

South Dakota Department of Transportation

Interstate Corridor Study

Phase II Report

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Office of Transportation Planning & Programs
700 East Broadway Avenue
Pierre, South Dakota 57501-2586

Prepared by:

Kirkham Michael Consulting Engineers
9110 West Dodge Road
Omaha, Nebraska 68124-0129

Felsburg, Holt & Ullevig
7951 E. Maplewood Ave., Ste 200
Englewood, Colorado 80111

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Introduction

The South Dakota Department of Transportation retained the services of Kirkham Michael Consulting Engineers and Felsburg, Holt & Ullevig to conduct an analysis of several segments of the interstate system located throughout the State of South Dakota. The study was conducted in two phases. Phase I included a review of the roadway geometrics, accident history, the forecasting of traffic volumes for the Years 2010 and 2020 and the evaluation of existing and future levels of service at the interchanges within the study corridors.

As a result of the findings from the Phase I report, a total of 26 interchanges were identified for further analysis. The primary objective of Phase II of the study, summarized in this report, is to identify improvements that will accommodate the future traffic volumes and address system deficiencies. Phase II consists of the development of detailed geometric layouts of these interchanges, and a review of the projected traffic operations associated with the interchange design. In some cases, additional traffic counts were obtained to evaluate traffic operations along the crossroad corridor through the interchange. Recommended improvements include such items as the number of lanes required, intersection channelization and traffic control improvements. A capacity analysis to determine the level of service on the mainline, ramps and connecting arterials will also be conducted.

In addition to the geometric figuration of the proposed interchange improvements, an estimate of the right of way requirements to construct the improvements is provided. The anticipated impact to the number of businesses or homes is also addressed. Access management in the vicinity of the interchange is also discussed in greater detail.

A statement of probable construction costs was developed for each proposed improvement. Construction quantities were estimated based on major items, such as pavement, bridges, traffic control devices and retaining walls. Items such as earthwork and drainage structures were based on rough assumptions and estimations based on available information.

It should be noted that the inclusion of an interchange in the Phase II report does not automatically indicate that it is one of the high priority locations for reconstruction. It simply means that there was a need for some additional design and/or analysis in order to fully evaluate the proposed improvements. In many cases, the information developed in Phase I was adequate to determine what improvements are required at that interchange. The interchange designs presented in this report are the recommendations of the consultant team. Local governments and the public will be solicited for input as the interchange improvements are developed and programmed by the South Dakota Department of Transportation.

The interchanges evaluated in Phase II of this study are shown in the following table. In addition to these interchanges, the feasibility of providing a direct connection from I-190 to Mount Rushmore Road (US 16) in Rapid City is also evaluated as a part of this study.

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Interchanges Evaluated in Phase II

Interstate	Exit No.	Description
Interstate 90	10	US 85 North, Spearfish
Interstate 90	44	Bethlehem Road, Piedmont
Interstate 90	46	Elk Creek Road, Piedmont
Interstate 90	48	Stagebarn Canyon, Piedmont
Interstate 90	51	Black Hawk Road (SD 79), Black Hawk
Interstate 90	55	Deadwood Avenue (SD 445), Rapid City
Interstate 90	59	LaCrosse Street, Rapid City
Interstate 90	60	East North Street (US 16B), Rapid City
Interstate 90	61	Elk Vale Road (SD 437), Rapid City
Interstate 90	332	SD 37, Mitchell
Interstate 90	395	Marion Road, Sioux Falls
Interstate 90	396	I-29/I-90 Interchange, Sioux Falls
Interstate 90	400	I-229/I-90 Interchange, Sioux Falls
Interstate 29	2	SD 105, North Sioux City
Interstate 29	4	McCook Lake, North Sioux City
Interstate 29	79	12 th Street (SD 42), Sioux Falls
Interstate 29	80	Madison Street, Sioux Falls
Interstate 29	81	Russell/Maple, Sioux Falls
Interstate 29	82	Benson Road, Sioux Falls
Interstate 29	129	County Road 26, Brookings
Interstate 29	132	US 14, Brookings
Interstate 29	177	US 212, Watertown
Interstate 229	3	Minnesota Avenue, Sioux Falls
Interstate 229	5	26 th Street, Sioux Falls
Interstate 229	7	Rice Street, Sioux Falls

In an effort to provide a consistent methodology for the review and analysis of each interchange, a standard format was developed. Each section of the report contains a brief review of the Phase I analysis of an interchange. The proposed alternative interchange concepts are then identified and evaluated based on geometry, safety, capacity, access control, right of way impacts and construction costs.

In addition to the evaluation of the interchanges listed above, a concept for a direct connection from I-190 to Mount Rushmore Road in Rapid City was also developed.

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Interchange Evaluation Process

A process was developed to evaluate the proposed interchange improvements for programming purposes. All of the interchanges evaluated in the Phase I report were included in the evaluation process. With over 60 interchanges evaluated across the state, it was necessary to develop an objective methodology for determining the areas of greatest need. It should be noted that the inclusion of a particular interchange or improvement in the Phase II study does not mean that it would have a higher resulting priority than those interchanges not included in Phase I.

The following descriptions of the evaluation criteria were used in the Interchange Evaluation Process. The criteria are not listed in any particular order of significance.

1. **Geometrics** - This criterion is an evaluation of five key geometric elements at the interchange. These elements include access spacing from the ramps, ramp intersection sight distance, ramp stopping sight distance, on-ramp taper rate, and cross-road stopping sight distance.
2. **Safety** - This is a measure of the accident history recorded at the interchange, measured in terms of the 3-year weighted crash rate (weighted accidents/million entering vehicles).
3. **Capacity** - This criterion assesses the level of congestion (measured by Level of Service) which is experienced today and which is projected to occur in the future at both the ramp terminal intersections and the freeway merge/diverge points.
4. **Structure/Pavement Condition** - This is a measure of the remaining life of the bridge structure and of the roadway pavement.
5. **Regional Significance** - This is an assessment of the relative importance of the interchange to the state and regional roadway system, based on the classification and the function of the crossroad.
6. **Cost-Effectiveness** - This criterion assesses the ratio of the relative benefits of the improvements to their relative capital and right-of-way costs.
7. **Constructability** - This is a qualitative assessment of the ease with which the improvements could be constructed with the least amount of impacts to the traveling public.
8. **Acquisition** - This criterion assesses the need to acquire right-of-way and to displace residences or businesses.
9. **Environmental Impact** - This criterion represents a general measure of the environmental impacts likely to be associated with the project and the ability to mitigate those impacts.
10. **Community Support** - This is an assessment of the level of support for or opposition to the project, as expressed by the community.

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I-90: Exit 10, US 85 North, Spearfish

The Phase I investigation of Exit 10 revealed that the interchange does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, significant accident history led to interchange improvement recommendations in the 1992 Interchange Justification Report prepared for the City of Spearfish. These recommendations are consistent with observations made during the Phase I analysis. Based on the 1992 Report and the results of Phase I, three options for improving the interchange are explored. Alternative #1 would maintain the existing twin structures over mainline I-90 and realign the south ramps to increase separation from the twin structures. This realignment would necessitate realignment of old US Highway 14 to maintain adequate access spacing south of the interchange. Alternatives #2a and #2b would replace the existing twin structures over mainline I-90 with a single structure to provide 4-lane continuity along US Highway 85 through the interchange. The single structure would also allow the eastbound ramp terminal intersection to remain at its current location. With Alternative #2a, old US Highway 14 would be realigned to maintain adequate access spacing south of the interchange. Alternative #2b proposes that a cul-de-sac be constructed along old US Highway 14, eliminating its intersection with US Highway 85.



Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The existing twin structures on US Highway 85 are wide enough to accommodate 2 travel lanes. The decks for the twin structures have been recently replaced so the structures should have a relatively long design life yet. Current striping delineates one lane on each bridge for through travel and the adjacent lane for left-turns onto the I-90 ramps. The sag k-values, which relate to headlight sight distance, are substandard on Ramps A and D. Ramp A has a substandard crest k-value, which relates to stopping sight distance. The distance between old US Highway 14 on the south side of the interchange and the ramp terminal intersection is below standards. With the amount of truck traffic that uses this interchange, the proximity of these two intersections is very problematic. In recognition of these geometric deficiencies and associated traffic safety issues, the South Dakota Department of Transportation developed a pavement marking plan dated April 19, 1999. The pavement marking plan restricts the through traffic to one lane in each direction and provides auxiliary lanes for the turning movements. One of the deficiencies the pavement marking plan does not address is the distance between old US Highway 14 and the south ramp terminal intersection.

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Traffic Safety

This interchange ranks 23rd of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. However, the City of Spearfish was experiencing a high number of access-related accidents occurring adjacent to the interchange and consulted Kirkham Michael Consulting Engineers to conduct an Interchange Justification Study in 1992. Kirkham Michael Consulting Engineers discovered that the primary cause of accidents was the close proximity of the local roadway access points to the interchange; a number of accidents were occurring on US Highway 85 between the old US Highway 14 intersection and the south ramp terminal intersection. Because the accident data compiled in the I-90 corridor study were limited to locations within the ramp termini, these accidents were not included.

Capacity

Projected traffic volumes at this interchange are expected to be accommodated by the current interchange configuration. The interchange ramp terminal intersections and ramp merge / diverge points are projected to operate at LOS D or better based on projected Year 2020 traffic volumes. By providing only a single through lane in each direction, the existing twin structures over I-90 represent a capacity constraint along US Highway 85, which carries two through lanes on both sides of the interchange.

Proposed Improvements

Based on the conditions noted previously and the recommendations from the Interchange Justification Report, the spacing between the south ramp terminal intersection and the US Highway 85 / old US Highway 14 intersection should be increased. Another deficiency that has been identified is the relatively close spacing between the south ramp terminal intersection and the twin structures over I-90, causing some sight distance concerns.

Two primary alternatives have been developed to address these deficiencies at the Exit 10 interchange. Alternative #1 retains the twin structures, but realigns the eastbound ramps and old US Highway 14. Alternatives #2a and #2b would replace the existing twin structures over I-90 with a single 5-lane structure (thus maintaining the location of the south ramp terminal intersection). Alternative #2a would modify old US Highway 14 to maintain adequate access spacing along US Highway 85, while Alternative #2b would create a cul-de-sac along old US Highway 14 east of US Highway 85.

Alternative #1 – Old US Highway 14 and Ramp realignment

With the implementation of Alternative #1 (Figure 1), the eastbound off ramp and the eastbound on ramp intersection would be realigned to separate the intersection from the bridge structures over Interstate 90. In addition, old US Highway 14 would be realigned to provide improved intersection spacing from the ramp terminals.

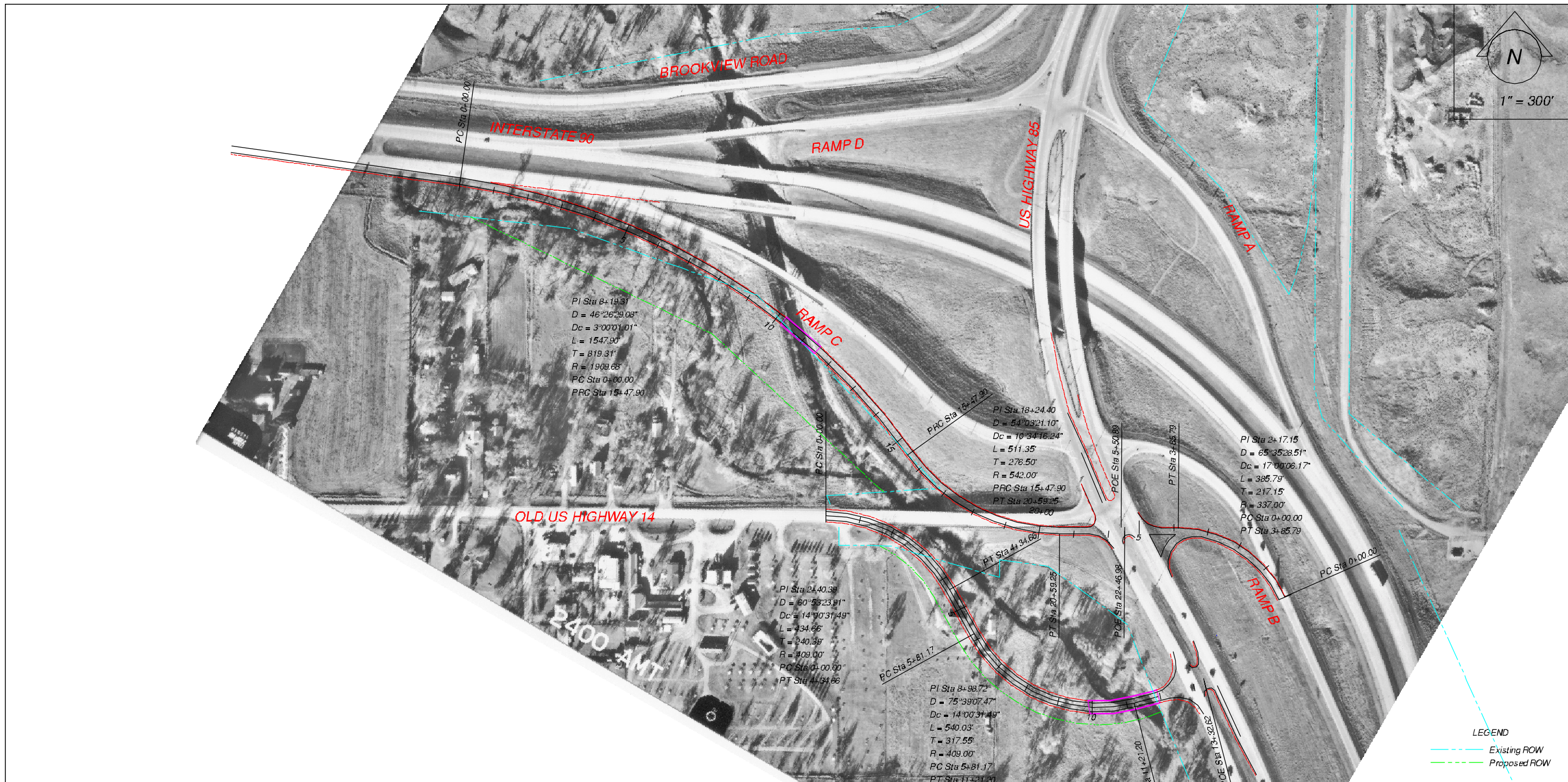


Figure 1
I-90 Exit 10
US 85 North, Spearfish
Alternative 1
Realign South Ramps/Realign Old US Highway 14

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Geometry

As shown on Figure 1, the south ramp terminal intersection would be realigned farther to the south, thus providing a longer distance between the intersection and the twin structures over Interstate 90 and enhancing sight distance to the north from the ramp terminal intersection. Old US Highway 14 would also be realigned farther to the south to create acceptable spacing from the south ramp terminal intersection. Adequate acceleration and deceleration lanes (especially for truck traffic) are essential at the intersection of old US Highway 14 and US Highway 85. Truck volumes at this interchange may be reduced once interchange improvements at Exit 8 are complete.

Traffic Safety

It is anticipated that increasing the distance between the south ramp terminal intersection and the twin structures for Interstate 90 and old US Highway 14 will improve traffic safety.

Capacity

No improvements are necessary to the interchange to accommodate future traffic volumes. However, realignment of the south ramps and old US Highway 14 will improve operations at the interchange.

Access Control

The access spacing on the north side of the interchange is adequate and will not need to be modified. No access modifications on the south side are required beyond the realignment of old US Highway 14.

Right-of-way

As identified in Figure 1, the relocation of the ramps and old US Highway 14 will require acquisition of right-of-way. The realignment of Ramp C has moderate right-of-way impacts while the realignment of old US Highway 14 has more severe right-of-way impacts. Both realignments would require new bridges over the river that may have environmental impacts. Approximately 9 acres of right-of-way will be needed for realigning the ramps and old US Highway 14.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed realignment of the south ramps and old US Highway 14. Construction of these realignments is estimated at \$2.6 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

The Interchange Justification Study (1992) estimated the cost for the preferred improvements to be \$1,529,000. This estimate was prepared in 1992 using historic costs from 1990 data.

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Alternative #2a – Replace structures and realign old US Highway 14

With the implementation of Alternative #2a, a single structure wide enough to accommodate 5 lanes (4 through lanes plus an auxiliary lane) would be constructed to replace the existing twin structures. The structure would provide for a continuous 4-lane section along US Highway 85 through the interchange area. This new structure would allow the eastbound ramp terminal intersection to remain at its current location. In addition, old US Highway 14 would be realigned to improve separation from the ramp intersection.

Geometry

As shown on Figure 2, the ramp terminal intersections for the interchange would remain at their current location. To alleviate the sight distance concerns, the twin structures over Interstate 90 would be removed and replaced with a single structure. To improve the control of access to the south, old US Highway 14 would be realigned farther to the south. The existing bridge for old US Highway 14 over Spearfish Creek would remain with this alternative. Two reverse horizontal curves would then be utilized to shift the existing intersection of old US Highway 14 and US Highway 85 approximately 130 feet to the south. The design speed for the proposed horizontal curves is 30 mph. Since old US Highway 14 is approaching a stop condition near these reverse curves, a low design speed should be acceptable.

Traffic Safety

It is anticipated that replacing the existing twin structures over I-90 and realigning old US Highway 14 would improve traffic safety.

