



Report on the

# Improvements to Highway-Rail Grade Crossings and Rail Safety

December 2014



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**Minnesota Department of Transportation**

395 John Ireland Boulevard  
Saint Paul, MN 55155

December 31, 2014

The Honorable Frank Hornstein, Chair  
House Transportation Finance Committee  
471 State Office Building  
Saint Paul, MN 55155

The Honorable Michael Beard, GOP Lead  
House Transportation Finance Committee  
207 State Office Building  
Saint Paul, MN 55155

The Honorable Ron Erhardt, Chair  
House Transportation Policy Committee  
543 State Office Building  
Saint Paul, MN 55155

The Honorable Linda Runbeck, GOP Lead  
House Transportation Policy Committee  
295 State Office Building  
Saint Paul, MN 55155

The Honorable Scott Dibble, Chair  
Senate Transportation and Public Safety Committee  
111 Capitol  
Saint Paul, MN 55155

The Honorable John C. Pederson  
Ranking Minority Member  
Senate Transportation and Public Safety Committee  
27 State Office Building  
Saint Paul, MN 55155

RE: Study on Grade Crossing and Rail Safety for Oil and other Hazardous Materials

Dear Legislators:

On behalf of the Minnesota Department of Transportation, I am submitting the final report on the Improvements to Highway-Rail Grade Crossings and Rail Safety.

The draft report submitted in October included information about how MnDOT calculated the risk assessments for crossings on oil routes, a list of the 100 highest risk crossings in the state, and preliminary recommendations for safety improvements based on Federal Railroad Administration criteria and additional information collected by MnDOT staff.

In order to make recommendations about safety improvements to grade crossings, it was essential that MnDOT work with each community affected to understand if our preliminary safety improvement recommendations adequately met the communities' needs. This final report contains the safety improvement recommendations with preliminary concurrence from each of the communities in which an improvement has been suggested.

Thank you for partnering with MnDOT to begin to address this critical issue.

Please contact me with any questions you may have, or you may contact Dave Christianson at 651 366-3017 or [dave.christianson@state.mn.us](mailto:dave.christianson@state.mn.us).

Sincerely,

Charles A. Zelle  
Commissioner

An Equal Opportunity Employer



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# Legislative Request

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This interim update is issued to comply with Laws of Minnesota 2014, Chapter 312, Article 10, Section 10.

## **IMPROVEMENTS STUDY ON GRADE CROSSINGS AND RAIL SAFETY FOR OIL AND OTHER HAZARDOUS MATERIALS TRANSPORTATION.**

(a) The commissioner of transportation shall conduct a study on highway-rail grade crossing improvement for oil and other hazardous materials transported by rail, and on rail safety. At a minimum, the study must:

- (1) provide information that assists in risk management associated with transportation of oil and other hazardous materials by rail;
- (2) develop criteria to prioritize needs and improvements at highway-rail grade crossings;
- (3) consider alternatives for safety improvements, including but not limited to active warning devices such as gates and signals, closings, and grade separation;
- (4) provide findings and recommendations that serve to direct accelerated investments in highway-rail grade crossing safety improvements; and
- (5) analyze state inspection activities and staffing for track and hazardous materials under Minnesota Statutes, section 219.015

(b) The commissioner shall submit an interim update on the study by August 31, 2014, and a final report by October 31, 2014, to the chairs and ranking minority members of the legislative committees with jurisdiction over transportation policy and finance.

### **Report cost**

The total cost to produce this study is approximately \$93,000, which includes all the drafts and previous iterations. All work performed to create this report was done as part of normal assigned duties for MnDOT staff and includes all GIS analysis and field work.

## Summary

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The 2014 Minnesota Legislature directed the Minnesota Department of Transportation to conduct a study of highway-rail grade crossings improvements for rail corridors carrying unit trains of crude oil and other hazardous materials<sup>1</sup>. The legislature also appropriated \$2 million for implementation of safety improvements at these grade crossings specifically along crude-by-rail corridors<sup>2</sup>. It is estimated that this appropriation will fund the installation of approximately 10 lower cost grade crossing improvements.

The MnDOT study identified more than 700 miles of train routes that carry the Bakken crude oil across Minnesota to refinery destinations on the East and Gulf coasts. These routes have 683 at-grade crossings of roads and railroads. Each grade crossing has the potential risk of a train and vehicle collision, or a train derailment. If a train filled with Bakken oil has an incident such as a derailment, there is a high probability that the oil, a highly volatile, hazardous material, would be released in significant volumes.

The volatility of the Bakken crude oil makes it highly prone to catching fire in the presence of an ignition source, including sparks and heated metal common at accident sites. The volatile makeup of Bakken crude oil and recent train accidents bring this issue to the forefront and raise safety concerns about transporting the oil across the state.

