South Dakota Department of Transportation

Interstate Corridor Study

Phase II Report

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SDDOT Interstate Corridor Study - Phase II

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SDDOT Interstate Corridor Study - Phase II

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.

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	12th 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	26th 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.

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.

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 is 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.

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.

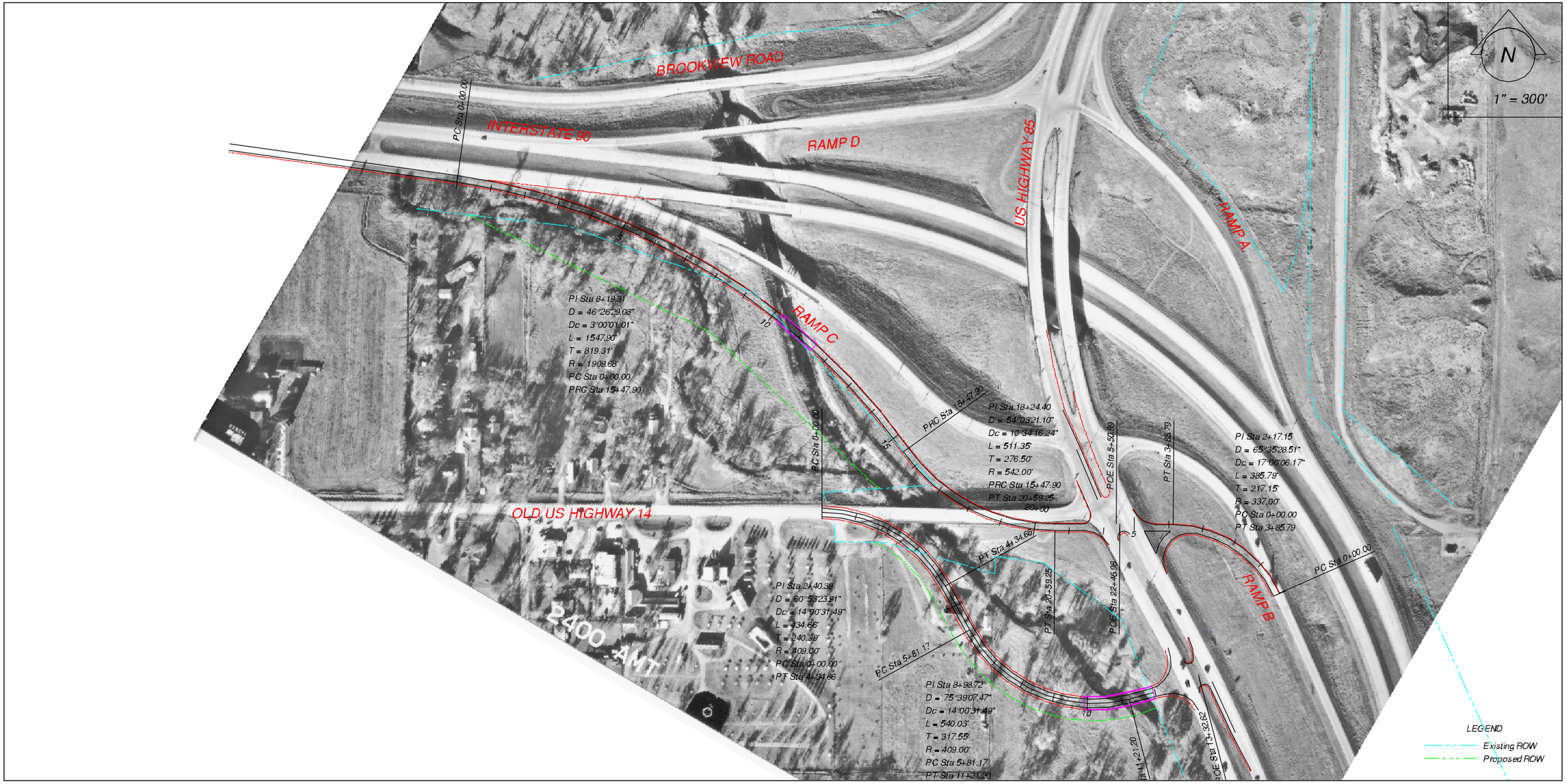

Figure 1
I-90 Exit 10
US 85 North, Spearfish
Alternative 1
Realign South Ramps/Realign Old US Highway 14

KIRKHAM MICHAEL
CONSULTING ENGINEERS

FELSBURG HOLT & ULLEVIG

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.

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 is 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.

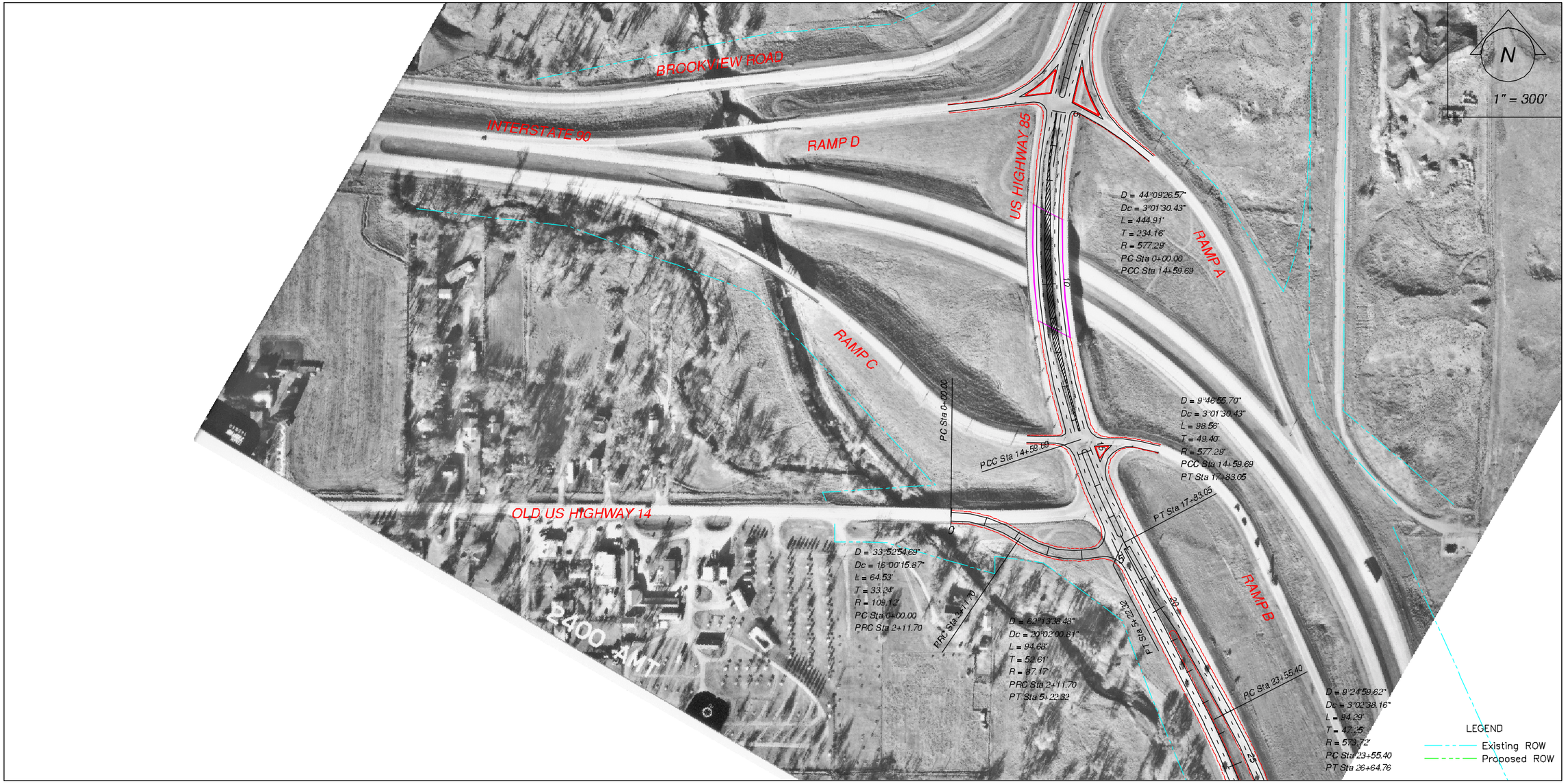

Figure 2
I-90 Exit 10
US 85 North, Spearfish
Alternative 2a
Replace Interstate 90 Structure/Realign Old US Highway 14

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CONSULTING ENGINEERS

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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.

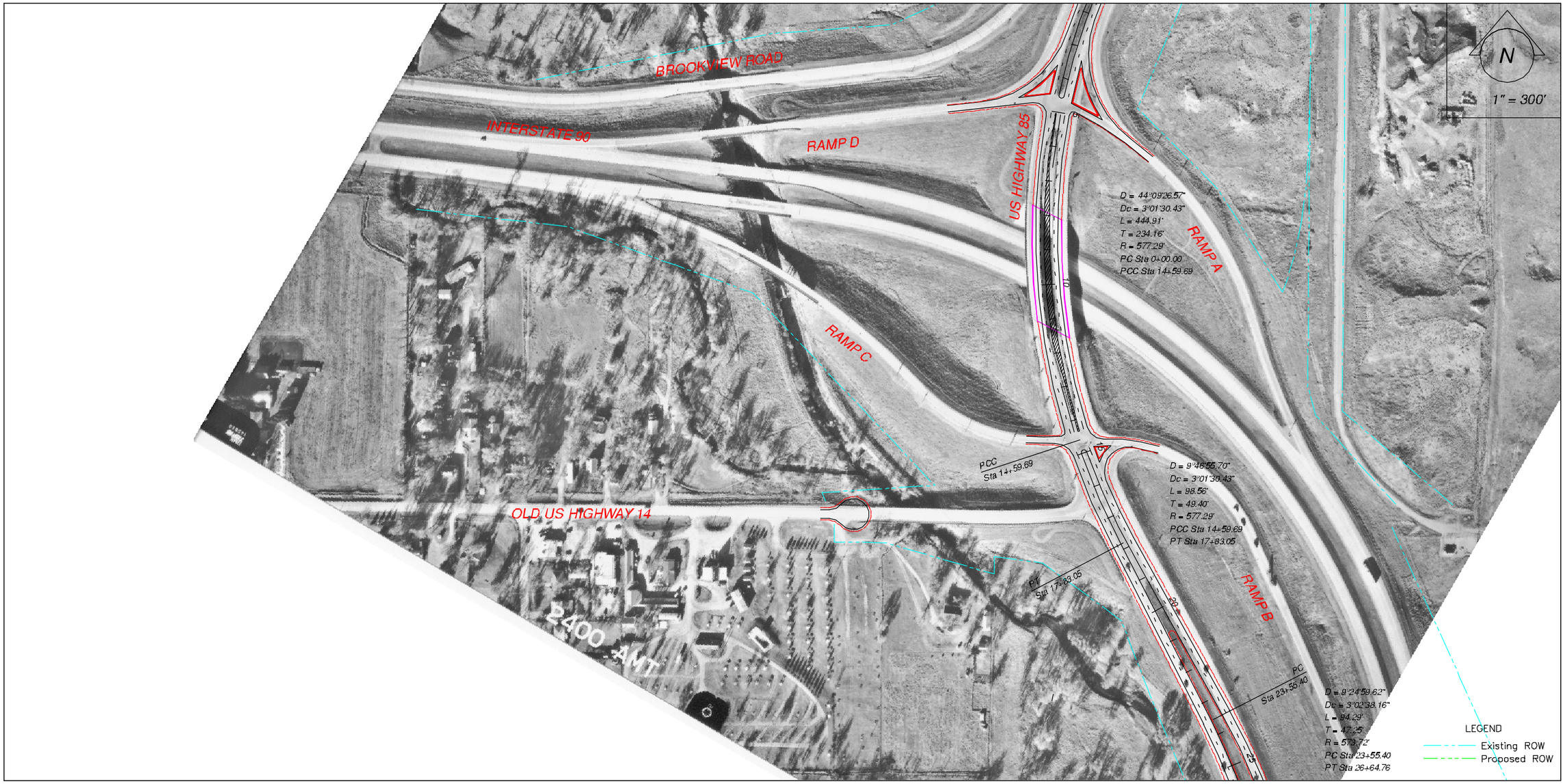
Right-of-way

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

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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CONSULTING ENGINEERS

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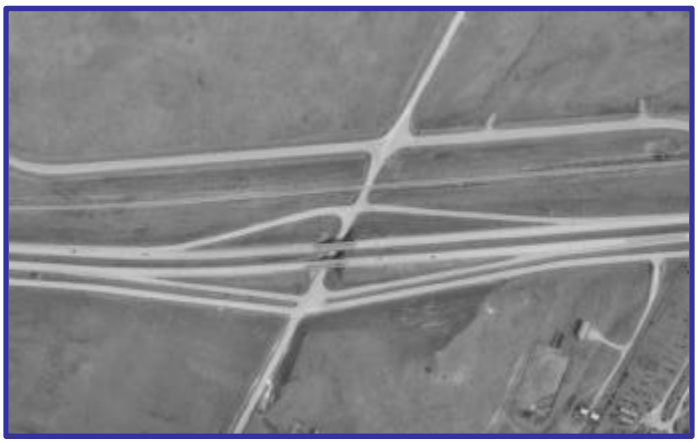
Figure 3
I-90 Exit 10
US 85 North, Spearfish
Alternative 2b
Replace Interstate 90 Structure/Cul-de-sac Old US Highway 14

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

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.

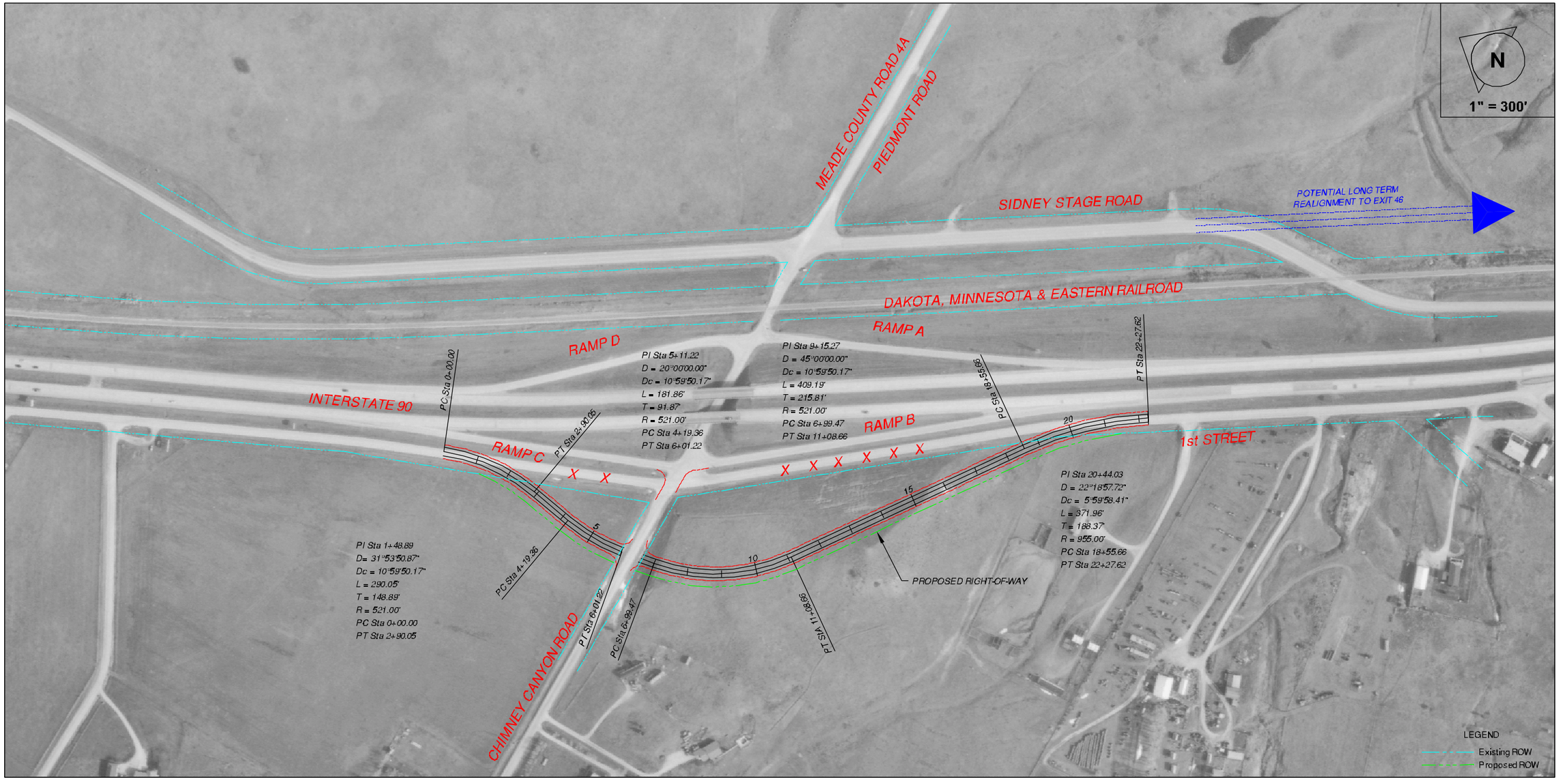


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Figure 4
I-90 Exit 44
Bethlehem Road, Piedmont
Realign Frontage Road

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.

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

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.

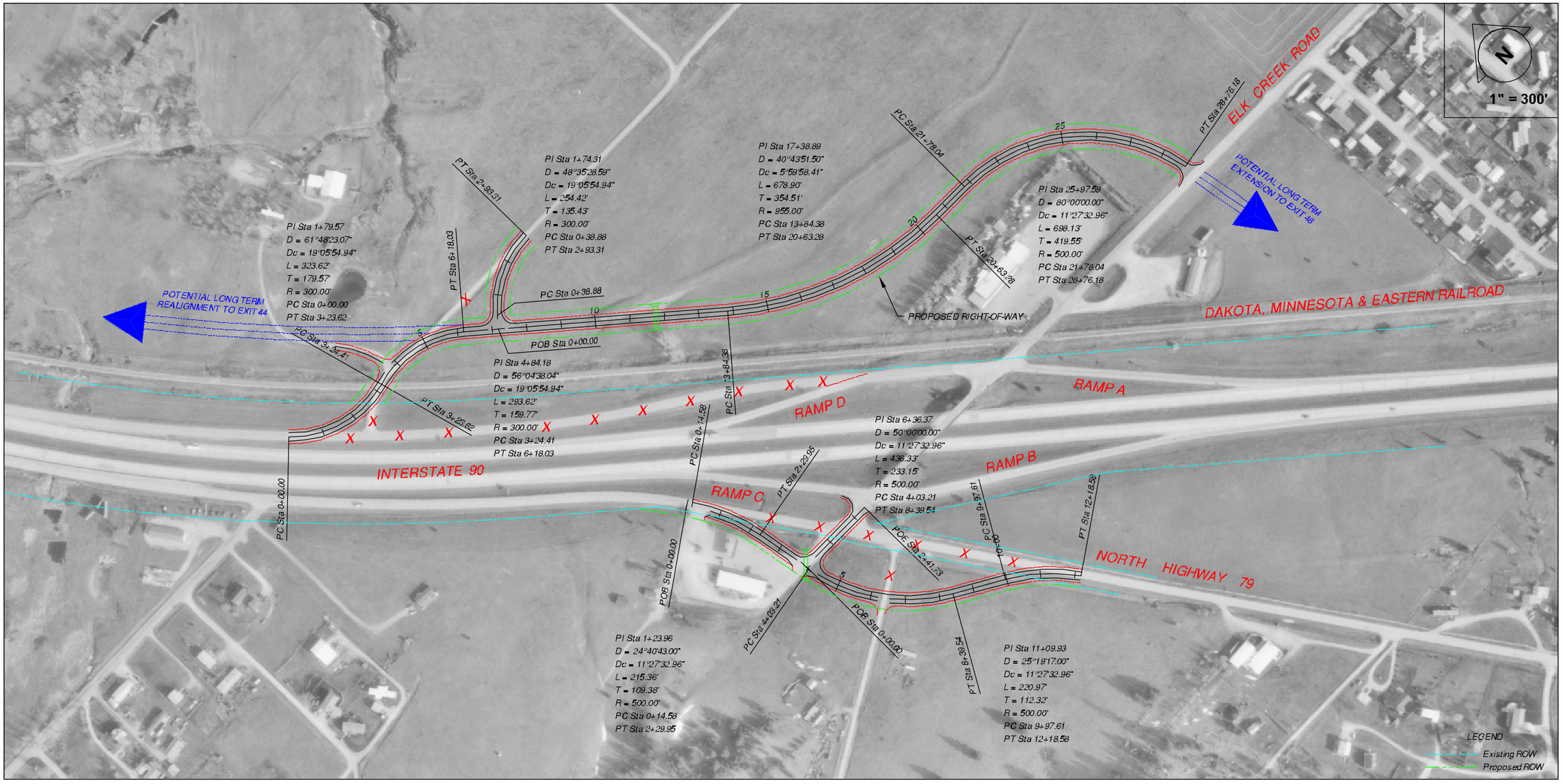

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Figure 5
I-90 Exit 46
Elk Creek Road, Piedmont
Realign Frontage Roads

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.

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.

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.

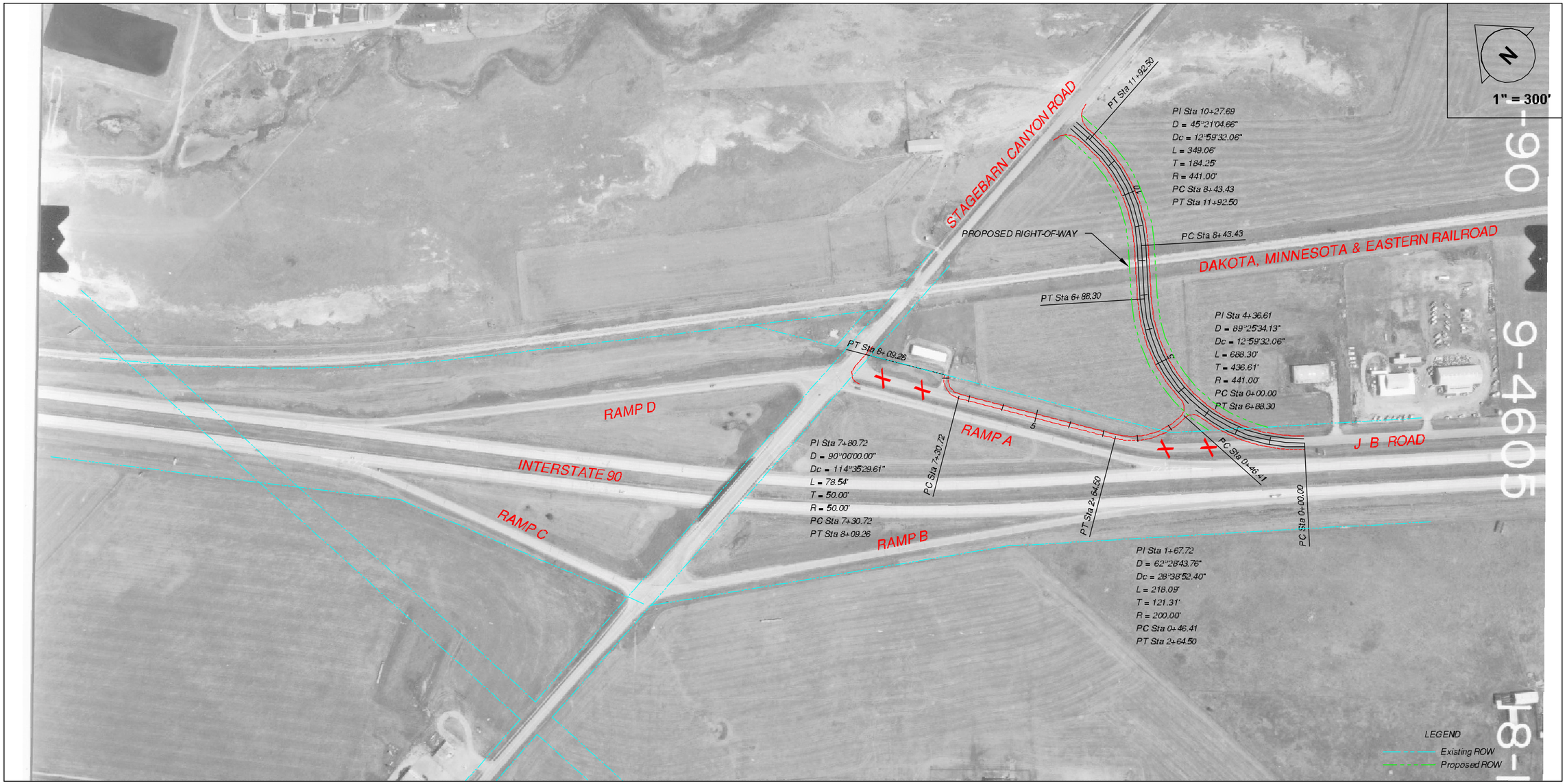

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Figure 6
I-90 Exit 48
Stagebarn Canyon, Piedmont
Short-Term Improvements

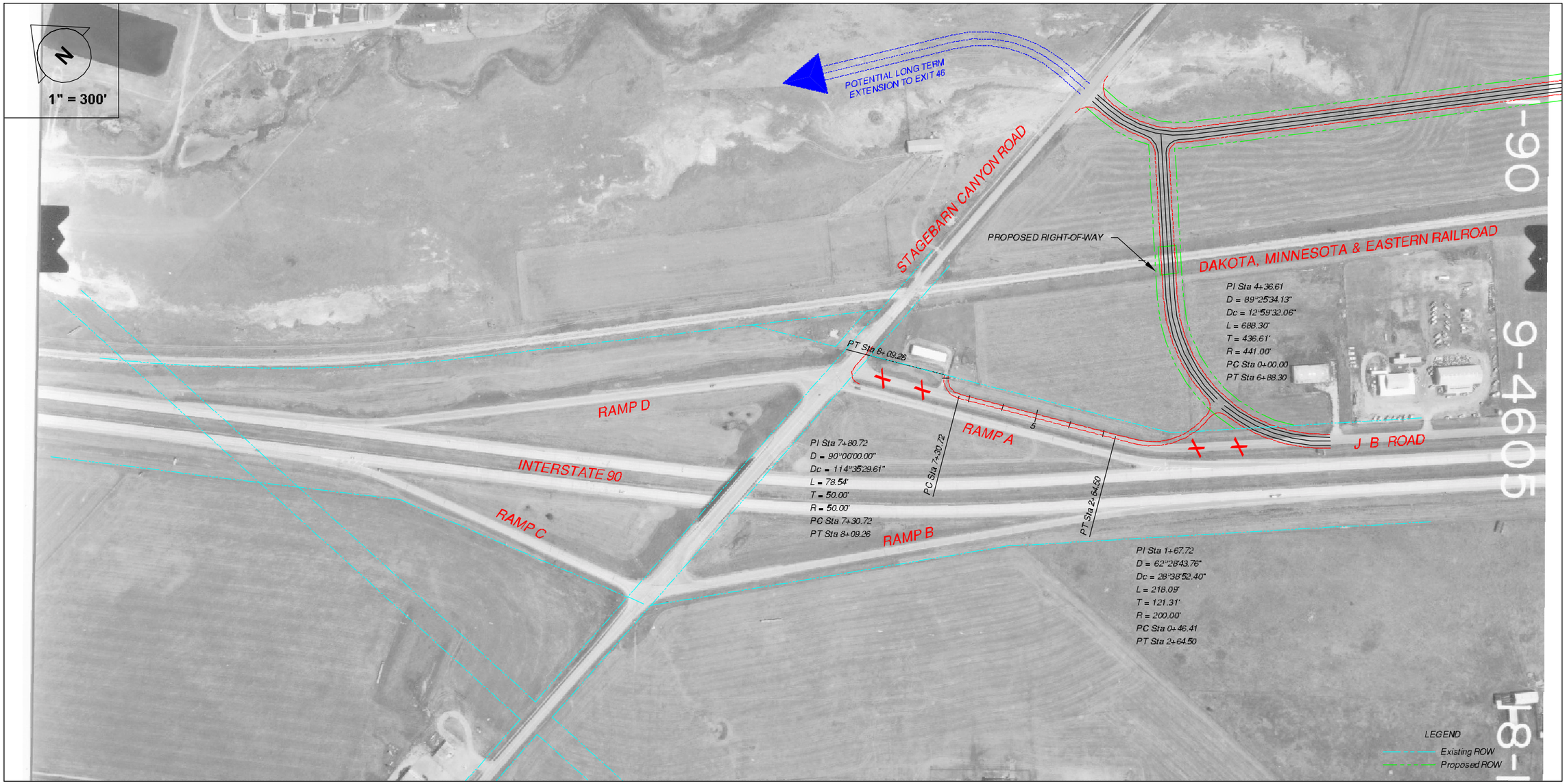

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Figure 7
I-90 Exit 48
Stagebarn Canyon, Piedmont
Long-Term Improvements

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.

