussed further in the *Detailed Evaluation by Crossing* section.

### **Increased Train Frequency**

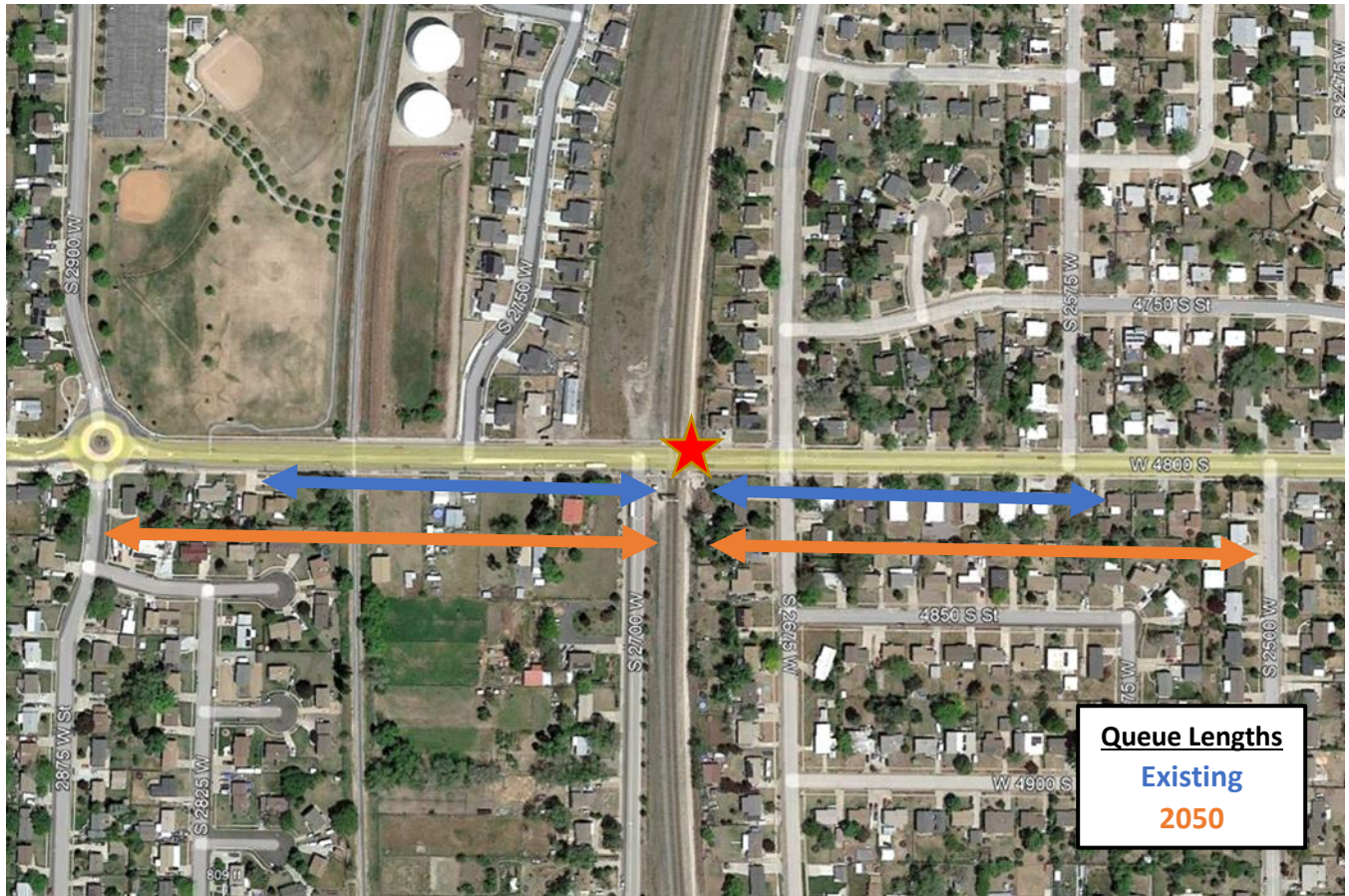
Increasing FrontRunner train frequency to 15-minute intervals during peak periods is not expected to increase existing or projected queues at any of the crossings evaluated, as the queues will have sufficient time to dissipate between train crossing events. Traffic simulation in Synchro/SimTraffic demonstrates that even the longest projected future queues of up to 3,000 feet will dissipate within two to three minutes. Furthermore, each of the crossings that have projected queues beyond 725 feet are planned to be grade-separated in the future. With a maximum of eight crossing events per hour (four in each direction), there would be an average of seven minutes between each crossing event.

Each of the FrontRunner analysis crossings also have Union Pacific Railroad (UPRR) train crossing events. According to the Federal Railroad Administration (FRA) crossing inventory database, UPRR trains range from nine to 26 per day at each crossing or one to two trains during the peak hour on average. Therefore, increasing the frequency of FrontRunner trains would increase the number of total train crossing events from an existing of five or six today during the PM peak hour, to a maximum of ten train crossing events with 15-minute FrontRunner train headways. It should be noted that UPRR train crossing events are typically longer than 60 seconds and, therefore overshadow the impact of a FrontRunner crossing event.

**Detailed Evaluation by Crossing**

**Roy / 4800 South** – The crossing at 4800 South in Roy is located 25 feet east of a minor intersection at 2700 West and approximately 1,000 feet east of a roundabout intersection at 2900 West. Existing traffic volumes are 15,000 vehicles per day and projected to be 17,500 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 830 feet during a PM peak hour crossing event and are expected to reach up to 1,160 feet by 2050. Existing and 2050 projected queues impact the minor intersections at 2675 West and 2700 West. The queues will not impact the minor intersection at 2750 West because it is a right-in/right-out intersection. 2050 queues would extend to the minor intersection at 2500 West and impact the 2900 West roundabout. However, this crossing is also designated as a WFRC Phase 3 (2041-2050) grade-separation project; therefore, the crossing would likely be grade separated before queue lengths would interfere with the roundabout. Figure 1 shows the 4800 South crossing location in Roy and the existing (blue) and 2050 (orange) 95<sup>th</sup> percentile queue lengths.

**Figure 1. Roy/4800 South Crossing Location**



**Sunset / 1800 North (SR-37)** – The crossing at 1800 North in Sunset is located approximately 75 feet west of a minor intersection at 475 West and 1,250 feet west of a signalized intersection at 250 West. Existing traffic volumes are 16,000 vehicles per day and projected to be 37,500 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 950 feet during a PM peak hour crossing event and are expected to be greater than 3,000 feet by 2050. Existing queues affect each of the three minor intersections on either side of the crossing and 2050 queues would extend beyond the closest signalized intersection at 250 West. However, this crossing is planned to be grade-separated as part of a new WFRC Phase 1 (2021-2030) interchange project at 1800 North and I-15 (1/2 mile to the east of crossing) which would mitigate future queues. This project is funded for construction within the next five years. Figure 2 shows the 1800 North (SR-37) crossing location in Sunset. The 2050 queue lengths would extend beyond the edges of the figure (over 3,000 feet).