Most of the Bakken crude oil is going to the Gulf Coast or the East Coast, but it passes through the state. Trains carrying the oil travel through major metropolitan areas, such as the Twin Cities, but also travel through rural Minnesota where response times to an accident may be an issue. The study is designed to address concerns about rail grade crossings and the safety needed to ensure trains carrying hazardous material reach their destinations while the citizens of the state are assured of the safety of the operation.

The study focuses on the transportation of Bakken crude oil by train since the volume exceeds any other flammable or hazardous material being transported through Minnesota by several times over. The recommended improvements to grade crossings cover some of the most heavily trafficked railroad mainlines in the state and will provide similar safety improvement to the transport of all hazardous materials on these key routes.

The study focuses on prioritizing risks, while also reducing potential collisions by improving the overall safety of each grade crossing. The risks are assessed by focusing on the people who would potentially be most affected by an accident involving a train, such as nearby residents, workers and emergency responders in the vicinity of the rail crossing. The focus on risk assessment for those people most likely impacted by any possible incidents is the key difference in the study from a conventional grade crossing safety assessment; therefore, the areas with the highest potential risk to the population informed all of the evaluations that identified improvable crossings in the recommendations. Due to this new focus in the risk assessments, all recommended improvements to specific crossings improve public safety in the presence of transporting the highly flammable Bakken crude oil by rail.

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<sup>1</sup> Laws of Minnesota, 2014 Chapter 312, Article 10; <https://www.revisor.mn.gov/laws/?id=312&year=2014&type=0>

<sup>2</sup> Laws of Minnesota, 2014 Chapter 312, Article 9; <https://www.revisor.mn.gov/laws/?id=312&year=2014&type=0>

## Background

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Bakken crude oil is identified by the federal government as a highly volatile flammable material. The transport of the oil accounts for significant new rail business, which increased from almost no rail transport in 2005 to nine fully loaded crude oil trains originating from North Dakota daily in 2014. Of the nine trains originating in North Dakota, five to seven of those trains cross Minnesota on a daily basis, destined for refineries on the East Coast and Gulf Coast.

There were several catastrophic incidents involving trains carrying crude oil, including the Lac Megantic, Quebec, derailment and fire that killed 47 persons in July 2013. There was also the fire in Casselton, N.D. in January 2014. Since Lac Megantic, six other incidents involving spills and fires from derailed and ruptured loaded crude oil tank cars were recorded in North America. None of the other recent incidents resulted in additional injuries or deaths, due to either unpopulated locations or limited and contained spills and fires. However, these incidents highlight the potential safety risks due to the substantial increase in traffic and large volumes of hazardous material transported by railroads.

The volatility of Bakken crude oil is the subject of debate, but it has consistently been shown to be more prone to vaporization and ignition compared to other heavier crude oil. Bakken crude has these characteristics that make it categorized as volatile:

- An average flash point of 73 degrees Fahrenheit, the point where natural atmospheric vaporization creates an ignitable air/fuel mix at the surface of the liquid
- A boiling point of 120 to 140 degrees Fahrenheit, the point where heating the liquid produces significant volumes of vaporization
- A specific gravity of 40, lighter than water and analogous to light motor fuels including gasoline, jet fuel, and diesel

It is notable that crude oil by definition is a natural mix of hydrocarbon compounds, ranging from ethanes, butanes and methanes through natural gasoline to heavy oils and bitumens, combined in a liquid mix. This often complicates the handling and emergency response requirements because of the wide range of chemical reactions exhibited by different compounds within the mix of crude oil.

As a result of these findings, the Federal Rail Administration, in conjunction with the Pipeline and Hazardous Material Safety Administration, issued emergency orders requiring documentation and labeling of all rail shipments carrying Bakken crude oil. The orders mandate that Bakken crude oil be classified under the most dangerous and highly controlled category of flammable liquids. This means the hazmat documentation must disclose a hazardous materials category of Flammable 3, Packing Group 1 without exception.

Increasing the risks associated with transporting Bakken crude oil is the design of the general purpose rail tank car carrying the crude oil. In 2005, there was virtually no Bakken crude oil to transport, so the majority of the general purpose rail tank car fleet is comprised of a DOT 111a car, with design specifications dating back to the 1960s. In recent years, the railroad industry recognized the design of the DOT 111a railcar as outdated and deficient, especially with regard to spill prevention and rupture protection. The industry adopted a new, more robust design standard in

2011, commonly referred to as the 1232 specification. Of the reported 90,000 tank cars currently used to transport Bakken crude oil, only an estimated 15,000 are the 1232 specification.

The federal agencies involved in railroad design and safety standards have not adopted the 1232 specification for rail tank cars. FRA and PHMSA are entered into the emergency rulemaking process. In part, the rulemaking process is to adopt improved rail tank car standards, which will most likely exceed the 1232 specification. The public and industry comment period on that rulemaking ended Sept. 29, 2014. Final rulemaking is expected to occur in the next several months, and a complete fleet transition to new safer cars is expected to take three years from the date of rule adoption.