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

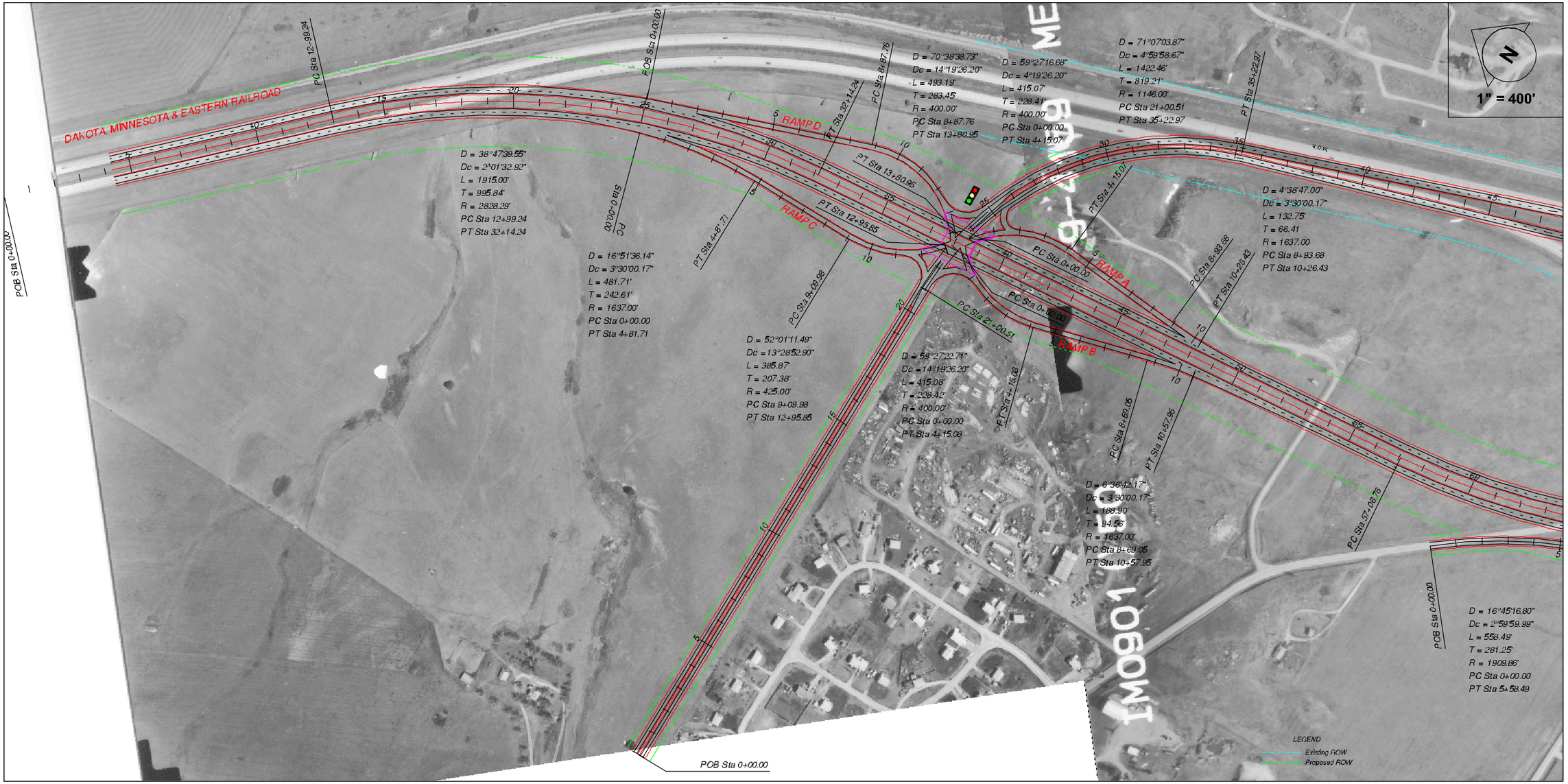

Figure 8
I-90 Exit 51
Black Hawk Road, Black Hawk
Alternative 1
Single Point Interchange

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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 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.

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 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.

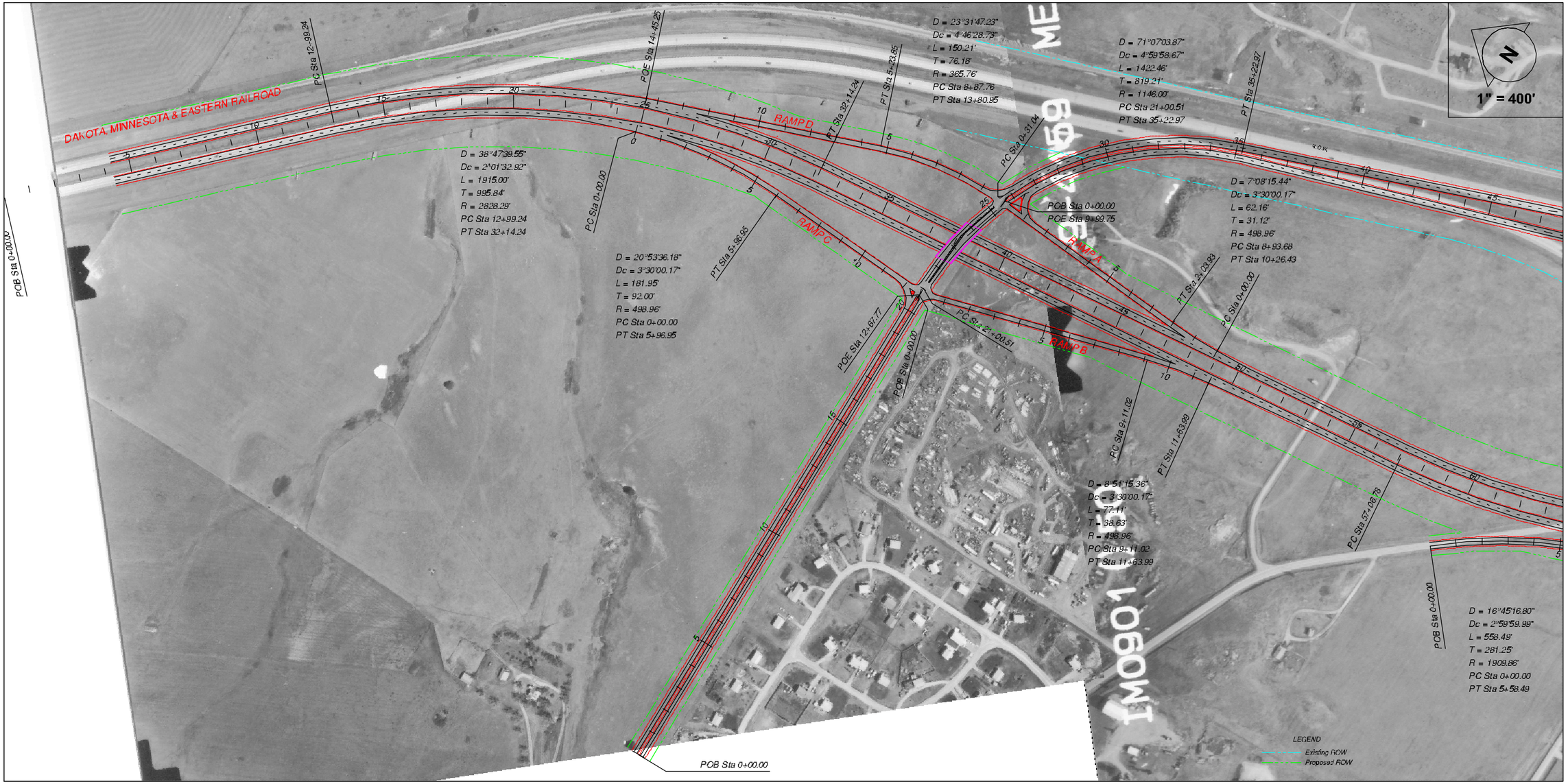

Figure 9
I-90 Exit 51
Black Hawk Road, Black Hawk
Alternative 2
Diamond Interchange

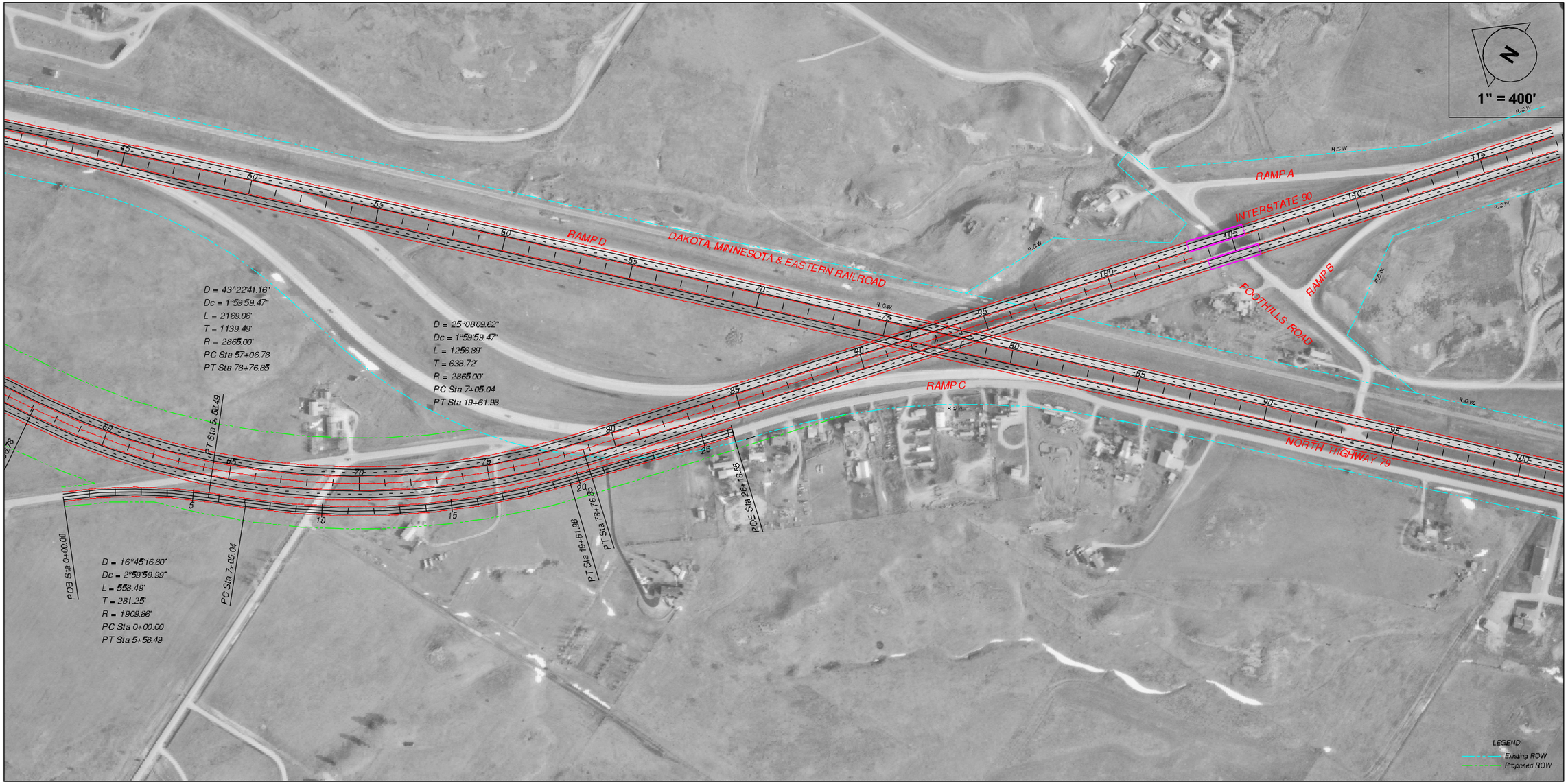

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Figure 10
I-90 Exit 51
Black Hawk Road, Black Hawk
Alternatives 1 and 2
Single Point/Diamond Interchange

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.

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.

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.

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.

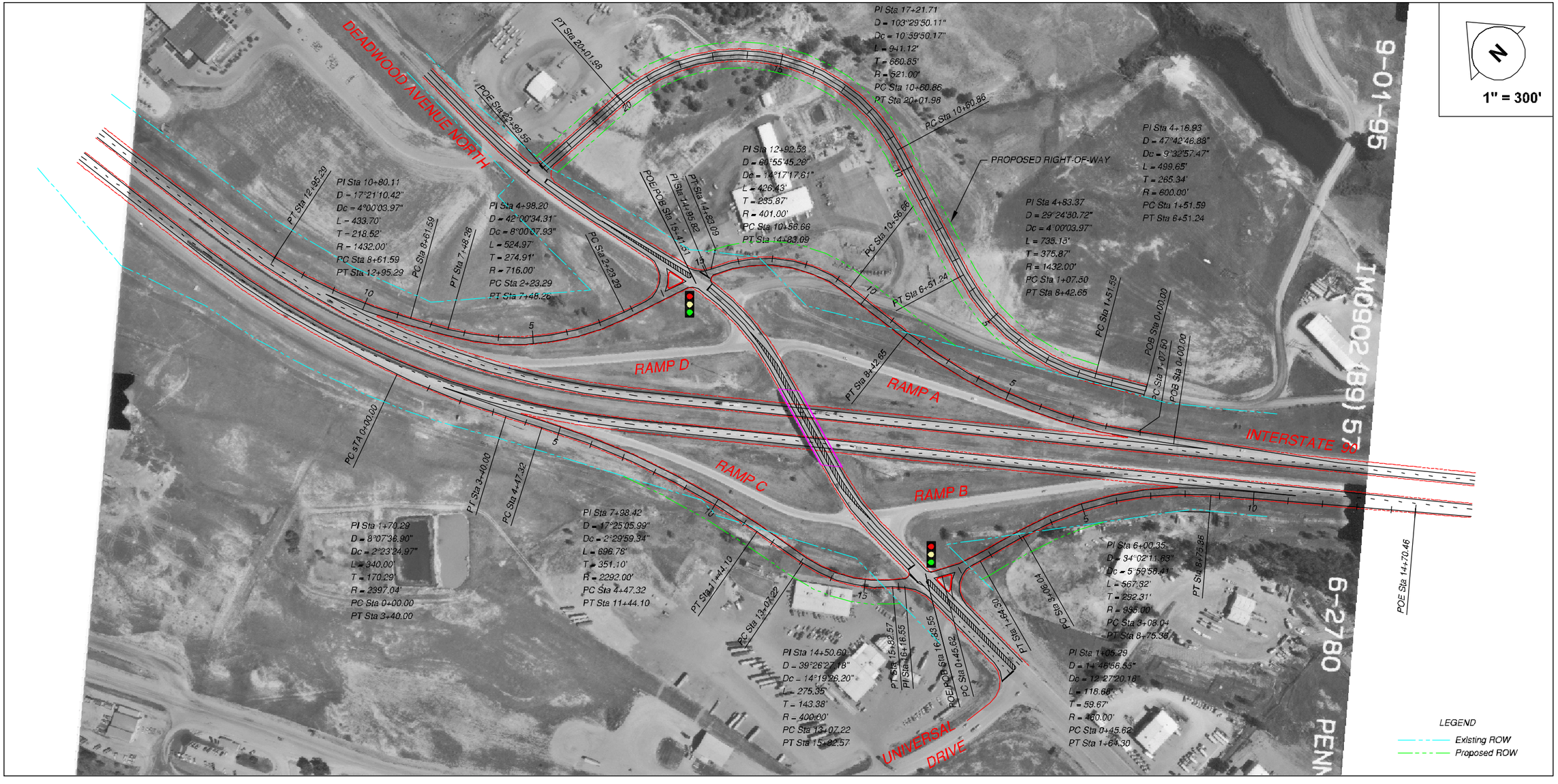

Figure 11
I-90 Exit 55
Deadwood Avenue, Rapid City
Alternative 1
Diamond Interchange

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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.

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.

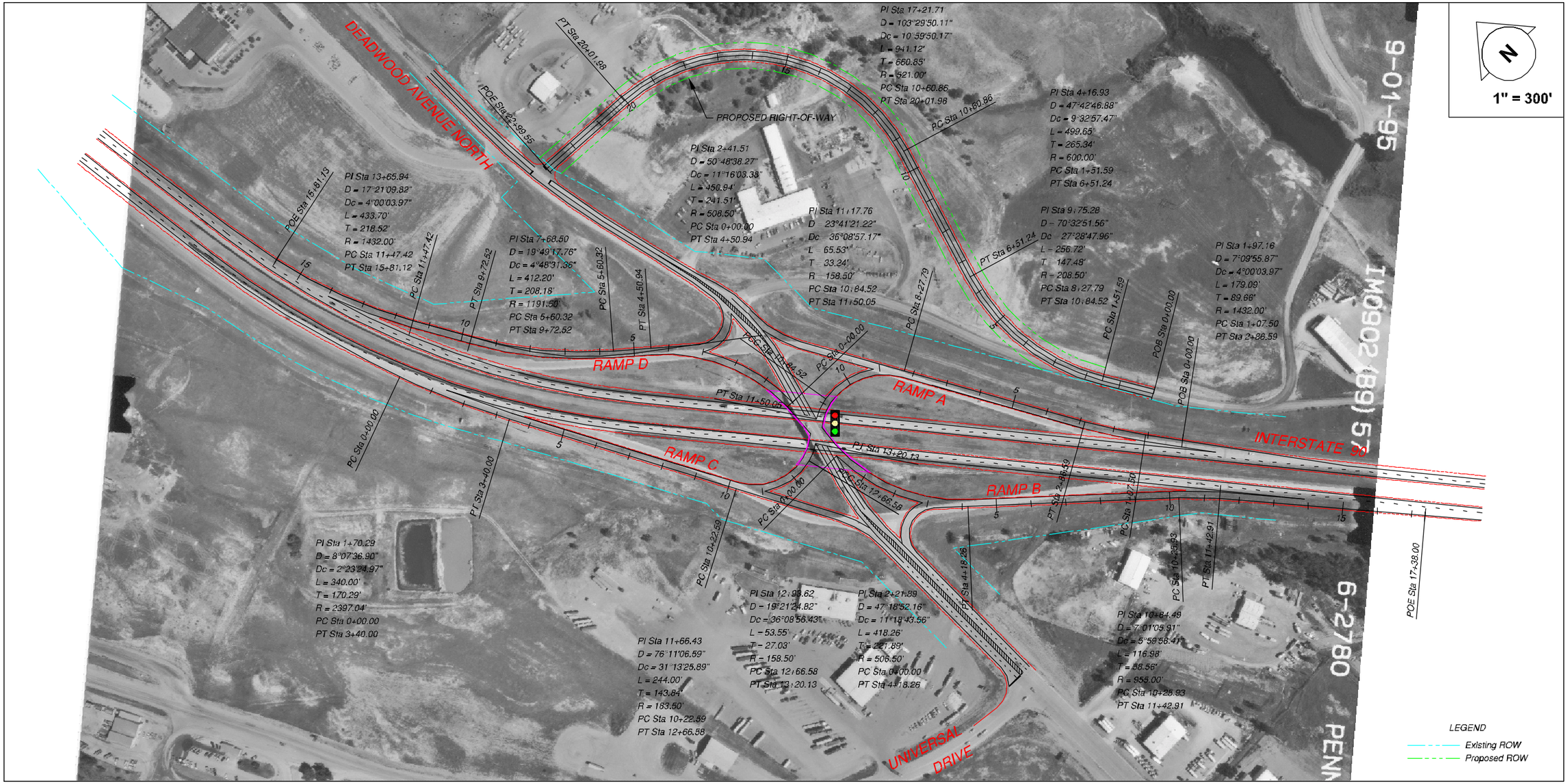

Figure 12
I-90 Exit 55
Deadwood Avenue, Rapid City
Alternative 2
Single Point Urban Interchange

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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.

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.

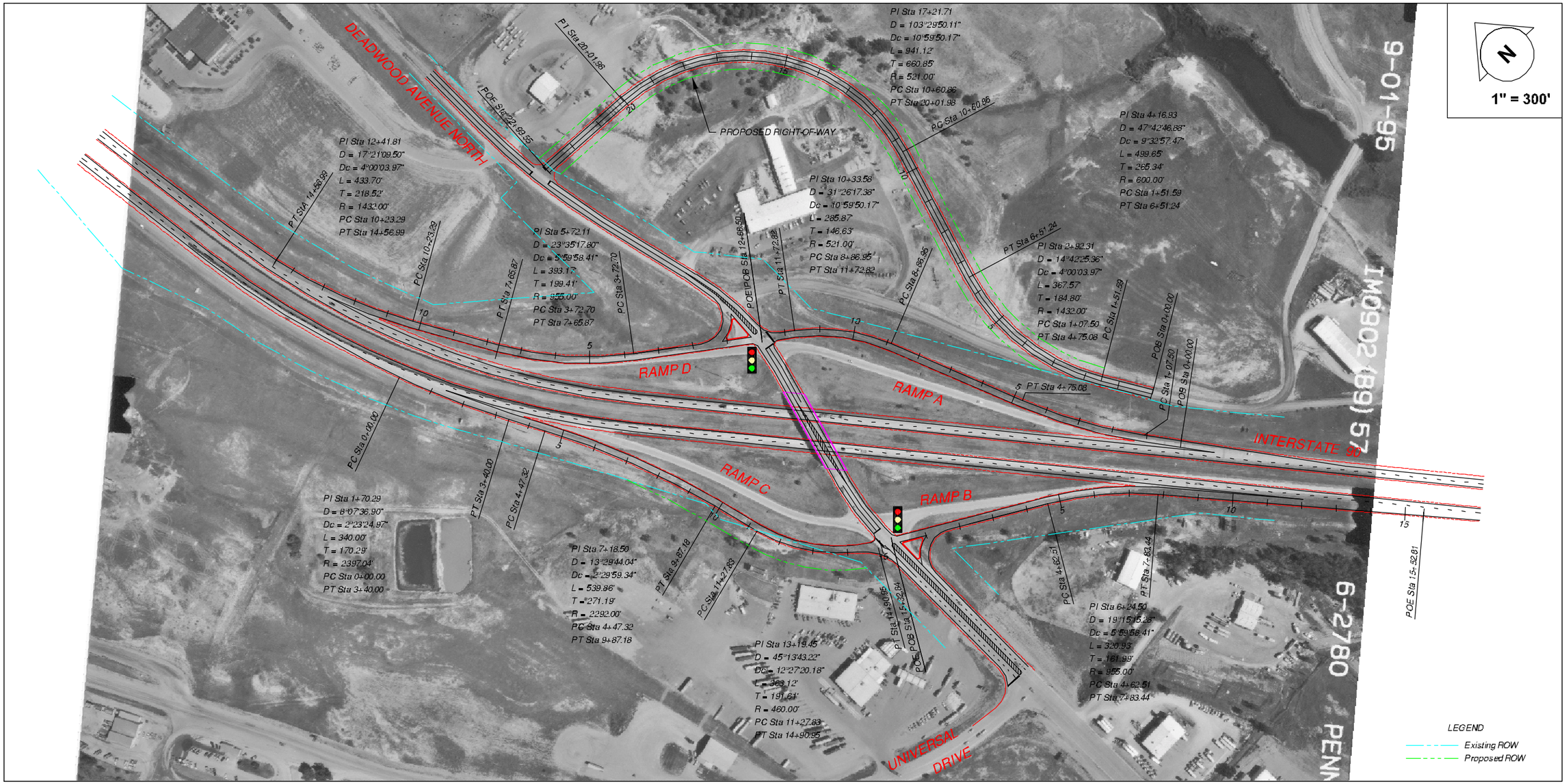

Figure 13
I-90 Exit 55
Deadwood Avenue, Rapid City
Alternative 3
Tight Diamond Interchange

KIRKHAM MICHAEL
CONSULTING ENGINEERS

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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.