**Figure 2. Sunset / 1800 North (SR-37) Crossing Location**



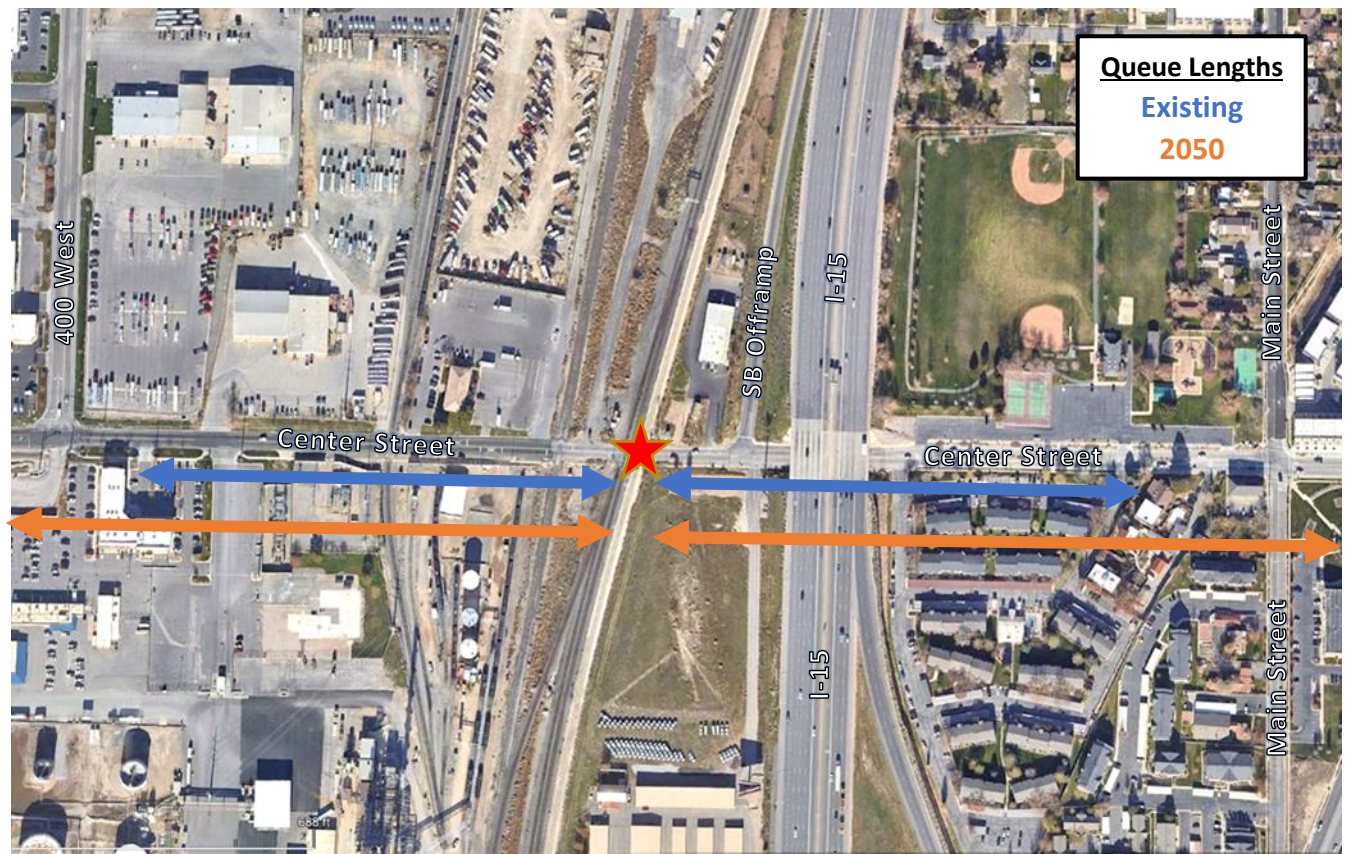
**Layton / Gentile Street** – The crossing at Gentile Street in Layton is located 20 feet east from a minor right-in/right-out intersection at Dawson Street and 900 feet west of a signalized intersection at Main Street. Existing traffic volumes are 11,000 vehicles per day and projected to decrease in the future to 10,000 vehicles per day in 2050. Existing 95<sup>th</sup> percentile queues reach 480 feet during a PM peak hour crossing event and are expected to be 415 feet in 2050. Queues at this crossing impact the minor intersections at Church Street, Cross Street, Dawson Street and Ellison Street during both existing and 2050, but do not interfere with the closest major intersection at Main Street during existing conditions or projected 2050 conditions. Figure 3 shows the Gentile Street crossing location in Layton.

**Figure 3. Layton / Gentile Street Crossing Location**



**North Salt Lake / Center Street** – The crossing at Center Street in North Salt Lake is located approximately 200 feet west of the I-15 southbound off-ramp intersection. Existing traffic volumes are 17,000 vehicles per day and projected to be 23,000 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 1,085 feet during a PM peak hour crossing event and are expected to reach up to 2,780 feet by 2050. Existing queues extend beyond the I-15 off-ramp intersection to the west and beyond the State Street intersection to the east by 2050. However, the crossing is designated as a WFRC Phase 1 (2021-2030) grade-separation project and would likely be grade-separated by 2050, mitigating the future queue projections. Figure 4 shows the Center Street crossing location in North Salt Lake.

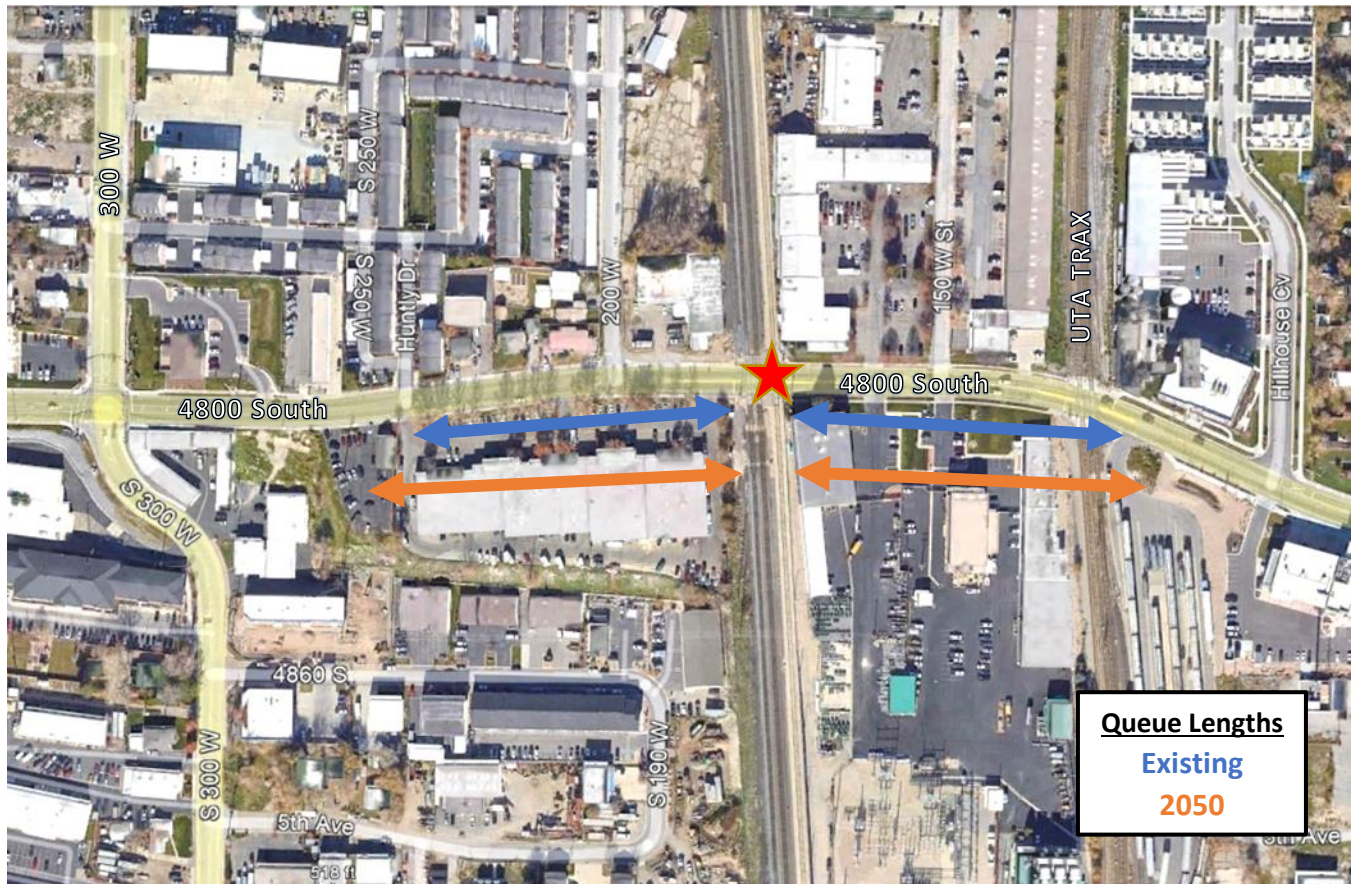
**Figure 4. North Salt Lake / Center Street Crossing Location**