Capacity

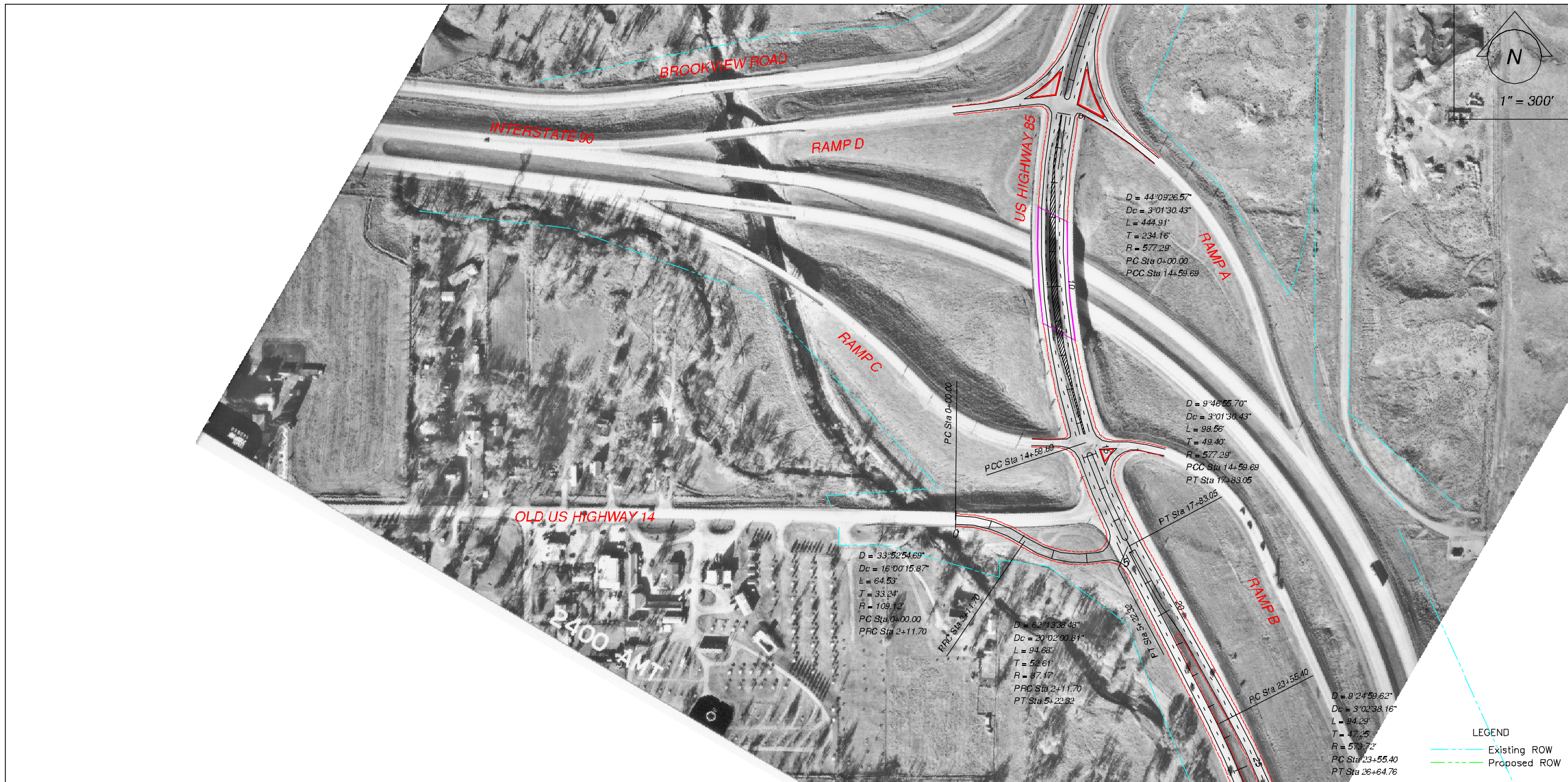
Based on the existing interchange configuration, the north and south ramp terminal intersections are both projected to operate at LOS D by the Year 2020, which is considered acceptable by SDDOT standards. Replacing the existing twin structures with a 5-lane bridge would be expected to improve traffic operations at both ramp intersections from LOS D to LOS C by the Year 2020.

Access Control

The access spacing on the north side of the interchange is adequate and will not need to be modified. Old US Highway 14 would be realigned to provide approximately 300 feet of distance between its intersection with US Highway 85 and the south ramp terminal intersection. The realignment of old US Highway 14 would be accomplished without modifying the crossing of Spearfish Creek.

Right-of-way

As identified in Figure 2, very minor if any right-of-way would need to be acquired with this alternative. The only portion of right-of-way that may be needed is adjacent to Spearfish Creek where old US Highway 14 is realigned. This alternative would have minimal environmental impacts to Spearfish Creek since no new bridges over the creek are proposed.



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Probable Construction Costs

A statement of probable construction costs was prepared for the proposed realignment of the US Highway 85 and old US Highway 14. Construction of these realignments is estimated at \$5.4 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Alternative #2b – Replace structures and cul-de-sac old US Highway 14

Alternative #2b is identical to Alternative #2a with the exception of how old US Highway 14 would be treated. In this alternative, a cul-de-sac would be constructed on old US Highway 14 west of Spearfish Creek, thus eliminating its intersection with US Highway 85. The elimination of this intersection would prevent travel along what is currently an important truck travel route through the City of Spearfish. Truck travel through this intersection, however, is expected to reduce significantly with the construction of Exit 8. Therefore, the construction of Exit 8 would need to be completed prior to cul-de-sacing old US Highway 14.

Geometry

As shown on Figure 3, this alternative is very similar to Alternative #2a. The alignment for US Highway 85 and the ramps for the interchange are the same as Alternative #2a. Because old US Highway 14 would have a cul-de-sac west of Spearfish Creek, the existing bridge over the creek could then be removed.

Traffic Safety

It is anticipated that replacing the existing twin structures over I-90 would improve traffic safety over existing conditions. Installing a cul-de-sac along old US Highway 14 west of US Highway 85 would mitigate a current traffic safety hazard by eliminating the existing intersection between these two roadways.

Capacity

Based on the existing interchange configuration, the north and south ramp terminal intersections are both projected to operate at LOS D by the Year 2020, which is considered acceptable by SDDOT standards. Replacing the existing twin structures with a 5-lane bridge would be expected to improve traffic operations at both ramp intersections from LOS D to LOS C by the Year 2020. The elimination of the old US Highway 14 / US Highway 85 intersection would further improve traffic operations in the vicinity of the south ramp terminal intersection.

Access Control

The access spacing on the north side of the interchange is adequate and will not need to be modified. Access spacing south of the interchange would also be adequate with the construction of a cul-de-sac on old US Highway 14.

Right-of-way

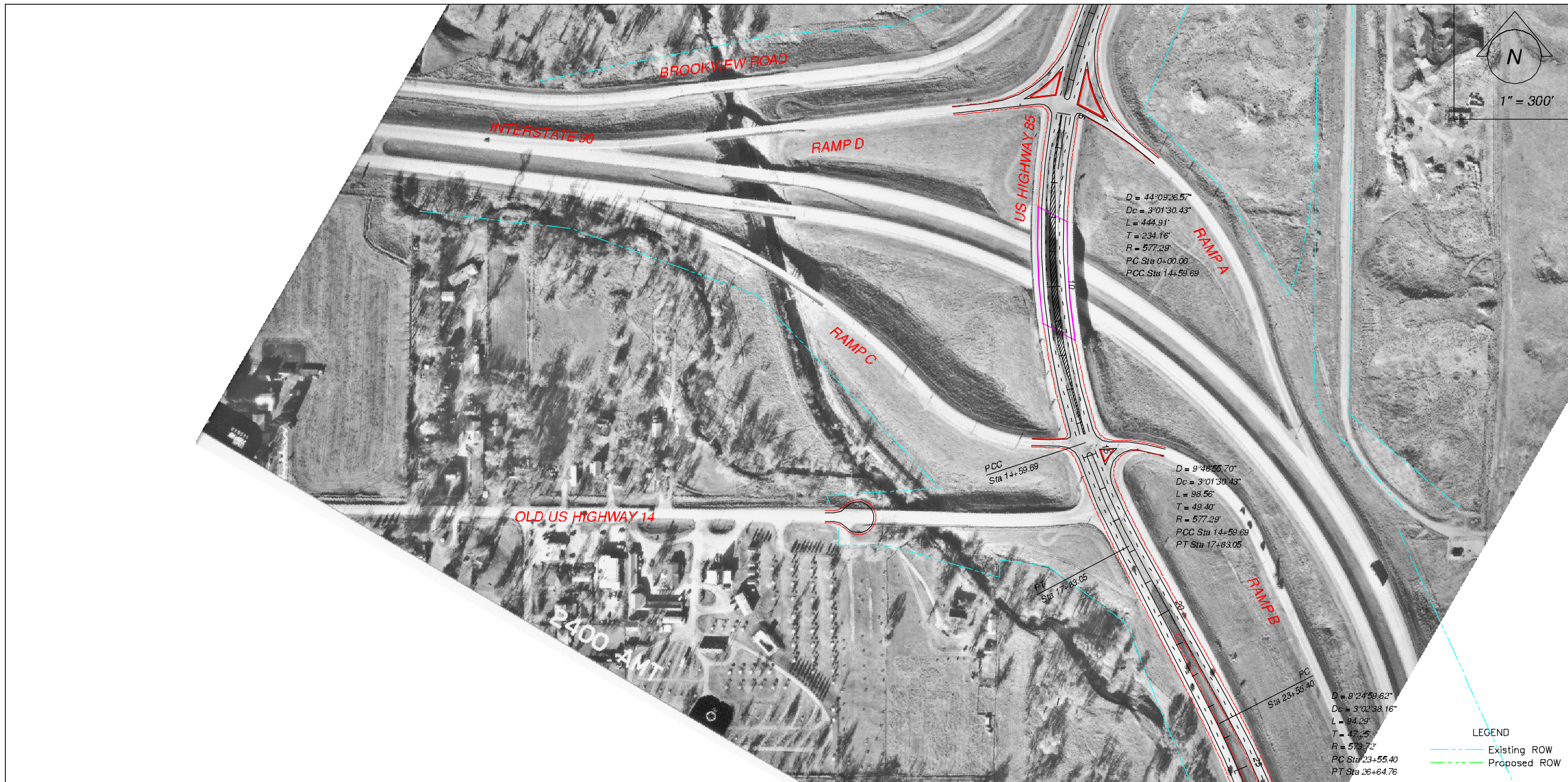
As identified in Figure 3, very minor if any right-of-way would need to be acquired with this alternative. The only portion of right-of-way that may be needed is on old US Highway 14 where

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the cul-de-sac would be constructed. The only environmental impacts for this alternative would be those associated with removing the bridge over Spearfish Creek on old US Highway 14.

Probable Construction Costs

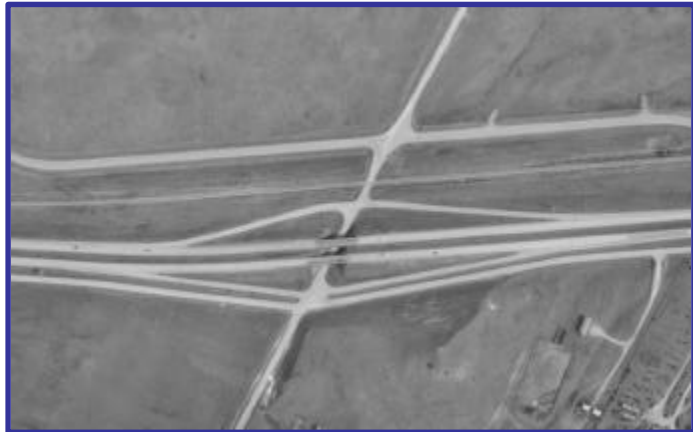
A statement of probable construction costs was prepared for the proposed realignment of the US Highway 85 and for the cul-de-sac on old US Highway 14. Construction of this realignment and cul-de-sac is estimated at \$5.7 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.



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I-90: Exit 44, Bethlehem Road, Piedmont

Based on the Phase I investigation, the existing interchange could accommodate the Year 2010 and Year 2020 traffic volume projections. Previous accident history did not support safety improvements for the interchange. The geometric deficiencies within the interchange that were discovered could be corrected when the existing pavement requires reconstruction.



The Phase I investigation of Exit 44 recommended that the frontage road located on the south side of the interchange be relocated farther to the south in order to improve spacing between the ramps and the frontage road. In this subsequent Phase II investigation, an alignment for relocating the frontage road was evaluated in greater detail.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange, as well as the plan set for the realignment of the frontage road located on the north side of the interchange. Bethlehem Road consists of one through lane in each direction without provision for auxiliary lanes. Geometric deficiencies exist on all ramps at this interchange. Crest k-values, which relate to stopping sight distance, are substandard on all ramps. The taper rates for the on ramps to Interstate 90 were also found to be inadequate. Adjacent to the railroad tracks, the cross street contains a substandard sag vertical curve. The distance from the intersection of the south frontage road to the southern ramp intersection is also substandard. The existing mainline I-90 bridges over are structurally deficient.

Traffic Safety

This interchange ranks 57th of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. A total of 4 accidents occurred at this interchange between 1997 and 1999. All of the accidents resulted in property damage only (PDO). It is unlikely that the interchange geometric deficiencies are contributing to the occurrence of traffic accidents at this interchange.

Capacity

The existing interchange configuration is expected to accommodate projected year 2010 and 2020 traffic volumes. Analysis of projected traffic conditions at the Exit 44 interchange indicates

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that no improvements to the interchange are necessary based on capacity requirements. All ramp junctions and ramp terminal intersections are projected to operate at LOS B or better by the Year 2020.

Proposed Short-Term Improvements

Based on the conditions noted previously, it is recommended that the south frontage road be realigned to provide adequate spacing between the frontage road and the south ramp terminal intersection. Figure 4 depicts a potential realignment for the frontage road.

Geometry

As shown on Figure 4, the south frontage road would be realigned to achieve a 300-foot separation from the south ramp intersection. The realigned frontage road was designed using 521-foot radii that correlate to a 40-mph design speed with 6% superelevation.

Traffic Safety

It is anticipated that increasing the distance between the south ramp intersection and the south frontage road intersection will slightly improve traffic safety.

Capacity

No improvements are necessary to the interchange to accommodate future traffic volumes. However, realignment of the frontage road will improve operations at the south ramp terminal intersection.

Access Control

No existing access modifications are required.

Right-of-way

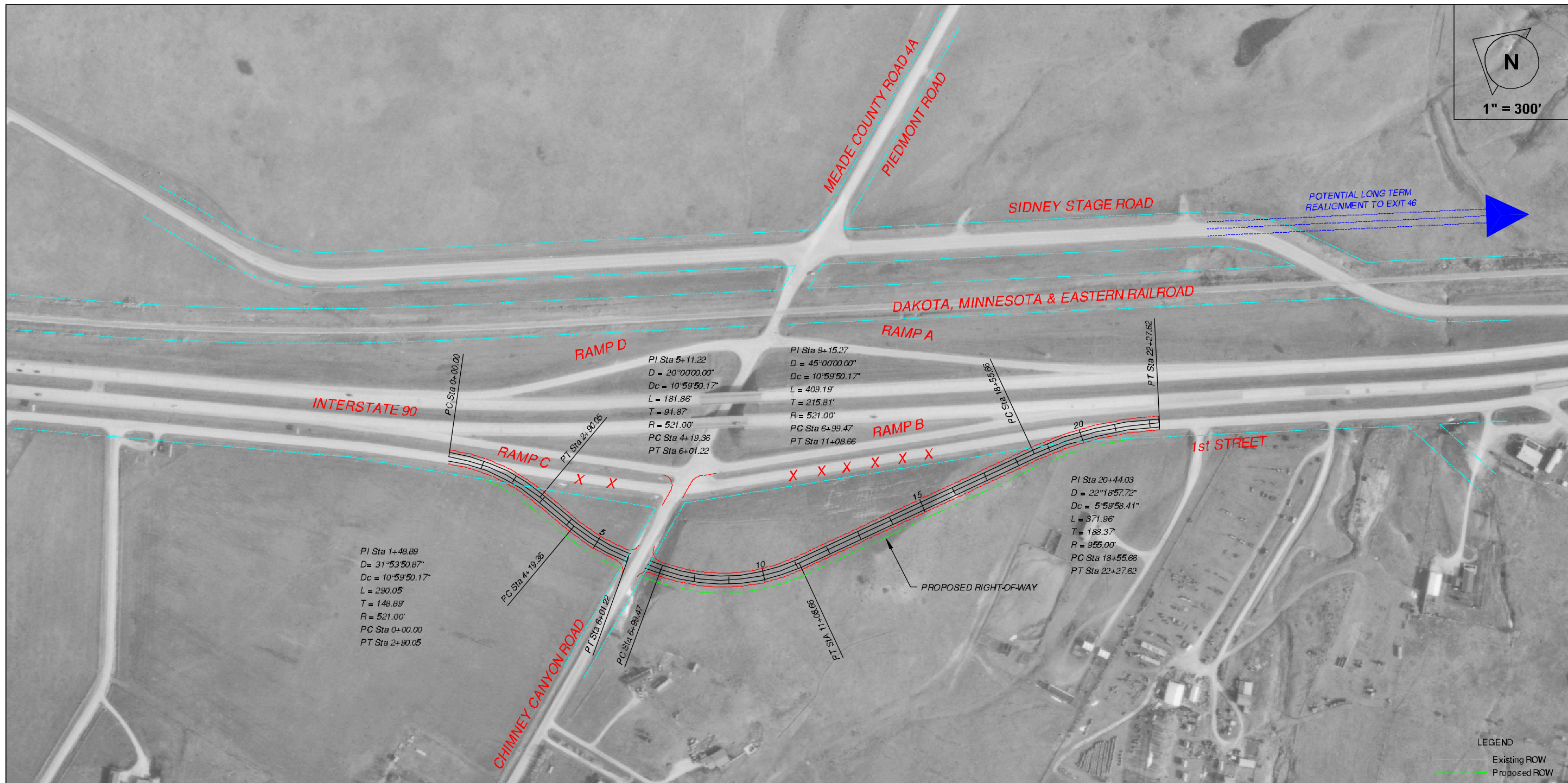
As identified in Figure 4, right of way will be required for relocating the frontage road. Presently, there are no developments adjacent to the frontage road where the realignment would occur. Approximately 6.2 acres of right-of-way will be needed for the realignment.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed realignment of the south frontage road. Construction of the frontage road is estimated at \$700,000. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Long-Term Future Improvements

In the long-term future, it is recommended that the north frontage road be extended along I-90, but north of the railroad tracks from the Exit 44 interchange to allow frontage road travel between the Exit 44, 46, 48, and 51 interchanges.



SDDOT Interstate Corridor Study - Phase II

I-90: Exit 46 – Elk Creek Road, Piedmont

Based on the Phase I investigation, the existing interchange could accommodate the Year 2010 and Year 2020 traffic volume projections. Previous accident history does not support safety improvements for the interchange. The geometric deficiencies that were identified could be corrected when the existing pavement requires reconstruction, with the exception of the realignment of the north and south frontage roads.



The Phase I investigation of Exit 46 recommended that the frontage roads on both sides of the interchange be relocated. In this subsequent Phase II investigation, alignments for relocating the frontage roads were evaluated in greater detail.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The existing Elk Creek Road bridge consists of one through lane in each direction. There is currently no provision for auxiliary lanes along Elk Creek Road. The sag k-values, which relate to headlight sight distance, are substandard on Ramps C and D. The taper rates for the on ramps to Interstate 90 were also found to be inadequate. The distance between the adjacent frontage road intersections and the ramp terminal intersections is below standards. The north frontage road actually intersects with the westbound on ramp. Future plans for the vicinity of the interchange include the installation of signals at the railroad grade crossing location north of the interchange in the next three years.