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.

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

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

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.

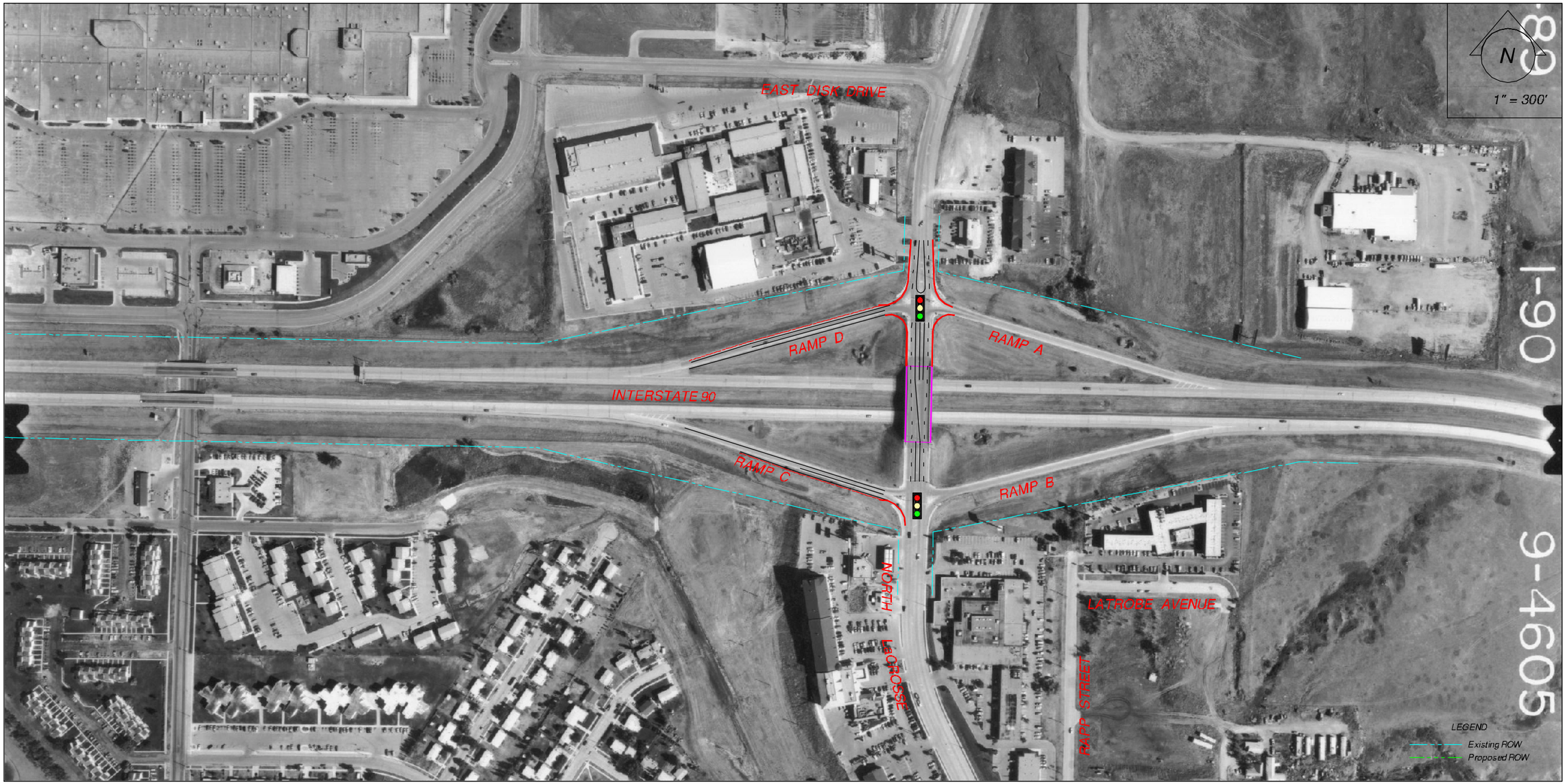

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Figure 14
I-90 Exit 59
LaCrosse Street, Rapid City
Replace Interstate 90 Structure

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.

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 consists 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.

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.

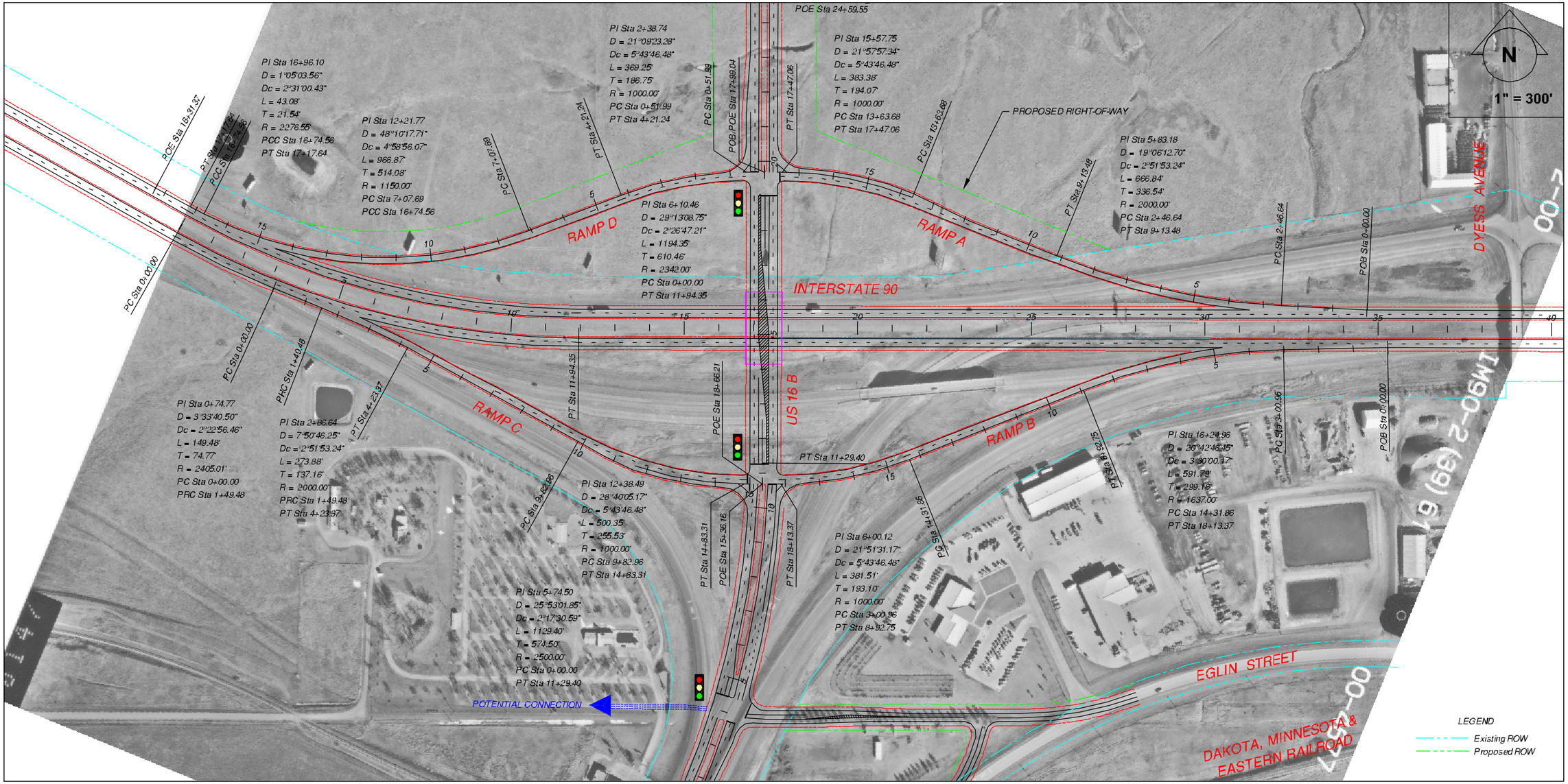

Figure 15
I-90 Exit 60
E. North Street, Rapid City
Alternative 1
Diamond Interchange

KIRKHAM MICHAEL CONSULTING ENGINEERS

FELSBURG HOLT & ULLEVIG

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.

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.

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.

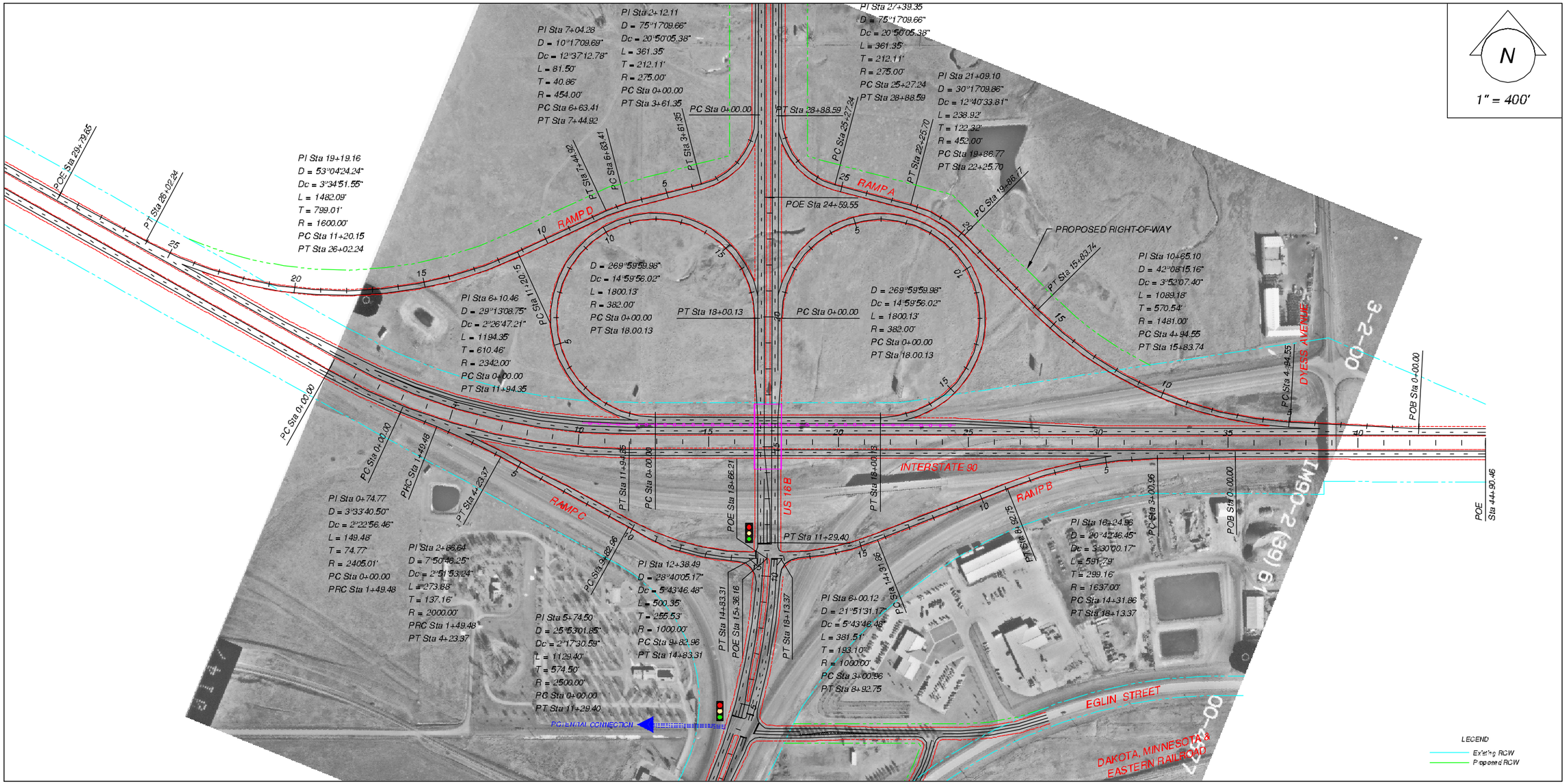

Figure 16
I-90 Exit 60
E. North Street, Rapid City
Alternative 2
Partial Cloverleaf Interchange

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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

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

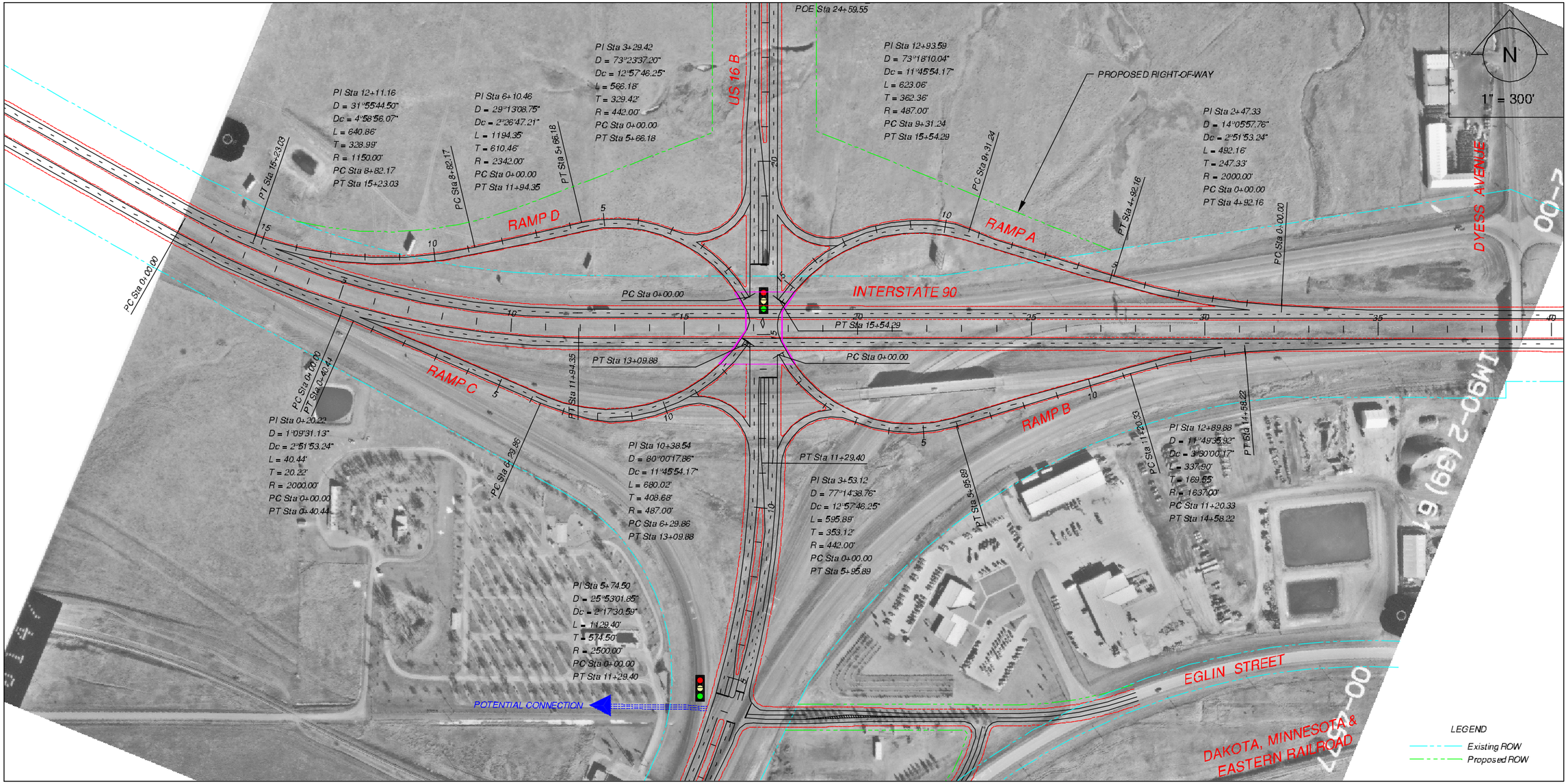

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Figure 17
I-90 Exit 60
E. North Street, Rapid City
Alternative 3
Single Point Urban Interchange

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.

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.

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.

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

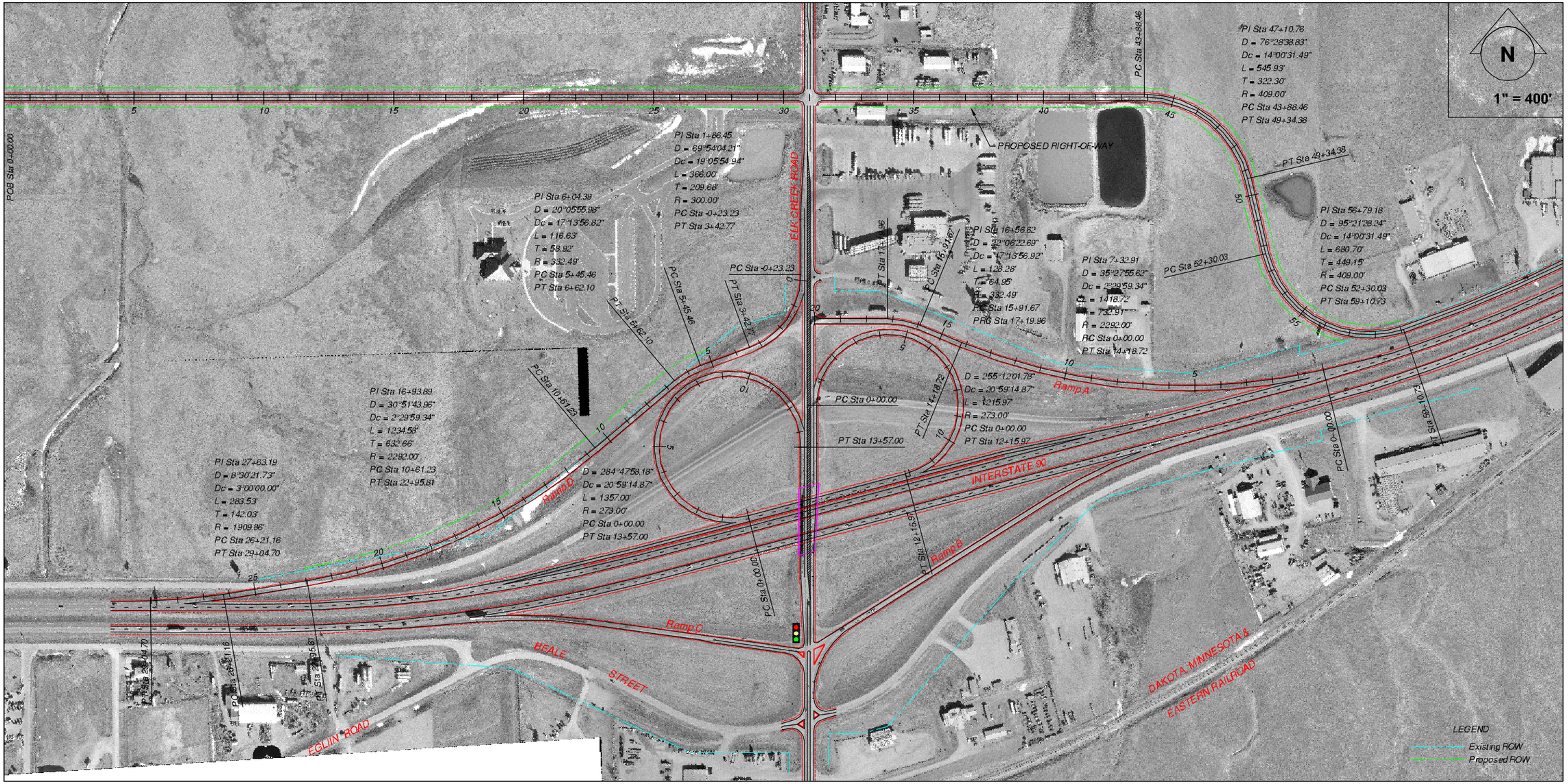

Figure 18
I-90 Exit 61
Elk Vale Road, Rapid City
Potential Ultimate Improvement
Partial Cloverleaf

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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

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.

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.

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Figure 19
I-190/Mt. Rushmore Road Connection

I-90: Exit 332 - SD 37, Mitchell

Traffic volumes at Exit 332 are expected to increase in future years due to additional development along the Highway 37 corridor. The Phase I analysis indicated that with the addition of traffic signals at the ramp intersections, the interchange will provide acceptable levels of service through the Year 2020. However, as traffic volumes on SD 37 grow, additional traffic signals will likely be required along the corridor. Consideration should be given to reconstructing the interchange with a single point configuration, which would increase the signal spacing from approximately 450' between the northern ramps and the next major intersection, to approximately 800'. If reconstructed, the relatively minor geometric deficiencies could be addressed at that time.

Existing Interchange Characteristics

Geometry

The existing interchange is a modified diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Hwy 37. The cross section of Hwy 37 is a four-lane divided section, with a wide median. Separate left turn lanes are provided at the major intersections. It should be noted that the spacing of access along Hwy 37 north and south of the interchange is less than desirable and affects the safety and operations of traffic using Hwy 37. Geometric deficiencies of note include a superelevation rate of 6.0% is provided on Ramp A and 5.0% on Ramp C. The K values for the sag vertical curves on Ramps A and B are well below the criteria of 90.

Traffic Safety

This interchange ranked 13th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 31 accidents occurred at this interchange between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the Exit 332 interchange indicates that all of the traffic movements are currently operating at or above level of service B. The Year 2010 and 2020 capacity analyses assumed the current diamond interchange configuration with traffic signalization. With minor improvements, all movements are anticipated to operate at or above LOS B for the years 2010 and 2020.

Capacity Analysis with Existing Configuration

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

Proposed Interchange Alternatives

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels with the construction of separate right turn lanes on the off-ramps and the use of access management techniques along SD 37. As an alternative to these improvements, a single point interchange concept was also developed for this location.

Alternative #1 – Off Ramp Improvements and Access Management

The first alternative simply consists of the construction of a separate right turn lane for both the eastbound and westbound off-ramps and some access management improvements along SD 37. A functional design of the proposed improvements is shown in Figure 20.

Geometry

In addition to the separate right turn lanes on the off-ramps, there are a few other geometric modifications recommended along Hwy 37. One recommendation is to provide improved sight distance for left turning vehicles at the major intersections. With the wide median, vehicles in the opposing left turn lane restrict the distance to see on coming through traffic. One effective method to improve the sight distance is to reconstruct the left turn lane closer to the opposing through lanes as shown in the figure. This also helps to reduce the distance the left turning vehicle must travel through the intersection. Storage lengths for the left turn lanes along Hwy 37 should provide 200' of storage, which is more than adequate to accommodate the projected traffic volumes. The northbound and southbound right turn lanes on the off-ramps should provide 150' of storage. A second recommendation is to reduce the numbers of access points

along Hwy 37 especially full movement access points. This will improve traffic flow and safety along the corridor.

Traffic Safety

The construction of the proposed improvements will improve traffic operations along Hwy 37, which should result in a reduction in accidents at the interchange and adjacent intersections.

Capacity

As previously stated, the interchange will operate at acceptable levels for the Year 2020 with the proposed improvements. It should be noted that the proposed off-ramp improvements could be delayed until 2010 and still have anticipated levels of service that are acceptable so that the current improvements would meet their service life.

Access Control

In addition to the modifications recommended for the left turn lanes on Hwy 37, some restrictions to turning movements at the adjacent intersections and into adjacent properties should also be considered. Currently, the traffic volumes at these intersections are low enough to function well. However, as traffic volumes grow, it will become more difficult to turn left onto Hwy 37 from the frontage road intersections. See proposed changes in Figure 20.

To be specifically noted are the access locations nearest to the interchange. The unsignalized intersection north of the interchange should continue to operate acceptably with improvements to the left turn lanes, however it should be monitored and at such time the access could be restricted to right in right out access by closing the median. Access to the adjacent developments could still be provided by the frontage road connection at the signal to the north.

The access points south of the interchange are anticipated to operate acceptably with the current land uses. In the event these areas are redeveloped, consideration should be given to access management improvements along this corridor. Full access could be limited to one point and possibly a right- in/right out could be provided closer to the interchange. The full movement access should be located as far from the interchange as possible without negatively impacting the signal at Hwy 37 and Spruce Street.

Right-of-Way

The proposed improvements for the off-ramps and the median along Hwy 37 will not require any additional right of way.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the right turn lanes and median reconstruction on Hwy 37 is estimated at $250 thousand. A breakdown of the quantities and construction costs is included in the Appendix.