The long term risks posed by the continuing presence of crude-by-rail shipments within Minnesota were researched internally by the Minnesota Department of Commerce and MnDOT. The research forecasts a potential range of outcomes over the next 10 years based on estimates of Bakken production growth, Alberta heavy oil production growth and potential capacity improvements in pipeline and rail transport systems.

The forecast assumes a long term continuing demand for crude oil production from these fields. The forecast also assumes that destinations for the crude oil movements remain roughly similar to current patterns, namely consumption by East Coast and Gulf Coast refineries for the majority of crude production. The forecast suggests that crude-by-rail traffic will, at best, stay at current levels, with five to seven loaded trains per day crossing Minnesota. However, if the demand and production doubles in volume, this doubling would strain the system. The report shows the new oil production will likely be equal to or possibly exceed planned new pipeline expansions; therefore, oil producers will continue to rely on the railroad's flexibility and capacity to transport the excess volumes in the next 10 years and beyond.

The analysis of the factors, influences and potential continuation of the transportation of Bakken crude oil via rail highlights the increased need for safety of at-grade highway-rail crossings. Along the three Bakken crude oil routes in Minnesota, there are 683 at-grade crossings, which means the intersection of railroad and highway traffic. Each crossing should be outfitted with appropriate warning devices and safety measures to prevent collisions. Collisions often cause a train derailment, ruptures of the loaded rail cars and subsequent spills and fires. The study specifically evaluates the top 100 crossings with the intent to improve current levels of safety at these key crossings.

Prior to the 2014 legislation, MnDOT only had one track inspector. With the added funding, provided through the state rail safety account, MnDOT hired an additional track inspector and a new hazardous materials inspector. Both track inspectors and the hazmat inspector all have previous experience in their fields, and were able to begin field work while undergoing FRA training. All the necessary training and federal certification are expected to be accomplished by the end of 2014.

The legislation allows the hiring of a third track inspector in 2015 after evaluating the effectiveness and workload of the new inspectors. That evaluation will take place beginning in spring 2015.



## Scope of Study

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The study focuses on the three rail corridors currently carrying five to seven unit trains of Bakken crude oil from North Dakota through Minnesota daily. The corridors are:

- BNSF mainline from the Twin Cities to Fargo/Moorhead via St Cloud, Staples and Detroit Lakes
- Canadian Pacific's mainline from La Crescent to the Twin Cities and then to North Dakota via Glenwood
- BNSF corridor from Fargo/Moorhead to Willmar to the South Dakota border via Marshal and Pipestone (Figure 1)

These three corridors represent more than 700 miles of the 4,450 miles of railroad track in Minnesota, and include 683 road crossings at grade, protected by a variety of installed at-grade crossing protection signage or equipment.

The statutory language included identifying sites where safety can be improved by one of four alternative strategies, with the goal of reducing public exposure to derailments, spills and fires in areas with the highest risks for personal injury and property damage. The named strategies include:

- Closing at-grade crossings
- Upgrading passive warnings to active signals
- Improving active protection with more effective safety treatments
- Constructing grade separations

As the study progressed, additional recognized and proven strategies were included for consideration. These strategies include:

- Improving the condition and signage of passive crossings (crossbucks combined with stop or yield traffic signs)
- Signal interconnects at adjacent traffic signals to reduce backups across grade crossings
- Programmed education and enforcement

The programmed education and enforcement strategy is a recognized FRA safety improvement, but requires proof and implementation of ongoing, systematic and sustainable actions by local education and enforcement agencies.

Conventional safety evaluations concentrate on reducing railroad and highway vehicle collisions at crossings. These evaluations and prevention strategies are well documented in a number of safety and design protocols and standards. These include:

- FHWA's Manual on Uniform Traffic Control Devices
- USDOT Technical Working Group reports on grade crossing traffic control
- FRA's Horn Rule and Quiet Zone Rules

This study is different because it expands the conventional evaluation scope to include the risk to adjacent residents and workers. The study shifts the focus to an area and population based risk assessment, rather than just an accident prediction assessment. The risk assessment for each grade crossing is defined by the population, facilities and activity within a half mile radius of each crossing. It also encompasses a half mile wide buffer zone on either side of the railroad tracks. This distance represents the evacuation zone around an incident site for a flammable material spill and fire.