**Murray / 4800 South** – The crossing at 4800 South in Murray is located 450 feet west of the UTA TRAX rail crossing. Existing traffic volumes are 11,000 vehicles per day and projected to be 12,500 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 480 feet during a PM peak hour crossing event and are expected to reach up to 590 feet by 2050. Existing queues impact the minor intersections at 150 West and 200 West and 2050 queues are projected to impact the minor intersection at Huntly Drive. Existing and 2050 queues are projected to extend beyond the UTA TRAX rail crossing to the east, but 2050 queues will not interfere with the closest signalized intersection at 300 West, approximately 1,000 feet west of the crossing.

UTA TRAX grade crossings have continuous video monitoring to identify incidents and potential incidents at the grade crossings. UTA operations monitors these intersections for issues such as queueing onto the track. As AADT increases in future years, queueing will be monitored and UTA will work with communities on future improvement projects if necessary. Figure 5 shows the 4800 South crossing location in Murray.

**Figure 5. Murray / 4800 South Crossing Location**



**Murray / 5900 South** – The crossing at 5900 South in Murray is located 500 feet west of a signalized intersection at 300 West (Cottonwood Street). Existing traffic volumes are 12,000 vehicles per day and projected to be 14,000 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 550 feet during a PM peak hour crossing event and are expected to reach up to 725 feet by 2050. Existing queues extend beyond the minor intersections at 350 West, Stratler Street and Commerce Drive. Projected 2050 queues may further extend through the minor intersection at Hatton Circle and through the signalized intersection at 300 West and the UTA TRAX rail crossing during a crossing event if no other improvements are made in the interim. There is currently no grade-separation project planned for this crossing.

UDOT, UTA, and Murray City conducted a railroad crossing diagnostic review in October 2022 at the 5900 South crossing. The diagnostic team recommended that UTA install communication equipment between the FrontRunner grade crossing signal and the TRAX rail line (300 W) signal. Furthermore, UTA TRAX grade crossings have continuous video monitoring to identify incidents and potential incidents at the grade crossings. UTA operations monitors intersections for issues such as queueing onto the track. As AADT increases in future years, queuing will be monitored and UTA will work with communities on future improvement projects if necessary. Figure 6 shows the 5900 South crossing location in Murray.

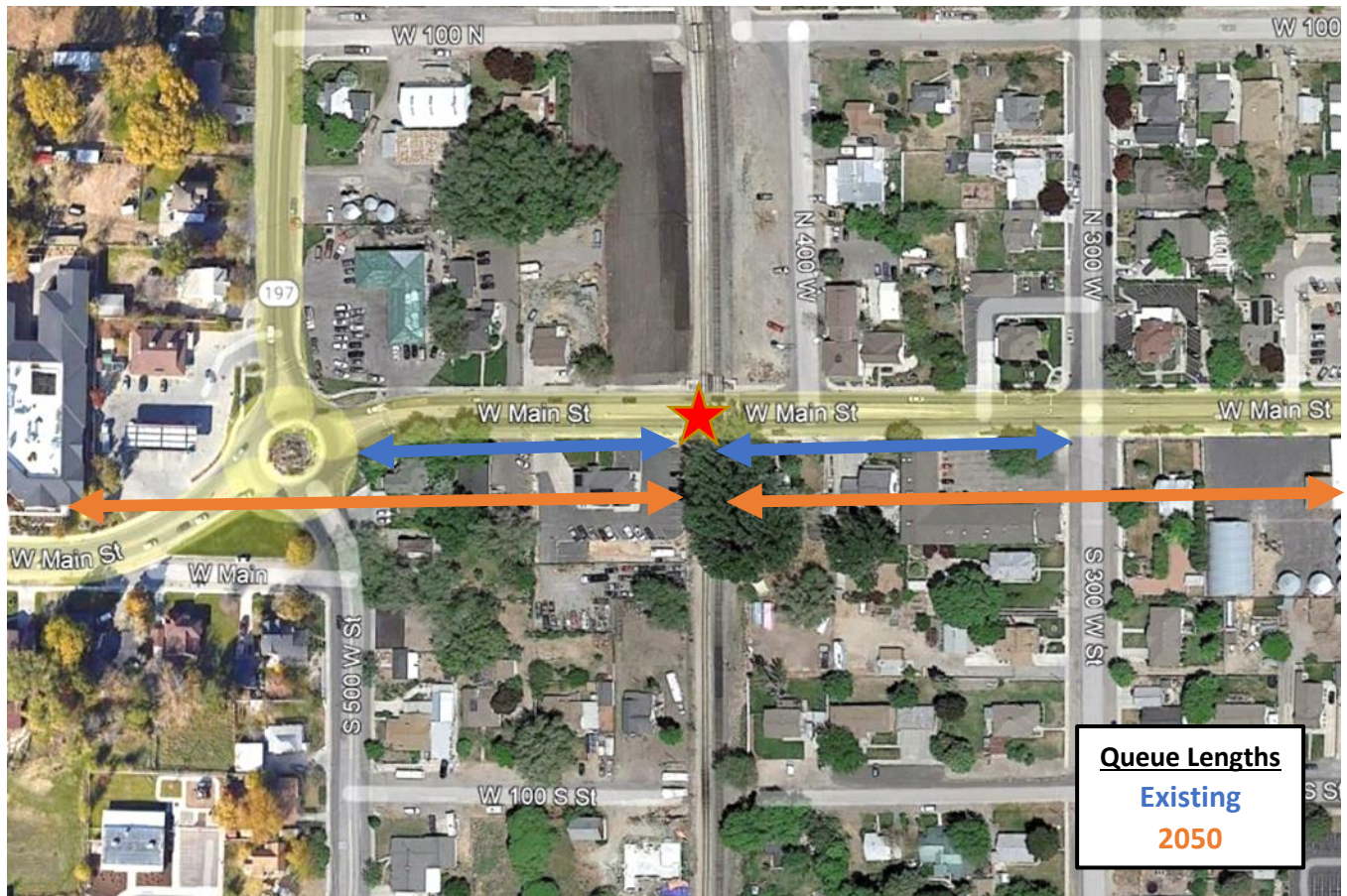
**Figure 6. Murray / 5900 South Crossing Location**