Traffic Safety

This interchange ranks 50th among the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. A total of 5 accidents occurred at this interchange between 1997 and 1999. The accidents that occurred at this interchange present no apparent accident patterns.

Capacity

Analysis of projected Year 2010 and 2020 traffic conditions at the Exit 46 interchange indicates that no improvements to the interchange are necessary based on capacity requirements. All ramp merge/diverge sections and ramp terminal intersections are projected to operate at LOS B or better by the Year 2020.

SDDOT Interstate Corridor Study - Phase II

Proposed Short-Term Improvements

Based on the conditions noted previously, it is recommended that the frontage roads on both the north and south sides of the interchange be realigned to provide adequate spacing between the frontage road intersections and the ramp terminal intersections. One frontage road realignment alternative is shown on Figure 5.

Geometry

As shown on Figure 5, the south frontage road would be realigned to achieve a 300-foot separation from the south ramp intersection. The realigned southern frontage road was designed using a minimum radius of 500 feet, which correlates to a 35-mph design speed with 5.8% superelevation. The realigned northern frontage road was designed using a minimum radius of 300 feet, which correlates to a 30-mph design speed with 6% superelevation. Two 300-foot radii are used on the northern frontage road at the switchback across the railroad. The northern frontage road was intentionally designed to cross the railroad at this location to prevent an additional at-grade crossing of the railroad. The other radii on the northern frontage road are 955 feet and 500 feet, which achieve a higher design speed.

Though bridge replacement is not recommended with this analysis, when the bridge needs to be replaced consideration should be given to extending the structure farther to the north over the railroad, thereby eliminating the existing at-grade railroad crossing.

Traffic Safety

It is anticipated that increasing the distance between the ramp intersection and the frontage road intersection on the south will slightly improve traffic safety adjacent to the interchange. Removing the road from the westbound on-ramp also represents a safety enhancement.

Capacity

No improvements to the interchange are necessary to accommodate future traffic volumes. However, realignment of the frontage roads will improve operations at the ramp terminal intersections.

Access Control

The existing access locations adjacent to Elk Creek Road, north of the interchange, can remain with the proposed realigned frontage road. The existing access south of the interchange will have to be altered to accommodate the realigned frontage road.

Right-of-way

As identified in Figure 5, the relocation of the frontage road will require acquisition of right of way. The existing building on the south side of the interchange will not be impacted with the realignment; neither should the operations of that property be affected with the realignment of the frontage road. The frontage road on the north side of the interchange was located as shown

SDDOT Interstate Corridor Study - Phase II

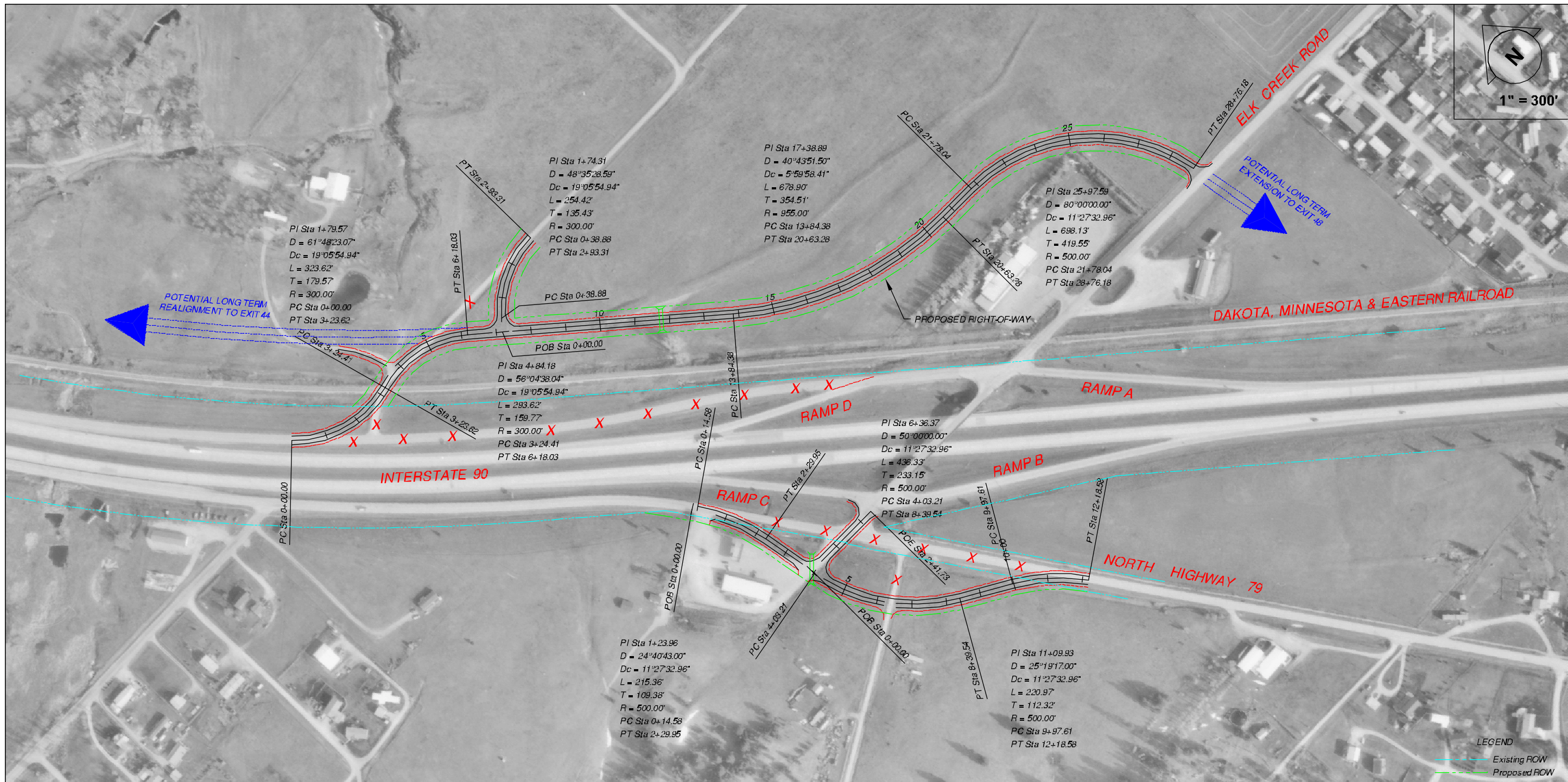
in Figure 3 to minimize the impacts on developed property. Approximately 7.5 acres of right-of-way will be needed for realigning both frontage roads.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed realignment of both frontage roads. Construction of the frontage roads is estimated at \$1.6 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Long-Term Future Improvements

In the long-term future, it is recommended that consideration be given to extending the north frontage road along I-90 north of the railroad tracks to allow for frontage road travel between the Exit 44, 46, 48 and 51 interchanges. This frontage road extension to the west would eliminate three at-grade railroad crossings between Exits 44 and 46. It should be noted, however, that the extension to the east as depicted by the arrow shown on Figure 5 might be difficult to construct because of the existing residential development northeast of the interchange.



SDDOT Interstate Corridor Study - Phase II

I-90: Exit 48 – Stagebarn Canyon, Piedmont

Based on the Phase I investigation, the existing interchange could accommodate the Year 2010 and Year 2020 traffic volume projections. Previous accident history did not support safety improvements for the interchange. The geometric deficiencies that were discovered could be corrected when the existing pavement requires reconstruction.



The Phase I investigation of Exit 48, however, recommended that the frontage road located on the north side of the interchange be relocated farther to the north. In this subsequent Phase II investigation, an alignment for relocating the frontage road was evaluated in greater detail.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The existing crossroad section consists of one through lane in each direction with no provisions for auxiliary lanes. The frontage road on the north side of the interchange serves properties adjacent to the interchange. The crest k-values, which relate to stopping sight distance, are substandard on the crossroad. The taper rates for the on ramps to Interstate 90 were also found to be inadequate. The distance from the intersection of the north frontage road to the northern ramp intersection at the crossroad is below standard.

Traffic Safety

This interchange ranks 30th among the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. A total of 17 accidents occurred at this interchange between 1997 and 1999. Most of the accidents at this interchange occurred during wet, icy, or snow-packed roadway conditions.

Capacity

Analysis of projected year 2010 and 2020 traffic conditions at the Exit 48 interchange indicates that no improvements to the interchange are necessary based on capacity requirements. All ramp junctions and ramp terminal intersections are projected to operate at LOS B or better by the Year 2020.

SDDOT Interstate Corridor Study - Phase II

Proposed Short-Term Improvements

It is recommended that the north frontage road be realigned to provide adequate spacing between the frontage road and the north ramp terminal intersection. For the short-term improvement scenario, the realigned frontage road would cross the railroad tracks at-grade.

Geometry

As shown on Figure 6, the north frontage road would be realigned to achieve a 300-foot separation from the north ramp intersection. The realigned northern frontage road was designed using a minimum radius of 441 feet, which correlates to a 35-mph design speed with 5.9% superelevation.

Traffic Safety

It is anticipated that increasing the distance between the ramp intersection and the frontage road intersection on the north will improve traffic safety over existing conditions.

Capacity

No improvements are necessary to the interchange to accommodate future traffic volumes. However, the realignment of the frontage road will improve operations at the north ramp terminal intersection.

Access Control

A short portion of the existing frontage road west of the proposed alignment would need to be removed. Part of the existing frontage road could be utilized for an access to the property directly north of the existing frontage road. The existing accesses located east of the proposed alignment would not be affected by the realigned frontage road.

Right-of-way

As identified in Figure 6, right-of-way acquisition would be required in association with relocating the frontage road. Presently, there are no developments that would be impacted adjacent to the frontage road. Approximately 1.8 acres of right-of-way would be needed for realigning the frontage road.

Probable Construction Costs

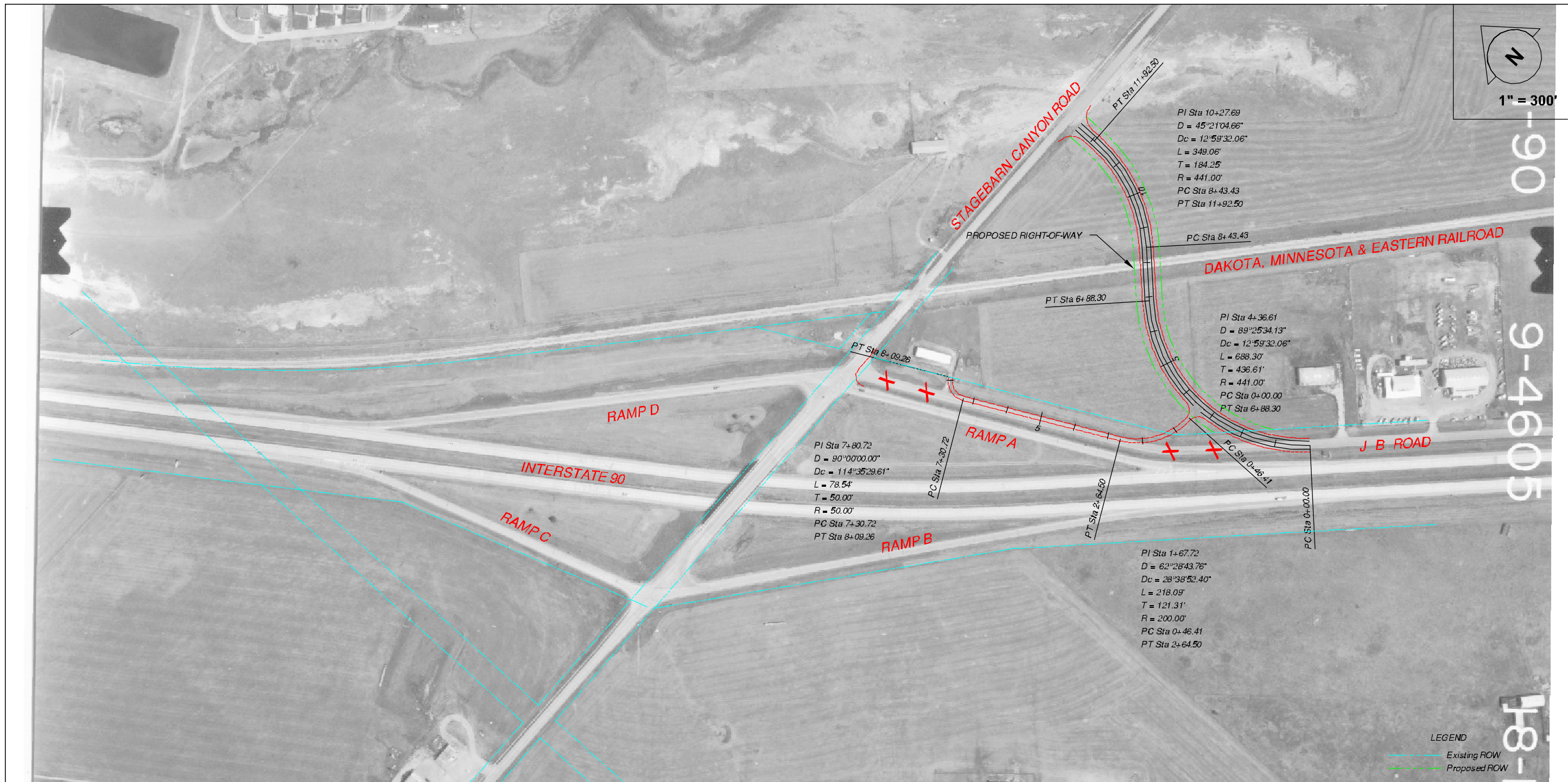
A statement of probable construction costs was prepared for the proposed realignment of the frontage road. Construction of the frontage roads is estimated at \$400,000. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

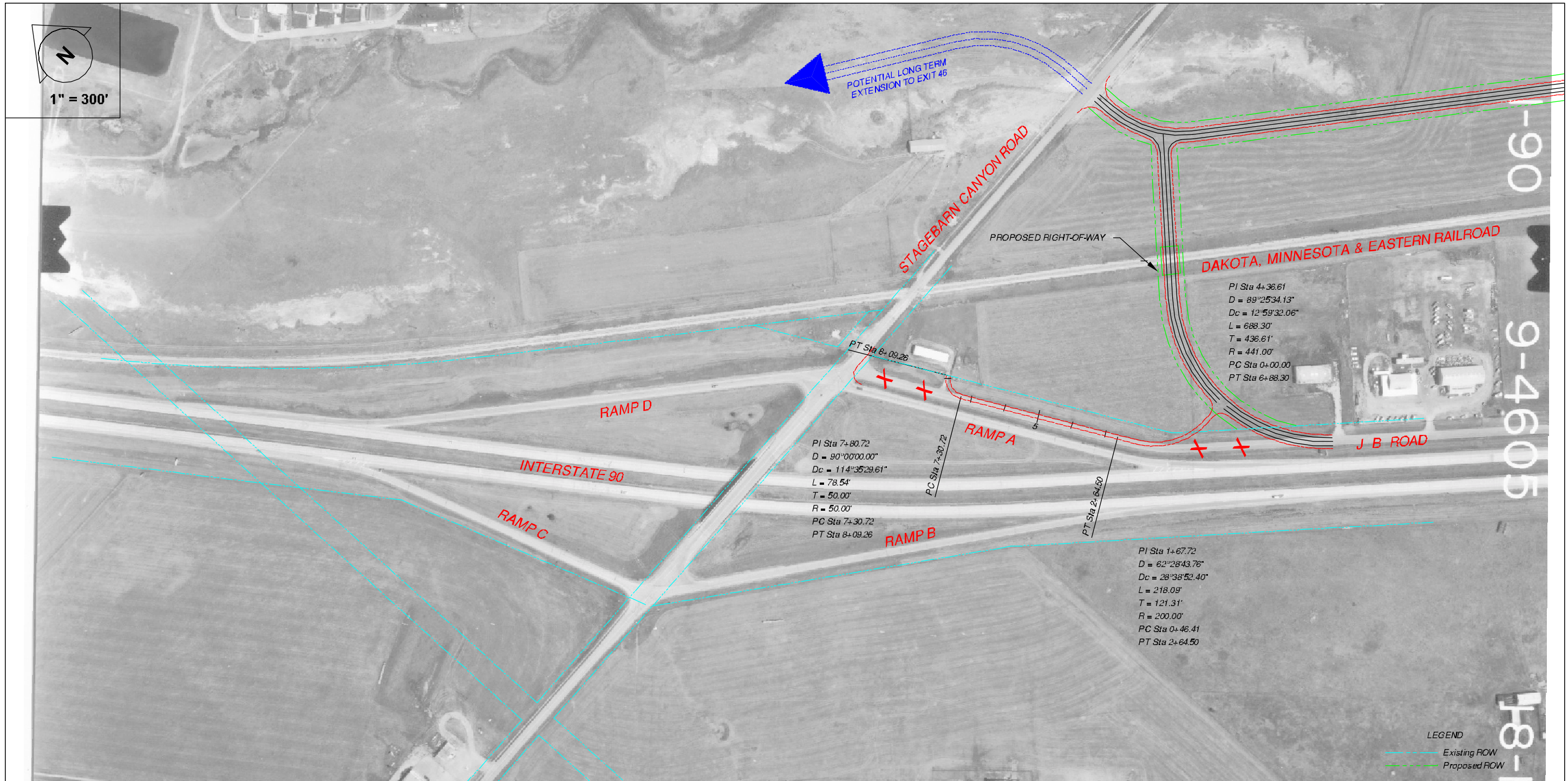
SDDOT Interstate Corridor Study - Phase II

Proposed Long-Term Improvements

The proposed long-term future improvements, as illustrated on Figure 7, include the construction of a grade-separated railroad crossing at the intersection of the north frontage road and the railroad tracks. It is also recommended that the construction of a minor arterial roadway paralleling the railroad on the north be considered. This roadway would extend from Exit 48 to Exit 51.

In order to allow continuous frontage road travel between Exits 44, 46, 48, and 51, the north frontage road is proposed to be extended west from Stagebarn Canyon Road (Exit 48) to connect to Elk Creek Road at the Exit 46 interchange.





SDDOT Interstate Corridor Study - Phase II

I-90: Exit 51 – Black Hawk Road, Black Hawk

Based on the Phase I analysis, the interchange located at Exit 51 on I-90 does not require improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, the horizontal curves located on the mainline of Interstate 90 west of the off ramp to North Highway 79 have a design speed of 60 mph with a 6% superelevation. These curves have



exhibited an accident history when conditions are wet or icy. The Phase II investigation of this interchange has been performed to provide recommendations for improving the mainline design speed while accommodating the connections to North Highway 79 and Foothills Road. The South Dakota Department of Transportation has been evaluating a wide range of alternative improvements, and this effort is ongoing. This Phase II investigation presents two potential alternatives for this location. One alternative includes the installation of a single-point urban interchange (SPUI) on a realigned portion of the interstate, while the second alternative would construct a standard diamond interchange along a realigned portion of the interstate.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The half-diamond interchange to Foothills Road along with the partial trumpet interchange to North Highway 79 were evaluated as part of this interchange. The taper rate for the westbound off ramp at Interstate 90 was found to be inadequate. The vertical alignments of Ramps A, B and C have substandard crest vertical curves, which correlate to inadequate stopping sight distances. Foothills Road also has a vertical alignment with a substandard crest vertical curve and a vertical grade difference of approximately 13% at the at-grade railroad crossing.