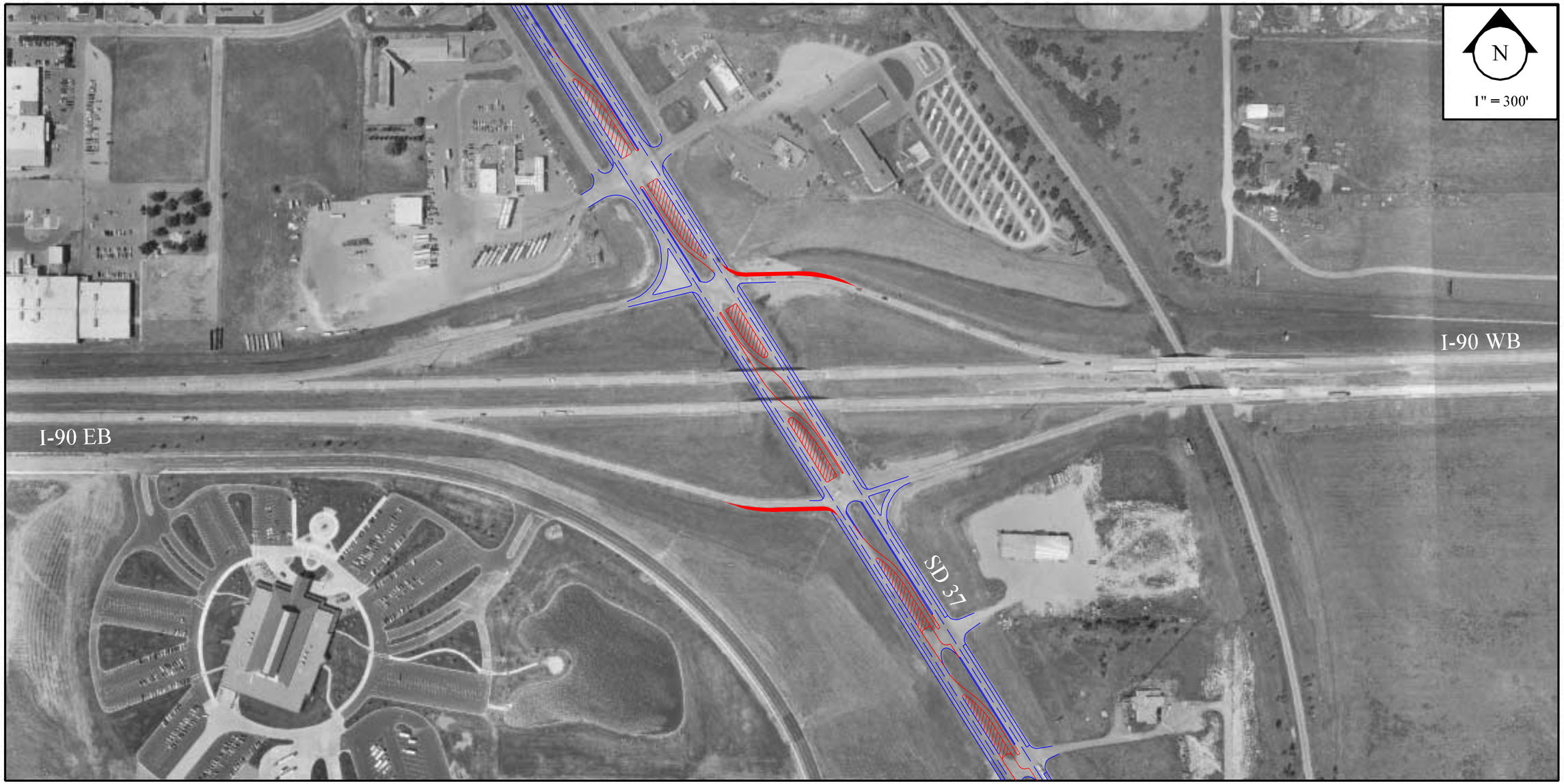

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Figure 20
I-90 Exit 332
SD 37, Mitchell
Single Point Interchange

Alternative # 2 – Single Point Interchange

Although the capacity analysis indicated that the diamond interchange configuration would provide acceptable traffic operations through the Year 2020 with some minor improvements, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. Another positive advantage to the construction of a single point interchange is the increased spacing that it would provide between the interchange and the closest intersections to the north and south as part of the access management concepts discussed previously. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 21.

Geometry

Based on the traffic projections, single left turn lanes for the single point interchange will provide acceptable traffic operations. As was the case for the diamond interchange, the left turn storage on the Hwy 37 approaches should be 200'. The configuration of the single point interchange results in approximately 200' of storage for the left and right turn lanes on the off-ramps.

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in the following table.

I-90/Hwy 37 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	
Hwy 37 Single Point Interchange	2010	Sig.	C	B	-	B	B	-	B	-	-	B	-	-	B
Hwy 37 Single Point Interchange	2020	Sig.	C	B	-	C	B	-	B	-	-	B	-	-	B

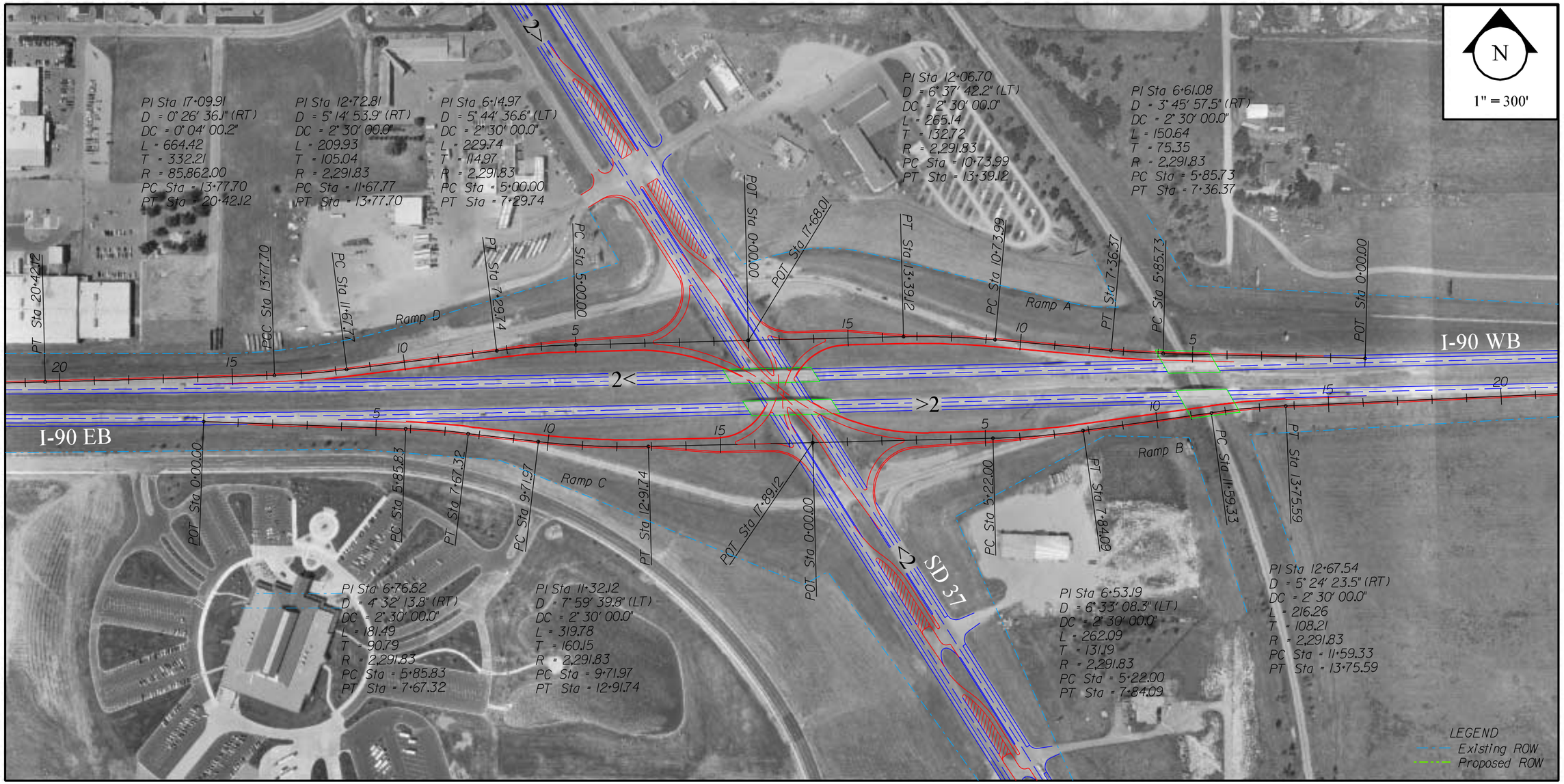

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Figure 21
I-90 Exit 332
SD 37, Mitchell
Single Point Interchange

Access Control

The modifications to the access points along Hwy 37 discussed for the previous alternative are recommended with the single point concept as well. The increased distance between the interchange and the next adjacent access breaks will help improve traffic operations along the corridor.

Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at Exit 332.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and reconstruction of the medians along Hwy 37 is estimated at $7.2 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-90: Exit 395 – Marion Road, Sioux Falls

A new interchange is proposed for the Marion Road crossing of I-90, located approximately one mile west of I-29. The City of Sioux Falls completed the *Interstate 90 and Marion Road Interchange Justification Study* in December 1999. This study recommended a typical diamond interchange. However, the capacity analysis conducted with this study revealed that with the lane configuration indicated in the justification study, the projected level of service in the Year 2020 is LOS D at the westbound ramp. Dual left turn lanes for the westbound off-ramps were evaluated in the Phase I study, which resulted in LOS C. This subsequent investigation evaluates providing a loop ramp on the north half of the interchange to accommodate the heavy westbound left turn movements. This partial cloverleaf concept also included laying out the interchange to construct additional loop ramps as needed in the future. The Phase II investigation has been performed to further evaluate geometric and operational characteristics for improving the new proposed interchange. The results of this investigation are summarized below along with selected information from the Exit 395 Phase I analysis.

Proposed Interchange Concept

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study completed by the City of Sioux Falls in December 1999 determined a typical diamond interchange was the preferred concept for this location at Marion Road and I-90. It was revealed during the Phase I investigation that the typical diamond interchange will not operate with an acceptable delay in the Year 2020. The Phase I study indicated that dual left turn lanes are recommended to accommodate the heavy projected left turn movements at the westbound on and off ramps. The investigation in Phase II evaluated a partial cloverleaf concept for this location. The results of this investigation with the partial cloverleaf interchange improved the Year 2020 level of service (LOS) to a “B” from a “D” with the original typical diamond concept at the north ramp intersection.

A functional design of the proposed partial cloverleaf interchange laid out with the necessary clearances to construct additional loops ramps as needed in the future is shown in Figure 22. The dotted westbound ramp shown in the figure provides reference to the amount of right of way that would be needed to build a typical diamond interchange.

Geometry

In order to accommodate the projected traffic volumes, it will be necessary to widen Marion Road to a four-lane divided section in the vicinity of the proposed interchange, with a raised median and separate left turn lanes to the I-90 on-ramps. A raised median is recommended to provide channelization at the intersections. The analysis indicated that a 500' northbound left turn lane and a 150' southbound left turn lane would accommodate the 95th percentile queue length. Each of the ramps has one lane and the off ramps each allow for a separate right movement from this lane. The eastbound to southbound right turn and the westbound to southbound left turn are projected to be heavy movements. The provision of separate right and left turn lanes for the off-ramps will allow for more efficient traffic operations. The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and additional through lanes.

Consideration, at the time of design, should be given to the possibility of providing three through lanes in each direction on the interstate mainline at some date in the future. The design of the bridge structure should allow for this future expansion if the need arises.

Traffic Safety

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Marion Road will result in some accidents occurring on the ramps and at the intersections with Marion Road. A similar accident pattern may develop initially associated with driver's unfamiliarity with a newly constructed interchange as compared to other newly constructed partial cloverleaf interchanges. It is anticipated that the accident frequency will decrease over time once drivers are familiar with this interchange configuration.

Capacity

The requirements for analysis of future traffic operations for the interchange concept were based on evaluation of the Year 2020 traffic volume projections. The results of the analysis are summarized below. As shown in the table, the partial cloverleaf interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

Although the Year 2010 and 2020 traffic volume projections at the south ramp intersection do meet the MUTCD peak hour traffic warrant, it will require future engineering study to determine whether a signal is necessary since the predominant movement at the off ramp is right turning traffic. The Phase II results indicate this intersection would operate sufficiently with no signalization in Year 2010 and 2020. A signalized analysis was also performed for this intersection for comparison, which indicated an improved level of service in Year 2010 and 2020.

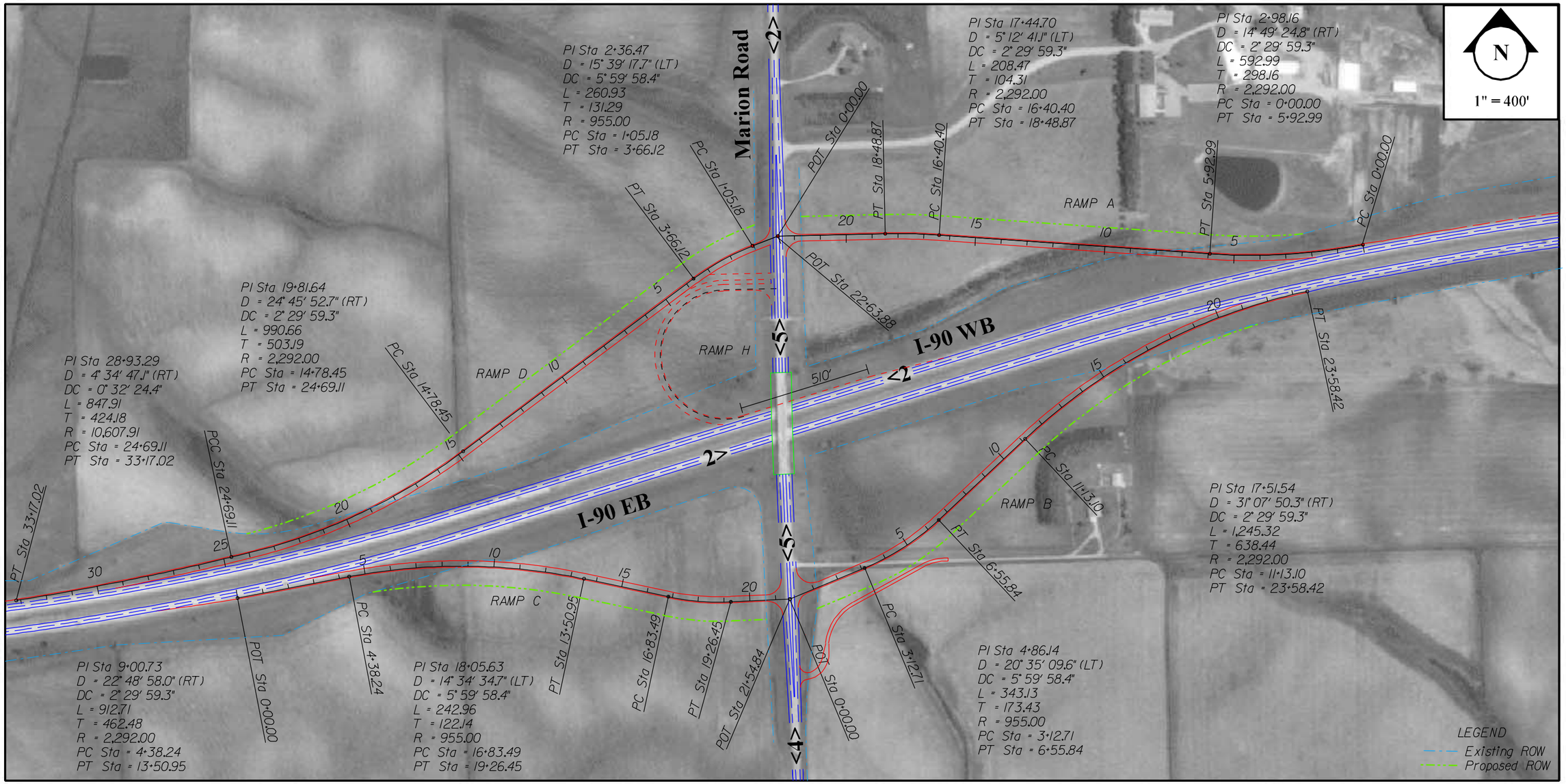

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Figure 22
I-90 Exit 395
Marion Road, Sioux Falls
Diamond Interchange

Related to traffic operations were concerns of the signing of Exit 395 and 396 due to the close spacing of the two interchanges. It was also noted that the existing signs and sign bridges are over thirty years old. During the design phase of any improvements to this area consideration should be given to the replacement and location of directional signs

I-90/Marion Road 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	
Marion Road/ I-90 WB Ramps	2010	Sig.	B	A	-	-	A	-	A	-	-	-	-	-	B
Marion Road/ I-90 EB Ramps	2010	Unsig.	-	-	-	A	-	-	C	-	B	-	-	-	B
Marion Road/ I-90 EB Ramps	2010	Sig.	-	A	-	A	A	-	A	A	-	-	-	-	A
Marion Road/ I-90 WB Ramps	2020	Sig.	C	A	-	-	A	-	C	-	A	-	-	-	B
Marion Road/ I-90 EB Ramps	2020	Unsig.	-	-	-	B	-	-	C	-	C	-	-	-	C
Marion Road/ I-90 EB Ramps	2020	Sig.	-	A	-	A	A	-	B	B	-	-	-	-	A

Future traffic operations for the ramp movements were also evaluated which includes the recommendation to construct a loop ramp in the northeast quadrant. The following table summarizes the analysis of the merge and diverge movements for the Year 2010 and 2020. The capacity analysis indicates that the level of service for these movements will operate at LOS B or better. The lane configuration assumes one lane on and off ramps and two through lanes in each direction on I-90.

I-90/Marion Road Ramp LOS Analysis

Direction	Year	Movement	LOS
I-90 Westbound	2010	Merge	A
		Diverge	A
I-90 Eastbound	2010	Merge	B
		Diverge	A
I-90 Westbound	2020	Merge	B
		Diverge	B
I-90 Eastbound	2020	Merge	B
		Diverge	A

Access Control

Since the property in the vicinity of the proposed interchange is currently undeveloped, there is an opportunity to limit the access locations along Marion Road. The farmstead driveway in the

southeast quadrant will need to be relocated to provide a minimum of 300' from the south ramp intersection. It appears some land acquisition may be necessary to relocate this driveway access depending on the ownership of the farmland in the southeastern quadrant. Since so much of the property is required for construction of the eastbound on-ramp, the SDDOT will investigate the feasibility and need for acquiring the entire parcel.

Right-of-Way

Other than farmland acquisition, there appears to be no geometric constraints in constructing the loop ramp and all of the on and off ramps in the three quadrants. It appears that adequate right of way is available to widen Marion Road to a four-lane divided section in the vicinity of the proposed interchange, with a raised median and separate left turn lanes to the I-90 on-ramps. Other than the northeast quadrant, triangular sections of right of way will be required in the remaining three quadrants of the interchange to accommodate construction of the ramps, with the necessary clearances to construct additional future loop ramps in the southern section of the interchange, totaling 42.8 acres. This includes the right of way necessary to relocate the private driveway in the southeast quadrant as discussed earlier. If the entire parcel is acquired, a total of 51.1 acres of right of way will be required to construct the interchange.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the partial cloverleaf interchange at Marion Road is estimated at $7.1 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Marion Road through the interchange area. It was assumed that it includes the portion of Marion Road through the ramp intersections. It is assumed that the widening of Marion Road will be constructed as a separate project. The City of Sioux Falls has indicated that they will participate in the construction of the local connections in coordination with the construction of the interchange.

I-90: Exit 396, I-29 / I-90, Sioux Falls

Exit 396 on I-90 is the full cloverleaf system interchange with I-29. The capacity analysis from the Phase I investigation revealed that that the existing interchange does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, the radii provided on the loop ramps are only 205', which is well below a 30 mph design speed. In addition, the weaving distance provided between the loop ramps does not meet current design criteria. The other geometric deficiencies are relatively minor, and can be corrected at the time of reconstruction. In an effort to address the geometric issues, a full cloverleaf interchange that meets current design criteria was developed for this system interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 395 Phase I analysis.

Existing Interchange Characteristics

Geometry

Existing geometry features reviewed using the as-built plans for this interchange. Every ramp at this interchange was found to have some deficiencies. The as-built plans indicate that the superelevation rate on Ramps A, B, C and D is are only slightly above the 4% criteria. The loop ramps have a radius of only 205', which is below a 30 mph design speed. They were constructed with a 6% superelevation rate, which is necessary with that radius. The on-ramp taper rate for Ramp D should also be lengthened when the interchange is reconstructed.

Traffic Safety

The accident analysis ranked this interchange 12th of the 62 interchanges evaluated. Since it did not meet the criteria of a high accident location, the individual accident records at this interchange were not reviewed. A total of 38 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The movements evaluated at a full cloverleaf interchange fall into three categories. The direct ramp movements (Ramps A, B, C, and D) are analyzed as a diverge movement from one interstate and a merge movement to the other interstate. For example, Ramp A, which provides the westbound to northbound movement, is analyzed as a westbound diverge on I-90, and a northbound merge on I-29. The area between the loop ramps is analyzed as a weave movement.

The results of the capacity analysis performed for the existing full cloverleaf interchange shown in the following table indicate that the ramp merge, diverge and weave areas are currently operating at level of service (LOS) A, with the exception of the northbound diverge movement, which is operating at LOS B. The Phase I results for Year 2010 and 2020 projected traffic volumes indicate the existing full cloverleaf interchange configuration will operate at a LOS B or better on all ramps.

I-90/I-29 Ramp LOS Analysis – with Existing Configuration

Direction	Year	Movement	LOS
I-90 Westbound	1998	Merge	A
		Weave	A
		Diverge	A
I-90 Eastbound	1998	Merge	A
		Weave	A
		Diverge	A
I-90 Westbound	2010	Merge	B
		Weave	A
		Diverge	A
I-90 Eastbound	2010	Merge	B
		Weave	A
		Diverge	A
I-90 Westbound	2020	Merge	B
		Weave	B
		Diverge	B
I-90 Eastbound	2020	Merge	B
		Weave	A
		Diverge	B
I-29 Northbound	1998	Merge	A
		Weave	A
		Diverge	B
I-29 Southbound	1998	Merge	A
		Weave	A
		Diverge	A
I-29 Northbound	2010	Merge	A
		Weave	A
		Diverge	B
I-29 Southbound	2010	Merge	B
		Weave	A
		Diverge	A
I-29 Northbound	2020	Merge	B
		Weave	A
		Diverge	B
I-29 Southbound	2020	Merge	B
		Weave	A
		Diverge	A

Proposed Interchange Alternatives

The primary problem at this interchange is the design speed on the loop ramps and the weaving distance provided between the loop ramps. When the interchange is reconstructed, it is recommended that the full cloverleaf concept be maintained, but designed to conform with current design standards. The proposed configuration is shown in Figure 23.

The Phase II investigation evaluated the concern about the proposed modified Exit 396 cloverleaf interchange concept further reducing the short distance provided between the on and off ramps for Exit 83 and the eastbound on ramp at Exit 395. According to the SDDOT Design Manual, the recommended distance between an entrance and an exit ramp is 2,000'. Currently, the Exit 396 ramps are approximately 1,400' apart at Exit 83 and 1,900' apart at Exit 395. With the concept shown in Figure 23, this distance is reduced even further. The LOS results from Phase II indicate the length of the auxiliary lane between the ramps at Exit 83 and Exit 396 and at eastbound Exit 395 and Exit 396 will provide acceptable weaving operations.

The other option would be to provide a collector-distributor (CD) road along both sides of I-29. Again, due to the proximity of the interchange to the south, the CD roads would need to begin south of Exit 83, and continue all the way through the I-90 interchange. This concept was not developed once the Phase II portion of the study concluded the auxiliary lane distance between ramp terminals and Exit 83 provided adequate LOS for the weaving movements projected for Year 2020 traffic volumes.

Another option would be to provide a CD road on both northbound and southbound I-29 just to accommodate the weave movements between the loop ramps. This would allow the weave movements to occur separate from the mainline movements, which may result in a safer weave operation. However, in order to accommodate the CD roads, it would be necessary to lengthen the I-90 bridges over I-29. The analysis indicates that the CD roads are not required to provide acceptable traffic operations for the projected traffic volumes.

A concept for the ultimate configuration of this interchange was also considered. Based on the Year 2015 traffic model, the heavy turning movements in the future appear to be the northbound to eastbound movement (Ramp B) and the westbound to southbound movement (Ramp H). The accommodation of the Ramp B volume is not a problem, since this is basically a right turn movement. However, the replacement of Ramp H to accommodate a higher turning volume beyond the Year 2020 is more difficult to address. A flyover ramp from westbound I-90 to southbound I-29 would have to first swing north of I-90, travel over I-29, over I-90 and tie back into southbound I-29 prior to the off-ramp for Exit 83. A preliminary review of this alignment indicates that there is not enough distance between the eastbound to southbound (Ramp C) on-ramp, and the Exit 83 off-ramp to accommodate this flyover connection. Therefore, the full cloverleaf design alternative was the only concept evaluated for this proposed interchange.

Alternative #1 – Full Cloverleaf

The Full Cloverleaf Interchange alternative is depicted on Figure 23. The interchange concept was formulated to meet the criteria found in the SDDOT Roadway Design Manual.

Geometry

As discussed previously, the primary problem at this interchange is the design speed on the loop ramps and the weaving distance provided between the loop ramps. When the interchange is reconstructed, it is recommended that the full cloverleaf concept be maintained, but designed to conform with current design standards. Each of the new on and off ramps will be continue to provide one lane, and will be constructed to meet the following design criteria.

Geometric Design Criteria

Geometric Feature	Criteria
Superelevation	4%
Lane Width	19’
Right Shoulder Width	4’
Inslope	6:1
On-Ramp Taper Rate	50:1
Minimum Horizontal Radius	330’

Traffic Safety

Since this interchange is recommended to remain as a full cloverleaf concept but reconstructed to conform with current design standards, it is anticipated that this alternative would improve any existing safety deficiencies related to the design speed on the loop ramps and the weaving distance provided between the loop ramps. The results from the Phase II investigation did not indicate any problems related with weaving operations between the Exit 395 ramps and the ramps at Exit 395 and Exit 83 for the projected Year 2010 and 2020 traffic volumes.

Capacity

As shown in the figure, the proposed concept for this interchange is basically the same configuration, with larger, constant radius loop ramps and more distance for the weaving areas between the loop ramps. Therefore, a capacity analysis was not performed with the reconstructed interchange. In the Year 2010 and 2020, based on the analysis of the existing configuration as shown in the following table, all of the movements evaluated are projected to still operate at a LOS A or B. Since the movements are the same, the only changes would be the distances between the adjacent ramps. The weaving areas between the adjacent ramps of Exit 395 and Exit 83 were also evaluated and determined that the auxiliary lanes with the reconstructed interchange will operate at a LOS A in the Year 2010 and 2020.