**Lehi / Main Street** – The crossing at Main Street in Lehi is located 75 feet west of a minor intersection at 400 West and 400 feet east of a roundabout intersection at 500 West. Existing traffic volumes are 9,200 vehicles per day and projected to be 14,000 vehicles per day by 2050. Existing 95<sup>th</sup> percentile queues reach 370 feet during a PM peak hour crossing event and are expected to reach up to 725 feet by 2050. Existing queues impact the minor intersection at 400 West today and that is projected to continue through 2050. 2050 queues are also projected to extend back through the 500 West roundabout intersection to the west and the 300 West intersection to the east during a crossing event if no other improvements are made. There is currently no grade-separation project planned for this crossing.

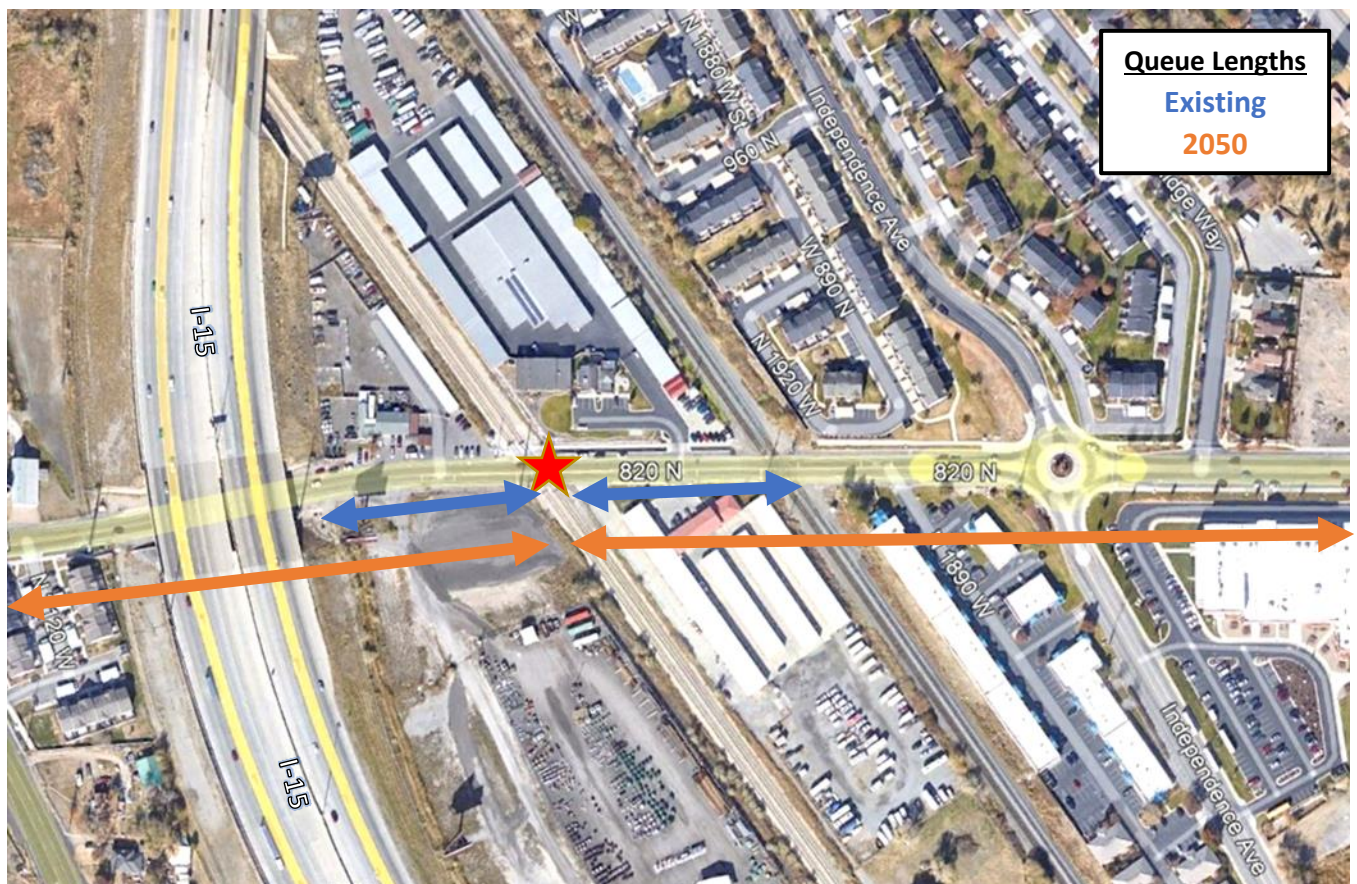
2050 queues are projected to extend west beyond the roundabout at 500 West which could cause failure for all traffic movements at the roundabout during a crossing event. However, the 2050 queues are projected to dissipate within one to two minutes of a crossing event. In other words, projected queues will become more frequent but not become longer with an increase in Frontrunner train frequency to 15-minute intervals. As AADT increases on Main Street in the future, queuing will be monitored and UTA will work with the local community to make future improvements to the roundabout intersection if necessary. Figure 7 shows the Main Street crossing location in Lehi.

**Figure 7. Lehi / Main Street Crossing Location**



**Provo / 820 North** – The crossing at 820 North in Provo is located 325 feet west of the UPRR railroad crossing and 725 feet west of a roundabout intersection at Independence Avenue. Existing traffic volumes are 9,400 vehicles per day and projected to be 50,000 vehicles per day by 2050 due to a proposed new I-15 interchange at 820 North just west of the railroad tracks. Existing 95<sup>th</sup> percentile queues reach 380 feet during a PM peak hour crossing event and would reach over 3,000 feet by 2050. Existing and future queues have the potential to extend through the UPRR railroad crossing to the east, and 2050 queue lengths would impact the roundabout intersection at Independence Avenue and the signalized intersection at Geneva Road west of I-15. However, the crossing is expected to be grade-separated in the future in conjunction with the I-15 interchange project which would mitigate future queues. Figure 8 shows the 820 North crossing location in Provo.

**Figure 8. Provo / 820 North Crossing Location**



**Other potential impacts**

**School Bus Routes**

Each of the eight analysis crossing locations are indicated as school bus routes in the FRA inventory database. School bus crossings per day range from 90 bus crossings per day at the Roy/4800 South crossing near Roy High School, to four bus crossings per day at the Murray/5900 South crossing. Four crossings have 50 or more bus crossings per day: Roy/4800 South, Lehi/Main Street, Layton/Gentile Street, and Provo/820 North. Table 5 shows the number of bus crossings per day at each of analysis the crossings.