The size of the evacuation zone is specified in the “USDOT Emergency Response Guidebook,” which is used by first responders reacting to the initial phases of a dangerous goods or hazardous materials transportation incident. The risk assessment also considered these influencing factors:

- Road usage, such as evacuation route and school bus routes
- Presence of heavy commercial vehicles in the traffic mix
- Volume and frequency of crude oil unit trains
- Overall traffic volumes and historic accident rates

# Methodology

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MnDOT used its internal expertise in rail and grade crossing safety to achieve a comprehensive evaluation of all the grade crossings in the targeted crude oil corridors. MnDOT completed a systematic evaluation of crossing safety based on an existing, detailed database, which was further expanded to accommodate the needs of the study. MnDOT is coordinating efforts with the Minnesota Department of Public Safety and surveyed MnDOT Districts, counties, and city engineers and administrators to isolate special conditions and concerns. The input provided through the Governor's Rail Safety Roundtables, which began on Aug. 11, 2014, was a valuable source of local feedback and is incorporated in the study findings. Other input is being integrated, such as the results of site visits and face-to-face communications with local officials, emergency responders and citizens along the corridors.

Crude-by-rail corridor grade crossings receive a multi-part comparative score involving three index numbers. The first score is the public risk assessment based on population density within one half mile of each crossing. This is from the federal hazmat response guidance for potential risk and recommended evacuation area for this particular hazardous material.

GIS mapping and satellite imagery were used to delineate the buffer zones and the number of households, businesses and other facilities within the threat area. Scores are given for residential population levels, fixed vulnerable populations such as hospitals, nursing homes and prisons, and transient vulnerable populations such as schools. The presence of public service facilities, including fire and police stations, were also located and counted. MnDOT analysts began with census population density figures, but in the case of high priority crossings identified for detailed study, actual building counts and city-level homestead occupancy rates were used to develop a site-specific population count.

The second score involves the use of the established Federal Railroad Administration Safety Index, a predictive index of possible grade crossing accidents. The FRA Safety Index also includes:

- Recorded accidents
- General vehicle counts
- Heavy commercial vehicle counts
- Special road uses such as emergency access
- Evacuation routes
- School bus routes
- Other nearby traffic generators

The FRA Safety Index includes consideration of train and highway vehicle counts and speeds specific to the location and the installed safety equipment, and allows for evaluation of variances in levels of traffic and levels of protection.

The third score evaluates the existing physical conditions, not specific to the first two indexes, which may influence accident risks and movements over the crossing. This score ranks the general crossing condition on a sliding scale, and includes evaluating the sight lines, the grades and approaches to the crossing, the crossing itself, the road surfaces and condition, and other variations

from the ideal specifications. On occasion, this score may include comments or scoring for unusual situations, such as proximity to refineries, truck terminals, power plants, special event venues, casinos, and chemical or fuel storage.

Each individual score is directly compared to the data about similar crossings, while the cumulative information gathered from the three scores together is designed to create the comprehensive picture of the safety of the crossing. The cumulative scores together informed the final evaluations and serves as the list of the top 102 crossings (Appendix D). An example of the evaluation template is included below for illustration (Figure1). The evaluation sheets for the 40 highest ranked grade crossings are included in Appendix E.

Figure1: Example of the form used to evaluate an at-grade rail crossing

Crude Oil by Rail Study  
 Railroad – Highway Grade Crossings Analysis

Location

USDOTNO \_\_\_\_\_

Railroad \_\_\_\_\_

Milepost \_\_\_\_\_

Location \_\_\_\_\_

AADT \_\_\_\_\_  
 HCADT \_\_\_\_\_  
 Oil Trains/Day \_\_\_\_\_

Criteria

A. Population Density (area within 1/2 mile/800 yard radius of crossing)

General Population Density (Per Sq. Mi.)

<500	1
500-1,500	2
1,500-3,000	3
3,000-5,000	4
>5,000	5

Vulnerable fixed population (hospital, nursing home, prison)

1	2
2	4
3	6
4	8
5	10

Vulnerable temporary population (schools, city halls)

1	1
2	2
3	3
4	4
5	5

Emergency Services (Police Department, Fire station)

1	1
2	2
3	3
4	4
5	5

Total \_\_\_\_\_

B. Safety (Safety Index – Per USDOT Crash Prediction Model)

0.005	1
0.008	2
0.010	3
0.030	4
0.050	5

Safety Record – Recorded crashes in last 5 years; add 2 points each \_\_\_\_\_

Near Misses - reported near misses by railroad; add 1 point each \_\_\_\_\_

Total \_\_\_\_\_

C. Conditions at Crossing (appropriate signal applications & safety-related conditions)

Appropriate safety application for condition (passive signals for low ADT, etc.)	1
Poor physical condition (poor geometry, surface, line of sight)	2
Very poor physical condition (inadequate geometry, stacking distance, line of sight)	3
Multiple crossings (two or more active tracks, especially main line, high speed)	4
Inadequate protection for vehicular traffic (allows drive-arounds, turn onto tracks, etc. )	5
Inappropriate safety application for traffic (passive needs active, 2 quad to 4 quad)	6
Grade separation needed (high speed, 20+ daily trains, high ADT or EMS access)	7