Traffic Safety

This interchange ranks 24th out of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations within the Interstate corridor. Most of the crashes that occurred at this location happened during wet, icy, or snow-packed roadway conditions. Though the 1997-1999 data do not reflect a significant crash history at Exit 51, observations made by the SDDOT regional office suggest that a pattern of severe accidents may exist.

SDDOT Interstate Corridor Study - Phase II

Capacity

Projected traffic volumes at this interchange would be accommodated by the current interchange configuration. No improvements are required based on capacity requirements. All of the Exit 51 ramp merge / diverge sections are projected to operate at LOS B based on projected Year 2020 traffic conditions. The at-grade intersections associated with the Interchange are also projected to operate at LOS B or better by the Year 2020.

Proposed Interchange Alternatives

In order to improve the horizontal curves on the mainline of I-90 adjacent to Exit 51, the interstate could be realigned to the southwest as shown on Figures 5 – 8. The connection to North Highway 79 could be constructed by extending the highway to form a crossroad with a new interchange, which could be constructed as a single point urban interchange (SPUI) or a standard diamond interchange. These alternatives are evaluated below.

Alternative #1 – Single-Point Urban Interchange

One possible interchange alternative is the installation of a single-point urban interchange along a realigned mainline I-90. This alternative was evaluated as Alternative #1, and is depicted on Figure 8. Figure 10 depicts the alignment of mainline I-90 east of the interchange.

Geometry

The proposed horizontal curves on the mainline of Interstate 90 have a radius of 2865 feet, thereby that achieving a design speed of 70 mph with a 5.5% superelevation. Extending North Highway 79 across the interstate as shown in Figure 8 would form a crossroad at the proposed interchange. A portion of the westbound lanes of North Highway 79 could be left at their present location. A section of the frontage road south of the proposed interstate would have to be realigned. The recommended turn lane storage lengths for this alternative are summarized in the following table.

Preliminary turn lane storage lengths – Exit 51 Alternative #1

Intersection	Movement	Recommended Storage Length
Ramp Terminal	Westbound Left-Turn (from westbound off-ramp)	75 feet
	Eastbound Left-Turn (from eastbound off-ramp)	50 feet
	Southbound Left-Turn (from crossroad to ramp)	100 feet
	Northbound Left-Turn (from crossroad to ramp)	125 feet

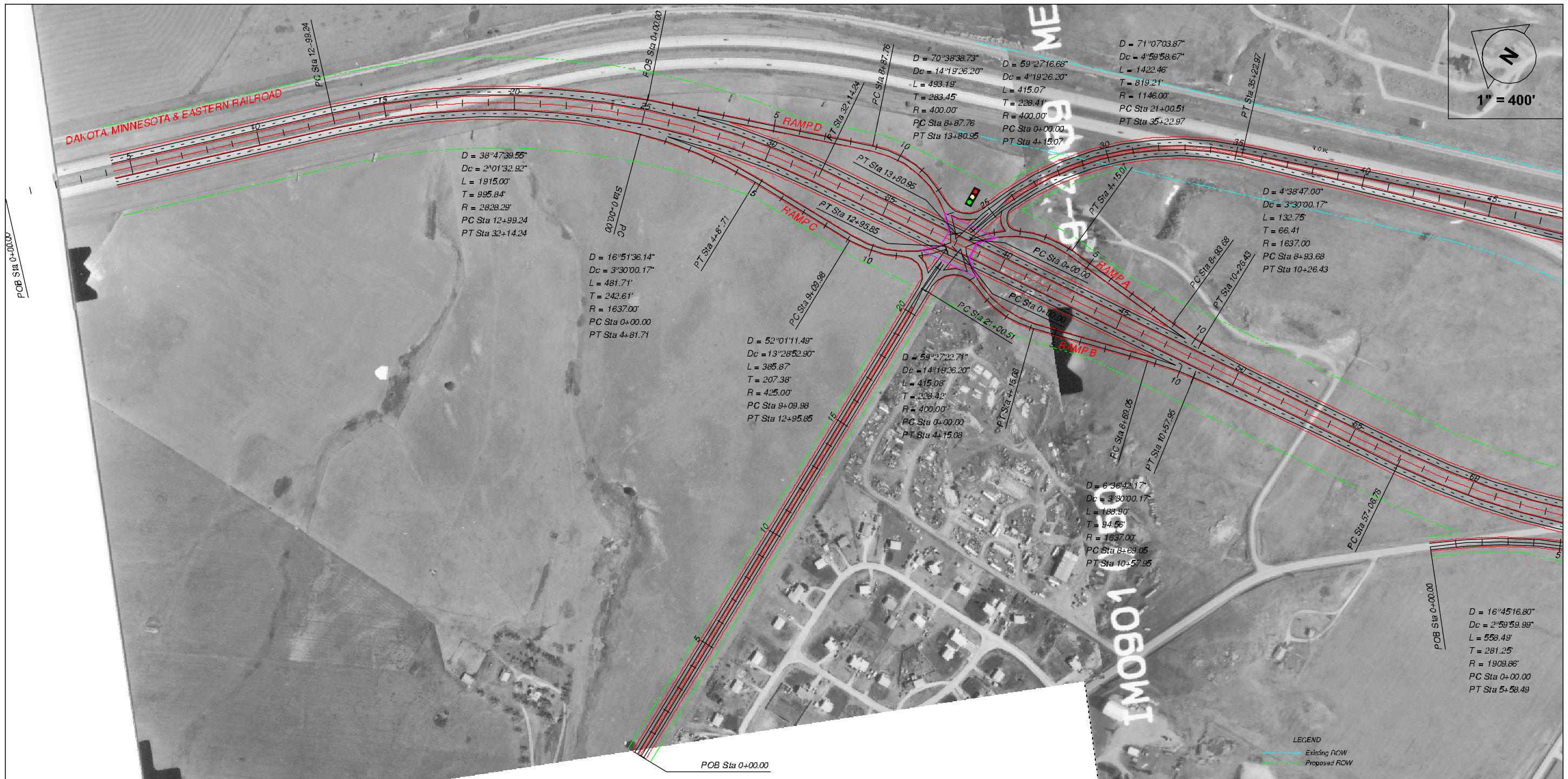


Figure 8
I-90 Exit 51
Black Hawk Road, Black Hawk
Alternative 1
Single Point Interchange

SDDOT Interstate Corridor Study - Phase II

Traffic Safety

Analysis of the accident history at the Exit 51 interchange revealed no safety deficiencies at the interchange. However, observations made by the SDDOT regional office indicate that a pattern of severe crashes that may be attributable to the existing horizontal curves along mainline I-90 in the vicinity of Exit 51 may exist. The improvement of these curves to a 70-mph design speed would likely improve traffic safety at the Exit 51 interchange.

The installation of a SPUI at Exit 51 would represent a departure from the typical I-90 interchange. Initial unfamiliarity with the interchange configuration may cause a short-term increase in accident rates at the interchange. However, as drivers become more familiar with the layout, traffic safety would likely improve.

Capacity

The installation of a SPUI at Exit 51 would consolidate interchange traffic movements at a single intersection. The proposed SPUI interchange is expected to accommodate projected Year 2010 and 2020 traffic volumes. As shown in table below, the interchange is projected to operate at LOS B based on projected Year 2010 and Year 2020 traffic volumes.

Alternative #1 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Ramp Terminal	2010	Sig.	B	C	-	B	C	-	B	-	A	B	-	A	B
Ramp Terminal	2020	Sig.	B	C	-	B	C	-	B	-	A	B	-	A	B

The ramp merge / diverge sections of the SPUI are also expected to operate at LOS B or better by the Year 2020.

Access Issues

The SPUI would improve access between Interstate 90 and the residential development south of the interchange. Access to this development is currently provided via the intersection between SD 79 and Foothills Road.

Right-of-way

As identified in Figures 8 and 10, a substantial amount of right-of-way would need to be acquired with this alternative. Right-of-way will also be needed to relocate the frontage road on the south side of the interchange. The estimated amount of right-of-way required for this alternative is approximately 55 acres.

Probable Construction Costs

A statement of probable construction costs was prepared for realigning Interstate 90 and constructing a new single point urban interchange. The construction of the interstate and single point urban interchange is estimated at \$20.3 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

SDDOT Interstate Corridor Study - Phase II

Alternative #2 – Standard Diamond Interchange

The installation of a standard diamond interchange along a realigned mainline I-90, Alternative #2, represents another possible interchange option. Figure 9 depicts the standard diamond alternative. Figure 10 depicts the alignment of mainline I-90 east of the interchange.

Geometry

As shown on Figure 9, the geometry of this alternative is similar to Alternative #1. With a diamond interchange, the horizontal curves on the ramps adjacent to the proposed crossroad are eliminated. The proposed structure over Interstate 90 will also be smaller in size than the structure required for the Single Point Urban Interchange alternative. The other geometric elements of this interchange are the same as Alternative #1. The recommended turn lane storage lengths for this alternative are summarized below.

Preliminary turn lane storage lengths – Exit 51 Alternative #2

Intersection	Movement	Recommended Storage Length
North Ramp Terminal	Westbound Left-Turn	100 feet
	Northbound Left-Turn	150 feet
South Ramp Terminal	Southbound Left-Turn	100 feet
	Eastbound Left-Turn	100 feet

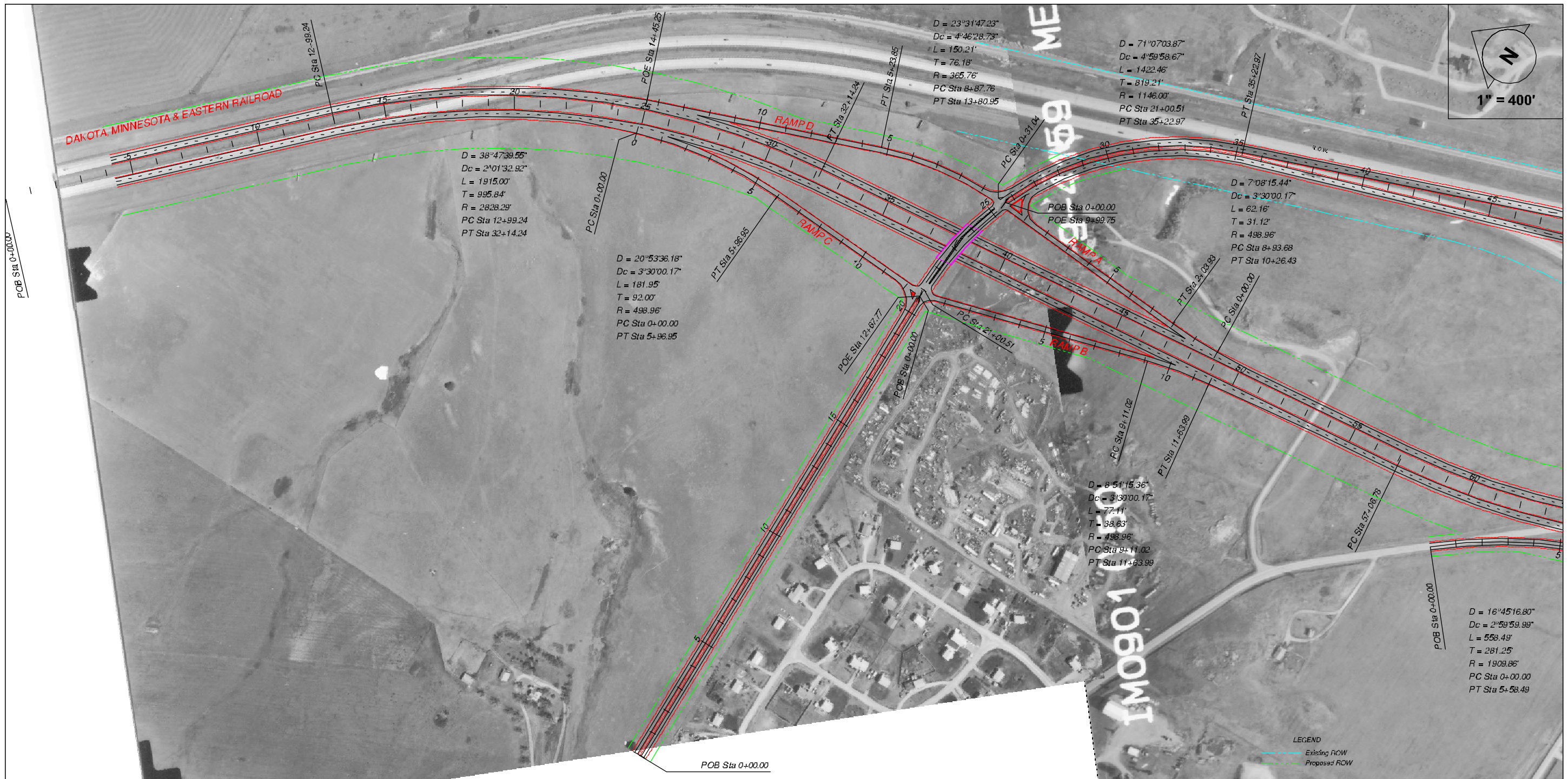
Traffic Safety

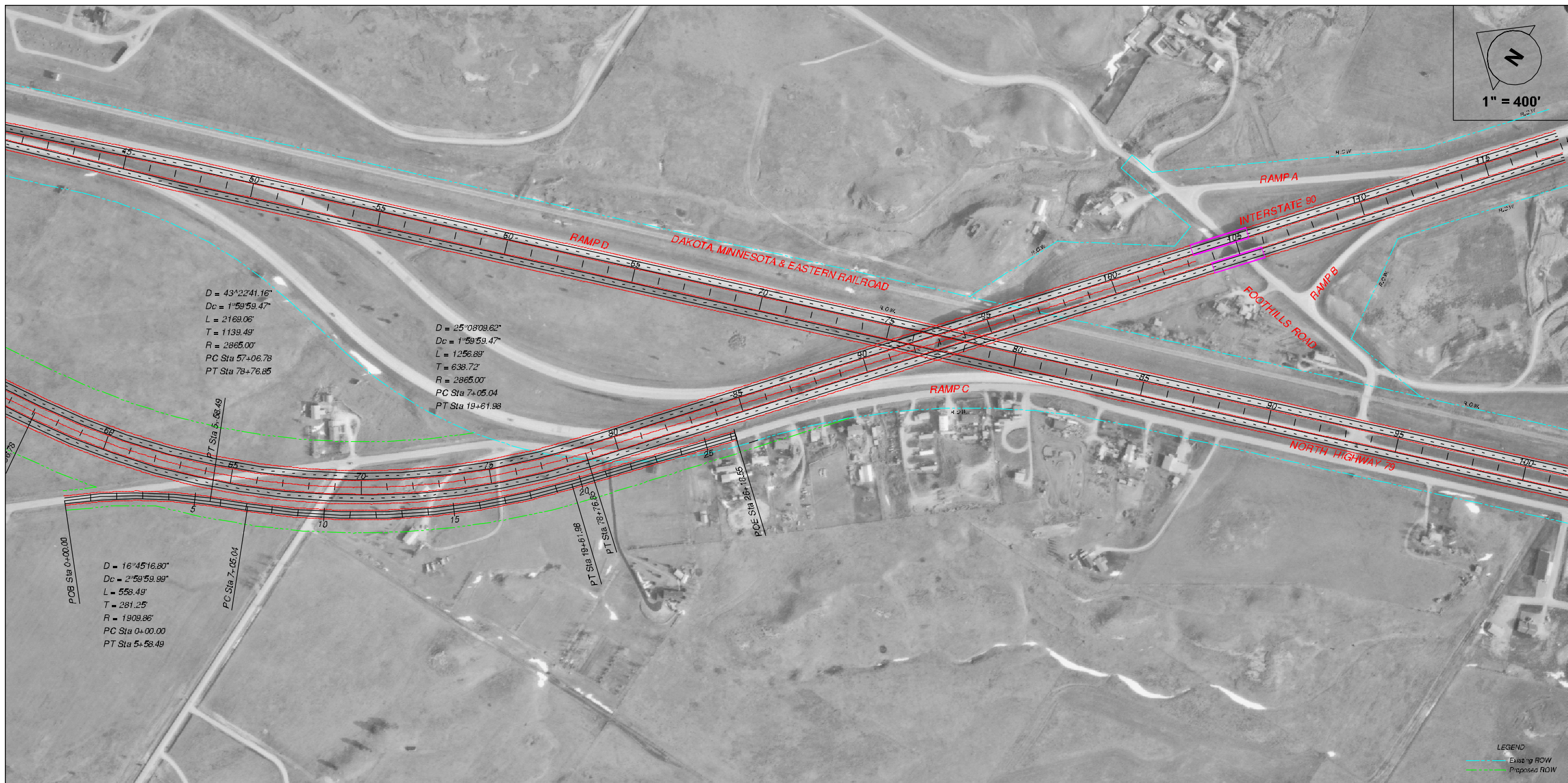
Analysis of the accident history at the Exit 51 interchange revealed no safety deficiencies at the interchange. However, observations made by the SDDOT regional office indicate that a pattern of severe crashes that may be attributable to the existing horizontal curves along mainline I-90 in the vicinity of Exit 51 may exist. The improvement of these curves to a 70-mph design speed would likely improve traffic safety at the Exit 51 interchange.

Analysis of the accident history at the Exit 51 interchange revealed no safety deficiencies at the interchange. However, the standard diamond configuration is likely to benefit overall traffic safety at the interchange. The existing Exit 51 configuration requires drivers to navigate a combination of directional ramps and a ½ diamond interchange to complete their trip through the interchange. The installation of a standard diamond interchange would simplify vehicle maneuvers through the interchange.

Capacity

The installation of a Standard Diamond interchange at Exit 51 would accommodate interchange traffic movements at two unsignalized ramp terminal intersections. The proposed Standard Diamond interchange is expected to accommodate projected Year 2010 and 2020 traffic volumes without requiring installation of traffic signals at the ramp terminal intersections. The interchange is projected to operate at LOS B based on projected Year 2010 and Year 2020 traffic volumes.