**Table 5. School Bus Crossings Per Day**

| CROSSING LOCATION                  | NUMBER OF SCHOOL BUS CROSSINGS PER DAY |
|------------------------------------|--|
| 1. Roy – 4800 South                | 90                                     |
| 2. Sunset – 1800 North (SR-37)     | 34                                     |
| 3. Layton – Gentile Street         | 54                                     |
| 4. North Salt Lake – Center Street | 21                                     |
| 5. Murray – 4800 South             | 4                                      |
| 6. Murray – 5900 South             | 8                                      |
| 7. Lehi – Main Street              | 62                                     |
| 8. Provo – 820 North               | 49                                     |

Crossings with a large number of bus crossings likely have added congestion during the existing AM peak hour. Increasing train frequency will likely cause additional delay for school buses at these crossings during the AM peak hour as the chance that any given bus will be stopped by a train when frequency is increased. School release and subsequent bus crossings during the afternoon will not coincide with the 15-minute FrontRunner train headways during the PM peak hour and thus will not be impacted in the PM by the increased FrontRunner train frequency.

**Emergency Services**

Seven of the eight analysis crossing locations are flagged as an emergency services route in the FRA inventory; the Provo/820 North crossing is the only one not considered an emergency services route. An emergency service route crossing is one where police, fire, and/or ambulance vehicles regularly cross. Existing train crossing events sometimes add delay to these emergency vehicles and increasing the FrontRunner train frequency will result in an increase in the potential number of times any given emergency vehicle has a chance to be stopped at a crossing.

**Pedestrian Safety**

There are pedestrian facilities at all eight crossings, including pedestrian markings, gates and signage. Four of the crossings also have illuminating pedestrian warning signs that are activated during a rail crossing event. Six of the eight crossings have pedestrian crossings on both sides of the roadway. The North Salt Lake/Center Street crossing only has pedestrian facilities on the south side of the roadway, and the Provo/820 North crossing only has pedestrian facilities on the north side of the roadway. All of the analysis crossings appear to have sufficient pedestrian safety facilities in place to ensure safe

crossings for pedestrians, therefore the increase in FrontRunner train frequency is unlikely to be detrimental to pedestrian safety.

### **Potential Consecutive Train Events**

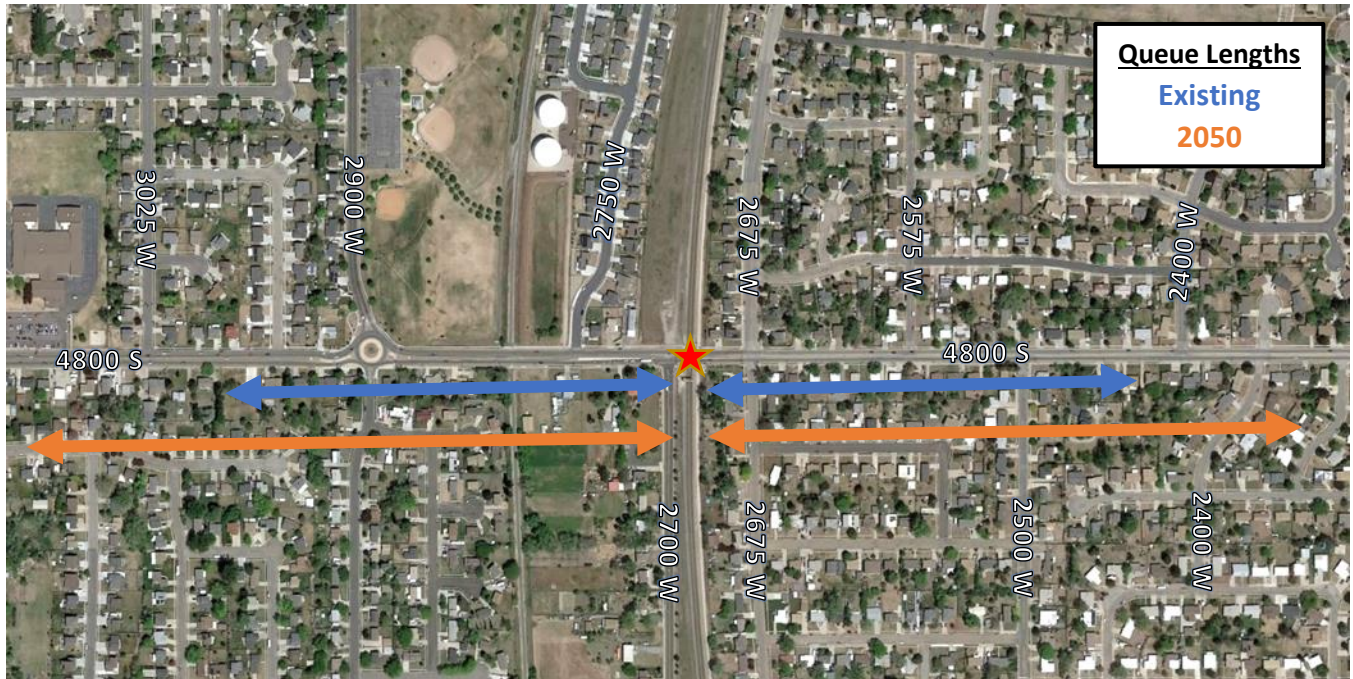
With respect to the proposed FrontRunner double-track project along several segments of the corridor, predicted FrontRunner station arrival times with the 15-minute train frequency were evaluated to determine if any of the eight analysis crossings would potentially experience back-to-back train events from trains arriving in the opposite direction, which would result in a delay longer than 60 seconds and possibly up to 120 seconds if the trains came consecutively.

Two crossing locations were determined to have trains that could pass the crossing within one or two minutes of each other: the 4800 South crossing in Roy, near the Roy FrontRunner station and the 5900 South crossing in Murray, just south of the Murray Central station. Projected time-space diagrams suggest that both trains will dwell at the Roy station and the Murray Central station at the same time.

Under ideal conditions, consecutive FrontRunner crossing events will likely not be a concern at 4800 South in Roy or 5900 South in Murray. However, there may be a minimal amount of time that the FrontRunner train will be delayed and operate outside model conditions, resulting in a small percentage chance of a consecutive train event of up to 120 seconds delay at the crossing. UTA FrontRunner service has a 95% on-time performance goal therefore the percentage chance of a consecutive train event would likely be less than five percent, and the chance of a full 120 seconds of delay at the crossing would be even lower. To assess the possible impact of a consecutive FrontRunner train event, the crossing locations at 4800 South in Roy and 5900 South in Murray were further analyzed.