Special Highway Status (school bus route, evacuation, emergency access, designated truck route); add 1 point each \_\_\_\_\_

Local designation as safety concern (county, city engineer call-out); add 2 points each \_\_\_\_\_

Total \_\_\_\_\_

## Scoring Background

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Each grade crossing received three numbers. These three numbers are scores that describe assigned point values for “Risk/Safety/Condition.” Maximum values are 19 points for risk, 15 points for safety and 10 points for condition. For example, the worst possible crossing would have an R/S/C rank of “19/15/10”

Each high-risk crossing should be evaluated for recommended treatment:

- |  |   |
|--|---|
| 1. Close Crossing                                | C |
| 2. Upgrade Passive Crossing to Active Crossing   | A |
| 3. Improve Active Crossing (ASM’s, SSM’s, Quads) | I |
| 4. Construct Grade Separation                    | S |

The spreadsheet has relevant information about the top 100 high priority grade crossings, which handle either significant traffic or are in high population areas. The information includes:

- USDOT identity number
- Railroad name
- Crossing location
- Intersecting roadways identified
- Annual Average Daily Traffic or AADT
- Accident Prediction Index

The spreadsheet also lists the combined evaluation scores and the population score. For the at-grade crossings that were scored as the top 40 high priority crossings, MnDOT performed actual traffic counts to verify past reported traffic volumes data. The counts include AADT, all vehicular traffic and Heavy Commercial Annual Average Daily Traffic or HCAADT. Each of the top 100 crossings on the spreadsheet is supported by GIS mapping that collected information from a wide variety of state databases. The map information was used in scoring both population and conditions, including emergency response facilities and certain specified routes such as evacuation and school bus routes.

## Status of Project

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Work began on the study immediately following the adjournment of the 2014 Legislative Session. An initial survey of county and city engineers and administrators was circulated on May 30, 2014. The survey asked for feedback about issues within each official's scope of knowledge and the results highlighted a list of local concerns. GIS and traffic specialists mapped facilities and buffer zones, confirmed traffic counts, and, in particular, the counts of heavy commercial vehicle traffic. Commercial trucks posed a unique derailment risk during a collision with a train at grade crossings.

MnDOT's rail project managers conducted engineering and safety evaluations along with outreach to the railroads. The railroads voluntarily provided their own crossing evaluations, accident reports and near-miss reports. Railroad employees reported safety violations at crossings, which greatly enhanced the study data.

The score sheet was developed in collaboration with all involved parties, and further refined by test application to a variety of random crossing sites with known ranges of conditions. The MnDOT grade crossing database, updated annually by road authorities and railroads, was used to populate the spreadsheet of all the targeted crossings. The final spreadsheet includes basic data, as well as the cumulative scores. A file of individual score sheets will be maintained for reference. Analysts scored all mainline crossings, deleted non-involved local crossings (those on branch lines or spurs that cannot accommodate a through-routed unit train) and corrected other data inconsistencies. The initial scoring was completed in mid-September 2014. The evaluation was reviewed by the team and a list of the top 102 high-priority candidates for safety improvements was created based on that review.

Each of the 102 high-priority crossing candidates was studied in greater detail to determine whether the installed protection was appropriate or could it be improved. If an improvement was suggested, then the most effective safety improvement was explored. Among the top 102 high priority candidates, the top 40 were designated for extensive GIS mapping and actual traffic counts of general vehicle traffic, as well as heavy commercial vehicle traffic, to confirm historic or formulaic traffic counts.

Once the mapping and traffic counts were completed, a detailed review was conducted with the completed data. Each of the evaluation sheets for the top 40 projects is included in Appendix E.

## Strategies for Safety

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The application and design of safety measures at grade crossings have advanced significantly in the last 20 years, with a corresponding decline in grade crossing incidents and fatalities. The current options for safety and protection draw heavily on scientific and engineering studies. Prior to these advancements, “state-of-the-art” often meant a simple raised flashing light installation without gates, and visible from a long distance. These are often dubbed “cants” in crossing descriptions and equipment inventories, because the warning lights are anchored or cantilevered out from a roadside pole with the flashing warning lights directly over the traffic lane.

Now “state-of-the-art” is represented by extended gate arms, quad gates and traffic control measures to prevent attempts at bypassing the safety measures. These traffic control measures might include raised medians, traffic delineators, and right-turn-only entrances and exits to streets and parking lots near the crossing gates. Road closures and grade separations are highly recommended when they are appropriate.

The basic premise for the installation of these improved options is safety. More aggressive safety applications are needed as the frequency of train and vehicle interactions rises at a given crossing.

Passive protection is generally a device that consists of a traditional crossbuck supplemented by either a stop sign or yield sign posted below the crossbuck. Passive protection is usually the lowest cost option. The FRA considers passive protection an acceptable safety installation only if the vehicle count at the crossing is low, and sight lines and conditions allow motor vehicle operators sufficient opportunity to detect approaching trains.