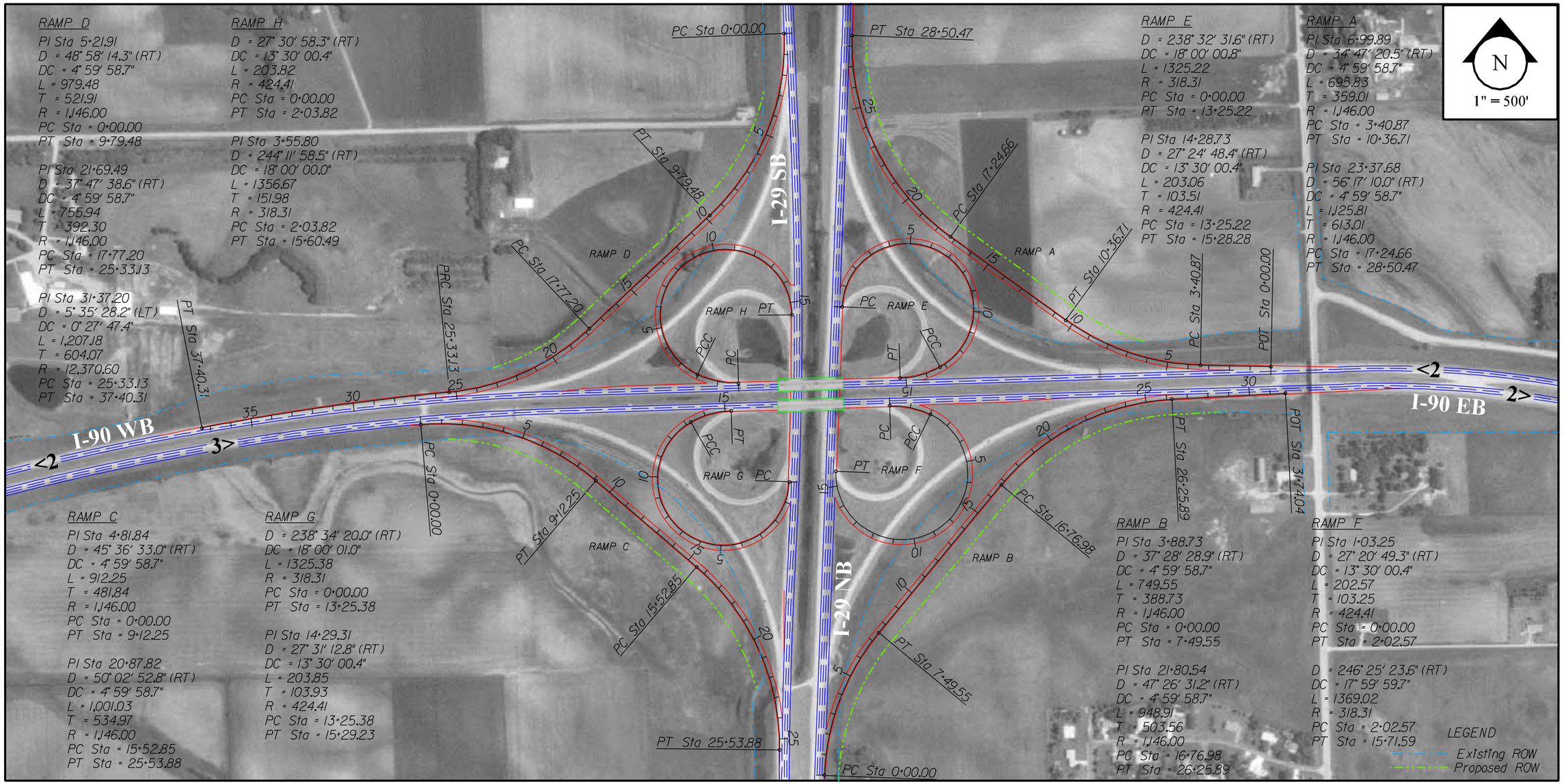

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Figure 23
I-90 Exit 396
I-29/I-90, Sioux Falls
Full Cloverleaf Interchange

Direction	Year	Movement	LOS
I-90 Eastbound	2010	Weave	A
I-90 Eastbound	2020	Weave	A
I-29 Northbound	2010	Weave	A
I-29 Southbound	2010	Weave	A
I-29 Northbound	2020	Weave	A
I-29 Southbound	2020	Weave	A

Access Control

Since the property in the vicinity of the existing full cloverleaf interchange is currently undeveloped, there is an opportunity to continue the limit of access locations along I-90 and I-29. There are no recommended changes to access control proposed for Exit 396.

Right-of-Way

There is a considerable amount of right-of-way that must be acquired in order to construct a new full cloverleaf interchange conforming with current design standards. Sections of right of way along the alignment of the existing ramps will be required in all four quadrants of the interchange to accommodate construction of the new ramps and loops, totaling 29.1 acres. Fortunately, other than farmland acquisition, there appears to be no geometric constraints in constructing the new full cloverleaf interchange. There should not be any major impacts to homes or businesses associated with the acquisition of the necessary right-of-way around the proposed interchange. Some development pressure is beginning to surface adjacent to the interchange. A more detailed identification of right of way requirements will be required in the near future.

Probable Construction Costs

A statement of probable construction costs was prepared for the reconstruction of the full cloverleaf interchange. The improvements as shown in Figure 23 are anticipated to cost approximately $11.3 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-90: Exit 399, Cliff Avenue, Sioux Falls

The capacity analysis conducted for the interchange located at Exit 399 (Cliff Avenue) on I-90 does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, the westbound off-ramp currently backs up onto the mainline during certain periods. As traffic volumes grow, even though the signalized intersections are projected to provide acceptable traffic operations, the queuing problem will continue. It may be desirable to construct a separate right turn lane on the westbound off-ramp to increase the capacity and storage length available on the ramp.

Ultimately, it may be necessary to construct a single point interchange at this location to address these deficiencies, to reduce the number of signals along Cliff Avenue and to provide improved traffic operations and progression. This interchange is programmed for reconstruction in the Year 2005. Access control along Cliff Avenue should also be addressed at the time of improvements, in cooperation with the City of Sioux Falls and the adjacent property owners.

Existing Interchange Characteristics

Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 500' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Cliff Avenue. The cross section of Cliff Avenue is a five-lane section, with a two-way left turn lane south of the interchange.

Traffic Safety

This interchange ranked 16th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 37 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the Cliff Avenue interchange indicates that the ramp intersections are currently operating at level of service A. By the Year

2020, the eastbound ramp intersection is projected to operate at LOS B and the westbound ramp intersection at LOS C.

Capacity Analysis with Existing Configuration

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

Proposed Interchange Concept

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels through the Year 2020. As an alternative to the existing diamond interchange, a single point interchange concept was also developed for this location. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 24.

Geometry

Based on the traffic projections, it appears that single left turn lanes for the single point interchange will provide acceptable traffic operations. However, with the cross section of Cliff Avenue, the left turn lanes on the off-ramps should be constructed to provide dual left turn lanes in the future. The configuration shown in the figure provides approximately 250' of storage for the left turn lanes and 200' of storage for the right turn lanes. If a raised median is constructed along Cliff Avenue, 200' of storage should be provided for the northbound and southbound left turn lanes.

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

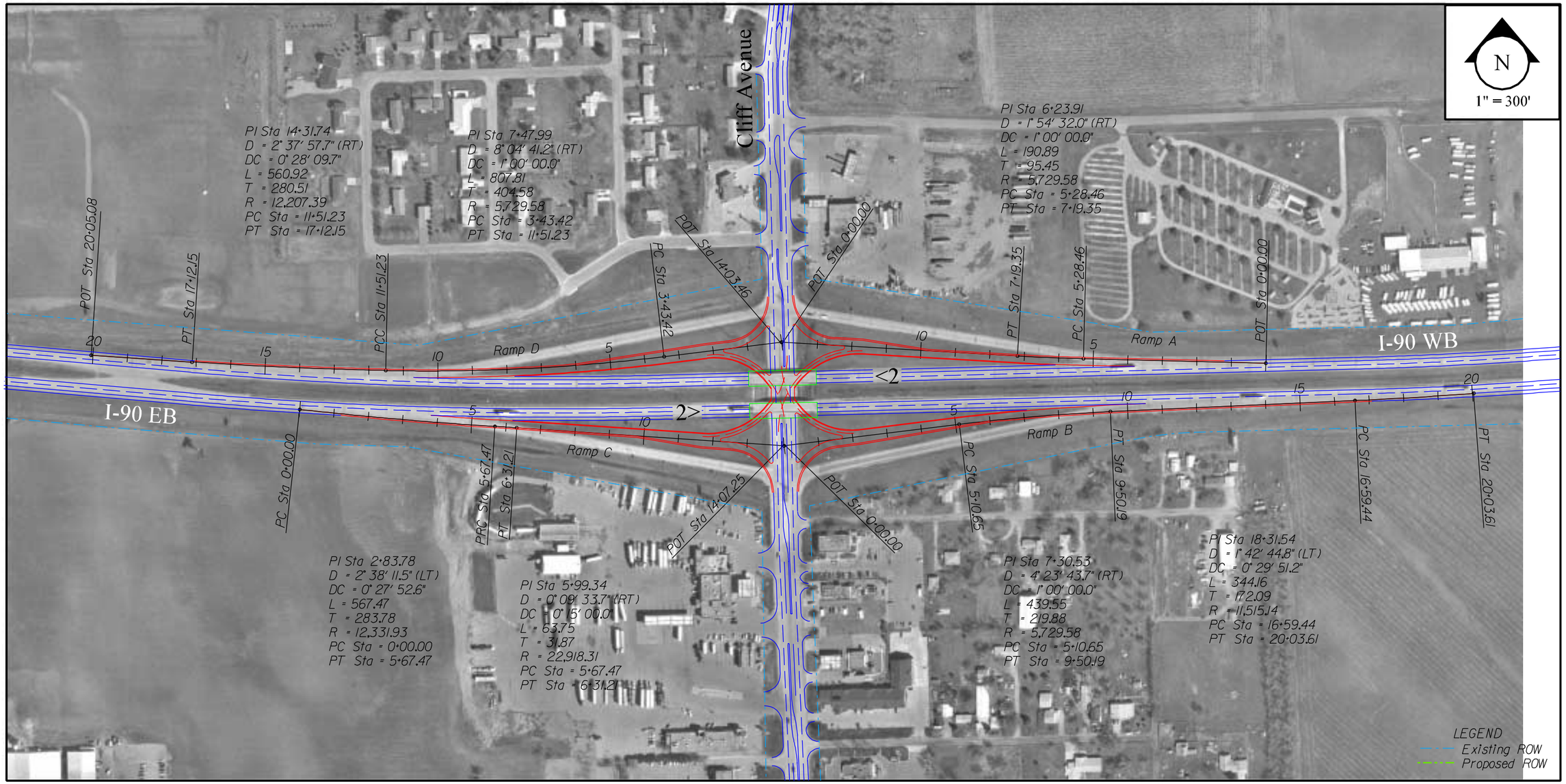

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Figure 24
I-90 Exit 399
Cliff Avenue, Sioux Falls
Single Point Interchange

Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.

I-90/Cliff Avenue 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	
Cliff Ave. Single Point Interchange	2020	Sig.	C	C	-	C	C	-	B	-	-	B	-	-	C

Access Control

On the north side of the interchange, an unsignalized intersection with Cliff Avenue to the west is located only 200' north of the ramp intersection. In addition, driveways to the property located on the east side of Clifff Avenue are only 150' north of the ramp intersection. It would be advantageous to continue the four lane divided section to the north and driveways be consolidated to create a four way intersection. The four lane divided section could then be transitioned back to the existing four lane undivided section, approximately 1500' to the north of the interchange.

South of the interchange Cliff Avenue is a five lane section with a center two way left turn lane. It would be beneficial for both operations and safety to continue a five lane divided section south of the interchange past the intersection of North 60th Street with Cliff Avenue. Currently there are many ingress/egress points for the adjacent properties. It is recommended to consolidate as many of these as possible and provide only one full movement access between the interchange and North 60th Street. A possible median configuration can be seen in Figure 24.

Concern has been expressed by the City of Sioux Falls regarding the impact a raised median would have on the heavy truck operations along this corridor. The resulting U-turn movements that would occur would be very difficult for the truck traffic that access the adjacent properties. A thorough access management study, working closely with the City of Sioux Falls and adjacent property owners, should be conducted on this section of Cliff Avenue to determine specific improvements to enhance traffic operations and safety.

Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at the Cliff Avenue interchange with I-90.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the single point interchange. Design and construction of the interchange is estimated at $5.74 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-90: Exit 400, I-229 Interchange, Sioux Falls

The capacity analysis performed for this interchange in the Phase I study indicated that the existing trumpet interchange will be able to accommodate the Year 2020 traffic volumes. The key issues at this interchange are providing I-90 access to and from the north and addressing the geometric deficiencies of the ramps.

A full cloverleaf interchange was developed in Phase I that meets current design standards and corrects the existing geometric deficiencies. The proposed full cloverleaf interchange can be constructed in phases, with the ramps for movements to and from the north added at a later date as warranted by growth and development in the area.

Existing Interchange Characteristics

Geometry

The existing trumpet interchange contains loop ramps in the northern quadrants of the interchange with substandard radii and 8% superelevation rates. The loop ramp in the northwest quadrant contains a minimum radius of 230', and the loop ramp in the northeast quadrant contains a 180' radius. In addition the direct ramps in the southern quadrants have a superelevation rate of 7%. The on-ramp taper rates for ramps B and C are also below the design criteria of 50:1.

Traffic Safety

This interchange ranked 10th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. The detailed analysis conducted for this interchange indicated that the predominate accident type is out of control vehicles, mostly during inclement weather. A total of 33 accidents occurred at this intersection between 1997 and 1999. One of the accidents was fatal, which vaulted this interchange into the high accident group. Since most of the out of control accidents occurred when there was snow or ice on the roadway, there could be some correlation with the superelevation rates provided on the ramps.

Capacity

The capacity analysis performed for the existing trumpet configuration indicates that all of the traffic movements are currently operating at level of service A or B. By the Year 2020, all of the traffic movements are projected to operate at LOS B or C.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
I-90 EB Diverge	C	A	B	C	Acceptable
I-90 EB Merge	C	B	B	C	Acceptable
I-229 NB/EB Diverge	C	A	B	B	Acceptable
I-229 NB/WS Diverge	C	A	B	B	Acceptable
I-229 EB/SB Merge	C	A	B	C	Acceptable
I-229 WB/SB Merge	C	A	B	B	Acceptable
I-229 WB Weave	C	A	B	C	Acceptable

Proposed Interchange Alternatives

Based on the capacity analysis conducted in Phase I, it appears that the current configuration of the interchange will accommodate the traffic projections through the Year 2020. The decision to reconstruct this interchange will be based on the desire to provide improved I-90 access to and from the north, or to address the geometric deficiencies on the ramps. A functional design of the proposed interchange is shown in Figure 25.

Geometry

The ultimate configuration for the interchange, as shown in the figure, provides loop ramps in each of the four interchange quadrants. The loop ramps as designed provide a 318' constant radius. The reconstruction of the two existing loop ramps also results in an extended weaving area between the loops on the I-90 westbound mainline.

In order to accommodate the construction of the loop ramps, it is necessary to realign the existing direct ramps in the southeast and southwest quadrants. This also provides an opportunity to correct the geometric deficiencies with regard to superelevation rate, taper lengths and pavement widths.

New direct ramps are proposed for the northeast and northwest quadrants to complete the accessibility of I-90 to and from the north. Although these ramps may not be required initially, the ultimate configuration of the interchange should be provided for through the right of way acquisition process.

It should be noted that the existing bridge structures are new and were designed for future expansion and therefore will not be considered in the cost estimates.

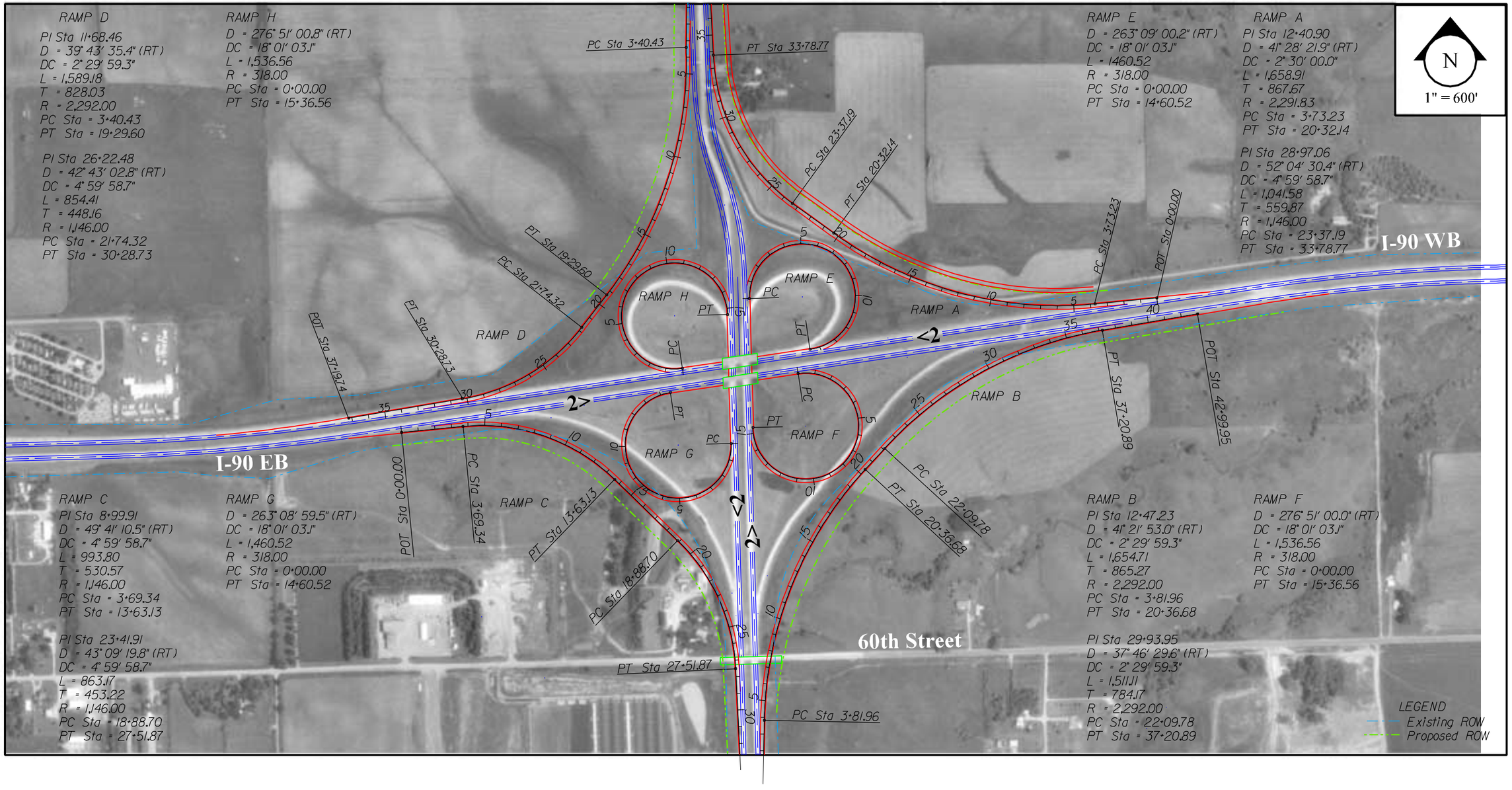


Figure 25
I-90 Exit 400
I-229, Sioux Falls
Clover Leaf Interchange

Traffic Safety

The reconstruction of the existing loop ramps and the direct ramps to the south should help to reduce the frequency of out of control accidents during inclement weather. It should be noted that the total number of accidents at this interchange is relatively low compared to the volume of traffic, however, the one fatal accident resulted in identification as a high accident location.

Capacity

The major turning movements at the I-90/I-229 interchange will remain constant with the full cloverleaf interchange. The only significant change is with regard to the weaving distance provided on I-90 westbound between the loop ramps. With the increased distance provided, this movement is projected to improve from LOS C to LOS B in the Year 2020. The remaining merge/diverge movements are projected to operate at LOS C or better in the Year 2020.

Based on the traffic projections developed for the existing configuration in the Year 2020, the volume of traffic to and from the north is anticipated to be considerably less than to I-229 to the south. With these lower turning volumes, the new merge and diverge movements on I-90 westbound and the weave movements between the loop ramps for I-90 eastbound are anticipated to also operate at LOS C or better.

Access Control

The only access control issues pertinent to this interchange are with regard to the roadway to the north. As the area north of I-90 develops, direct access to the county road should be controlled and kept sufficient distance away from the northern ends of the ramp tapers. The first access point to the north should probably be a minimum of ½ mile north of the ramp tapers. A frontage road should be constructed to provide access to the two properties located north of I-90.

Right-of-way

A total of 29.5 acres of right of way will be required to construct the full cloverleaf interchange as shown in the figure. The most significant impact to adjacent property is in the southeast quadrant of the interchange. In order to construct a loop ramp and realign the direct ramp in that quadrant, it will be necessary to acquire the farmstead. Based on the aerial photo, it appears that the construction limits will result in a total acquisition of this property.

The farmstead located on the northern edge of the new interchange, on the east side of the county road, will also be impacted by the construction. However, it appears that this impact will be relatively minor. In fact, a slight shift in the roadway alignment to the west would minimize the impact even further.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the full cloverleaf interchange. Design and construction of the interchange is estimated at $6.7 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 2, North Sioux City

The capacity analysis performed for this interchange in the Phase I study indicated that the existing tight diamond configuration will be able to accommodate the Year 2020 traffic volumes with signalization provided at both of the ramp intersections. However, with the amount of undeveloped property in the immediate vicinity of the interchange, and the close proximity of adjacent access points on the cross road, a single point interchange concept was developed. The single point configuration has the ability to accommodate considerably more traffic through the interchange, should any future development result in a significant increase in traffic above the levels forecast. It will also provide an opportunity to improve the geometric deficiencies of the present configuration.

Existing Interchange Characteristics

Geometry

The existing interchange is a tight diamond configuration, with a spacing of approximately 400' between the interchange ramp intersections. Both intersections are presently signalized. The northbound off-ramp widens to a three-lane section, providing dual right turn lanes and a shared through/left turn lane. The southbound off-ramp provides a shared left/through/right lane. The crossroad provides a shared through/left turn lane at each of the ramp intersections.

Traffic Safety

This interchange ranked 15th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 40 accidents occurred at this intersection between 1997 and 1999. The Exit 2 accident history does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the Exit 2 interchange indicates that all of the traffic movements are currently operating at level of service A or B. By the Year 2020, all of the traffic movements are projected to operate at LOS B, with the exception of the southbound off-ramp intersection, which is projected to operate at LOS C.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	B	B	Acceptable
NB Merge	C	A	B	B	Acceptable
SB Diverge	C	A	B	B	Acceptable
SB Merge	C	B	B	B	Acceptable
East Intersection	D	B	B	B	Acceptable
West Intersection	D	A	A	C	Acceptable

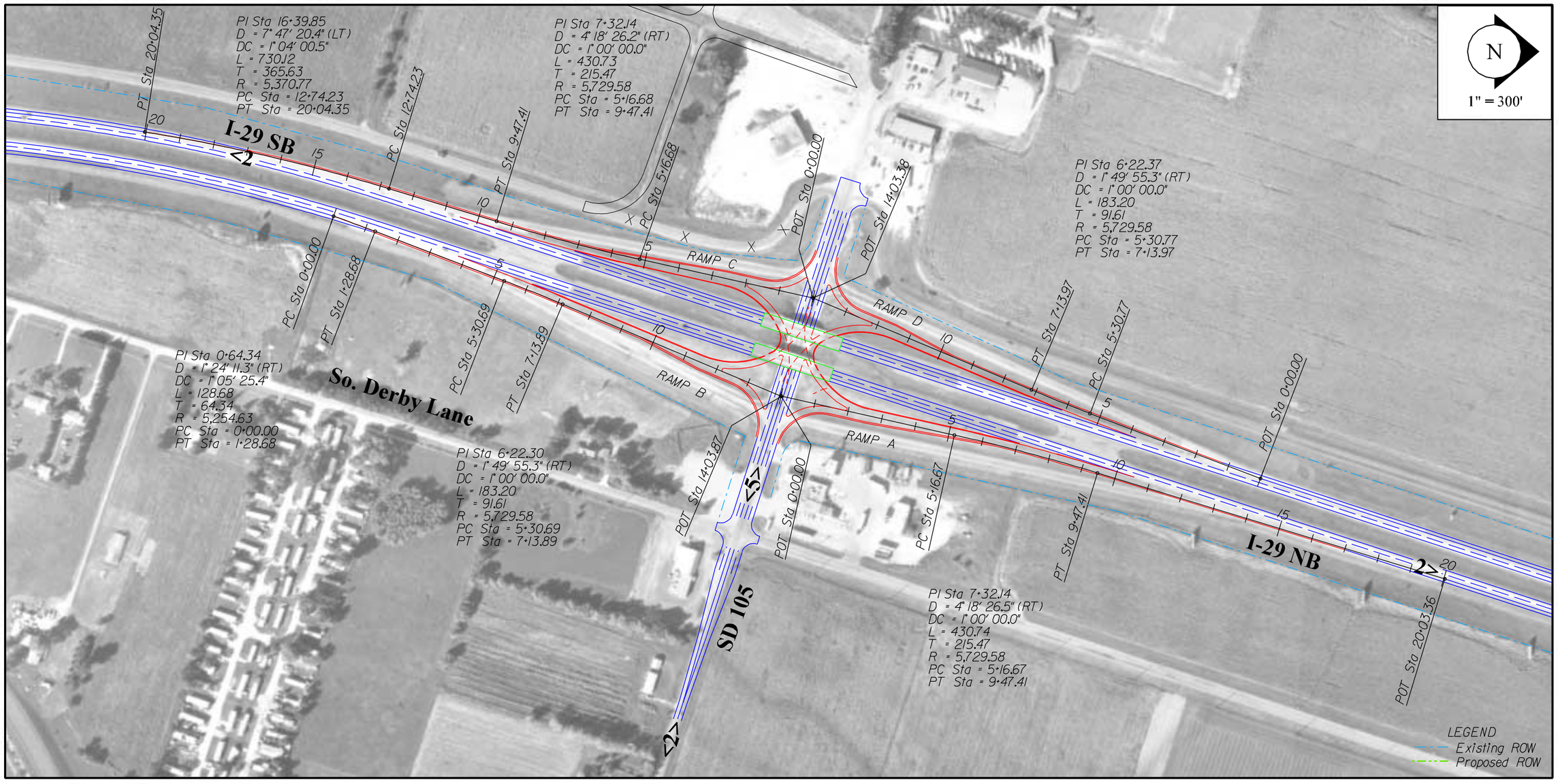
Proposed Interchange Alternatives

Although the capacity analysis indicated that the present tight diamond configuration would provide acceptable traffic operations through the Year 2020, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of the single point interchange is likely to be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed interchange is shown in Figure 26.