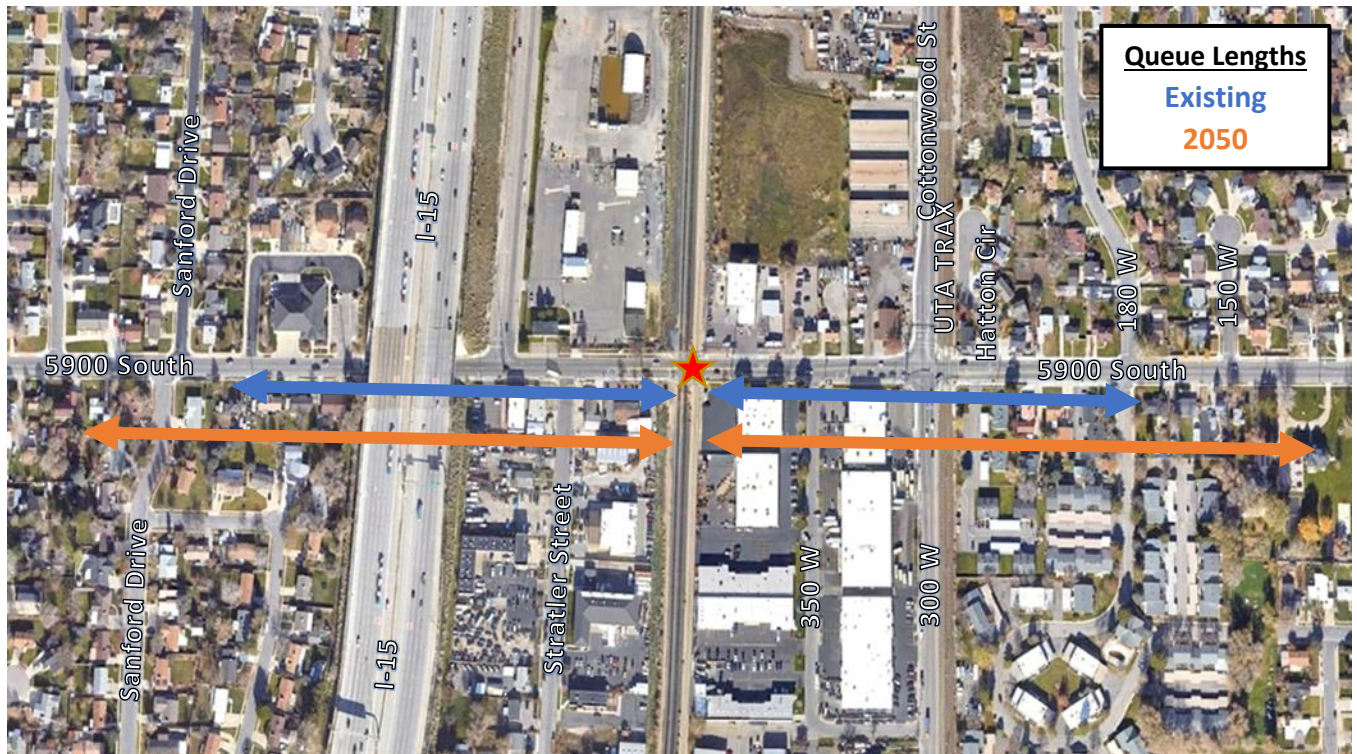
At the 4800 South crossing in Roy, consecutive FrontRunner trains would result in a 120 second delay at the crossing which would result in 95<sup>th</sup> percentile queues extending 1,660 feet in existing and 2,320 feet in 2050. Existing queues would impact the minor intersections at 2500 West, 2575 West, 2675 West and 2700 West and 2950 West, and the 2900 West roundabout. 2050 queues would further impact the minor intersections at 2400 West and 3025 West. As mentioned, this crossing is designated as a WFRC Phase 3 (2041-2050) grade-separation project; therefore, the crossing would likely be grade separated before 2050. Figure 9 shows the 4800 South crossing location in Roy and the intersections that would be impacted from a potential consecutive crossing event.

**Figure 9. Roy/4800 South Crossing Location – Consecutive Train Event**



At the 5900 South crossing in Murray, a consecutive train event with 120 seconds of delay at the crossing would result in 95<sup>th</sup> percentile queues of 1,100 feet in existing and 1,450 feet in 2050. Existing queues would extend beyond the minor intersections at 350 West, Stratler Street and Commerce Drive to the west and would extend through the signalized intersection at 300 West, the UTA TRAX rail crossing and the minor intersections at 180 West and Hatton Circle to the east. 2050 queues would further impact the minor intersections at Sanford Drive to the west and 150 West to the east. There is currently no grade-separation project planned for this crossing. Figure 10 shows the 5900 South crossing location in Murray and the intersections that would be impacted from a potential consecutive crossing event.

Figure 10. Murray / 5900 South Crossing Location – Consecutive Train Event



In the event of a consecutive crossing event at either of these crossing locations, it would be anticipated that there would be 10 to 15 minutes before another FrontRunner train crossing, therefore the projected longer queues would still have sufficient time to dissipate. Maximum projected 2050 queues during a consecutive train event would take approximately two minutes and 30 seconds to dissipate. As mentioned, these crossings both also serve UPRR trains, but the chance of a consecutive FrontRunner train event followed by a UPRR train at the crossing would be very minimal.

### **Summary / Conclusions**

A traffic analysis was conducted to determine the impacts of doubling FrontRunner train frequencies which includes increasing to 15-minute headways during the peak hours. There were 69 at-grade crossings analyzed on the FrontRunner corridor from Ogden to Provo. Through an initial screening process, eight crossings were chosen for more detailed traffic evaluation.

Each of the eight crossings were evaluated for existing and future 2050 conditions during the PM peak hour, with 95<sup>th</sup> percentile queue lengths as the primary traffic measurement. There was an evaluation of potential effects to roadway and intersection performance for facilities in the vicinity of the crossing due to expected increases in rail services frequencies. Impacts to school/bus routes, emergency services, and pedestrian safety were also evaluated.

2050 peak hour queue lengths are projected to be over 1,000 feet at several of the crossing locations, but each of these crossings is programmed for a future grade-separation project which would fully mitigate queues at the crossings. The analysis crossings at 5900 South in Murray and Main Street in Lehi will have projected 2050 queues which extend beyond the nearest major intersection, but these queues

do not become worse with increased train frequency. As AADT increases in future years, queuing will be monitored at 5900 South in Murray and Main Street in Lehi and UTA will work with communities on future improvement projects if necessary. Increasing FrontRunner train frequency to 15-minute intervals during peak periods is not expected to increase the lengths of existing or projected 2050 queues at any of the crossings evaluated as the queues will have sufficient time to dissipate between train crossing events. In other words, queues will not be any longer than without the increased FrontRunner frequency, though the queuing will occur more frequently. The increased FrontRunner train frequency may cause some minor impacts to school routes and emergency services due to an increased potential for any given vehicle to get stopped at the crossing.

The possibility of a consecutive FrontRunner train event was also analyzed at the 4800 South crossing in Roy and the 5900 South crossing in Murray, and the results showed that projected queues would still be able to dissipate within two to three minutes of a consecutive train crossing event.

Increasing train frequency will likely cause additional delay for school buses at crossings during the AM peak hour but school release will not coincide with the 15-minute FrontRunner train headways during the PM peak hour and buses will not be impacted. Seven analysis crossing locations are flagged as an emergency services route and the increase in train frequency will result in an increase in the potential number of times any given emergency vehicle has a chance to be stopped at a crossing. However, emergency service providers likely have alternate route plans due to the existing UPRR trains causing a worse condition than is projected from the increase in FrontRunner trains.

Pedestrian facilities already feature sidewalks on one or both sides at all eight crossings and pedestrian safety is not expected to be impacted with increased train frequency. Finally, the FrontRunner crossing locations also serve UPRR trains which have longer crossing events than FrontRunner trains. Therefore, traffic impacts at each location from FrontRunner are already overshadowed by the impacts incurred by existing and future UPRR events.