SDDOT Interstate Corridor Study - Phase II

Alternative #2 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
North Ramp Terminal	2010	Unsig.	A	-	-	-	-	-	-	-	-	B	-	A	B
South Ramp Terminal	2010	Unsig.	-	-	-	A	-	-	B	-	A	-	-	-	B
North Ramp Terminal	2020	Unsig.	A	-	-	-	-	-	-	-	-	B	-	A	B
South Ramp Terminal	2020	Unsig.	-	-	-	A	-	-	B	-	A	-	-	-	B

The ramp merge / diverge sections of the SPUI are also expected to operate at LOS B or better by the Year 2020.

Access Issues

The standard diamond interchange would improve access between Interstate 90 and the residential development south of the interchange. Access to this development is currently provided via the intersection between SD 79 and Foothills Road.

Right-of-way

As identified in Figures 9 and 10, a substantial amount of right-of-way would need to be acquired with this alternative. Right-of-way will also be needed to relocate the frontage road on the south side of the interchange. The estimated amount of right-of-way required for this alternative is approximately 55 acres.

Probable Construction Costs

A statement of probable construction costs was prepared for realigning Interstate 90 and constructing a new diamond interchange. The construction of the interstate and diamond interchange is estimated at \$20.1 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Summary of Alternatives

Analyses of the geometry, capacity, and safety characteristics of the existing Exit 51 interchange have been performed. The analyses revealed particular deficiencies in the geometry category. To remedy these deficiencies, two alternative interchange configurations have been formulated.

Alternative #1, shown on Figure 8, proposes the construction of a Single-Point Urban Interchange (SPUI). Analysis shows that traffic operations at the SPUI would be at LOS B by the Year 2020. A potential advantage to this alternative probable construction cost for Alternative #1 is approximately \$20.3 million.

SDDOT Interstate Corridor Study - Phase II

Alternative #2, a Standard Diamond interchange, is depicted on Figure 9. This configuration was designed based on guidelines contained in the SDDOT Roadway Design Manual. The ramp terminal intersections are both projected to operate at LOS B by the Year 2020 as unsignalized intersections. The probable construction cost for Alternative #2 is approximately \$20.1 million.

As shown on Figures 8 and 9, the construction of the either alternative would create a horizontal curve along North Highway 79 north of the interchange. One advantage of the SPUI instead of the Standard Diamond interchange is that the north ramp intersection with North Highway 79 would be farther from the horizontal curve, enhancing traffic safety.

SDDOT Interstate Corridor Study - Phase II

I-90: Exit 55 – Deadwood Avenue, Rapid City

The Phase I investigation of Exit 55 revealed geometric deficiencies at the existing interchange. Unacceptable traffic operations are expected to occur based on projected Year 2010 and Year 2020 traffic volumes. Access control could be improved with a realignment of the service road on the north side of the interchange.



The Phase II investigation evaluates geometric and operational characteristics of the interchange and formulates alternatives for improving the interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 55 Phase I analysis.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The bridge for Deadwood Avenue consists of one through lane in each direction and left turn lanes at the ramp terminal intersections. Every ramp at this interchange was found to have geometric deficiencies. The vertical alignments on all of the ramps have substandard k-values, which correlates to inadequate stopping sight distances. The taper rates for the on and off ramps at Interstate 90 were also found to be inadequate. Ramps A and D have vertical grades that exceed the design standards.

Traffic Safety

This interchange ranks 33rd of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. A total of 28 accidents occurred at this intersection between 1997 and 1999. The Exit 55 crash history does not imply any specific geometric deficiencies.

Capacity

Though existing traffic operations at the Exit 55 interchange are within the acceptable range, future traffic operations are expected to be problematic if no interchange improvements are constructed. As shown in Table 1, analysis of projected traffic conditions at the Exit 55 interchange indicated that traffic operations at the STOP sign-controlled north ramp terminal intersection are projected to reach Level of Service (LOS) F (shown in red) by the Year 2010. The south ramp terminal intersection and the interchange ramp junctions with I-90 are projected to operate at acceptable levels based on Year 2010 and Year 2020 projections.

SDDOT Interstate Corridor Study - Phase II

Existing Interchange Configuration – Levels of Service

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
WB Diverge	C	B	B	B	Acceptable
WB Merge	C	B	B	B	Acceptable
EB Diverge	C	B	B	B	Acceptable
EB Merge	C	B	B	C	Acceptable
North Intersection	D	C	F	F	Unacceptable
South Intersection	D	B	C	D	Acceptable

Proposed Interchange Alternatives

Based on the conditions noted previously, interchange improvements are warranted. Three interchange alternatives were evaluated to improve the existing geometric deficiencies and to improve the future traffic operations of the interchange.

Alternative #1 – Standard Diamond

The Standard Diamond Interchange alternative is depicted on Figure 11. The interchange concept was formulated based on the typical diamond interchange criteria as published in the SDDOT Roadway Design Manual.

Geometry

As shown on Figure 11, the ramps with this alternative have been extended to allow for the appropriate merge / diverge taper rates. The ramp terminal intersections are located approximately 550 feet from the centerline of Interstate 90. The existing Deadwood Avenue Bridge over I-90 could be salvaged with the implementation of this alternative. The laneage for the Deadwood Avenue Bridge would consist of a 3-lane section with left-turn lanes. The recommended turn lane storage lengths based on projected Year 2020 traffic volumes are summarized in the following table. With lanes added at the south ramp terminal intersection, Deadwood Avenue would become a 4-lane section south of the interchange.

Recommended Year 2020 Vehicle Storage Lengths – Alternative #1

Intersection	Movement	Recommended Storage Length
South Ramp Terminal	Southbound Left-Turn	200 feet
North Ramp Terminal	Northbound Left-Turn	200 feet

Traffic Safety

Analysis of the accident history at the Exit 55 interchange revealed no safety deficiencies at the interchange. With geometric improvements, it is anticipated that the construction of Alternative #1 would slightly improve traffic safety over existing conditions at Exit 55.

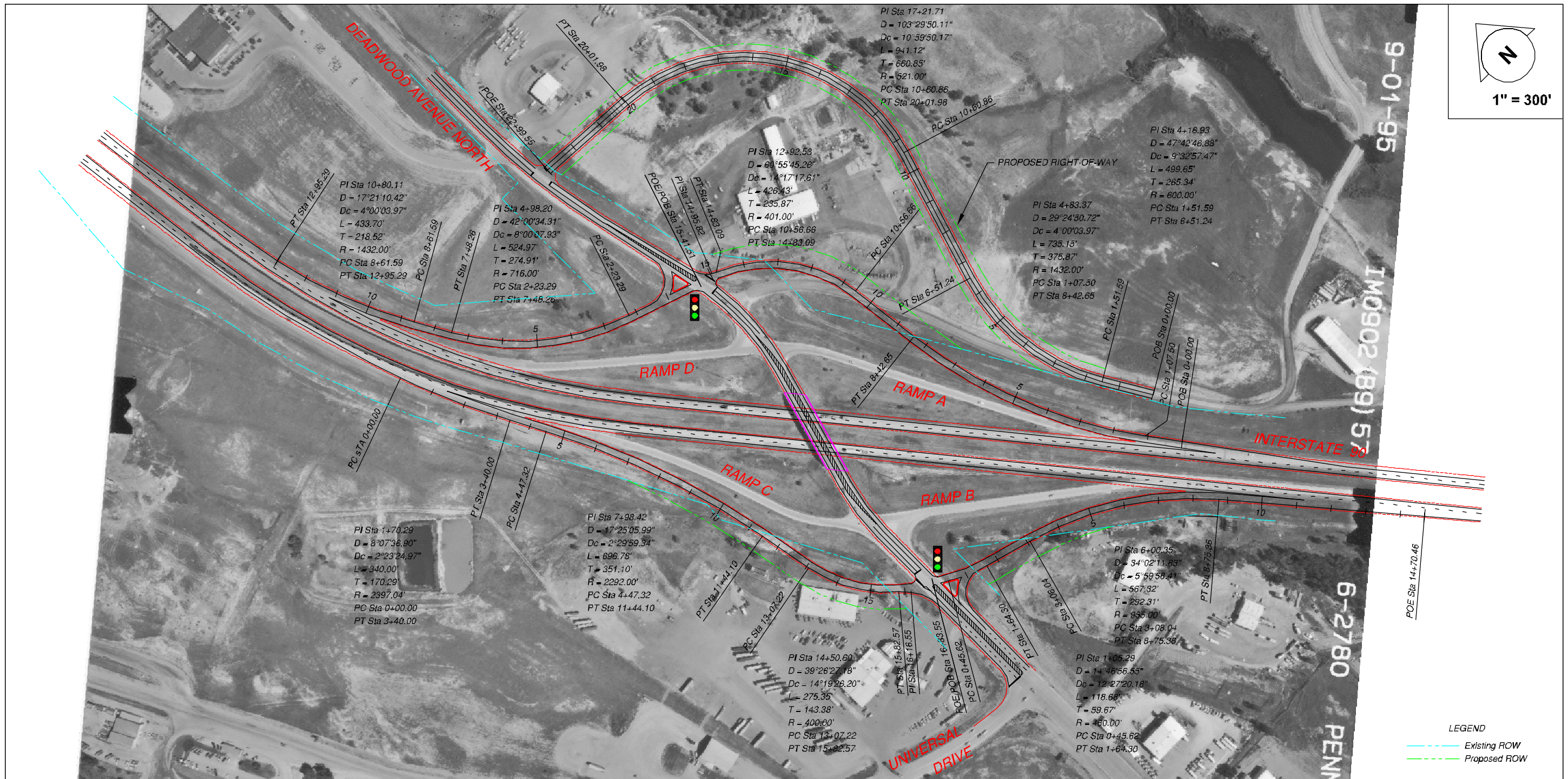


Figure 11
I-90 Exit 55
Deadwood Avenue, Rapid City
Alternative 1
Diamond Interchange

SDDOT Interstate Corridor Study - Phase II

Capacity

Phase II operational analyses of Alternative #1 were performed using the Synchro software tool to account for coordination between the two signalized ramp terminal intersections. Synchro is capable of analyzing systems of intersections, and accounts for system effects such as vehicle progression when performing LOS calculations. Synchro also provides system-wide measures of effectiveness such as vehicle delay.

Installation of traffic signals is recommended at the two ramp terminals to improve intersection operations and accommodate the significant left-turn demand. With traffic signals installed and coordinated, operations are expected to improve from LOS F to LOS B at the north ramp terminal and from LOS D to LOS A at the south ramp terminal based on projected Year 2020 traffic conditions. The results of the analysis are depicted below.

Alternative #1 – Ramp terminal intersection Levels of Service

Intersection	Criteria	Year 2010	Year 2020	Comments
North Intersection	D	B	B	Acceptable
South Intersection	D	A	A	Acceptable

Alternative #1 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
North Ramp Terminal	2010	Sig.	B	B	-	-	C	A	-	-	-	B	B	B	B
North Ramp Terminal	2020	Sig.	B	B	-	-	C	A	-	-	-	B	B	B	B
South Ramp Terminal	2010	Sig.	-	B	A	A	A	-	A	A	A	-	-	-	A
South Ramp Terminal	2020	Sig.	-	B	A	A	A	-	A	A	A	-	-	-	A

The projected Alternative #1 Year 2010 and Year 2020 traffic volumes and levels of service are included in the appendix.

Access Control

The control of access north of the interchange would be improved by realigning the frontage road, which is presently directly north of the ramp intersection, to the north side of the heavy equipment dealership facility. The access to the heavy equipment dealership facility would then be closed or reconfigured as a right-in / right-out (RIRO) access on Deadwood Avenue. Another full movement access would be constructed to the heavy equipment dealership facility on the relocated frontage road. The access on Deadwood Avenue to the truck stop on the south side of the interchange would also be closed or reconfigured as a right-in / right-out (RIRO) access.

SDDOT Interstate Corridor Study - Phase II

Right-of-way

As identified in Figure 11, substantial right-of-way impacts are associated with this alternative. A building at the truck stop located in the southwest quadrant of the interchange may need to be acquired and the parking facility at the dealership located in the northeast quadrant may be significantly altered. Right-of-way would also be required to relocate the frontage road on the north side of the interchange. The estimated amount of right-of-way required for this alternative is approximately 6.8 acres.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the standard diamond interchange is estimated at \$2.74 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Alternative #2 – Single-Point Urban

Alternative #2, a Single-Point Urban Interchange (SPUI), is shown on Figure 12. The SPUI would consolidate all turning movements to and from Interstate 90 into a single signalized intersection.

Geometry

A SPUI typically operates in optimal fashion when the crossroad intersects the mainline freeway at a 90-degree angle. Deadwood Avenue, however, crosses Interstate 90 at a 55-degree angle. A skew of this magnitude increases the size and complexity of the required bridge over Interstate 90 in comparison to an interchange with the cross-road crossing over the freeway at a 90-degree angle. The width of Deadwood Avenue at the proposed bridge would still accommodate a 3-lane section. The recommended turn lane storage lengths based on projected Year 2020 traffic volumes are summarized below. The configuration of the on and off ramps are similar to Alternative #1.

Recommended Year 2020 Vehicle Storage Lengths – Alternative #2

Intersection	Movement	Recommended Storage Length
Ramp Terminal	Southbound Left-Turn	200 feet
	Northbound Left-Turn	200 feet

Traffic Safety

Analysis of the accident history at the Exit 55 interchange revealed no safety deficiencies at the interchange. The installation of a SPUI at Exit 55 would represent a departure from the typical I-90 interchange. Initial unfamiliarity with the interchange configuration may cause increased accident rates at the interchange. However, as drivers become more familiar with the layout, traffic safety would likely improve.

SDDOT Interstate Corridor Study - Phase II

Capacity

Installation of a traffic signal is recommended at the ramp terminal intersection to accommodate the consolidated interchange traffic movements. As shown in the following table, with a traffic signal installed, LOS B traffic operations are anticipated by the Year 2020. Ramp merge / diverge operations are projected to be LOS C or better by the Year 2020.

Alternative #2 – Ramp terminal intersection Levels of Service

Movement	Criteria	Year 2010	Year 2020	Comments
Single-Point Intersection	D	B	B	Acceptable

Alternative #2 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Ramp Terminal	2010	Sig.	C	C	-	C	C	-	B	-	A	C	-	A	B
Ramp Terminal	2020	Sig.	C	C	-	C	C	-	B	-	A	C	-	A	B

The projected Alternative #2 Year 2010 and Year 2020 traffic operations are included in the appendix.

It is important to note that the extreme skew angle between the alignment of Deadwood Avenue and that of I-90 increases intersection clearance time and limits the amount of sight distance available to drivers approaching the intersection.

Access Control

The control of access north of the interchange would be improved by realigning the frontage road, which is presently directly north of the ramp intersection, to the north side of the heavy equipment dealership facility. The access to the heavy equipment dealership facility would then be closed or reconfigured as a right-in / right-out (RIRO) access on Deadwood Avenue. Another full movement access would be constructed to the heavy equipment dealership facility on the relocated frontage road. The access on Deadwood Avenue to the truck stop on the south side of the interchange would also be closed or reconfigured as a right-in / right-out (RIRO) access.

Right-of-way

In order to minimize right-of-way impacts, the existing skewed alignment of Deadwood Avenue was utilized over Interstate 90. The only right-of-way required for this alternative is the right-of-way for the frontage road relocation on the north side of the interchange. The estimated amount of right-of-way required for this alternative is approximately 3.6 acres.

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Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the single point interchange is estimated at \$5.52 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Alternative #3 – Tight Diamond

A Tight Diamond interchange alternative is shown on Figure 13. The ramp terminal intersections for this alternative closely resemble the existing interchange. Alternative #3, which is similar to Alternative #1, differs primarily in the spacing between the ramp terminal intersections.

Geometry

The geometrics of this alternative closely resemble the geometrics for Alternative #1, with the exception of the ramp terminal intersection locations. The ramps have been extended to allow for the appropriate taper rates. The ramp terminal intersections are shifted from the existing locations to eliminate the ramp intersection sight distance deficiency present with the existing interchange. The bridge for Deadwood Avenue over I-90 could be salvaged for this alternative. The existing width of the bridge accommodates a 3-lane section, with left-turn lanes at the ramp terminal intersections. The recommended turn lane storage lengths based on projected Year 2020 traffic volumes are summarized below. The projected traffic volumes on Deadwood Avenue show that one lane in each direction over Interstate 90 would be adequate. Two additional lanes for Deadwood Avenue would be created at the south ramp terminal intersection and would continue to the south. The frontage road located on the north side of the interchange would be realigned to increase access spacing with respect to the ramp terminal intersection.

Recommended Year 2020 Vehicle Storage Lengths – Alternative #3

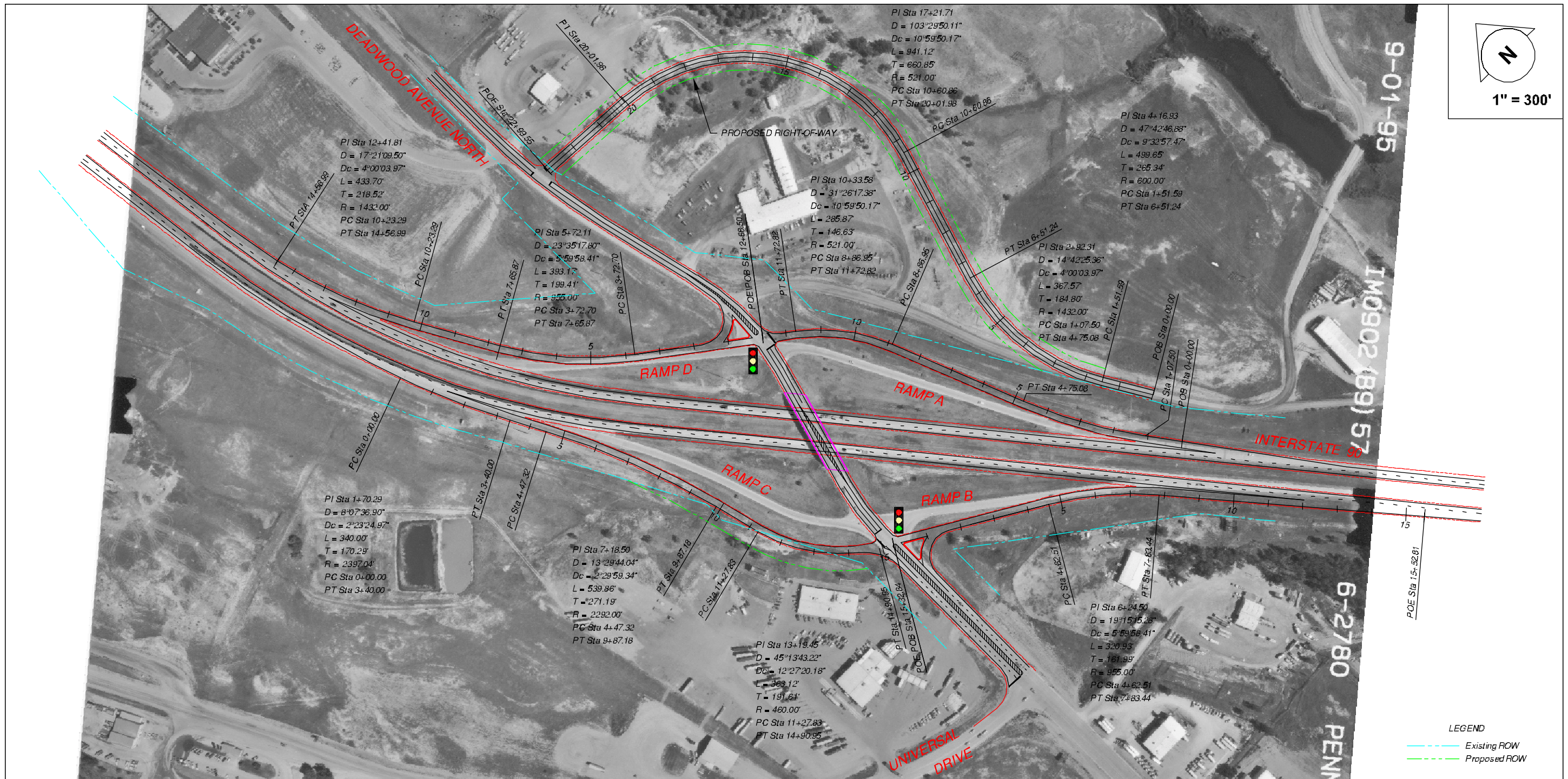
Intersection	Movement	Recommended Storage Length
South Ramp Terminal	Southbound Left-Turn	200 feet
North Ramp Terminal	Northbound Left-Turn	200 feet

Traffic Safety

Analysis of the accident history at the Exit 55 interchange revealed no safety deficiencies at the interchange. It is anticipated that Alternative #3 would maintain the existing level of traffic safety at Exit 55.