Geometry

At the time of reconstruction, it is recommended that a five-lane section be provided on the crossroad, from the intersection with South Derby Lane on the east to the frontage road intersection on the west. It may be desirable to consider the construction of a raised median on the crossroad approaches to the interchange, which would restrict the driveways to the property in the northeast quadrant to right-in/right-out access.

The westbound left turn lane at the interchange will require a storage length of approximately 300' to accommodate the 95th percentile queue length. The eastbound left turn lane will only require 100' of storage, however, it is recommended that the minimum of 200' of storage be constructed. The capacity analysis indicates that the 200' of storage for the left and right turn lanes on the off-ramps will be more than adequate to accommodate the projected traffic volumes. It should be noted that the configuration shown in the figure has the ability to accommodate dual left turn lanes from the off-ramps, should conditions require the additional capacity. The table below summarizes the recommended right and left turn storage lengths.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PT Sta = 7+13.97
RAMP C
RAMP D
PC Sta 0+00.00
PT Sta 1+28.68
PC Sta 5+30.69
PT Sta 7+13.89
PT Sta 7+13.97
PC Sta 5+30.77
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PC Sta = 0+00.00
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So. Derby Lane
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RAMP A
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DC = 1° 00' 00.0"
L = 183.20
T = 91.61
R = 5,729.58
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PC Sta = 5+16.67
PT Sta = 9+47.41
I-29 NB
2>
POT Sta 20+03.36
LEGEND
Existing ROW
Proposed ROW

Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Exit 2 Single Point Off-Ramps	Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Exit 2	Westbound Left-turn	300 feet
	Eastbound Left-turn	200 feet

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The capacity analysis performed for the existing conditions applies to this concept as well. The turning movements, lane configurations and traffic control were kept constant between the two scenarios. As previously indicated, this configuration will operate at acceptable levels of service through the Year 2020.

The results of the capacity analysis are depicted in the following table. As shown in the table, the single point interchange as shown in the figure will operate at acceptable levels of service in the Year 2025.

I-29 Exit 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	
Exit 2 Single Point Interchange	2010	Sig.	B	-	-	B	-	-	B	B	-	B	A	-	B
Exit 2 Single Point Interchange	2020	Sig.	B	-	-	B	-	-	C	B	-	B	A	-	B

Future traffic operations for the ramp movements will be the same as evaluated for the existing conditions, since one-lane on and off ramps will still be provided. The capacity analysis indicated that the level of service for these movements will operate at LOS B for the Year 2020.

Access Control

The widening of crossroad through the interchange will offer the opportunity to either combine driveways or limit access to right-in/right-out only on the east side of the interchange. On the west side, the frontage road in the southwest quadrant of the interchange has recently been

relocated to the west side of the development. Ultimately, the frontage road in the northwest quadrant should also be relocated to west to provide more separation from the interchange ramps and to align with the frontage road to the south.

Right-of-Way

It appears that no additional right of way will be required to construct the proposed single point interchange at Exit 2.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and widening of crossroad is estimated at $5.5 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 4, McCook Lake, North Sioux City

The diamond interchange located at Exit 4 on I-29 is likely to be relocated approximately 1,400' to the north in order to align with a future dike road to the west. The Phase I study developed a two concepts, a diamond interchange and a single point interchange. The capacity analysis indicated that either concept will be able to accommodate the Year 2020 traffic forecasts at this interchange. Under both concepts, a grade separation over the adjacent railroad on the east side of I-29 and Military Road will be required. The interchange is ready to proceed into preliminary design, with the improvements programmed for the Year 2004. The ultimate interchange configuration should be conducive to the heavy truck traffic leaving the Gateway Industrial Park and Flynn Business Park, with good connections to Military Road and the former SD 105 highway. The design and construction should be coordinated with the future Dike Road. The business community and public should be involved during the design process. SIMPCO recommends that the interchange provide a connection to Streeter Drive.

Existing Interchange Characteristics

Geometry

The existing diamond interchange provides single lane off-ramps with stop sign control. The crossroad provides a three-lane section, with separate left turn lanes at the ramp intersections. On the west side of the interchange, a frontage road intersection is located approximately 250' west of the southbound ramp intersection. To the east, an at-grade railroad crossing is located approximately 400' east of the northbound ramp intersection. An intersection with Military Road is located another 75' east of the railroad crossing. There are a few minor geometric deficiencies at the existing interchange, however, the reconstruction of the interchange to the north will remove those deficiencies.

Traffic Safety

This interchange ranked 44th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 7 accidents occurred at this intersection between 1997 and 1999. The Exit 4 accident history does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing diamond interchange configuration of the Exit 4 interchange indicates that all of the traffic movements are currently operating at level of service A. By the Year 2020, all of the traffic movements are projected to operate at LOS B. Based on the traffic projections, traffic signalization should not be required at the ramp intersections with the crossroad.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	B	Acceptable
NB Merge	C	A	B	B	Acceptable
SB Diverge	C	A	A	B	Acceptable
SB Merge	C	A	B	B	Acceptable
East Intersection	D	A	B	B	Acceptable
West Intersection	D	A	A	B	Acceptable

Proposed Interchange Concept

The capacity analysis indicates that the present tight diamond configuration provides acceptable traffic operations through the Year 2020. With that in mind, a diamond interchange concept was developed for the relocated interchange. A single point interchange was also designed for comparison purposes.

Alternative #1 – Diamond Interchange

This concept is shown in Figure 27. Due to the proximity of the railroad and Military Road to the east of the interstate, the northbound ramps must be constructed closer to the mainline of the interstate than under normal conditions. In order to provide acceptable spacing between the ramp intersections, the southbound ramps were kicked out further to the west, which results in approximately 950' between the intersections.

Geometry

Based on the capacity analysis, it appears that single lane off-ramps will accommodate the projected traffic volumes. However, it is recommended that the northbound and southbound off-ramps be constructed to provide separate left and right turn lanes. This will eliminate the need to widen the off-ramps at the intersection if traffic signal warrants are met in the future.

With the diamond interchange concept, it is possible maintain the tangent alignment of the future dike road to the west. Although this results in a skewed crossing of the interstate, requiring a longer bridge, the benefit of a tangent alignment is worth the additional structure costs. The typical section of this dike road is two-lanes with separate left turn lanes at the intersections.

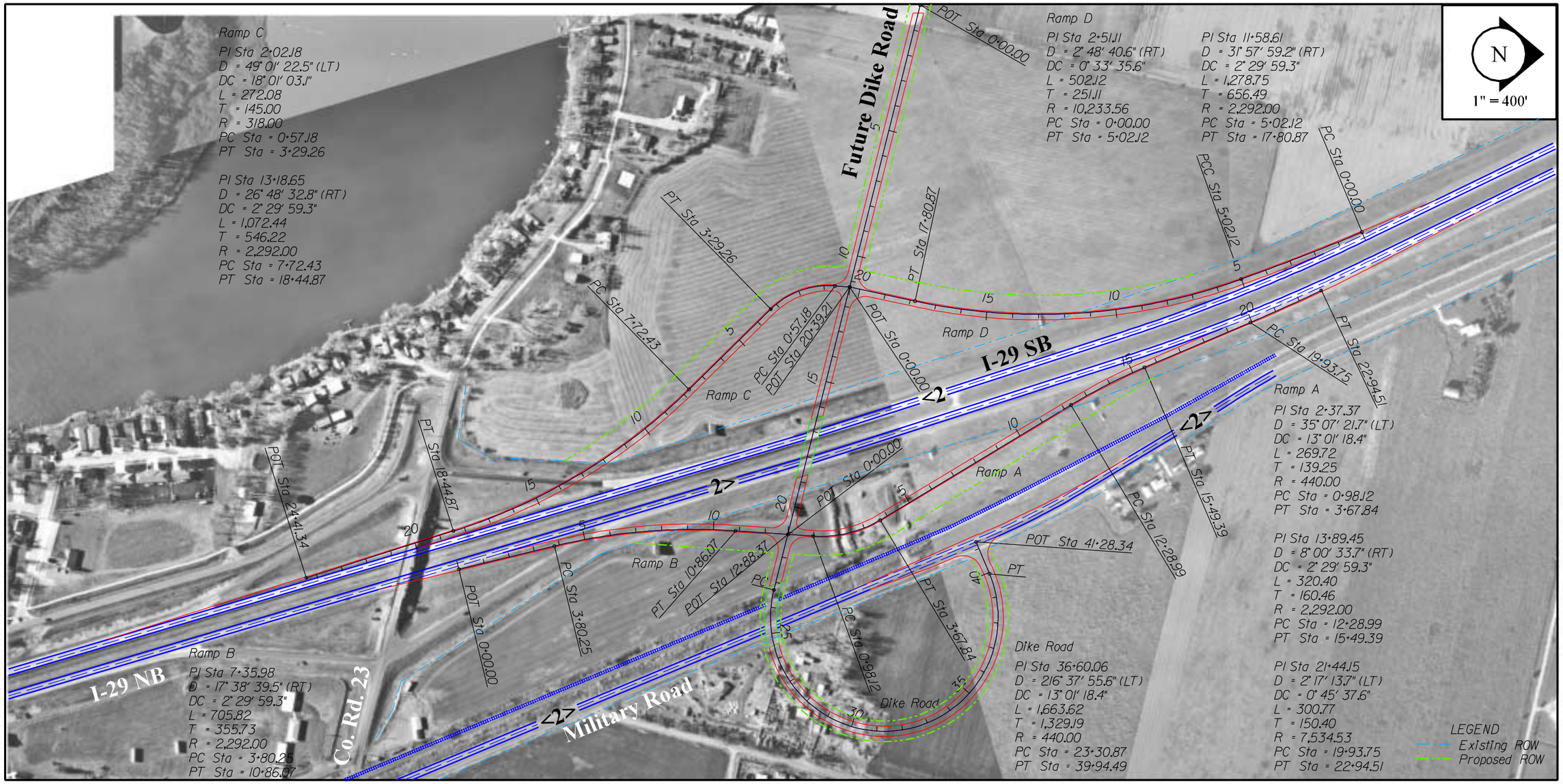

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Figure 27
I-29 Exit 4
McCook Lake, No. Sioux City
Diamond Interchange

In order to provide access to Military Road on the east side of I-29, it is necessary to provide a grade separation over the railroad and the roadway, and provide a connection back to Military Road as shown in the figure. Since the crossroad travels over the interstate, it is impossible to get back down to grade before reaching the railroad crossing. Military Road will require widening at the new intersection to provide a southbound left turn lane.

The eastbound and westbound left turn lanes on the dike road at the interchange should be constructed with a storage length of 150' to accommodate the projected turning movements. The separate left turn lanes on the northbound and southbound off-ramps should also provide 150' of storage. The westbound left turn lane from the dike road to the frontage road is recommended to provide 150' of storage, as is the southbound left turn lane on Military Road at the new connection.

Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Diamond Interchange Off-Ramps	Northbound Left-Turn	150 feet
	Southbound Left-turn	150 feet
Future Dike Road/ Interchange Ramps	Westbound Left-turn	150 feet
	Eastbound Left-turn	150 feet
Dike Rd./Frontage Rd.	Westbound Left-turn	150 feet
Dike Rd./Military Rd.	Southbound Left-turn	150 feet

Traffic Safety

The construction of the diamond interchange shown in the figure will likely not have any significant effect on the frequency of traffic accidents at this location. Any change would likely result in a reduction in accident frequency due to the elimination of some of the existing geometric deficiencies, such as the limited sight distance created by the existing bridge over I-29.

Capacity

The capacity analysis performed for the existing conditions applies to this concept as well. The turning movements, lane configurations and traffic control were kept constant between the two scenarios. As previously indicated, this configuration will operate at acceptable levels of service through the Year 2020.

Access Control

There are no major access control issues as there are no access points in the immediate vicinity of the proposed diamond interchange. If at a future date an access in the vicinity of the interchange is constructed it should be a minimum of 300' away from the proposed interchange ramps.

Right-of-Way

Since the interchange will be relocated to the north, a considerable amount of right of way will be required to construct the proposed improvements. A total of 32.0 acres of right of way will be necessary to construct the diamond interchange and connection to Military Road. A right of way width of 80' is recommended for the future dike road and new frontage road. The proposed improvements will also require the acquisition and relocation of the business located between I-29 and Military Road, and the business located on the east side of Military Road. The right of way associated with the remainder of the future dike road to the west of the frontage road intersection was not calculated.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the diamond interchange and other proposed improvements. Design and construction of the diamond interchange, frontage road and connection to Military Road is estimated at $6.06 million. This includes the grade separation over the railroad and Military Road. A breakdown of the quantities and construction costs is included in the Appendix.

Alternative #2 – Single Point Interchange

This concept is shown in Figure 28. It is difficult to construct a single point interchange when the crossroad is skewed to the interstate. Therefore, in order to eliminate the skew, the alignment of the future dike road was shifted to provide a more perpendicular crossing of I-29.

Geometry

The single point interchange shown in the figure is a very compact design, which works well with the proximity of the railroad and Military Road to the east. As was the case with the diamond interchange concept, a grade separation is provided over both the railroad and Military Road. The number of lanes and the length of left turn storage length required is the same as for the diamond interchange concept. The length of frontage road that needs to be constructed is less due to the shifted alignment of the future dike road.

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The capacity analysis performed for the single point interchange indicates that this configuration will operate at acceptable levels of service through the Year 2020.

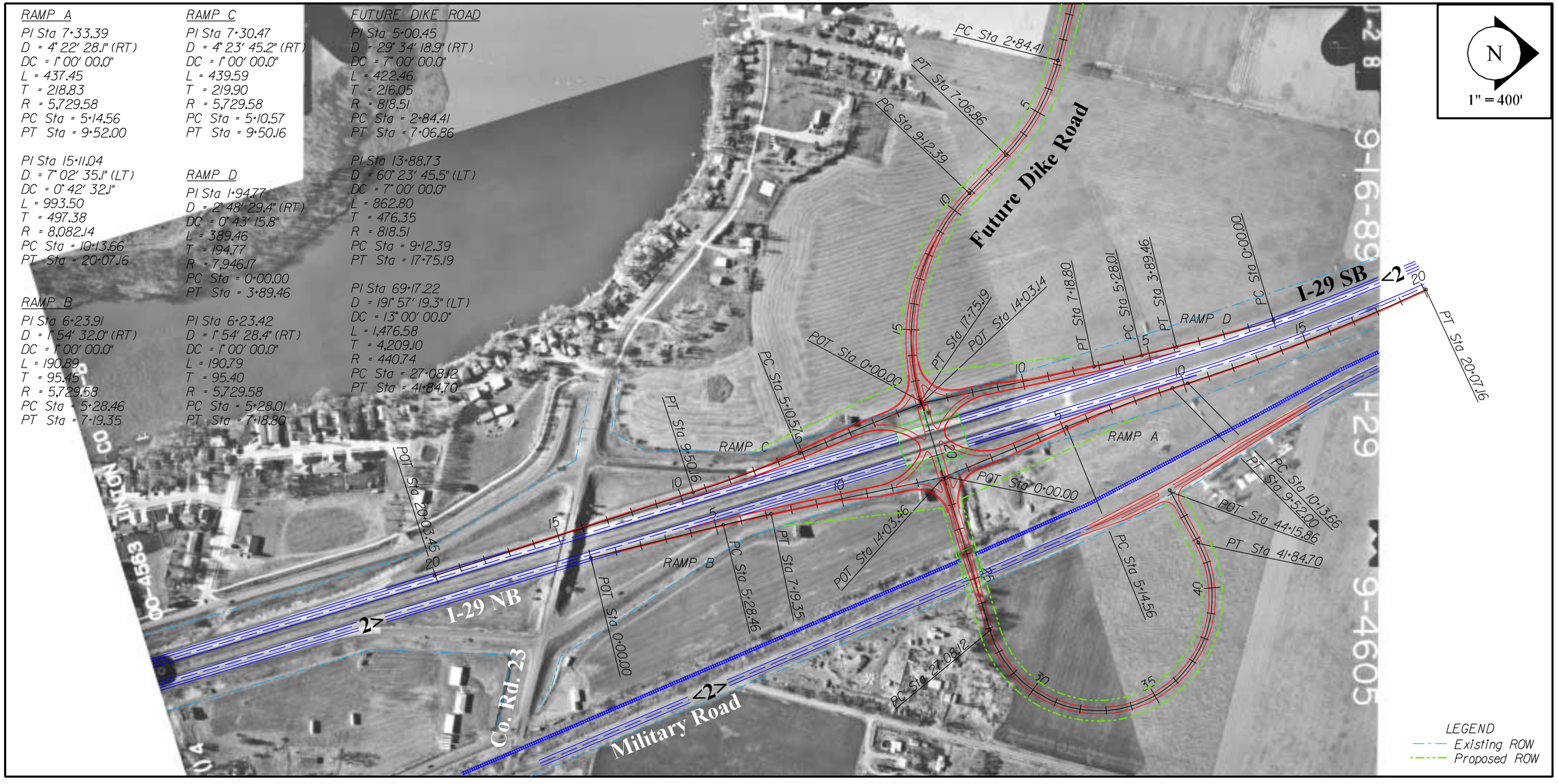

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Figure 28
I-29 Exit 4
McCook Lake, No. Sioux City
Single Point Interchange

Capacity Analysis with Single Point Interchange

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
Single Point Interchange	D	N/A	A	B	Acceptable

Access Control

There are no major access control issues as there are no access points in the immediate vicinity of the proposed diamond interchange. If at a future date an access in the vicinity of the interchange is constructed it should be a minimum of 300' away from the proposed interchange.

Right-of-Way

Since the interchange will be relocated to the north, a considerable amount of right of way will be required to construct the proposed improvements. A total of 12.9 acres of right of way will be necessary to construct the single point interchange and connection to Military Road. A right of way width of 80' is recommended for the future dike road and new frontage road. The proposed improvements will also require the acquisition and relocation of the business located between I-29 and Military Road. With this alignment, the business located on the east side of Military Road can remain. The right of way associated with the remainder of the future dike road to the west of the frontage road intersection was not calculated.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the single point interchange and other proposed improvements. Design and construction of the interchange, frontage road and connection to Military Road is estimated at $8.74 million. This includes the grade separation over the railroad and Military Road. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 79 – 12th Street, Sioux Falls

This interchange is currently programmed for reconstruction in the Year 2004. Along with the proposed interchange improvements, I-29 will be widened to provide three lanes in each direction from 41st Street (Exit 77) to SD 38 (Exit 38). The segment of 12th Street, from I-29 to Marion Road, is also scheduled for widening during 2004. At that time the 12th Street segment will consist of a six-lane section.

The area surrounding the interchange is highly developed close to the interchange, particularly on the west side. As a result, there are some constraints on potential interchange improvements. Due to the projected traffic volumes and heavy turning movements near the on and off ramps, proposed improvements must be able accommodate the traffic flow and minimize the impacts to the adjacent properties. A single point interchange was developed in Phase I of this study to address these issues. As a part of the Phase II study, further investigation has been performed to evaluate geometric and operational characteristics of the proposed concept for reconstruction of the interchange. The results of the Phase II investigation are summarized below along with selected information from Exit 79 Phase I analysis.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange. Every ramp at this interchange was found to have some geometric deficiencies. The as-built plans indicate that the clear zone provided on Ramps B and D is less that 30'. The grade on Ramp C is 6%, which exceeds the design criteria. The on-ramp taper rates for Ramps A and C are below the design criteria of 50:1. The profiles on several of the ramps are slightly below the 50 mph design criteria.

Traffic Safety

This interchange ranks 7th out of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is considered one of the high accident locations. A detailed accident analysis was conducted at this interchange to determine if any accident trends are present that could be addressed by the development of alternative interchange concepts. The predominate accident type at this interchange is rear-end accidents. A total of 54 rear-end accidents occurred during the three-year evaluation period at the two ramp intersections. The largest number occurred on the northbound off-ramp. Westbound rear-end accidents at the west ramp intersection were also

relatively high. The other predominate accident type at this interchange is associated with the turning movements at the ramp intersections. A total of 33 left turn and right angle accidents were reported during the three-year period. The accidents related to turning movements were relatively evenly distributed on all of the ramps.

Capacity

Most of the existing traffic operations at the Exit 79 interchange are within the acceptable range, except for the eastbound left turn at the northbound off-ramp intersection, and the southbound right turn movement at the southbound off-ramp intersection. Future traffic operations are expected to be problematic if no interchange improvements are made. As shown in the table below, analysis of projected future traffic conditions in both the Year 2010 and 2020 indicated that there would be a number of movements operating at or above capacity at each intersection.

I-29/12th Street 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	
12th Street/ I-29 NB Ramps	1998	Sig.	C	-	A	-	-	-	E	A	-	-	C	A	B
12th Street/ I-29 SB Ramps	1998	Sig.	-	-	-	D	-	F	-	C	-	D	A	-	C
12th Street/ I-29 NB Ramps	2010	Sig.	E	-	A	-	-	-	E	A	-	-	D	A	C
12th Street/ I-29 SB Ramps	2010	Sig.	-	-	-	D	-	F	-	E	-	D	A	-	D
12th Street/ I-29 NB Ramps	2020	Sig.	E	-	A	-	-	-	F	A	-	-	E	A	D
12th Street/ I-29 SB Ramps	2020	Sig.	-	-	-	D	-	F	-	F	-	F	A	-	D

Along with the analysis performed on the intersection movements, the movements on the interchange ramps were also analyzed. All of the existing ramp movements and future projected ramp movements operate at an acceptable LOS of C or better. The results of the ramp analysis are shown in the following table.

For the year 2010 and 2020 ramp and interchange analyses, the currently scheduled improvements were included. These improvements included the widening of I-29 to three lanes in each direction and adding storage length to the left turn lanes off of 12th Street onto the northbound and southbound on ramps.

I-29/12th Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	1998	Merge	B
		Diverge	B
I-29 Southbound	1998	Merge	C
		Diverge	B
I-29 Northbound	2010	Merge	B
		Diverge	B
I-29 Southbound	2010	Merge	B
		Diverge	B
I-29 Northbound	2020	Merge	C
		Diverge	C
I-29 Southbound	2020	Merge	C
		Diverge	B

Proposed Interchange Alternatives

Based on the geometric deficiencies and capacity problems stated previously, a complete reconstruction of the interchange is warranted. When it becomes necessary to reconstruct this interchange, the opportunity of implementing an entirely different interchange type may exist. The new interchange design was limited by existing characteristics and development in the vicinity of the interchange. Due to the amount of development surrounding the interchange and the limited right away available, it was determined that a single point urban interchange would have the least impact on adjacent development and still provide adequate capacity to accommodate the heavy turning movements. A functional design of the proposed interchange is shown in Figure 29.

Geometry

In order to accommodate the projected traffic volumes, it will be necessary to widen 12th Street to a six-lane cross section, with a raised median and dual left turn lanes. The dual left turn lanes will be able to accommodate the future traffic movements from 12th Street onto the northbound and southbound on ramps. The City of Sioux Falls has expressed concern with regard to the merging movements on the on-ramps created by the dual left turn lanes from 12th Street. It is suggested that the raised median begin at the interchange and extend two blocks to the west and one block to the east. The single point interchange configuration provides free right turns for the eastbound and westbound movements from 12th Street to the I-29 on-ramps.

Traffic Safety

The current interchange is considered a high accident interchange with the accident history over the last three years. The installation of a SPUI would represent a change from the existing type of interchange and may result in a slight increase at first because of a driver's unfamiliarity with the interchange configuration. However, it is anticipated that the accident frequency will decrease over time as the drivers become more familiar with the SPUI layout.

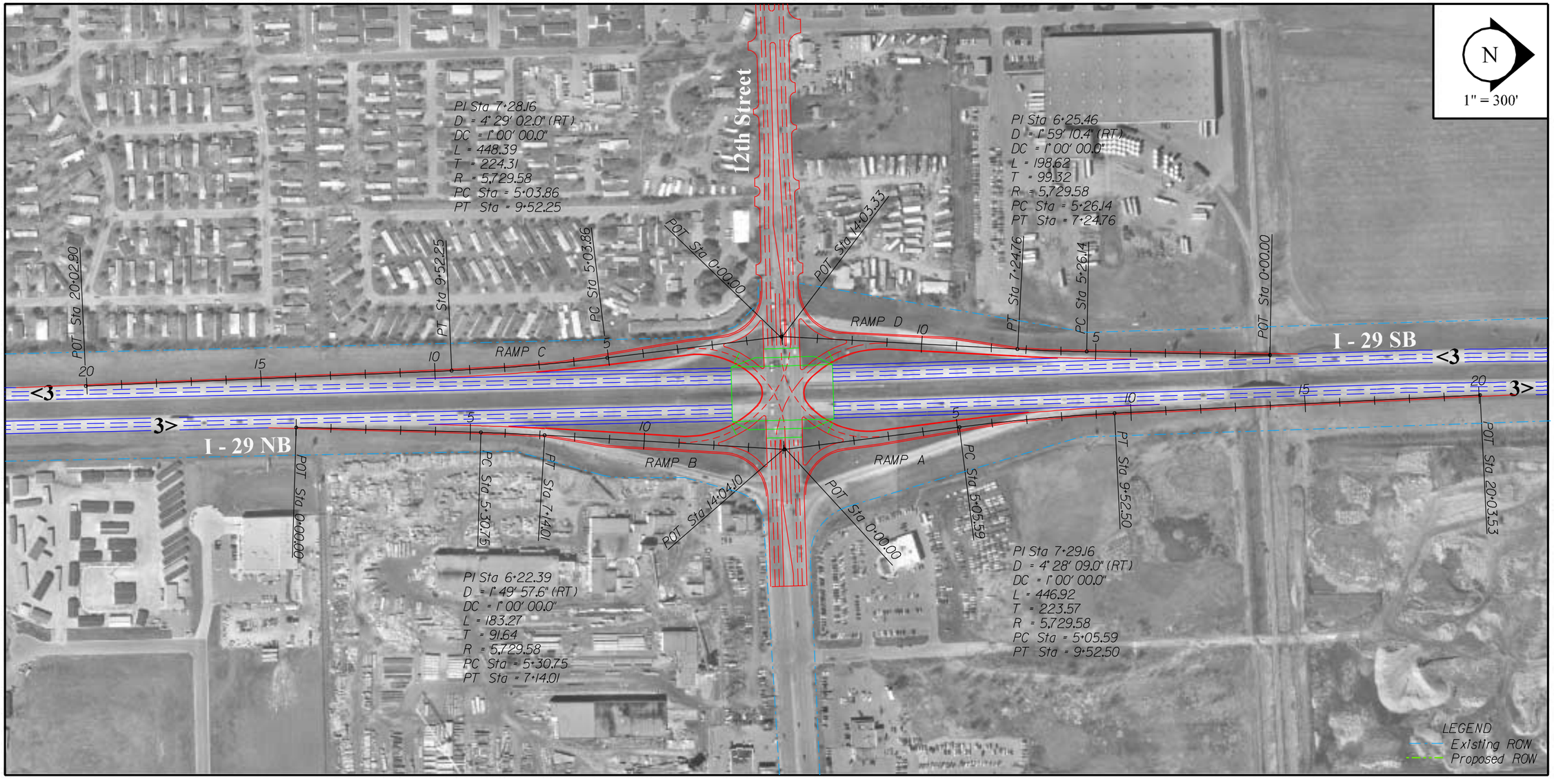

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Figure 29
I-29 Exit 79
12th Street, Sioux Falls
Single Point Interchange

Capacity

With the SPUI concept, the number of signalized intersections on 12th Street would be reduced. Analysis of the traffic movements for Year 2010 and 2020 was performed and the results are depicted in the following table. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service through the Year 2020. All of the traffic movements operate at an acceptable level of C or better.