**Appendix:**  
**FrontRunner Forward Frequency Traffic Analysis**  
**At-grade Crossings**

| FRA ID  | UTA Milepost | UPRR Subdivision | County    | City            | Cross Street         | Public/Private | Angle | Median | # of Lanes | AADT  | AADT/Lane | 60% Dir Split AADT/Lane | 60% Dir Split 95th% Queue | Closest Roadway | Closest Major Intersection      |
|---------|--------------|------------------|-----------|-----------------|----------------------|----------------|-------|--------|------------|-------|-----------|-------------------------|---------------------------|-----------------|---------------------------------|
| 805669Y | N6.00        | Salt Lake        | Davis     | North Salt Lake | Center St            | Public         | 60 N  |        | 2          | 17000 | 8500      | 10200                   | 1,085 ft                  | n/a             | 130 ft W(RR)/200 ft E(Off-ramp) |
| 805619V | N29.42       | Salt Lake        | Davis     | Sunset          | 1800 N / SR-37       | Public         | 90 N  |        | 2          | 16000 | 8000      | 9600                    | 950 ft                    | 100             | 1,250 ft E(Signal)              |
| 805615T | N31.99       | Salt Lake        | Weber     | Roy             | 4800 S               | Public         | 90 Y  |        | 2          | 15000 | 7500      | 9000                    | 830 ft                    | 25              | 1,000 ft E(RAB)                 |
| 254762G | S8.31        | Provo            | Salt Lake | Murray          | 5900 S               | Public         | 90 Y  |        | 2          | 12000 | 6000      | 7200                    | 550 ft                    | 120             | 500 ft E(Signal)                |
| 254630W | S0.83        | Provo            | Salt Lake | Salt Lake City  | 900 S                | Public         | 90 Y  |        | 2          | 11000 | 5500      | 6600                    | 480 ft                    | 120             | 2,200 ft W(Signal)              |
| 805613E | N33.08       | Salt Lake        | Weber     | Roy             | 4000 S               | Public         | 60 Y  |        | 2          | 11000 | 5500      | 6600                    | 480 ft                    | 120             | 1,300 ft E(RAB)                 |
| 805634X | N22.67       | Salt Lake        | Davis     | Layton          | W Gentile St         | Public         | 45 Y  |        | 2          | 11000 | 5500      | 6600                    | 480 ft                    | 20              | 900 ft E(Signal)                |
| 254773U | S6.59        | Provo            | Salt Lake | Murray          | 4800 S               | Public         | 90 Y  |        | 2          | 11000 | 5500      | 6600                    | 480 ft                    | 120             | 450 ft E(RR)                    |
| 805631C | N23.81       | Salt Lake        | Davis     | Layton          | Hill Field Rd        | Public         | 90 Y  |        | 4          | 20000 | 5000      | 12000                   | 415 ft                    | 250             | 1200 ft E(Signal)               |
| 805638A | N20.62       | Salt Lake        | Davis     | Kaysville       | Old Mill Ln          | Public         | 60 Y  |        | 2          | 9780  | 4890      | 5868                    | 400 ft                    | 300             | n/a                             |
| 806927E | S41.73       | Provo            | Utah      | Provo           | 820 N                | Public         | 45 Y  |        | 2          | 9400  | 4700      | 5640                    | 380 ft                    | n/a             | 325 ft E(RR), 750 ft E(RAB)     |
| 254884L | S28.08       | Provo            | Utah      | Lehi            | Main St              | Public         | 90 Y  |        | 2          | 9200  | 4600      | 5520                    | 370 ft                    | 75              | 400 ft W(RAB)                   |
| 254717M | S43.99       | Provo            | Utah      | Provo           | 200 W / Freedom Blvd | Public         | 90 Y  |        | 2          | 8800  | 4400      | 5280                    | 350 ft                    | 75              | 400 ft N(U), 1200 ft S(RAB)     |
| 805633R | N23.25       | Salt Lake        | Davis     | Layton          | 650 W / King St      | Public         | 45 Y  |        | 2          | 8350  | 4175      | 5010                    | 325 ft                    | n/a             | 1,900 ft S(Signal)              |
| 805630V | N24.20       | Salt Lake        | Davis     | Layton          | 1000 N / Gordon Ave  | Public         | 45 Y  |        | 2          | 8100  | 4050      | 4860                    | 300 ft                    | 120             | 1,150 E(Signal)                 |
| 805655R | N9.03        | Salt Lake        | Davis     | West Bountiful  | 500 S / SR-68        | Public         | 60 Y  |        | 4          | 16000 | 4000      | 9600                    | 300 ft                    | 120             | 1,000 ft E(Off-ramp)            |
| 254345X | S13.44       | Provo            | Salt Lake | Sandy           | 10000 S              | Public         | 60 Y  |        | 4          | 16000 | 4000      | 9600                    | 300 ft                    | 120             | 350 ft E(Signal),570 W(Signal)  |
| 906693E | S14.53       | Provo            | Salt Lake | South Jordan    | S Jordan Gateway     | Public         | 90 Y  |        | 4          | 16000 | 4000      | 9600                    | 300 ft                    | 200             | 325 ft W(Signal)                |
| 805617G | N30.44       | Salt Lake        | Weber     | Roy             | 6000 S               | Public         | 60 Y  |        | 2          | 7800  | 3900      | 4680                    | 295 ft                    | 120             | 1,100 ft W(RAB)                 |
| 254715Y | S43.71       | Provo            | Utah      | Provo           | 500 W                | Public         | 90 Y  |        | 2          | 7500  | 3750      | 4500                    | 280 ft                    | 75              | 3,200 ft E(Signal)              |
| 805662B | N7.41        | Salt Lake        | Davis     | North Salt Lake | 1100 N               | Public         | 60 Y  |        | 3          | 10000 | 3333      | 6000                    | 245 ft                    | 300             | 400 ft W(Signal)                |
| 254882X | S27.80       | Provo            | Utah      | Lehi            | 500 W                | Public         | 45 Y  |        | 2          | 6600  | 3300      | 3960                    | 240 ft                    | 120             | 1,300 ft E(Signal)              |
| 805647Y | N10.67       | Salt Lake        | Davis     | West Bountiful  | 1600 N               | Public         | 90 Y  |        | 2          | 6100  | 3050      | 3660                    | 220 ft                    | n/a             | n/a                             |
| 254790K | S1.96        | Provo            | Salt Lake | Salt Lake City  | 1700 S               | Public         | 90 Y  |        | 4          | 12000 | 3000      | 7200                    | 215 ft                    | n/a             | n/a                             |
| 805618N | N29.92       | Salt Lake        | Davis     | Sunset          | 2300 N               | Public         | 90 N  |        | 2          | 5800  | 2900      | 3480                    | 210 ft                    | 120             | n/a                             |
| 254659U | S0.68        | Provo            | Salt Lake | Salt Lake City  | 800 S                | Public         | 90 Y  |        | 4          | 11000 | 2750      | 6600                    | 195 ft                    | 120             | n/a                             |
| 254905C | S37.99       | Provo            | Utah      | Orem            | 400 S                | Public         | 45 Y  |        | 2          | 5300  | 2650      | 3180                    | 185 ft                    | n/a             | n/a                             |
| 805664P | N7.05        | Salt Lake        | Davis     | North Salt Lake | Main St              | Public         | 30 Y  |        | 2          | 5100  | 2550      | 3060                    | 175 ft                    | n/a             | n/a                             |
| 254772M | S7.00        | Provo            | Salt Lake | Murray          | 5100 S / Vine St     | Public         | 60 Y  |        | 4          | 7600  | 1900      | 4560                    | 130 ft                    | n/a             | n/a                             |
| 805829K | N0.59        | Salt Lake        | Salt Lake | Salt Lake City  | 600 W                | Public         | 60 Y  |        | 2          | 3564  | 1782      | 2138                    | n/a                       | 75              | n/a                             |
| 254712D | S43.32       | Provo            | Utah      | Provo           | 900 W                | Public         | 45 Y  |        | 2          | 3200  | 1600      | 1920                    | n/a                       | 75              | n/a                             |