When the frequency of vehicle crossings occurs just as train volumes and speeds increase, then passive protection is no longer an adequate safety measure. At this point, active warning devices consisting of flashing lights, bells and gates are recommended. Active protection places the emphasis on preventing vehicles from bypassing or driving around the gates, or excluding vehicles from the crossing entirely as in full-span or four quadrant (four quad) gates that block all accessible traffic lanes.

The one notable strategy not included in the list of safety options is grade separation, where road traffic and rail traffic are permanently separated by either an overpass or an underpass. The selection of alternatives and design components of the grade separation is considered site specific and was not evaluated in the study, other than to make informed assumptions on the grade separation design to estimate a rough cost.

Another option which can be a highly effective alternative is to close a crossing. The permanent closure creates an absolute level of safety, similar to a grade separation, with no ongoing maintenance expense for crossing equipment.

Other strategies were considered as the study progressed. A routine option is a signal interconnect. This is possible where an active traffic signal or light is in place on a nearby intersection close to the crossing, yet the traffic signal is not tied into the grade crossing activation circuitry. When a traffic signal is not tied into the grade crossing program, it can cause safety concerns at the light. This happens when the train gates are activated, yet the traffic light continues to go through its program, stopping traffic and trapping vehicles on the tracks in the path of an approaching train. An



interconnected signal can warn, hold or divert traffic away from a grade crossing when the grade crossing system is activated.

The final strategy suggested by the FRA is programmed education or programmed enforcement. Either of these is effective if the effort is local and sustained. If the program is not sustainable, then it has no lasting safety effect and must be discounted as an effective prevention tool. The state currently works with and partially funds "Operation Lifesaver," a nationwide rail safety and grade crossing program. This is a local program, and if sustained, shows good results.

# Grade Separations

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Grade separations are the complete and permanent separation of road and rail traffic, with an absolute level of crossing safety. The threshold for considering a grade separation is covered by Minnesota Rules 8830.2740<sup>3</sup>. The following is a summary of the criteria needed to consider the option of a grade separation from the Minnesota Rules:

- Train speeds are 40 mph or more and the roadway has four or more lanes of traffic
  - The road has a 30 mph or greater speed limit and an ADT of 5,000 or more vehicles
  - The road has a 55 mph or greater speed limit and an ADT of 3,000 or more vehicles
- There is already an active warning device, yet in the past five years, there was a serious vehicle-train accident at the crossing
- The construction of a grade separation would eliminate another safety problem in the immediate area

Many of the grade separations listed in this study fail to meet the thresholds listed in the Minnesota Rules., but, were included because of community concerns about grade crossing safety, connectivity to portions of the community, and emergency response access, which are negatively impacted by multiple, frequent train movements and blocked crossings due to stopped or slowly moving trains.

Installing a grade separation is a very expensive, but effective solution. In general, to install a grade separation on a rural, two-lane road costs \$10 to 15 million. Urbanized areas and multiple-lane construction are usually more expensive.

An example of a proposed grade separation project is the Moorhead downtown area. The at-grade crossings intersect two of the state's three oil train routes. Every day there are approximately six loaded oil trains that run through these crossings, as well as about 80 other train movements. The current at-grade crossings, while safe, experience up to 90 minutes per day of train blockages and are a serious detriment to emergency response in the city.

This project would construct two overpasses, each with four lanes, to remove any potential interaction between vehicles and trains. The estimated cost is around \$40 million.

The at-grade crossing on the most densely populated segment of the entire oil train route is along Como Avenue in St. Paul. The Como Avenue at-grade crossing is one of two at-grade crossings between University Junction in Minneapolis and Hoffman Junction in St. Paul, which are about 12 miles apart. The Como Avenue crossing has a highly effective safety treatment, four quad gates, but in order to make improvements to the safety of this crossing, a grade separation is the most likely alternative.

The Como Avenue crossing experiences 55 to 70 trains per day, has high bus traffic, and has the highest residential population estimate of all the areas studied. The risks to people living near the crossing are high although there are other grade separations in the area that do allow emergency