I-29/12th Street 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	
12th Street/ I-29 SPUI	2010	Sig.	C	-	-	C	-	-	D	C	-	C	B	-	C
12th Street/ I-29 SPUI	2020	Sig.	C	-	-	C	-	-	D	C	-	C	C	-	C

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for Year 2010 and 2020. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better.

I-29/12th Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2010	Merge	B
		Diverge	B
I-29 Southbound	2010	Merge	B
		Diverge	C
I-29 Northbound	2020	Merge	C
		Diverge	C
I-29 Southbound	2020	Merge	C
		Diverge	B

Access Control

With the new SPUI design and construction of a raised median on 12th Street, there are instances where access would differ from existing conditions. To the west of the interchange, the median would extend two blocks and would affect the turning movements at four driveways on the north side of 12th Street. All four of the driveways affected by the median allow for free movements currently, but would be changed to only right-in/right-out (RIRO) access. These driveways serve as access for a truck stop, a residence, and a fast food restaurant. The first break in the median could be provided at the intersection of 12th Street and South Petro, as shown in the figure. On the south side, the raised median would change five driveways into RIRO access. These driveways are mainly for a residential subdivision and a hotel.

The heavy truck traffic along this section of 12th Street may have difficulty maneuvering with the raised medians. A thorough access management study, with participation from the City of Sioux Falls and the adjacent property owners should be conducted at the time of design of the proposed single point interchange.

Right-of-Way

It appears that the new SPUI interchange will be able be constructed within the available right of way. The SPUI interchange is a more compact design and the ramps would be able to fit inside the limits of the existing ramps.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the single point interchange. Construction of this concept is anticipated to be approximately $8.51 million. A breakdown of the quantities and construction costs is included in the Appendix. This includes the additional costs of widening 12th Street to provide dual left turn lanes through the interchange. It is assumed that the reconstruction of 12th Street from I-29 to Marion Road will include the remainder of the 12th Street construction costs.

I-29: Exit 80 - Madison Street, Sioux Falls

A new interchange is proposed at Madison Street and I-29 in the northwest portion of Sioux Falls. The Phase I analysis indicated that due to the proximity of deep rock quarries located on the east side of I-29, a single point interchange would be the preferred concept for this interchange. An interchange justification study was prepared for this interchange to provide a detailed evaluation of the proposed configuration, anticipated traffic operations and the impacts associated with construction. This section of the report summarizes the information developed in that study.

Proposed Interchange Concept

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study evaluated a single point urban interchange, a tight diamond interchange and the construction of frontage roads as alternative concepts. The evaluation in the justification study determined that a single point interchange was the preferred concept for this location. It was determined that the SPUI will operate with acceptable delay and will have significantly less right of way requirements compared to the diamond interchange alternative. A functional design of the proposed interchange is shown in Figure 30.

Geometry

In order to accommodate the projected traffic volumes, it will be necessary to widen Madison Street to a four-lane divided section, with a raised median and separate left turn lanes. At the interchange, dual left turn lanes from Madison Street to the I-29 on-ramps are provided. The City of Sioux Falls has expressed concern about the merging movements on the on-ramps created by the dual left turn lanes from Madison Street. The analysis indicated that 200' eastbound and westbound left turn lanes would accommodate the 95th percentile queue length. The single point interchange configuration provides free right turns for the eastbound and westbound movements from Madison Street to the I-29 on-ramps. A summary of the recommended vehicle storage lengths for the turning movements is shown in the following table.

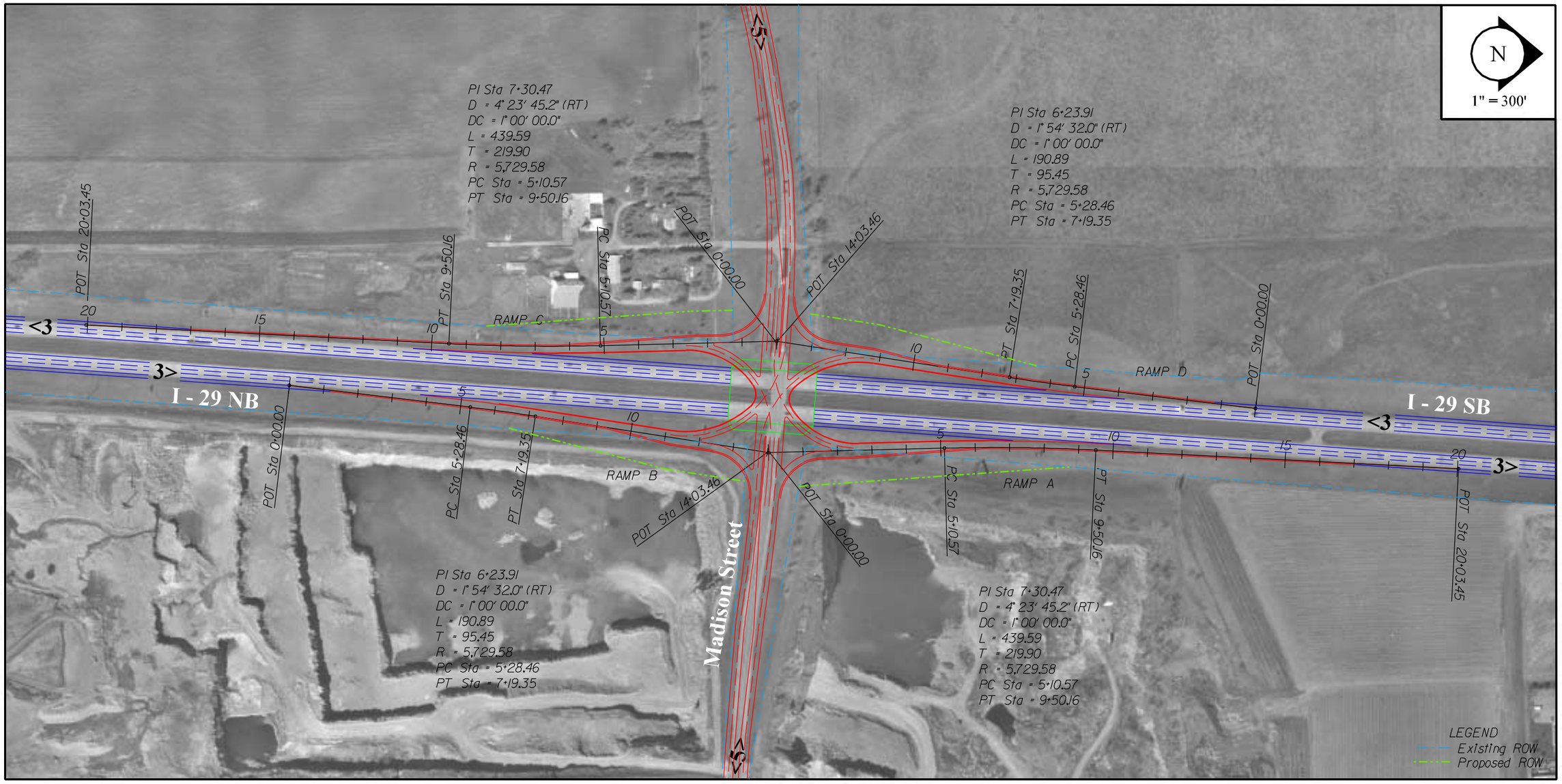

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Figure 30
I-29 Exit 80
Madison Street, Sioux Falls
Single Point Interchange

Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Madison Street Single Point Off-Ramps	Dual Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Dual Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Madison Street	Westbound Dual Left-turn	200 feet
	Eastbound Dual Left-turn	200 feet

The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and the free right turn lanes. However, since the cross section of Madison Street can accommodate dual left turn lanes from the off-ramps, it is recommended that the interchange be constructed with the dual left turn lanes. The concept shown in the figure provides approximately 250' of storage in one of the left turn lanes, and approximately 175' of storage in the other, which is considerably more than is required to accommodate the 95th percentile queue length.

Traffic Safety

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Madison Street will result in some accidents occurring on the ramps and at the intersections with Madison Street. In fact, the accident history at the single point interchange with 10th Street on I-229 has experienced accidents associated with driver's unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The requirements for analysis of future traffic operations for the interchange justification study were based on evaluation of the Year 2025 traffic volume projections. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information in the area, the analysis performed at this interchange utilized those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study. The results of the analysis are depicted in the table below. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

I-29/Madison Street 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	
Madison Street Single Point	2025	Sig.	C	-	-	C	-	-	C	B	-	C	B	-	B

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

I-29/Madison Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2025	Merge	C
		Diverge	B
I-29 Southbound	2025	Merge	C
		Diverge	C

Access Control

Since the property in the vicinity of the proposed interchange is currently undeveloped, with the exception of the farmstead located in the southwest quadrant, there is an opportunity to limit the access locations along Madison Street. On the east side of I-29, the rock quarries located on the north and south side of Madison Street will effectively prevent any access point being constructed within 800' to 1,000' of the interchange. On the west side of I-29, access to the farmstead in the southwest quadrant should either be restricted to right-in/right-out access or be relocated to provide a minimum of 400' from the beginning of the right turn lanes at the interchange. It appears that adequate right of way is available to relocate this driveway access.

Right-of-Way

The construction of the single point interchange will require minimal amounts of right of way. Triangular sections of right of way will be required in each quadrant of the interchange to accommodate construction of the ramps, totaling 3.7 acres.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the single point interchange at Madison Street is estimated at $7.13 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Madison Street through the interchange area. It is assumed that the widening of Madison Street will be constructed as a separate project.

I-29: Exit 81 - Russell / Maple, Sioux Falls

Several concepts for reconstruction of this interchange were developed and evaluated as a part of Phase I of this study. As a result of that evaluation and further detailed analysis by the South Dakota Department of Transportation, it was determined that the preferred concept for this interchange consists of a realignment of the Russell Street to provide a direct connection to the west to Maple Street. In addition to the realignment of the crossroad, the interchange concept provides loop ramps in the northwest and southeast quadrants to accommodate heavy turning movements onto the interstate. The new bridge on Maple/Russell Street should be designed with a sidewalk wide enough to accommodate a bicycle path.

Existing Interchange Characteristics

Geometry

The most notable geometric deficiency at this interchange is the left hand exit provided from southbound I-29 to the intersection with Maple and Russell Streets. The current interchange configuration is unconventional, and does not meet driver expectation. The turning movements at the intersection of Maple Street with Russell Street show that the major movement is the northbound to westbound left turn from Russell Street to Maple Street, and the eastbound to southbound right turn movement. In addition, the traffic control provided at the intersection on Maple Street with the southbound on-ramp requires the eastbound movement on Maple Street to stop and allows the westbound to southbound left turn movement, which is the heaviest, to turn without stopping.

Traffic Safety

This interchange ranks 5th out of the 62 interchanges evaluated in the study, with a three-year crash rate of 2.45 weighted accidents per million entering vehicles. A detailed accident analysis was conducted to determine if any accident trends are present that could be addressed by the development of alternative interchange concepts. The predominate accident types at this interchange are rear-end and out of control accidents. The number of intersections and various turning movements required at within the interchange area, along with the large volumes, appear to play a role in these types of accidents. The most prominent area for rear-end accidents is at the southbound off-ramp intersection with Maple Street and Russell Street. A total of 9 rear-end accidents occurred during the three-year evaluation period.

The other predominate accident type at this interchange is out of control vehicles. A total of 25 out of control vehicle accidents occurred during the three-year period. Eleven of these were on I-29 northbound, near the area where the northbound on-ramp from Russell Street merges with

the mainline. These accidents may be associated with the 4E curve on the northbound mainline in this area. Eight more out of control vehicles were involved in accidents on or near the I-29 southbound exit to Russell Street. Most of these accidents occurred during inclement weather conditions, with snow or ice on the roadway.

Capacity

The capacity analysis performed for the existing configuration of the Maple Street/Russell Street interchange indicates that the northbound off-ramp at Maple Street and the southbound off-ramp at Maple Street are currently operating at level of service F. With that being the case, the Year 2010 and 2020 analyses were conducted assuming traffic signalization has been installed at these two intersections. The northbound off-ramp is projected to operate at LOS B for the Year 2010, however, the southbound off-ramp remains at LOS F. By the Year 2020, both intersections are projected to operate at LOS F, even with signalization. In addition, the signalized intersection of Maple Street/Russell Street and the southbound off-ramp is projected to operate at LOS F in the Years 2010 and 2020. The merge and diverge analysis of the ramps with the I-29 mainline indicates that they will operate at acceptable levels of service through the Year 2020.

Proposed Interchange Concept

The preferred interchange configuration for this interchange begins with a realignment of the connection from Russell Street to Maple Street. The primary traffic movement at the intersection of Russell Street with Maple Street is the east/west directional movement. The concept consists of introducing a curve on Russell Street to the northwest to provide a direct connection to Maple Street to the west of I-29. This realignment creates significant impact to the property located in the southwest corner of the Maple/Russell Street intersection, which is mostly owned by the South Dakota DOT.

This realignment provides enough room to construct a loop ramp in the northwest quadrant of th interchange to accommodate the heavy westbound to southbound left turn movement onto the interstate. Another loop ramp is provided in the southeast quadrant. Although this left turn movement is not as heavy, configuration of the interchange makes it very difficult to construct a typical left turn movement with a direct on-ramp to northbound I-29. The left hand exit for the southbound off-ramp is replaced with a conventional direct off-ramp, which requires relocation of the frontage road in the northwest quadrant of the interchange. It also creates a conventional intersection with the southbound off-ramp and on-ramp.

The difficult movement to accommodate with this concept is the connection to Maple Street on the east side of I-29. In order to provide a direct connection to Maple Street without interfering with the northbound on-ramp connection from Russell Street, it is necessary to provide a grade separation structure, with the connection to Maple Street passing under the elevated northbound on-ramp. A separate connection from the east leg of Maple Street must also be provided to the northbound on-ramp. A conceptual design of the proposed interchange is shown

in Figure 31. The SDDOT is in the process of developing the preliminary design for this interchange.

Geometry

The realignment of the Russell Street/Maple Street connection will provide a typical four-lane divided cross section with separate left and right turn lanes to accommodate the projected traffic volumes. The construction of loop ramps at the interchange eliminates left turn movements from Maple Street onto I-29. The only left turn lane on this portion of Maple Street is to provide access to the continuation of Maple Street to the east. Separate right turn lanes are proposed for the eastbound and westbound approaches of Maple Street at the signalized intersections. The table below summarizes the right and left turn storage lengths required to accommodate the 95th percentile queue length.

Recommended Vehicle Storage Lengths

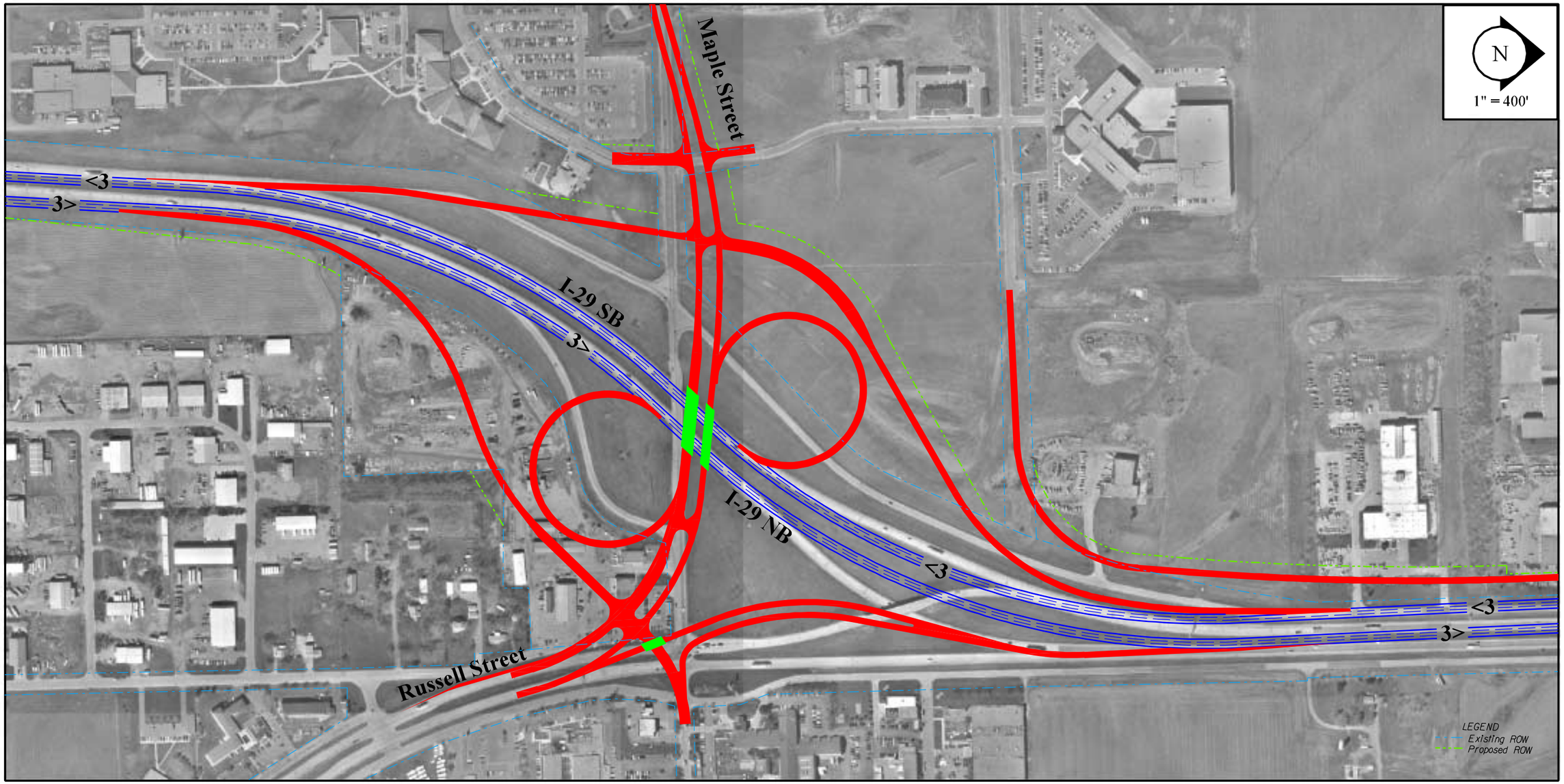
Intersection	Movement	Recommended Storage Length
Russell Street/ Maple Street/ NB Off-Ramp Intersection	Eastbound Left-turn	300 feet
	Northbound Right-turn	400 feet
	Northbound Dual Left-turn	200 feet
	Westbound Right-turn	150 feet
Maple Street/ SB Off-Ramp Intersection	Southbound Dual Left-turn	200 feet
	Southbound Right-turn	150 feet
	Eastbound Right-turn	150 feet

A three-lane section is proposed for the northbound and southbound off-ramps at the intersections with Maple Street. The configuration consists of dual left turn lanes and separate right turn lanes.

In addition to the construction of the interchange, it will be necessary to relocate the frontage roads on the east and west sides of I-29 to the north. As shown in the figure, the frontage road on the west side of I-29 can be relocated to connect with the existing roadway network in the development in the northwest quadrant of the interchange. On the east side, the frontage road connection to Maple Street must be eliminated to accommodate the proposed connection to the northbound on-ramp to I-29.

Traffic Safety

The construction of the proposed interchange to provide a more conventional interchange that meets driver's expectations should help to reduce the accident frequency at this location. In addition, the reconstruction will provide an opportunity to address the other geometric deficiencies present at the existing interchange.



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FELSBURG HOLT & ULLEVIG

Figure 31
I-29 Exit 81
Maple/Russell, Sioux Falls
Partial Cloverleaf Interchange w/ 2 Loop Ramps

Capacity

As a part of the interchange justification studies performed for the Madison Street and Benson Road interchanges, located one mile north and south of this interchange, Year 2025 traffic forecasts were developed for this interchange. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information in the area, the analysis performed at this interchange utilizes those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study.

Three roadway network scenarios were evaluated as a part of the two justification studies. Traffic projections were developed assuming the construction of a Madison Street interchange, the construction of a Benson Road interchange, and the construction of both new interchanges. For purposes of this analysis, the traffic forecasts used assumed that both new interchanges would be in place by the Year 2025.

The results of the capacity analysis are depicted in the table. As shown in the table, the partial cloverleaf interchange as shown in the figure will operate at acceptable levels of service in the Year 2025.

I-29/Russell/Maple 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	
Maple Street East Intersection	2025	Sig.	B	-	C	-	-	-	-	A	-	-	B	A	B
Maple Street West Intersection	2025	Sig.	-	-	-	B	-	C	-	A	A	-	A	-	A

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

I-29/Russell/Maple Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2025	Loop Merge	B
		Ramp Merge	B
		Diverge	B
I-29 Southbound	2025	Loop Merge	B
		Ramp Merge	B
		Diverge	B

Access Control

The major reconstruction of the Maple Street and Russell Street corridor through the interchange will provide an opportunity to clean up the location of access points in the vicinity of the interchange. On the west side of the interchange, the first full movement access point will be located approximately 300 feet from the intersection with the southbound off-ramp. On the east side, the closest intersection on Russell Street will be approximately 1,050 feet from the intersection with the northbound off-ramp.

Right-of-Way

The construction of the partial cloverleaf interchange will require a significant amount of right of way to accommodate the proposed interchange and the realignment of the Russell Street/Maple Street connection. The proposed improvements will require the relocation of the SDDOT and State Patrol facilities located in the southeast quadrant of the interchange. The SDDOT maintenance yard and State Patrol represents 19.5 acres of the total 40.3 acres of right of way required for this concept.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the partial cloverleaf interchange and realignment of the Russell Street/Maple Street connection is estimated at $11.5 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 82 - Benson Road, Sioux Falls

A new interchange is proposed at Benson Road and I-29 in the northwest portion of Sioux Falls. This interchange was not originally analyzed as a part of the Phase I study. However, an interchange justification study was prepared for this interchange in the Fall of 2000 to provide a detailed evaluation of the proposed configuration, anticipated traffic operations and the impacts associated with construction. This section of the report summarizes the information developed in that study.

Proposed Interchange Concept

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study evaluated a single point urban interchange, a typical diamond interchange and the use of the existing frontage roads as alternative concepts. The evaluation in the justification study determined that a single point interchange was the preferred concept for this location. It was determined that the SPUI will operate with acceptable delay and will have significantly less right of way requirements compared to the diamond interchange alternative. Due to the topography in the area of the interchange, it is recommended that the mainline of I-29 be constructed over the extension of Benson Road. A functional design of the proposed interchange is shown in Figure 32.

Geometry

In order to accommodate the projected traffic volumes, it will be necessary to widen Benson Road to a four-lane divided section, with a raised median and separate left turn lanes. At the interchange, single left turn lanes from Benson Road to the I-29 off-ramps are provided. The analysis indicated that 200' of storage would accommodate the 95th percentile queue length for all of the left turn movements, with the exception of the westbound left turn, which will require 450' of storage. The single point interchange configuration also provides free right turns for the eastbound and westbound movements from Benson Road to the I-29 on-ramps.