| 806933H | S40.46       | Provo            | Utah      | Provo           | 2800 W               | Public         | 45 Y  |        | 2          | 3100  | 1550      | 1860                    | n/a                       | 120             | n/a                             |
| 805660M | N8.34        | Salt Lake        | Davis     | Woods Cross     | 1500 S               | Public         | 60 Y  |        | 2          | 3000  | 1500      | 1800                    | n/a                       | 150             | n/a                             |
| 805673N | N3.54        | Salt Lake        | Salt Lake | Salt Lake City  | 1800 N               | Public         | 90 Y  |        | 2          | 2600  | 1300      | 1560                    | n/a                       | 75              | n/a                             |
| 805688D | N1.31        | Salt Lake        | Salt Lake | Salt Lake City  | 400 N                | Public         | 90 Y  |        | 2          | 2600  | 1300      | 1560                    | n/a                       | 75              | n/a                             |
| 806934P | S40.35       | Provo            | Utah      | Orem            | 2000 N               | Public         | 45 Y  |        | 2          | 2500  | 1250      | 1500                    | n/a                       | n/a             | n/a                             |
| 805689K | N1.16        | Salt Lake        | Salt Lake | Salt Lake City  | 300 N                | Public         | 90 Y  |        | 2          | 2400  | 1200      | 1440                    | n/a                       | 75              | n/a                             |
| 254714S | S43.52       | Provo            | Utah      | Provo           | 700 W                | Public         | 60 Y  |        | 2          | 2400  | 1200      | 1440                    | n/a                       | 75              | n/a                             |
| 805612X | N34.43       | Salt Lake        | Weber     | Ogden           | 3300 S               | Public         | 45 Y  |        | 2          | 2250  | 1125      | 1350                    | n/a                       | 120             | n/a                             |
| 254895Y | S31.12       | Provo            | Utah      | American Fork   | S Storrs Ave         | Public         | 45 Y  |        | 2          | 2100  | 1050      | 1260                    | n/a                       | 140             | n/a                             |
| 254774B | S6.12        | Provo            | Salt Lake | Murray          | 4500 S Frontage Rd   | Public         | 90 Y  |        | 2          | 2000  | 1000      | 1200                    | n/a                       | 75              | n/a                             |
| 254922T | N0.23        | Provo            | Salt Lake | Salt Lake City  | 200 S                | Public         | 60 Y  |        | 4          | 3800  | 950       | 2280                    | n/a                       | 120             | n/a                             |
| 254346E | S12.66       | Provo            | Salt Lake | Sandy           | 9400 S               | Public         | 90 Y  |        | 2          | 1900  | 950       | 1140                    | n/a                       | 120             | n/a                             |
| 805627M | N25.28       | Salt Lake        | Davis     | Clearfield      | 2200 W               | Public         | 30 Y  |        | 2          | 1800  | 900       | 1080                    | n/a                       | n/a             | n/a                             |
| 805620P | N28.92       | Salt Lake        | Davis     | Sunset          | 1300 N               | Public         | 90 N  |        | 2          | 1200  | 600       | 720                     | n/a                       | 75              | n/a                             |
| 254898U | S32.64       | Provo            | Utah      | American Fork   | 1100 S               | Public         | 45 Y  |        | 2          | 1100  | 550       | 660                     | n/a                       | 25              | n/a                             |
| 254891W | S28.74       | Provo            | Utah      | Lehi            | Center St            | Public         | 60 Y  |        | 2          | 1100  | 550       | 660                     | n/a                       | 300             | n/a                             |
| 254879P | S26.43       | Provo            | Utah      | Lehi            | 1500 N               | Public         | 45 Y  |        | 2          | 1100  | 550       | 660                     | n/a                       | n/a             | n/a                             |
| 254897M | S31.92       | Provo            | Utah      | American Fork   | 100 E                | Public         | 45 Y  |        | 2          | 1000  | 500       | 600                     | n/a                       | 120             | n/a                             |
| 254900T | S33.30       | Provo            | Utah      | American Fork   | 1500 S / 600 N       | Public         | 45 Y  |        | 2          | 1000  | 500       | 600                     | n/a                       | 120             | n/a                             |
| 254896F | S31.40       | Provo            | Utah      | American Fork   | 100 W                | Public         | 45 Y  |        | 2          | 850   | 425       | 510                     | n/a                       | 120             | n/a                             |
| 254902G | S35.12       | Provo            | Utah      | Vineyard        | 1600 N / Vineyard Rd | Public         | 45 Y  |        | 2          | 700   | 350       | 420                     | n/a                       | 120             | n/a                             |
| 254894S | S30.87       | Provo            | Utah      | American Fork   | 200 S / 7750 N       | Public         | 30 Y  |        | 2          | 500   | 250       | 300                     | n/a                       | 120             | n/a                             |
| 254886A | S28.22       | Provo            | Utah      | Lehi            | 200 S                | Public         | 90 Y  |        | 2          | 500   | 250       | 300                     | n/a                       | 200             | n/a                             |
| 254881R | S27.13       | Provo            | Utah      | Lehi            | 900 N                | Public         | 45 Y  |        | 2          | 500   | 250       | 300                     | n/a                       | 120             | n/a                             |
| 807067P | S42.29       | Provo            | Utah      | Provo           | N Draper Ln          | Public         | 45 Y  |        | 2          | 250   | 125       | 150                     | n/a                       | 75              | n/a                             |
| 806932B | S40.76       | Provo            | Utah      | Provo           | 1680 N               | Public         | 45 Y  |        | 2          | 250   | 125       | 150                     | n/a                       | n/a             | n/a                             |
| 254906J | S38.58       | Provo            | Utah      | Orem            | 800 S                | Public         | 45 Y  |        | 2          | 170   | 85        | 102                     | n/a                       | 120             | n/a                             |
| 970216G | S3.16        | Provo            | Salt Lake | South Salt Lake | UP Yard              | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | n/a             | n/a                             |
| 970181H | S0.12        | Provo            | Salt Lake | Salt Lake City  | 420 S                | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | 75              | n/a                             |
| 254883E | S28.01       | Provo            | Utah      | Lehi            | 100 N                | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | 75              | n/a                             |
| 970200K |              | Provo            | Utah      | American Fork   | 200 S Pedestrian     | Public         | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | 75              | n/a                             |
| 254903N |              | Provo            | Utah      | Vineyard        | 400 N                | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | 75              | n/a                             |
| 921199K | S18.90       | Provo            | Salt Lake | Draper          | 14000 S              | Private        | 60 N  |        | 1          | 10    | 10        | 6                       | n/a                       | n/a             | n/a                             |
| 254876U | S20.49       | Provo            | Salt Lake | Bluffdale       | W Cinch Way          | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | n/a             | n/a                             |
| 805686P | N1.45        | Salt Lake        | Salt Lake | Salt Lake City  | 550 N                | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | n/a             | n/a                             |
| 928484H | N2.32        | Salt Lake        | Salt Lake | Salt Lake City  | 1050 N / UTA Yard    | Private        | 90 N  |        | 1          | 10    | 10        | 6                       | n/a                       | n/a             | n/a                             |