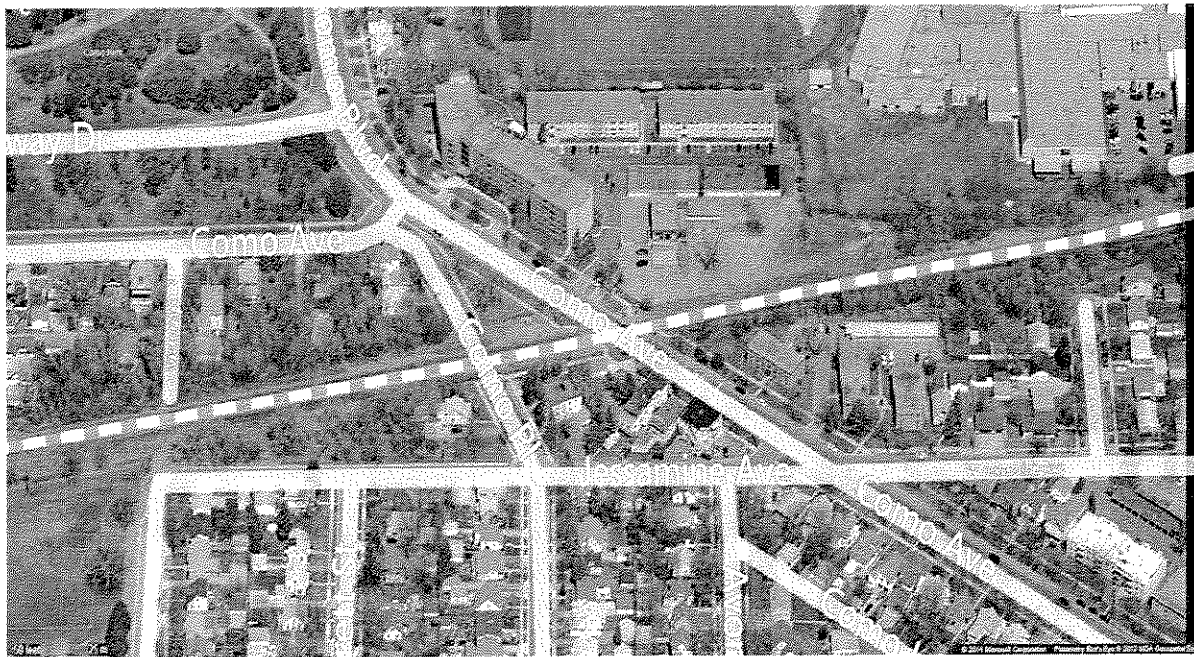
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<sup>3</sup> <https://www.revisor.mn.gov/rules/?id=8830.2740>

responder's access on either side of the tracks. A grade separation would reduce the risk to people living near the area by removing the need for vehicles and trains to interact.

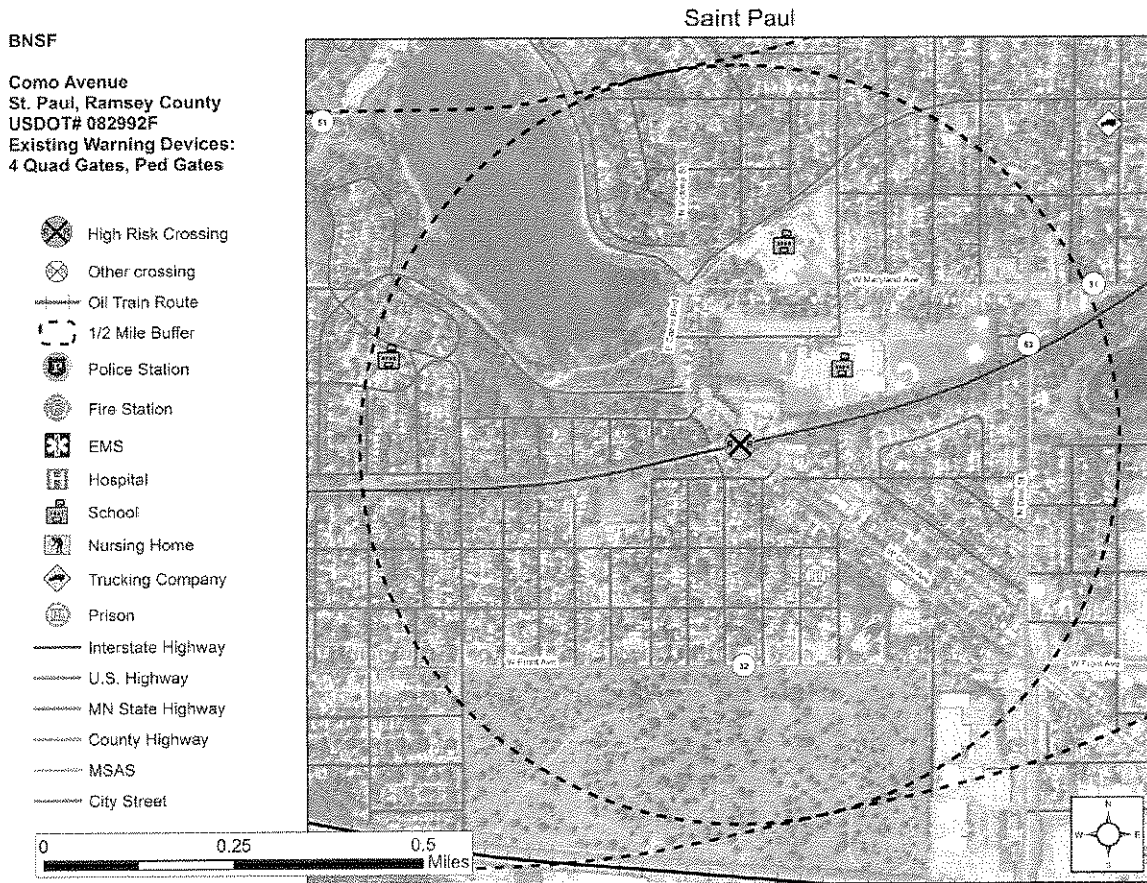
The estimated cost of a grade separation for Como Avenue has yet to be determined. Constructing the Como Avenue grade separation poses unique challenges. The estimated costs and probable disruptions to vehicle and rail traffic make this project problematic because of its location within such a heavily populated area and along one of the busiest rail corridors. An overhead view (Figure 2) and the risk assessment mapping for the Como Avenue crossing show some of the factors and influences considered when making the recommendation about this crossing (Figure 3).