Capacity

As in the case of Alternative #1, the Synchro software tool was used for capacity analyses of the interchange. Synchro is capable of accounting for coordination between the two signalized ramp terminal intersections.



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Installation of traffic signals is recommended at the two ramp terminals to improve intersection operations and to accommodate the large left-turn demand. With traffic signals installed, operations are expected to improve from LOS F to LOS B at the north ramp terminal and from LOS D to LOS A at the south ramp terminal based on projected Year 2020 traffic conditions. The results of the analyses are depicted in the table below. The ramp merge / diverge sections are projected to operate at LOS C or better by the Year 2020.

Alternative #3 – Ramp terminal intersection Levels of Service

Movement	Criteria	Year 2010	Year 2020	Comments
North Intersection	D	B	B	Acceptable
South Intersection	D	A	A	Acceptable

Alternative #3 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
North Ramp Terminal	2010	Sig.	B	B	-	-	C	A	-	-	-	B	B	B	B
North Ramp Terminal	2020	Sig.	B	B	-	-	C	A	-	-	-	B	B	B	B
South Ramp Terminal	2010	Sig.	-	B	A	A	A	-	A	A	A	-	-	-	A
South Ramp Terminal	2020	Sig.	-	B	A	A	A	-	A	A	A	-	-	-	A

The projected Alternative #3 Year 2010 and Year 2020 traffic volumes and levels of service are included in the appendix.

Access Control

The control of access north of the interchange would be improved by realigning the frontage road, which is presently directly north of the ramp intersection, to the north side of the heavy equipment dealership facility. The access to the heavy equipment dealership facility would then be closed or reconfigured as a right-in / right-out (RIRO) access on Deadwood Avenue. Another full movement access would be constructed to the heavy equipment dealership facility on the relocated frontage road. The access on Deadwood Avenue to the truck stop on the south side of the interchange would also be closed or reconfigured as a right-in / right-out (RIRO) access.

Right-of-way

Right-of-way acquisition would be required for the frontage road relocation on the north side of the interchange and adjacent to Ramp C. The estimated amount of right-of-way required for this alternative is approximately 4.2 acres.

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Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the tight diamond interchange is estimated at \$2.43 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Summary of Alternatives

Analyses of the geometry, capacity, and safety characteristics of the existing Exit 55 interchange have been performed. The analyses revealed particular deficiencies in the geometry and capacity categories. To remedy these deficiencies, three alternative interchange configurations have been formulated.

Alternative #1, a Standard Diamond interchange, is depicted on Figure 11. This configuration was designed based on guidelines contained in the SDDOT Roadway Design Manual. Traffic signals would be installed at the ramp terminal intersections to improve operations over the existing unsignalized configuration. The north ramp terminal intersection is projected to operate at LOS B by the Year 2020, while the south ramp terminal intersection is projected to operate at LOS A with these improvements. The construction of this alternative would require the acquisition of several properties adjacent to the interchange. The probable construction cost for Alternative #1 is approximately \$2.74 million.

Alternative #2, shown on Figure 12, proposes the construction of a Single-Point Urban Interchange (SPUI). Analysis shows that traffic operations at the SPUI would be at LOS B by the Year 2020. The SPUI, however, would be the most expensive alternative to construct. The probable construction cost for Alternative #2 is approximately \$5.52 million.

Alternative #3, a Tight Diamond interchange is shown on Figure 13. It is similar to the Standard Diamond Alternative, with a difference in spacing between ramp terminal intersections. The north ramp terminal intersection is projected to operate at LOS B by the Year 2020, while the south ramp terminal intersection is projected to operate at LOS A. The construction of Alternative #3 would have less Right-of-Way (ROW) impact than that of Alternative #1. The probable construction cost for Alternative #3 is approximately \$2.43 million.

Reconstruction of mainline I-90 in the vicinity of Exit 55 is planned for the near future, perhaps as soon as the Year 2005. It is suggested that modifications to the interchange ramp alignment and configuration should be completed with the reconstruction project. Any adjustments to the ramps or ramp terminal intersections should be made to accommodate the preferred ultimate Exit 55 interchange configuration. Therefore, it is important that more detailed analysis of Exit 55 alternatives be performed in order to select a preferred ultimate interchange alternative prior to the mainline reconstruction project.

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I-90: Exit 59 - LaCrosse Street, Rapid City

Based on the results of the Phase I investigation, the interchange located at Exit 59 (Lacrosse Street) on I-90 does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. The existing geometric deficiencies are minor, and can be corrected at the time of pavement reconstruction. Multiple access points are present in close proximity to the interchange ramp terminals.



The accident data highlight a crash history among eastbound right-turning vehicles at the south ramp terminal intersection. A Phase II investigation has been performed to analyze the accident pattern at this location and determine possible countermeasures to address the occurrence of crashes. Phase II also addresses access control along LaCrosse Avenue in the vicinity of the interchange. Interchange traffic operations are re-evaluated based on recent traffic count information and updated traffic projections.

Existing Interchange Characteristics

Geometry

The existing Exit 59 interchange is a diamond interchange with LaCrosse Street crossing over I-90. The LaCrosse Street bridge is currently a 5-lane section that includes 2 through lanes in each direction and single left-turn lanes at both ramp terminal intersections. The sag k-values, which relate to headlight sight distance, are substandard on Ramps B and C. The taper rate for the eastbound on ramp to Interstate 90 was also found to be inadequate. The distances between the ramp terminal intersections and adjacent accesses are below standards.

Traffic Safety

This interchange ranks 9th of the 62 interchanges evaluated in the study based on a 3-year crash rate (1997-1999), and is considered one of the high accident locations. A review of the detailed accident records showed that 28 of the 67 crashes occurred at the eastbound ramp terminal intersection. This indicates that problems may exist with the geometric configuration of this intersection. In particular, the sight distance available to eastbound vehicles approaching the intersection may be deficient.

The predominant crash pattern was rear-end type crashes occurring along the eastbound approach to the south ramp terminal intersection, with 13 occurring during the study period. Each of these collisions involved vehicles seeking to turn right from the ramp onto southbound LaCrosse Street. The accident reports for these crashes indicated an uncertainty among drivers regarding the behavior of the lead right-turning driver. A typical rear-end crash occurred when a

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vehicle following the lead right-turning driver moved forward without making certain that the vehicle ahead of them had proceeded into the intersection.

Capacity

Traffic volumes at the intersections of LaCrosse Street with Disk Drive, Latrobe Avenue, and the north and south interchange ramps were collected by SDDOT during September of the Year 2000. These traffic volumes were used to refine the existing design hour turning movement estimates used for the Phase I evaluation. Traffic volume growth rates were also modified to reflect information included in the [Rapid City Area Long Range Transportation Plan](#), completed by Felsburg Holt and Ullevig in August of 2000. Based on this information, an annual growth rate of approximately 1.74 percent was used for the Phase II evaluation. The annual growth rate used in Phase I was approximately 0.53 percent.

Operational analyses of the ramp merge and diverge sections were performed based on the updated traffic volume projections. These results are shown below. As shown, traffic operations at the ramp connections are expected to remain acceptable to the Year 2020.

Ramp Movement Levels of Service

Movement	LOS Criteria	Existing LOS	2010 LOS	2020 LOS	Comments
WB Diverge	C	B	B	C	Acceptable
WB Merge	C	B	B	C	Acceptable
EB Diverge	C	B	C	C	Acceptable
EB Merge	C	B	B	C	Acceptable

Capacity analyses of existing and projected PM peak hour traffic volumes at the Exit 59 interchange were performed using the Synchro software tool. Synchro was utilized for the analyses because of its ability to account for system effects such as vehicle progression when calculating the LOS at a given signalized intersection. Synchro also is capable of calculating system measures of effectiveness such as vehicle delay. The evaluated roadway network included the LaCrosse Street intersections with Disk Drive and the north and south interchange ramp terminals. The results of these analyses are summarized in the following table.

LOS Results based on Synchro Analysis

Intersection	Existing	Year 2010	Year 2020
LaCrosse Street / Disk Drive	A	B	B
LaCrosse Street / North Ramp Intersection	B	B ¹	A ³
LaCrosse Street / South Ramp Intersection	B	B ²	B ²

¹ Based on lengthened northbound left-turn lane

² Based on added eastbound right-turn lane

³ Based on dual northbound left-turn lane

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With the improvements noted in the table, traffic operations are expected to remain at LOS B or better to the Year 2020.

Proposed Improvements

Based on the interchange characteristics previously noted, several improvements to the I-90/LaCrosse Street interchange are recommended. The recommendations apply to three categories: Left-turn storage, traffic safety, and access control.

Left-Turn Storage

Based on the Synchro analyses, levels of service at the signalized LaCrosse Street intersections in the vicinity of Exit 59 are expected to remain acceptable to the Year 2020. However, improved vehicle storage capacity is required to maintain the operational conditions shown in the previous table.

Single left-turn lanes at each ramp terminal intersection currently accommodate vehicles turning left from LaCrosse Street onto I-90. The two abutting left-turn lanes are approximately 200 feet in length and together form the center lane of the 5-lane bridge. The existing configuration is adequate to accommodate existing traffic volumes. However, if the northbound left-turn lane is not lengthened, it is likely that queued vehicles will spill out of the left-turn lane into the northbound through travel lanes by the Year 2010. By the year 2020, it is anticipated that a dual northbound left-turn lane will be necessary to prevent the northbound and southbound left-turn queues from conflicting.

In order to accommodate left-turn storage, it is recommended that the center turn lane be restriped to accommodate approximately 250 feet of northbound left-turn vehicle storage length by the year 2010. Based on projected Year 2020 traffic conditions, it is recommended that northbound left-turn storage be further improved by the installation of a dual left-turn lane. Depicted on Figure 14, this installation would require a widening of the LaCrosse Avenue Bridge to 6 lanes and an additional lane along the westbound I-90 on-ramp to receive dual left-turns. As shown on Figure 14, the two lanes along this ramp would taper to a single lane before merging with mainline I-90.

Traffic Safety

Based on the previously described traffic accident history at the eastbound approach to the south ramp terminal intersection, it is recommended that eastbound right-turns on red be eliminated at the intersection. With right-turns only allowed during the eastbound green indication, the behavior of the lead driver will be easier for the following vehicles to anticipate.

Currently, a channelized right-turn lane accommodates eastbound right-turning vehicles. This lane provides minimal vehicle storage length. The elimination of right-turns on red would require the installation of a right-turn lane along the eastbound approach to the south ramp terminal intersection to accommodate vehicles awaiting the green indication. It is recommended that this lane be approximately 250 feet in length, as shown on Figure 10. Intersection operations remain at LOS B with the elimination of right-turns on red.



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Access Control

As previously noted, spacing between the LaCrosse Street accesses to existing commercial developments and the ramp terminal intersections is below standards prescribed in the SDDOT Roadway Design Manual. This substandard spacing decreases operational efficiency and detracts from traffic safety along LaCrosse Street. It is recommended that access control strategies such as converting full movement intersections to partial or right-in / right-out movements by use of raised medians and / or channelization islands be considered. Evaluation of these strategies along LaCrosse Street could be accomplished by formulating an Access Control Plan, which would require, in addition to other tasks, a detailed inventory of existing accesses and discussions with property owners.

Probable Construction Costs

A statement of probable construction costs was prepared for the widening of LaCrosse Street for dual left-turns and widening Ramps C and D. Construction of the improvements is estimated at \$2.8 million. A breakdown of the quantities and construction costs is included in the Appendix. The proposed improvements can be constructed within the existing right-of-way; therefore, there should not be a cost associated with right-of-way.

More detailed construction costs could be developed as a part of the access control plan development. A programming budget for an access control plan could be \$25,000 to \$30,000.

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I-90: Exit 60 – East North Street, Rapid City

The Phase I investigation of this interchange revealed that the existing directional interchange could accommodate projected Year 2020 traffic volumes. The Exit 60 interchange was identified as a high accident location, with most of the crashes occurring during slippery roadway conditions. This interchange has been reviewed in the “I-90/East North Street Interchange Reconstruction Concept Study” and the 1992 supplement prepared by Kirkham Michael and Associates for the SDDOT. The 1992 supplement recommended reconstruction of the interchange to provide safety improvements and to provide a north connection to the interchange.



Two interchange alternatives for Exit 60 were preferred in the previous study and a third alternative was developed with Phase I of this study. These interchange alternatives are evaluated in greater detail in this Phase II investigation. The feasibility of extending Eglin Street from the east to North Street was also reviewed as a part of this investigation.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The proposed section for North Street which would extend to the north of Interstate 90 would consist of two through lanes in each direction with dual northbound and southbound left turn lanes for the ramps to Interstate 90. Some of the geometric deficiencies for the interchange include the sag k-value, which relates to headlight sight distance and is substandard for the westbound on ramp from Dyess Avenue. The taper rates for the westbound off ramp and eastbound on ramp to Interstate 90 were also found to be inadequate. The structure for eastbound Interstate 90 that crosses the westbound off ramp has a substandard width. Some deficiencies were also discovered with Dyess Avenue, such as substandard crest k-values and flat vertical grades.

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Traffic Safety

This interchange ranks 3rd of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is considered one of the high accident locations. Most of the crashes at this interchange occurred during wet, icy, or snow-packed roadway conditions. Investigation of detailed accident reports indicated a large number of crashes on the eastbound I-90 bridge over US Highway 16B. The majority of these accidents occurred during slippery roadway conditions. Several crashes involved vehicles losing control during slippery roadway conditions at the westbound I-90 off ramp to US Highway 16B.

Capacity

It is expected that projected traffic volumes at this interchange would be accommodated by the current interchange configuration. No improvements are necessary based on capacity requirements. The interchange ramp merge / diverge sections and ramp terminal intersections are expected to operate at LOS C or better based on projected Year 2020 traffic volumes.

Proposed Interchange Alternatives

Based on the conditions noted previously and to enhance access to the north of Interstate 90, three interchange alternatives have been developed to replace the existing interchange configuration.

A Standard Diamond configuration and a Partial Cloverleaf alternative were recommended for further study as part of the I-90/East North Street Interchange Reconstruction Design Concept Study supplement. A Single-Point Urban Interchange (SPUI) alternative was formulated in Phase I of the Interstate Corridor Study.

Each interchange configuration provides access to the north of Interstate 90, which is not currently provided at Exit 60. The north access is expected to cause a shift in travel patterns through the interchange. The projected Year 2015 traffic volumes included in the 1992 Kirkham Michael supplementary report were used to develop Year 2010 and 2020 projections.

Alternative #1 – Standard Diamond

The Standard Diamond interchange alternative is shown on Figure 15. This alternative was initially formulated in the 1992 Kirkham Michael supplement.

Geometry

As shown on Figure 15, Alternative #1 proposes a standard diamond that was developed using the South Dakota Roadway Design Manual. The alignment of westbound Interstate 90 is proposed to remain at its present location. The alignment of eastbound Interstate 90 would be moved so it would parallel the westbound alignment. All of the existing ramps at the interchange would be removed and replaced with the ramps shown on Figure 11. The recommended left-turn and right-turn lane storage lengths for the ramps and North Street are shown in the following table.