Figure 2: Overhead view of the Como Ave. at-grade crossing in St. Paul\*



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Figure 3: Risk assessment map for the Como Avenue crossing\*



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## Project Recommendations

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The analysis performed for this study, the data gathered, the feedback from the Governor's Rail Safety Roundtables, and the input from local stakeholders informed the recommendations in three specific areas related to rail safety. The first list of recommendations is for grade crossing improvement projects that can be funded using the \$2 million allocated by the 2014 Legislature. These include substantial improvements to existing at-grade crossings and will enhance collision avoidance systems on rail corridors shipping crude oil.

When the preliminary recommendations for at-grade safety improvements were released in October, MnDOT then solicited feedback from each community to determine whether MnDOT's proposed safety improvement met community needs and expectations. Each of the communities was contacted and gave their initial approval to move forward with the recommended projects. The recommendations are listed in Appendix B.

The second set of recommendations to improve rail corridor safety is a list of priority grade separation projects. This list stems from data collected during a Risk Management Assessment analysis completed with the assistance of the Minnesota Department of Public Safety, and from local community input during the Governor's Rail Safety Roundtables.

This list of priority grade separation projects was compiled from findings indicating that grade crossing blockages on high traffic railroad mainlines, especially those railroad mainlines shipping crude oil, pose a substantial risk for emergency responders and the community. Generally, the blockages pose the most risk because they tend to be chronic and prolonged. This list can be found in Appendix C.

Lastly, the most comprehensive list of recommendations can be found in Appendix D, the top high priority grade crossings recommendations. This list was compiled using detailed evaluations about each grade crossing, including safety index scores, population data, public facilities mapping, traffic levels and possible improvement strategies. This list encompasses all of the recommendations from Appendix B and Appendix C.

# Appendix A: Grade Crossing Safety Improvement

## Definitions

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**Adequate Safety:** This indicates a grade crossing with the maximum possible level of collision avoidance already installed at the site. This may include four quadrant gates, two quadrant gates with 100-foot medians to channelize traffic and prevent drive-arounds at the gates, and complementary traffic signal interconnects.

**Adequate/Improvable:** This denotes a crossing that is adequately protected by warning devices that are appropriate to the current level of vehicular and train traffic, but could be further improved to reduce the likelihood of collisions by use of the maximum possible level of collision avoidance design and equipment, or a closure, or a grade separation which completely removes the conflict point.

**Closures:** Closing a road can be an effective strategy to eliminate a conflict point if low levels of traffic can be redirected on a reasonably short route to an adequately protected crossing.

**Grade Separation:** An underpass or overpass of the road with the rail line is a very high cost strategy but is effective in a high volume situation or on a critical route. It accomplishes three goals, all of which may represent high risks at the site. It eliminates vehicular/train conflict at the site, allows for unrestricted emergency access and evacuation, and preserves community traffic flows while providing an alternative to nearby at-grade crossings.

**Medians:** If no unusual geometric problems or traffic flows exist around a crossing, 100-foot raised medians to channelize traffic and prevent vehicles from driving around lowered gates can be approximately as effective as four quad gates.

**Medium-Term:** A recommended improvement that requires further development work or funding but could be delivered in two to five years under normal circumstances.

**Long-Term:** A recommended improvement that is suggested by current conditions, may be a lower risk and priority than Medium-Term projects, and requires further study and development. Reasonable delivery of these projects may be beyond 5 years in the future.

**Short-Term (\$2M):** A recommendation that is included in the recommended list of projects funded by the 2014 \$2 million appropriation.

**Quad Gates-4:** All four quadrants of a grade crossing are protected by active warning devices in the form of lights, bells, and gates. While the most expensive of a range of crossing safety options, it is particularly appropriate for multiple lane, high volume situations and can be designed to protect the crossing in situations close to intersections or involving local traffic entrances and exits.