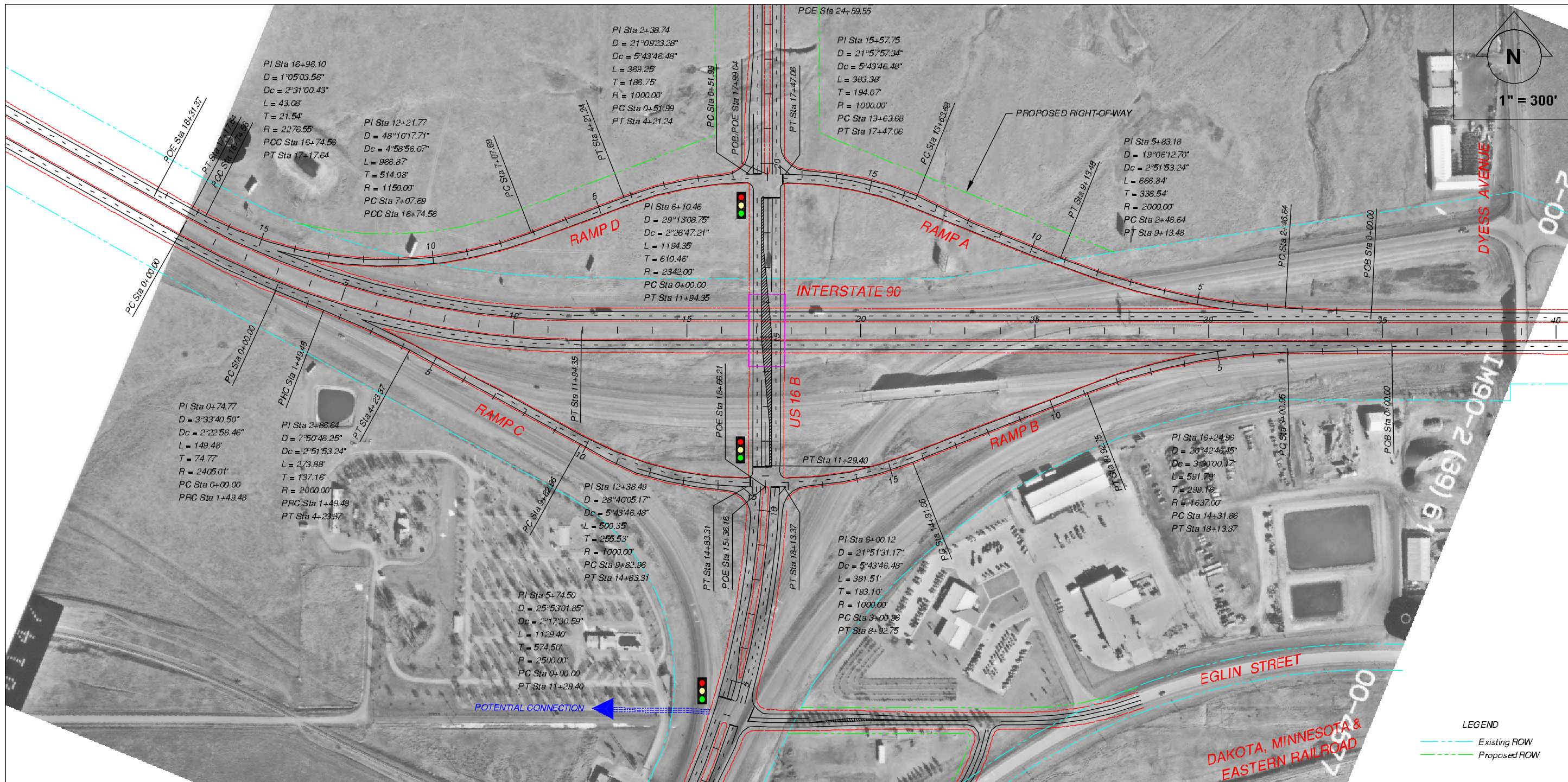


Figure 15
I-90 Exit 60
E. North Street, Rapid City
Alternative 1
Diamond Interchange

KIRKHAM
MICHAEL
 CONSULTING ENGINEERS

FELSBURG
HOLT &
ULLEVIG

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Recommended Vehicle Storage Lengths – Alternative #1

Intersection	Movement	Recommended Storage Length
South Ramp Terminal	Dual Southbound Left-Turn	200 feet
	Northbound Right-turn	50 feet
	Dual Eastbound Left-turn	150 feet
	Eastbound Right-turn	150 feet
Eglin Street / North Street	Westbound Left-turn	150 feet
	Westbound Right-turn	50 feet
	Southbound Left-turn	50 feet
	Northbound Right-turn	50 feet
North Ramp Terminal	Dual Northbound Left-Turn	200 feet
	Southbound Right-turn	50 feet
	Dual Westbound Left-turn	250 feet
	Westbound Right-turn	100 feet

The feasibility of extending Eglin Street to North Street was reviewed. The proposed alignment of Eglin Street attempts to minimize the impacts for the area between Eglin Street and North Street by aligning through a landscaped area. The new intersection of Eglin Street and North Street is located approximately 500 feet south of the south ramp terminal intersection and approximately 500 north of the existing at grade railroad crossing; it aligns with a proposed access on the west side.

Traffic Safety

Alternative #1 would represent a significant improvement over existing traffic safety conditions at the Exit 60 interchange by eliminating the existing eastbound I-90 Bridge over US Highway 16B. Slippery roadway conditions along this bridge contributed to 13 accidents from January of 1997 to December of 1999.

Capacity

Projected Year 2010 and Year 2020 capacity analyses of Alternative #1 were performed using the Synchro software tool, which is capable of analyzing roadway networks as a system of coordinated signalized intersections. The analyzed roadway network for Alternative #1 included the ramp terminal intersections and the proposed North Street / Eglin Street intersection. The LOS analysis results for the three signalized intersections are shown below. The intersections are projected to operate at LOS B or better based on Year 2010 and Year 2020 traffic volume projections.

The distance between the Eglin Street intersection and the North Street / South ramp terminal intersection would be approximately 500 feet with the implementation of Alternative #1. Based on the Synchro analyses and coordination of traffic signal operations between the intersections, it is expected that the 500-foot separation would be sufficient to provide satisfactory vehicle progression along North Street and acceptable traffic operations at the two intersections.

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Alternative #1 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Eglin Street / North Street	2010	Sig.	-	A	A	A	A	-	-	-	-	C	-	A	A
Eglin Street / North Street	2020	Sig.	-	B	A	A	A	-	-	-	-	C	-	A	A
North Ramp Terminal	2010	Sig.	A	A	-	-	C	A	-	-	-	C	-	A	B
North Ramp Terminal	2020	Sig.	B	A	-	-	C	A	-	-	-	C	-	A	B
South Ramp Terminal	2010	Sig.	-	A	A	A	A	-	C	-	B	-	-	-	A
South Ramp Terminal	2020	Sig.	-	A	A	A	A	-	C	-	B	-	-	-	A

Analyses of the ramp merge / diverge sections for Alternative #1 were performed during Phase I of this evaluation. All of the ramp junctions are projected to operate at LOS C based on projected Year 2020 traffic volumes.

Access Control

An adjustment to existing access that is anticipated to occur with the implementation of Alternative #1 is the extension of Eglin Street to connect with North Street. Though direct access from Dyess Avenue to I-90 would be eliminated, the Dyess Avenue overpass would likely remain in place to provide access to properties located along Dyess Avenue north of the Interstate.

It is also anticipated that Mall Drive will be extended east from its intersection with LaCrosse Avenue to intersect with East North Street. Based on a conversation with Rapid City Planning Staff, the Mall Road intersection with East North Street would be located between 750 feet and 1250 feet north of the right-of-way boundary along the north edge of mainline I-90 at East North Street. In addition, this intersection would likely be signalized. The construction of Alternative #1 would place the signalized north ramp terminal intersection approximately 350 feet north of the north I-90 right-of-way boundary. This would represent a distance of approximately 400 feet between the north ramp terminal intersection and the southernmost possible location of the Mall Drive intersection. Though this distance represents adequate access spacing based on SDDOT standards, it is recommended that with the implementation of Alternative #1, the East North Street / Mall Drive intersection be located as far north as possible within the available right-of-way. This would create a more suitable spacing of approximately 900 feet between adjacent signalized intersections along East North Street, which is considered to be a major arterial roadway. It is recommended that a minimum distance of 600 feet be provided between the north ramp terminal intersection and the East North Street / Mall Drive intersection.

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Right-of-way

As identified in Figure 15, the extension of Eglin Street to North Street south of the interchange would require the acquisition of right-of-way. This acquisition is not expected to impact any existing structures. Right-of-way north of the interchange would also be acquired to accommodate the north diamond ramps. Approximately 15 acres of right-of-way will be needed for this alternative.

Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the standard diamond interchange is estimated at \$8.6 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Alternative #2 – Partial Cloverleaf

As shown in Figure 16, Alternative #2 is a partial cloverleaf with loop ramps on the north side of Interstate 90 and a standard diamond configuration on the south side of Interstate 90.

Geometry

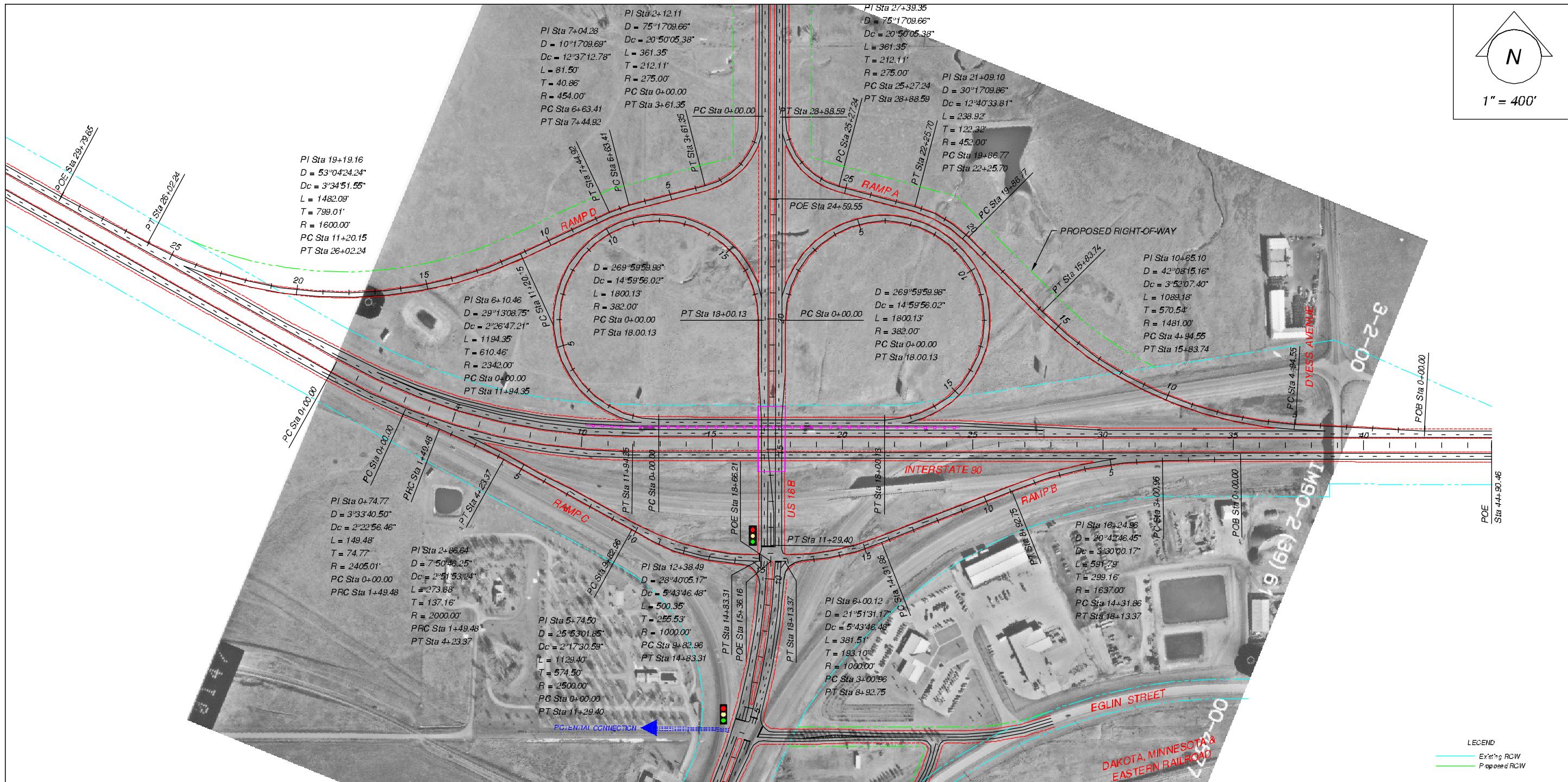
The Partial Cloverleaf north of the interchange is serviced by a collector/distributor (C/D) road along westbound I-90. The loop ramps adjacent to the C/D road have a 35 mph design speed. Both of the loop ramps would be single lane ramps that would use a parallel type taper to merge to and from North Street. The North Street Bridge section over I-90 would consist of four through lanes. The south ramp terminal intersection would be signalized with dual southbound left-turn lanes. The recommended vehicle storage lengths for Alternative #2 are shown below.

Recommended Vehicle Storage Lengths – Alternative #2

Intersection	Movement	Recommended Storage Length
South Ramp Terminal	Dual Southbound Left-Turn	200 feet
	Northbound Right-turn	50 feet
	Dual Eastbound Left-turn	150 feet
	Eastbound Right-turn	150 feet
Eglin Street / North Street	Westbound Left-turn	150 feet
	Westbound Right-turn	50 feet
	Southbound Left-turn	25 feet
	Northbound Right-turn	50 feet

Traffic Safety

Heightened crash rates are often associated with Partial Cloverleaf interchanges similar to the proposed Alternative #2. These incidents often occur within the mainline weave portion of a cloverleaf interchange. In the proposed Alternative, the weaving vehicles would be accommodated by a C/D road configuration, allowing the weaving movements to occur at a lower speed than if the weaving was performed along mainline I-90, enhancing traffic safety. This is likely to make Alternative #2 somewhat safer than a partial cloverleaf interchange with a mainline weaving section.



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Capacity

The capacity of Alternative #2 based on projected Year 2010 and Year 2020 traffic volumes was analyzed using the Synchro software tool. Based on this analysis, the signalized south ramp terminal intersection is projected to operate at LOS A by the Year 2010 and remain at LOS A by the Year 2020. Vehicles traversing the directional cloverleaf ramps north of I-90 would encounter minimal delay. The Eglin Street / North Street intersection is projected to operate at LOS A based on Year 2010 traffic volume projections and LOS B based on projected Year 2020 traffic conditions. The LOS analysis results are summarized below.

Alternative #2 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Eglin Street / North Street	2010	Sig.	-	B	A	A	A	-	-	-	-	C	-	A	A
Eglin Street / North Street	2020	Sig.	-	B	A	A	A	-	-	-	-	C	-	A	B
South Ramp Terminal	2010	Sig.	-	A	A	A	A	-	C	-	B	-	-	-	A
South Ramp Terminal	2020	Sig.	-	A	A	A	A	-	C	-	B	-	-	-	A

Similar to Alternative #1, the ramp merge / diverge sections are projected to operate at LOS C by the Year 2020. The C/D road weaving section is projected to operate at LOS B by the Year 2020. Again similar to Alternative #1, the distance between the Eglin Street intersection and the North Street / South ramp terminal intersection would be approximately 500 feet with the implementation of Alternative #2. Based on the Synchro analyses and coordination of traffic signal operations between the intersections, it is expected that the 500-foot separation would be sufficient to provide satisfactory vehicle progression along North Street and acceptable traffic operations at the two intersections.

Access Control

An adjustment to existing access anticipated to occur with the implementation of Alternative #2 is the extension of Eglin Street to connect with North Street. Though direct access from Dyess Avenue to I-90 would be eliminated, the Dyess Avenue overpass would likely remain in place to provide access to properties located along Dyess Avenue north of the Interstate.

The construction of Alternative #2 would place the north ramp connections with East North Street approximately 750 feet north of the north I-90 right-of-way boundary, equivalent to the southernmost possible location for the Mall Drive intersection, as shown on Figure 16. In order to maximize access spacing north of the intersection, it is recommended that the Mall Drive intersection be located approximately 1050 feet north of the north I-90 right-of-way boundary if Alternative #2 is constructed. This would provide approximately 300 feet of distance between

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the north ramp connections and the Mall Drive intersection with East North Street, considered adequate based on SDDOT standards.

Right-of-way

Right-of-way north of the interchange is largely undeveloped, and this land would need to be acquired to accommodate the interchange loop ramps. Additionally, the extension of Eglin Street to North Street south of the interchange would require the acquisition of right-of-way. This acquisition is not expected to impact any existing structures. Approximately 49 acres of right-of-way would be needed for this alternative.

Construction Costs

A statement of probable construction costs was prepared for the proposed construction of Alternative #2. Construction of the partial cloverleaf interchange is estimated at \$11.1 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Alternative #3 – Single Point Interchange

As shown in Figure 17, Alternative #3 is a single point urban interchange (SPUI). This alternative was formulated during Phase I of the SDDOT Corridor Study. The SPUI interchange concept consolidates all interchange turning movements into a single intersection.

Geometry

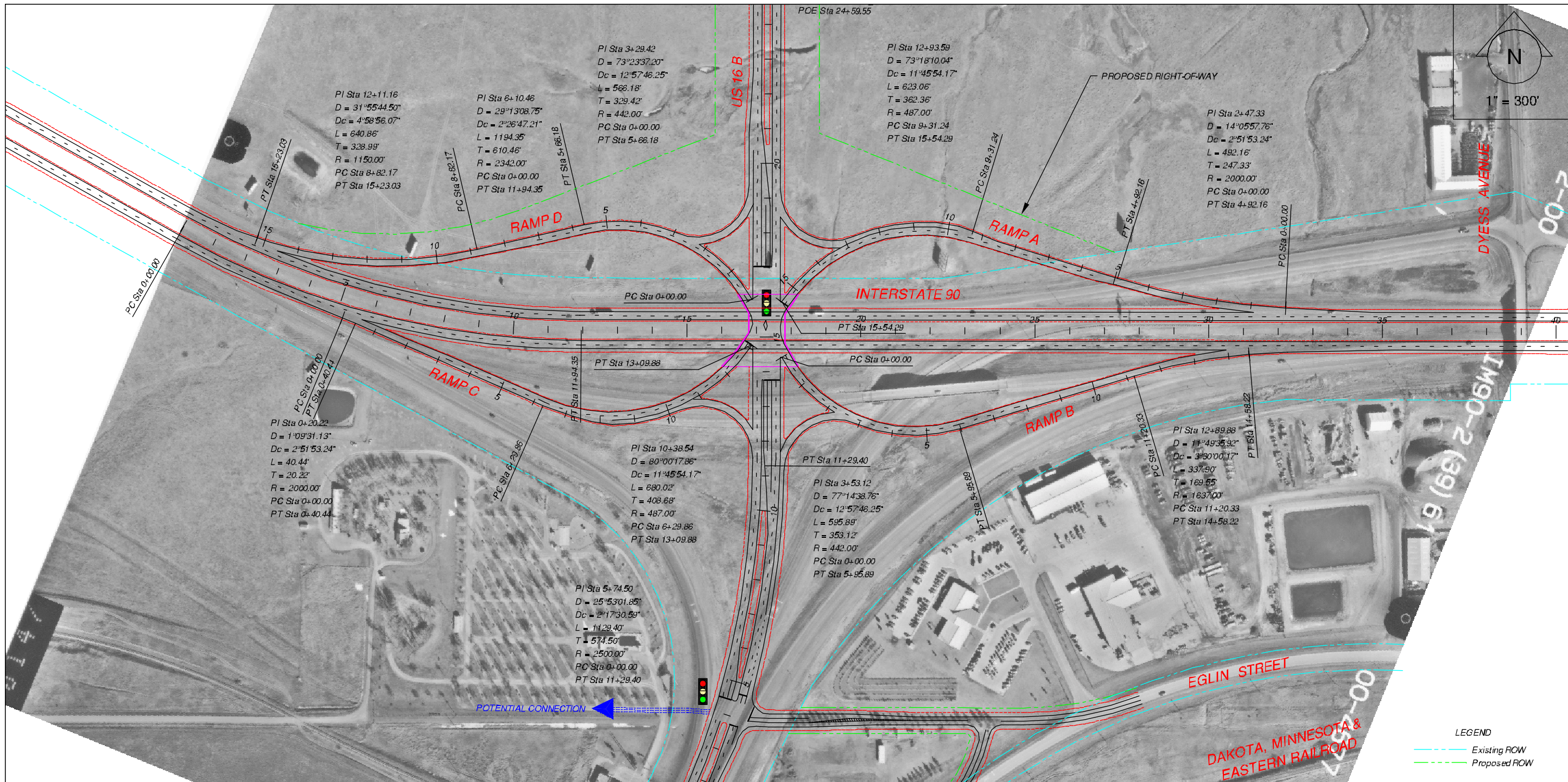
Similar to Alternatives #1 and #2, the SPUI alternative includes the extension of Eglin Street to North Street. As shown on Figure 17, the North Street Bridge section is proposed to consist of 4 through travel lanes and dual northbound and southbound left-turn lanes at the ramp terminal intersection. The interchange ramps are shown as single lane ramps, widened near the intersection to accommodate turning vehicles. The recommended turn lane storage lengths are summarized below.

Recommended Vehicle Storage Lengths – Alternative #3

Intersection	Movement	Recommended Storage Length
Ramp Terminal Intersection	Dual Southbound Left-Turn	250 feet
	Dual Northbound Left-Turn	250 feet
	Dual Eastbound Left-turn	200 feet
	Dual Westbound Left-turn	350 feet
Eglin Street / North Street	Westbound Left-turn	150 feet
	Westbound Right-turn	50 feet
	Southbound Left-turn	50 feet
	Northbound Right-turn	50 feet

Traffic Safety

The installation of a SPUI at Exit 60 would represent a departure from the typical I-90 interchange. Initial unfamiliarity with the interchange configuration may cause increased



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accident rates at the interchange. However, as drivers become more familiar with the layout, traffic safety would likely improve.

Capacity

The capacity of Alternative #3 in conjunction with the Eglin Street / North Street intersection was analyzed using the Synchro software tool. The intersection LOS results are summarized in the following table. As shown, both intersections are projected to operate at acceptable levels of service by the Year 2020.

Alternative #3 - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Eglin Street / North Street	2010	Sig.	-	B	A	A	A	-	-	-	-	B	-	A	A
Eglin Street / North Street	2020	Sig.	-	B	A	A	A	-	-	-	-	B	-	A	B
Ramp Terminal	2010	Sig.	D	C	A	D	C	A	D	-	A	D	-	A	C
Ramp Terminal	2020	Sig.	D	D	A	D	C	A	D	-	A	D	-	A	C

Access Control

The only adjustment to existing access anticipated to occur with the implementation of Alternative #3 is the extension of Eglin Street to connect with North Street. Though direct access from Dyess Avenue to I-90 would be eliminated, the Dyess Avenue overpass would likely remain in place to provide access to properties located along Dyess Avenue north of the Interstate.

As shown on Figure 17, the construction of Alternative #3 would place the signalized SPUI ramp terminal intersection directly at the north I-90 right-of-way boundary. This would represent a distance of approximately 750 feet between the north ramp terminal intersection and the southernmost possible location of the Mall Drive intersection.

Though a distance of 750 feet represents adequate access spacing based on SDDOT standards, it is recommended that with the implementation of Alternative #1, the East North Street / Mall Drive intersection be located as far north as possible within the available right-of-way. This would create a more suitable spacing of approximately 1250 feet between the adjacent signalized intersections along East North Street, which is considered to be a major arterial roadway. It is recommended that a minimum distance of 600 feet be provided between the single-point intersection and the East North Street / Mall Drive intersection.

Right-of-way

The extension of Eglin Street to North Street south of the interchange would require the acquisition of right-of-way. This acquisition is not expected to impact any existing structures.

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Right-of-way north of the interchange would be acquired to accommodate the north SPUI ramps. Approximately 15 acres of right-of-way would be needed for this alternative.

Construction Costs

A statement of probable construction costs was prepared for the proposed construction of Alternative #3. Construction of the SPUI is estimated at \$9.5 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate does not include costs associated with right-of-way.

Summary of Alternatives

Analysis of the geometry, capacity, and safety characteristics of the existing Exit 60 interchange has been performed. The analyses revealed particular deficiencies in the traffic safety category. Also, a north connection to the interchange has been recommended in previous studies. To remedy traffic safety deficiencies and provide access to the north, three interchange alternatives have been formulated.

Alternative #1, a Standard Diamond interchange, is depicted on Figure 15. This configuration was designed based on guidelines contained in the SDDOT Roadway Design Manual. Traffic signals would be installed at the ramp terminal intersections along with dual northbound and southbound left-turn lanes. The north ramp terminal intersection is projected to operate at LOS B by the Year 2020, while the south ramp terminal intersection is projected to operate at LOS A. The Eglin Street connection to North Street is projected to operate at LOS A by the Year 2020. A spacing between signalized intersections of approximately 900 feet could be achieved north of the interchange with the implementation of Alternative #1. The construction of this alternative would require the acquisition of several properties adjacent to the interchange. The probable construction cost of this alternative is \$8.6 million excluding right-of-way expenses.

Alternative #2, a Partial Cloverleaf interchange is shown on Figure 16. It is configured as a diamond interchange south of mainline I-90, while a partial cloverleaf interchange serves traffic north of the interchange. The south ramp terminal intersection is projected to operate at LOS A by the Year 2020, while the Eglin Street / North Street intersection is projected to operate at LOS B. Vehicles traversing the directional cloverleaf ramps north of I-90 would encounter minimal delay. The construction of Alternative #2 would have more right-of-way (ROW) impacts than Alternative #1 and #3. The probable construction cost of Alternative #2 is \$11.1 million excluding right-of-way expenses.

Alternative #3, shown on Figure 17, proposes the installation of a Single-Point Urban Interchange (SPUI). Analysis shows that traffic operations at the SPUI would be at LOS C by the Year 2020. Similar to Alternatives #1 and #2, the Eglin Street / North Street intersection is projected to operate at LOS A by the Year 2020. A spacing between signalized intersections of approximately 1250 feet could be achieved north of the interchange with the implementation of Alternative #3. Probable construction costs for Alternative #3 are \$9.5 million excluding right-of-way expenses.

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I-90: Exit 61 – Elk Vale Road, Rapid City

Based on the Phase I investigation, the existing Exit 61 interchange configuration could accommodate the Year 2010 and Year 2020 traffic volume projections with the addition of traffic signals and left-turn lanes at the ramp terminal intersections. The Elk Vale Road bridge currently does not have enough width for left turn lanes to be developed. The other geometric deficiencies that were discovered could be corrected when the existing pavement requires replacement. The previous accident history did not support safety improvements for the interchange.



This interchange would be the northern terminus of the Heartland Expressway when this regional roadway concept is implemented. At that time, the goal for more free-flow traffic patterns may justify reconfiguration of the interchange. In this subsequent Phase II investigation, a partial cloverleaf interchange was evaluated that contained two directional loop ramps on the north side of Interstate 90. This alternative represents a potential ultimate configuration for the Exit 61 interchange.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. The section of Elk Vale Road consists of one through lane in each direction with no left turn lanes. Several geometric deficiencies for the existing interchange were discovered. Crest k values, which relate to stopping sight distance, are substandard on Ramp A. The taper rate for the on ramp to westbound Interstate 90 was also found to be inadequate. The superelevation rates for ramps A and C also exceed the maximum that was established for this study. Elk Vale Road exhibits flat vertical grades across the interchange. The distance from the ramp terminal intersections to the adjacent frontage road intersections on Elk Vale Road is also below standards.

Traffic Safety

This interchange ranks 29th of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is not considered one of the high accident locations. The majority of the crashes that occurred at this location were classified as Property Damage Only (PDO) accidents.

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Capacity

Projected traffic volumes at this interchange would not be accommodated by the current interchange configuration. As shown in the table, both ramp terminals are projected to operate at Level of Service (LOS) F by the Year 2020 if no improvements are made.

Level of Service results – existing interchange configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
WB Diverge	C	B	B	C	Acceptable
WB Merge	C	B	B	C	Acceptable
EB Diverge	C	B	C	C	Acceptable
EB Merge	C	B	B	C	Acceptable
North Intersection	D	C	F	F	Unacceptable
South Intersection	D	C	F	F	Unacceptable

Short-Term Improvements

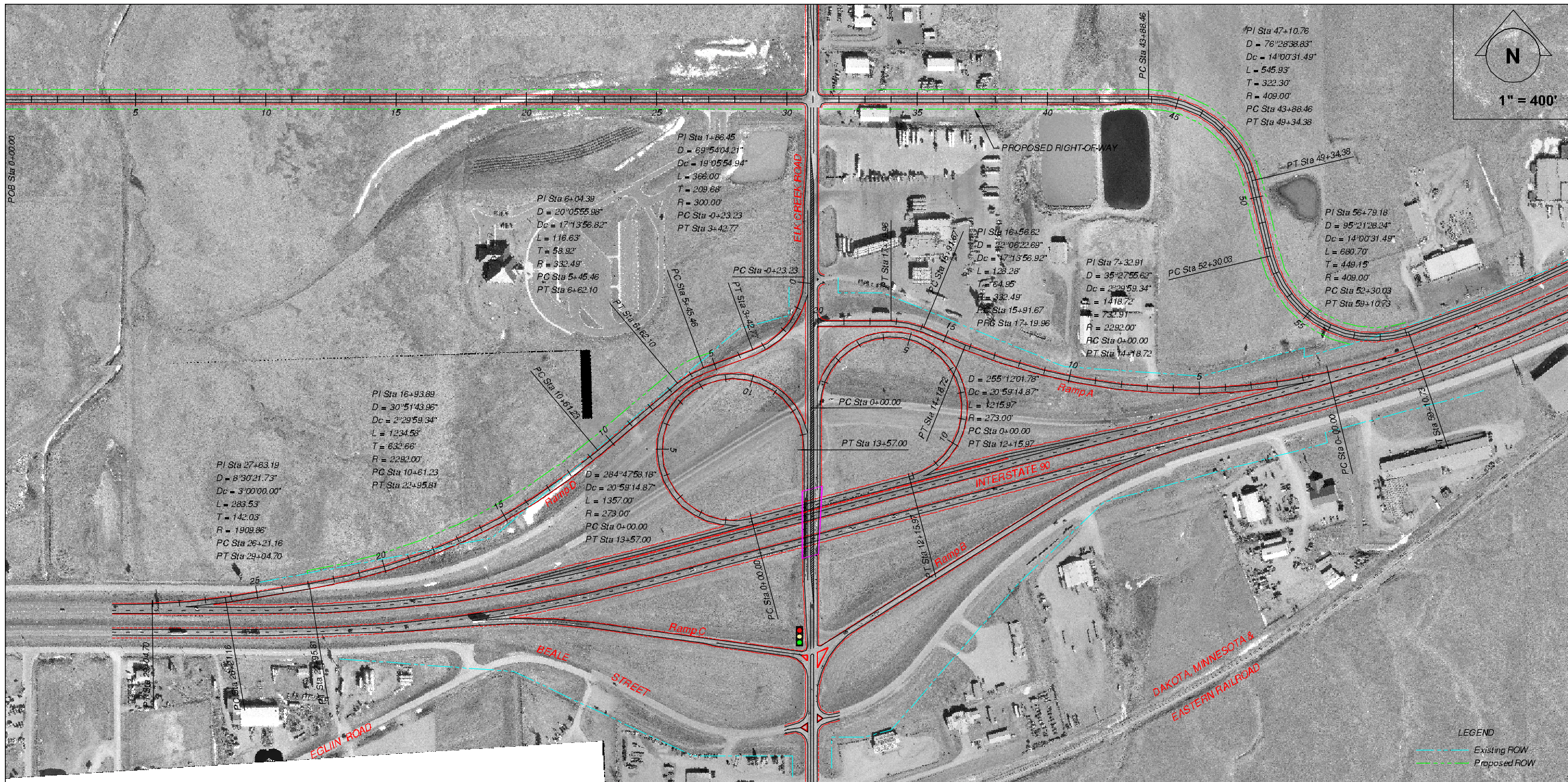
The Exit 61 interchange is currently configured as a diamond interchange with unsignalized ramp terminal intersections. As shown above, both ramp terminal intersections are expected to operate at LOS F in the future as unsignalized intersections. With the installation of traffic signals and left and right-turn auxiliary lanes at the ramp terminal intersections, both are projected to operate at LOS C by the Year 2020. The installation of auxiliary lanes would require widening of the cross street roadway and bridge. This widening would improve existing sight distance conditions at the north ramp terminal intersection.

Potential Ultimate Improvement

The South Dakota Department of Transportation and the City of Rapid City have formulated a concept for ultimate improvements to the Exit 61 interchange. The concept, shown on Figure 18, is a Partial Cloverleaf interchange with a diamond configuration south of Interstate 90 and a loop/directional ramp configuration north of Interstate 90. The existing south ramp terminal intersection would remain at its current location and would be signalized to accommodate anticipated growth in traffic volumes. The characteristics of the Partial Cloverleaf interchange are summarized in the text below.

Geometry

The proposed Partial Cloverleaf alternative would widen the existing Elk Vale Road bridge to accommodate two through lanes and auxiliary lanes for the loop ramps. In order to minimize impacts to the existing developments adjacent to the interchange, the proposed loop ramps were designed to a 30-mph design speed, which correlates to a 273-foot radius and 6% superelevation. The existing frontage road south of the interchange would maintain its current



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alignment. To accommodate the space needed for the loop ramps, the existing frontage road north of the interchange would need to be realigned farther to the north. The new intersection of the north frontage road with Elk Vale Road would align with the Mall Road extension. To minimize the speed difference for the traffic using the loop ramps, a collector/distributor (C/D) road is proposed to facilitate traffic to and from Interstate 90. The recommended turn lane storage lengths are summarized in the table below.

Recommended turn lane storage lengths – Exit 61 Partial Cloverleaf

Intersection	Movement	Recommended Storage Length
South Ramp Terminal	Southbound Left-Turn	200 feet
	Eastbound Right-Turn	300 feet
	Eastbound Left-Turn	275 feet

Traffic Safety

Heightened crash rates are often associated with Partial Cloverleaf interchanges similar to this proposed Partial Cloverleaf interchange. These incidents often occur within the mainline weave portion of a cloverleaf interchange. In the proposed alternative, the weaving vehicles would be accommodated by a C/D road configuration. The C/D road would allow the weaving movements to occur at a lower speed than if the weaving was performed on the mainline of Interstate 90. This is likely to make the proposed Exit 60 Partial Cloverleaf interchange somewhat safer than a partial cloverleaf interchange with a mainline weaving section.

Capacity

The capacity of the proposed Partial Cloverleaf interchange was evaluated based on projected Year 2010 and Year 2020 traffic volumes. Based on these analyses, the signalized south ramp terminal intersection is projected to operate at LOS B by the Year 2010 and at LOS C by the Year 2020. The C/D road weaving section is projected to operate at LOS A based on projected Year 2010 and Year 2020 traffic volumes. Vehicles traversing the directional and cloverleaf ramps north of I-90 would encounter minimal delay. The LOS analysis results are summarized below. The ramp merge/diverge sections are projected to operate at LOS C by the Year 2020.

Partial Cloverleaf - Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
South Ramp Terminal	2010	Sig.	-	B	A	B	B	-	B	-	C	-	-	-	B
South Ramp Terminal	2020	Sig.	-	B	A	D	B	-	C	-	D	-	-	-	C

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Access Issues

The implementation of the proposed Partial Cloverleaf interchange would present several vehicular access issues. Due to the size of the proposed loop ramp in the northeast quadrant of the interchange, the westbound off-ramp alignment would be shifted from its current location to the approximate existing north frontage road alignment. Several properties currently access this existing north frontage road, and these accesses would be closed or realigned to the proposed frontage road. The gas station on the northeast side of the interchange currently has an access directly north of the existing frontage road. When the westbound off ramp to northbound Elk Vale Road is constructed, the access will be in very close proximity to the ramp. Therefore, closure of this access may be required. However, as shown on Figure 18, constructing the intersection of Ramp A with Elk Vale Road as a 90-degree STOP sign controlled intersection may allow this access to remain open as a right-in / right-out access. Another possibility is the provision of a full-movement gas station access along Elk Vale Road farther north.

Right-of-way

As identified on Figure 18, right-of-way on the north side of Interstate 90 would be required to accommodate the proposed partial cloverleaf interchange and realigned frontage roads. Approximately 6.4 acres of right-of-way would be needed for the alternative.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of this alternative. Construction of the partial cloverleaf is estimated at \$8 million. A breakdown of the quantities and construction costs is included in the Appendix. It should be noted that right-of-way costs are not included in the probable construction costs.

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Mount Rushmore Road Connection

The feasibility of realigning Interstate 190 at Omaha Street to provide a direct connection to Mount Rushmore Road (US 16) was preliminarily evaluated in this Phase II Investigation. A potential conceptual alignment for the direct connection is shown on Figure 19. A larger radius of 819 feet was used for the north horizontal curve and a radius of 573 feet was used for the south horizontal curve near Omaha Street. The north radius would achieve a design speed of 45 mph, which is essential due to the higher speeds of Interstate 190 to the north, while the south radius would achieve a design speed of 40 mph, which is acceptable for vehicles approaching a signalized intersection. It is anticipated that traffic signals would be required at the intersection of Interstate 190 and the realigned North Mount Rushmore Road and at the intersection of Interstate 190 and Omaha Street. There would be approximately 500 feet of distance between the two intersections. The existing sections of North Mount Rushmore Road and Interstate 190 could be removed.

Access from parallel ramps serving North Street is provided to Interstate 190 just north of the existing structure for Rapid Creek. Ramps may need to be closed at the highway and rerouted to North Street and North Mount Rushmore Road. Two new structures would be required over Rapid Creek for the proposed alignment. The structure needed for Interstate 190 would be at a skew to Rapid Creek causing a longer structure and possibly more impacts to the floodplain of Rapid Creek. The radii discussed above were used to minimize the impacts to the existing linear park that has been developed through the heart of the City. The trail system for the park and access to the tennis courts would need to be realigned approximately where the North Mount Rushmore Road and Interstate 190 intersection is proposed to be located.

Because of the significant impacts of the I-190 realignment as shown, the SDDOT is not pursuing this connection at this time.