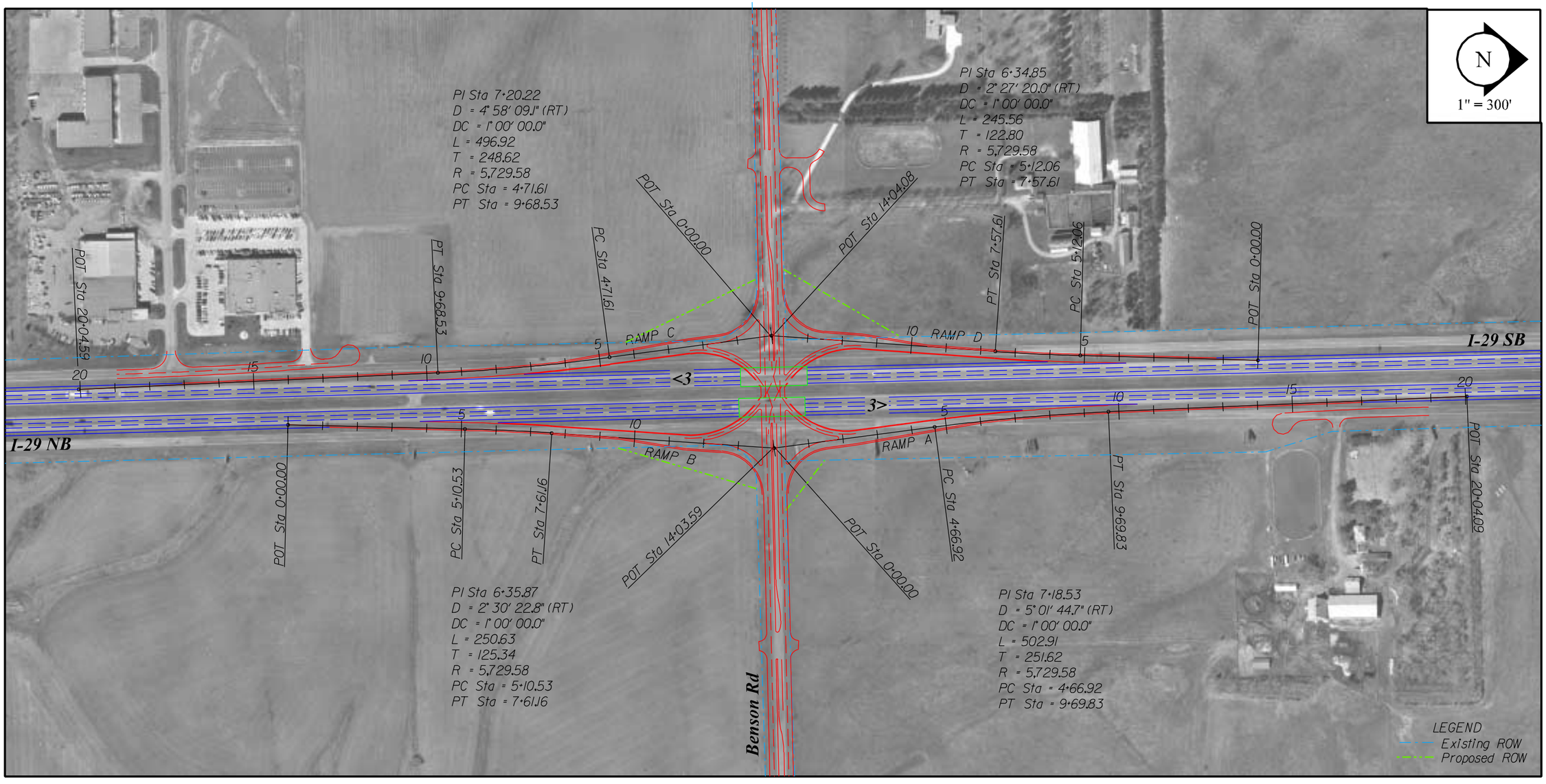

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Figure 32
I-29 Exit 82
Benson Road, Sioux Falls
Single Point Interchange

Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Benson Road Single Point Off-Ramps	Dual Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Dual Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Benson Road	Westbound Single Left-turn	450 feet
	Eastbound Single Left-turn	200 feet

The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and the free right turn lanes. However, since the cross section of Benson Road can accommodate dual left turn lanes from the off-ramps, it is recommended that the interchange off-ramps be constructed with the dual left turn lanes. The concept shown in the figure provides approximately 250' of storage in one of the left turn lanes, and approximately 175' of storage in the other, which is considerably more than is required to accommodate the 95th percentile queue length.

The mainline of I-29 will be widened to provide three-lanes in each direction in the near future. The topography in the vicinity of the proposed interchange is best suited to having the interstate mainline pass over the extension of Benson Road. This will require the construction of twin bridges on I-29 over Benson Road along with fill material required on the approaches to the structures.

In addition to the construction of the interchange, it will be necessary to eliminate the frontage roads on the east and west sides of I-29 in the vicinity of the interchange. As shown in the figure, the frontage road on the east side of I-29, north of Benson Road, will terminate at the driveway to provide access to the property. Similarly, the frontage road on the west side of I-29, south of Benson Road will also terminate at the northern driveway of the property located southwest of the interchange.

Traffic Safety

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Benson Road will result in some accidents occurring on the ramps and at the intersections with Benson Road. In fact, the accident history at the single point interchange with 10th Street on I-229 has experienced accidents associated with driver's unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well. Since two separate structures will be provided on I-29 over Benson Road, icy conditions during inclement weather will not be as significant as created by one large structure when the turning movements are above the interstate mainline. The narrower bridges and the separated by a median will reduce the area of icing created by the shadow of the structure.

Capacity

The requirements for analysis of future traffic operations for the interchange justification study were based on evaluation of the Year 2025 traffic volume projections. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information, the analysis performed at this location utilized those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

I-29/Benson Road 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	
Benson Road Single Point	2025	Sig.	D	-	-	D	-	-	C	A	-	C	A	-	B

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

I-29/Benson Road Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2025	Merge	C
		Diverge	B
I-29 Southbound	2025	Merge	C
		Diverge	B

Access Control

Since the property in the vicinity of the proposed interchange is currently undeveloped, with the exception of the farmstead located in the northwest quadrant, there is an opportunity to limit the access locations along Benson Road. On both sides of I-29, the first access point should be the intersection with the relocated frontage roads. These intersections should be located a minimum of 400' from the end of the return for the right turn lanes at the interchange. Beyond that access location, desirable spacing to the next full movement intersection should be limited to 600'.

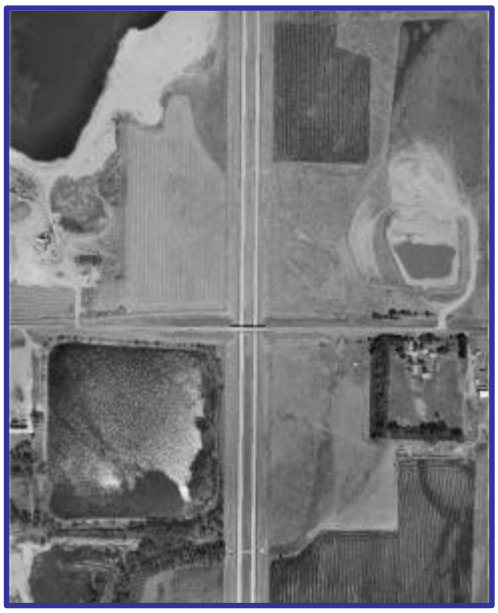
Right-of-Way

The construction of the single point interchange will require minimal amounts of property beyond the available interstate right of way. A total of 2.2 acres of right of way is required to construct the concept shown.

Probable Construction Costs

A statement of probable construction costs was prepared for the proposed construction of the interchange. Design and construction of the single point interchange at Benson Road is estimated at $7.94 million. Another element of the project is the cost of elevating the mainline of I-29 over Benson Road. The preliminary cost estimate for design and construction of the mainline reconstruction is $2.66 million. The bridges and approach slabs are included in the cost of the interchange. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Benson Road through the interchange area. It is assumed that the paving and widening of Benson Road will be constructed as a separate project.

I-29: Exit 129 – C.R. 26, Brookings



The city of Brookings is proposing that an interchange be constructed at the cross road located 3 miles south of U.S. 14 (Exit 132). The Phase I investigation stated that this interchange will serve the expected new development in the area and divert some traffic from Exit 132. There has been a considerable amount of growth in the southern portion of Brookings, and this growth is expected to continue over the next 20 years. This new interchange would provide direct access to the interstate for much of this development, while allowing traffic from currently using Exit 132 to use a less congested route. This Phase II analysis will further evaluate geometric and operational characteristics of the proposed interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 129 Phase I analysis.

Proposed Interchange Alternatives

Since this is a new interchange, there are no limitations in place by an existing structure or interchange. However, there are a few constraints that affect the design of an interchange at this site. There are two lakes in the vicinity of the proposed interchange location; one in the southwest quadrant and the other in the northwest quadrant. Due to the location of the lake in the southwest quadrant, it is necessary to provide a partial cloverleaf design, with a loop in the northwest quadrant to provide access to southbound I-29. The lake located in the northwest quadrant is located far enough to the west to provide the necessary room for construction of the loop ramp. Due to these constraints, only the partial cloverleaf design alternative was evaluated for this proposed interchange.

Geometry

The Partial Cloverleaf Interchange alternative is depicted on Figure 33. The interchange concept was developed to meet the criteria found in the SDDOT Roadway Design Manual. As shown in the figure, the design is a partial cloverleaf with the loop ramp in the northwest quadrant. There is enough room in the northwest quadrant of the interchange to accommodate both the loop ramp and the southbound off-ramp in the same quadrant. Each of the ramps provides for one lane of travel, with widening to provide separate left and right turn lanes at the intersections with the crossroad. County Road 26 should remain a two lane road, with widening at the ramp intersections to provide separate left turn lanes.

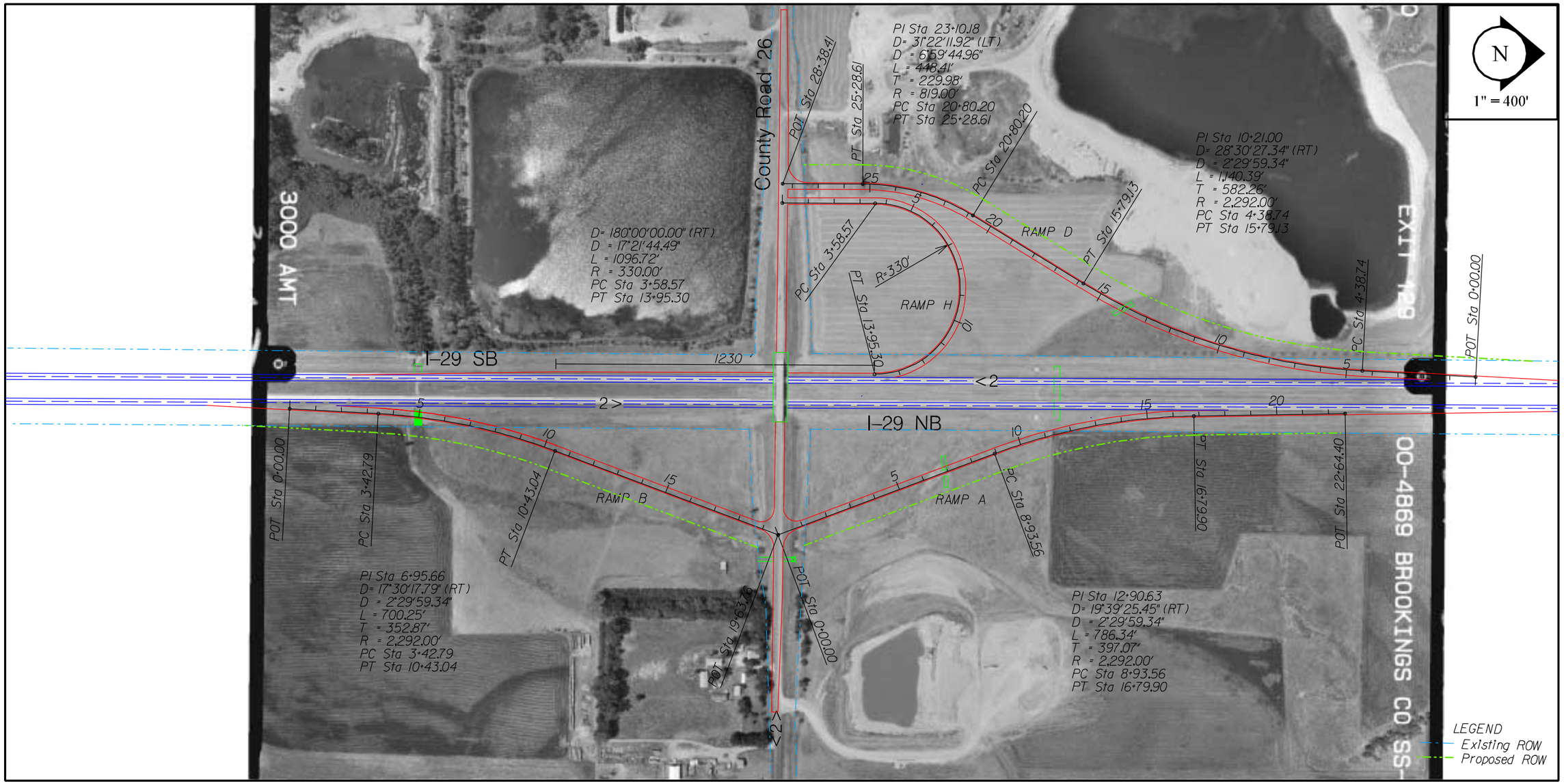


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Figure 33
I-29 Exit 129
C.R. 26, Brookings
Partial Cloverleaf Interchange

Traffic Safety

Since this is a new interchange, there is no accident history for existing conditions. Although the construction of a new interchange will result in some accidents at this location, it is anticipated that this alternative would not create unusual safety concerns.

Capacity

The two intersections with the county road will provide stop sign control for the off-ramps. The projected traffic volume at each of the intersections does not meet the MUTCD traffic warrants and would operate sufficiently with no signalization. All of the traffic movements are projected to operate at an acceptable level of C or better. The level of service (LOS) for all of the projected turning movements for both the 2010 and the 2020 are shown below.

Intersection 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	
C.R. 26/ I-29 NB Ramps	2010	Unsig.	C	-	-	-	-	-	A	-	-	-	-	-	-
C.R. 26/ I-29 SB Ramps	2010	Unsig.	-	-	-	B	-	-	-	-	-	A	-	-	-
C.R. 26/ I-29 NB Ramps	2020	Unsig.	C	-	-	-	-	-	A	-	-	-	-	-	-
C.R. 26/ I-29 SB Ramps	2020	Unsig.	-	-	-	B	-	-	-	-	-	A	-	-	-

The level of service of the ramp movements was also analyzed. All of the ramp movements in both the Year 2010 and the Year 2020 are projected to operate at LOS A. The LOS of the ramp movements for 2010 and 2020 are shown in the table below.

I-29/Exit 129 Ramp Movement Level of Service Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2010	Merge	A
		Diverge	A
I-90 Southbound	2010	Merge	A
		Diverge	A
I-29 Northbound	2020	Merge	A
		Diverge	A
I-90 Southbound	2020	Merge	A
		Diverge	A

Access Control

Access along the county road should be restricted within 300' of the ramp intersections, if possible.

Right-of-way

There is a considerable amount of right-of-way that must be acquired to construct the new interchange. The estimated area required is approximately 32.2 acres. There should not be any major impacts to homes or businesses associated with the acquisition of the necessary right-of-way around the proposed interchange

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the partial cloverleaf interchange. Construction of this concept is anticipated to be approximately $5.63 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 132 – US 14, Brookings

The interchange located at Exit 132 on I-29 does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. The geometric deficiencies of the ramps are minor, and can be corrected at the time of pavement reconstruction. With the installation of traffic signals, the interchange is projected to operate at acceptable levels of service. In addition to the traffic signalization, it is recommended that the southbound right turn lane on Ramp D be constructed to provide 200' of storage. There is also concern about pedestrian access across I-29, once the new ice rink and the new events facility are constructed on the east side of the interstate.

Ultimately, if traffic volumes warrant, the construction of a loop ramp in the northeast quadrant would be necessary to reduce the impact from northbound left turns and avoid a new hotel that has been constructed in the southeast quadrant. Access control along US 14 to the east and west should also be addressed at the time of improvements.

Existing Interchange Characteristics

Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 1000' between the interchange ramp intersections. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto US 14. The cross section of US 14 is a five-lane divided section, with a wide median.

Traffic Safety

This interchange ranked 21st out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 35 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the US 14 interchange indicates that the ramp intersections are currently operating at level of service C. By the Year 2020, the northbound ramp intersection is projected to operate at LOS E and the southbound ramp intersection at LOS F, with the existing unsignalized intersections.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	A	Acceptable
NB Merge	C	A	A	A	Acceptable
SB Diverge	C	A	A	A	Acceptable
SB Merge	C	A	A	A	Acceptable
West Intersection	D	C	F	F	Unacceptable
East Intersection	D	C	C	E	Unacceptable

Proposed Interchange Concept

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at unacceptable levels in the year 2010 and 2020. Signalization of the ramp terminals and the extension of the southbound off ramp right turn storage is anticipated to provide acceptable levels of service at the terminals. However, in the event that it becomes necessary to reconstruct the interchange due to higher traffic volumes, an alternative to the existing diamond interchange, a partial cloverleaf interchange concept was also developed for this location. A functional design of the proposed partial cloverleaf interchange is shown in Figure 34.

Geometry

For the existing diamond interchange, only a few modifications are necessary to provide acceptable traffic operations in the Year 2020. Based on the traffic projections, it is recommended that a right turn lane with 200' of storage be provided on the southbound off ramp to accommodate that heavy turn movement, along with the installation of traffic signals at both ramp intersections. If a raised median is constructed along US 14, 200' of storage should be provided for the eastbound and westbound left turn lanes.

The construction of partial cloverleaf interchange at Exit 132 has been restricted somewhat due to recent development in the area. A hotel was recently constructed in the southeast quadrant of the interchange, which restricts the ability to reconstruct the interchange with a northbound to westbound free right loop ramp. With that concept, it would be necessary to reconstruct the northbound off-ramp further to the east to align with the northbound on-ramp on the north side of US 14. Therefore, the loop ramp shown in the figure provides for both right and left turns onto US 14. Signalization will be required at this intersection to provide acceptable traffic operations.

If at a later date it is determined that US 14 needs to be reconstructed, consideration should be given to narrowing or eliminating the median. One advantage to this option is that only one structure over I-29 would be needed.

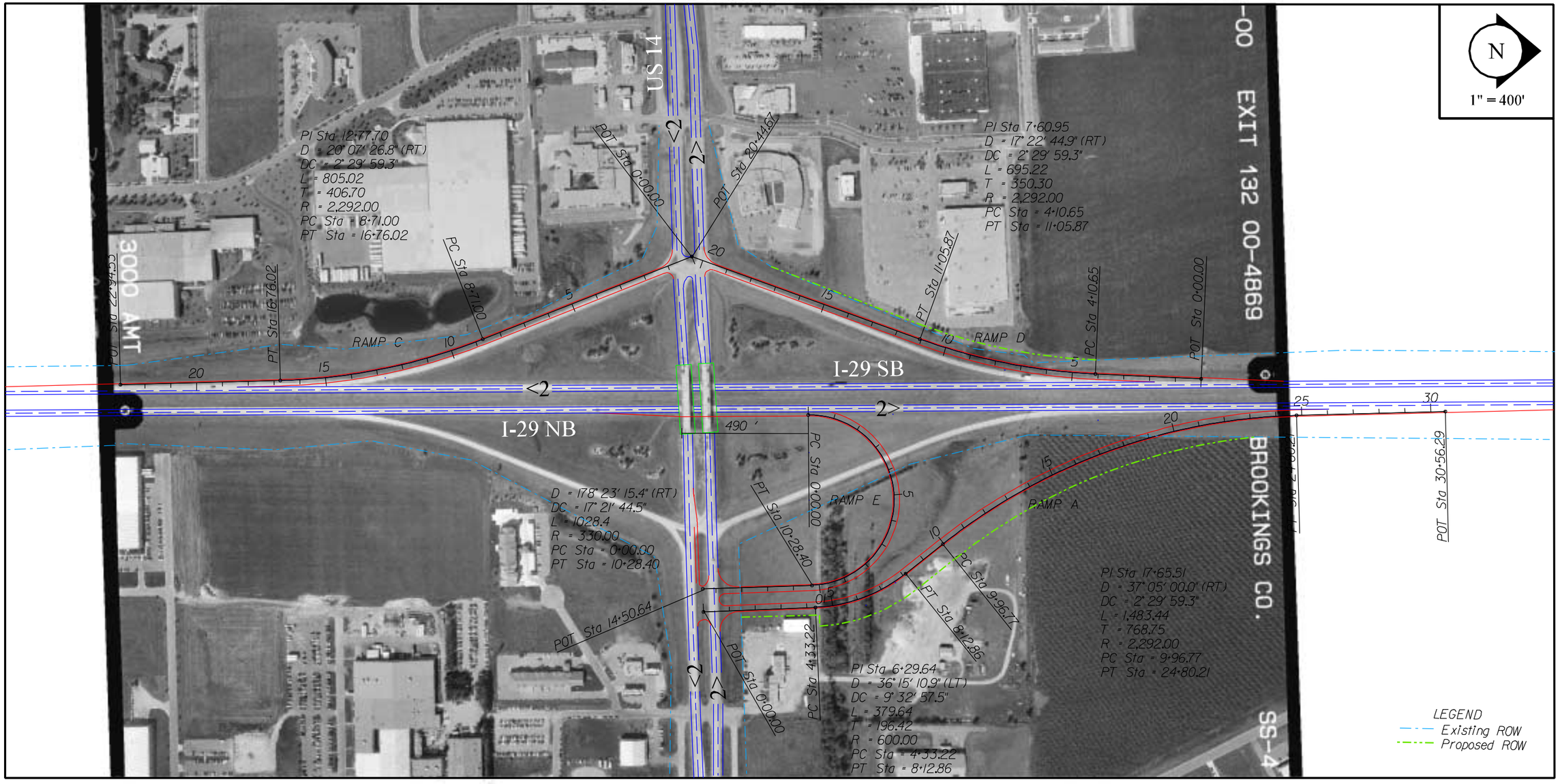

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Figure 34
I-29 Exit 132
U.S. 14, Brookings
Partial Cloverleaf - NE Quadrant

Traffic Safety

The construction of a partial cloverleaf interchange is not anticipated to adversely affect the safety of the interchange.

Capacity

The capacity analysis performed for the partial cloverleaf interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.

I-29/US 14 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	
US 14 Partial Cloverleaf East Ramps Terminal	2020	Sig.	-	-	-	C	-	A	A	A	-	-	A	-	A
US 14 Partial Cloverleaf West Ramps Terminal	2020	Sig.	-	-	-	B	-	A	-	A	A	A	A	-	A

Access Control

In the immediate area of the interchange the existing access management is acceptable. Further to the north and south consideration should be given at the time of reconstruction to the use of a five lane divided section and the reduction of the access points to adjacent properties to as few as possible. This will improve traffic flow through the corridor and increase the safety in the area.

Right-of-Way

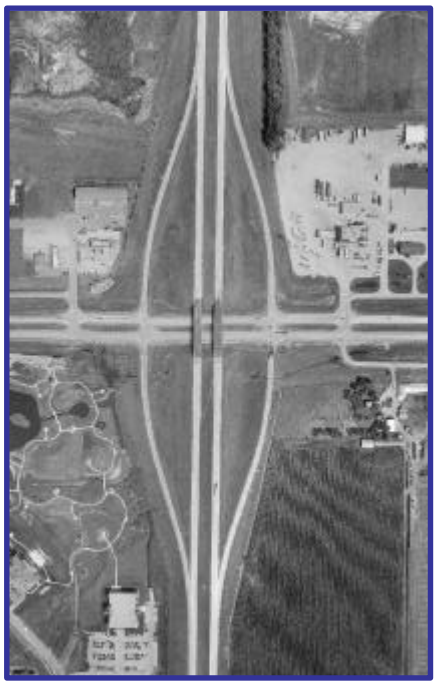
The South Dakota Department of Transportation owns the property located in the northeast quadrant of the interchange. This facility will be relocated within the next several years, which presents an opportunity to construct the partial cloverleaf interchange. A total of 13.2 acres of right of way will be required to construct the concept shown in Figure 34. The majority of the right of way is associated with the construction of the ramps in the northeast quadrant. However, some right of way will also be required in the northwest quadrant to reconstruct that southbound off-ramp to meet current design criteria.

Probable Construction Costs

A statement of probable construction costs was prepared for the installation of traffic signals for the existing diamond interchange and for construction of the partial cloverleaf interchange. The installation of the traffic signals and construction of a southbound right turn lane are estimated at $365,000. The design and construction of the interchange is estimated at $6.3 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-29: Exit 177 – US 212, Watertown

The capacity analysis performed for this interchange in the Phase I study indicated that the diamond interchange configuration will require some minor modifications in order to accommodate the Year 2020 traffic volumes. Traffic signalization is recommended at each of the ramp intersections, along with the construction of separate right turn lanes on the off-ramps. Due to the close proximity of adjacent access points on US 212, a single point interchange concept was also developed. The single point configuration has the ability to accommodate considerably more traffic through the interchange, should any future development result in a significant increase in traffic above the levels forecast. It will also provide an opportunity to improve the minor geometric deficiencies of the present interchange.



Existing Interchange Characteristics

Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently unsignalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto US 212. The cross section of US 212 is a four-lane divided section, with a wide median. Separate left turn lanes are provided at the major intersections.

Traffic Safety

This interchange ranked 17th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 19 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the Exit 177 interchange indicates that all of the traffic movements are currently operating at level of service B. By the Year 2020, the northbound ramp intersection is projected to operate at LOS F and the southbound ramp intersection at LOS D, without the installation of traffic signals.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	A	Acceptable
NB Merge	C	A	A	A	Acceptable
SB Diverge	C	A	A	A	Acceptable
SB Merge	C	A	A	A	Acceptable
East Intersection	D	B	D	**F**	**Unacceptable**
West Intersection	D	B	C	D	Acceptable

Proposed Interchange Alternatives

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels with the construction of separate right turn lanes on the off-ramps and the installation of traffic signals at both ramp intersections. As an alternative to these improvements, a single point interchange concept was also developed for this location.

Alternative #1 – Signalization and Access Management

The first alternative simply consists of the construction of a separate right turn lane for both the northbound and southbound off-ramps and the installation of traffic signals at both intersections. A functional design of the proposed improvements is shown in Figure 35.

Geometry

In addition to the separate right turn lanes on the off-ramps, there are a few other geometric modifications recommended along US 212 to provide improved sight distance for left turning vehicles at the major intersections. With the wide median, vehicles in the opposing left turn lane restrict the distance to see on coming through traffic. One effective method to improve the sight distance is to reconstruct the left turn lane closer to the opposing through lanes as shown in the figure. This also helps to reduce the distance the left turning vehicle must travel through the intersection. Storage lengths for the left turn lanes along US 212 should provide 200' of storage, which is more than adequate to accommodate the projected traffic volumes. The northbound and southbound right turn lanes on the off-ramps should provide 150' of storage.

Traffic Safety

The construction of the proposed improvements will improve traffic operations along US 212, and should result in a reduction in accidents at the interchange and adjacent intersections.

Capacity

As previously stated, the interchange will operate at acceptable levels for the Year 2020 with the proposed improvements.

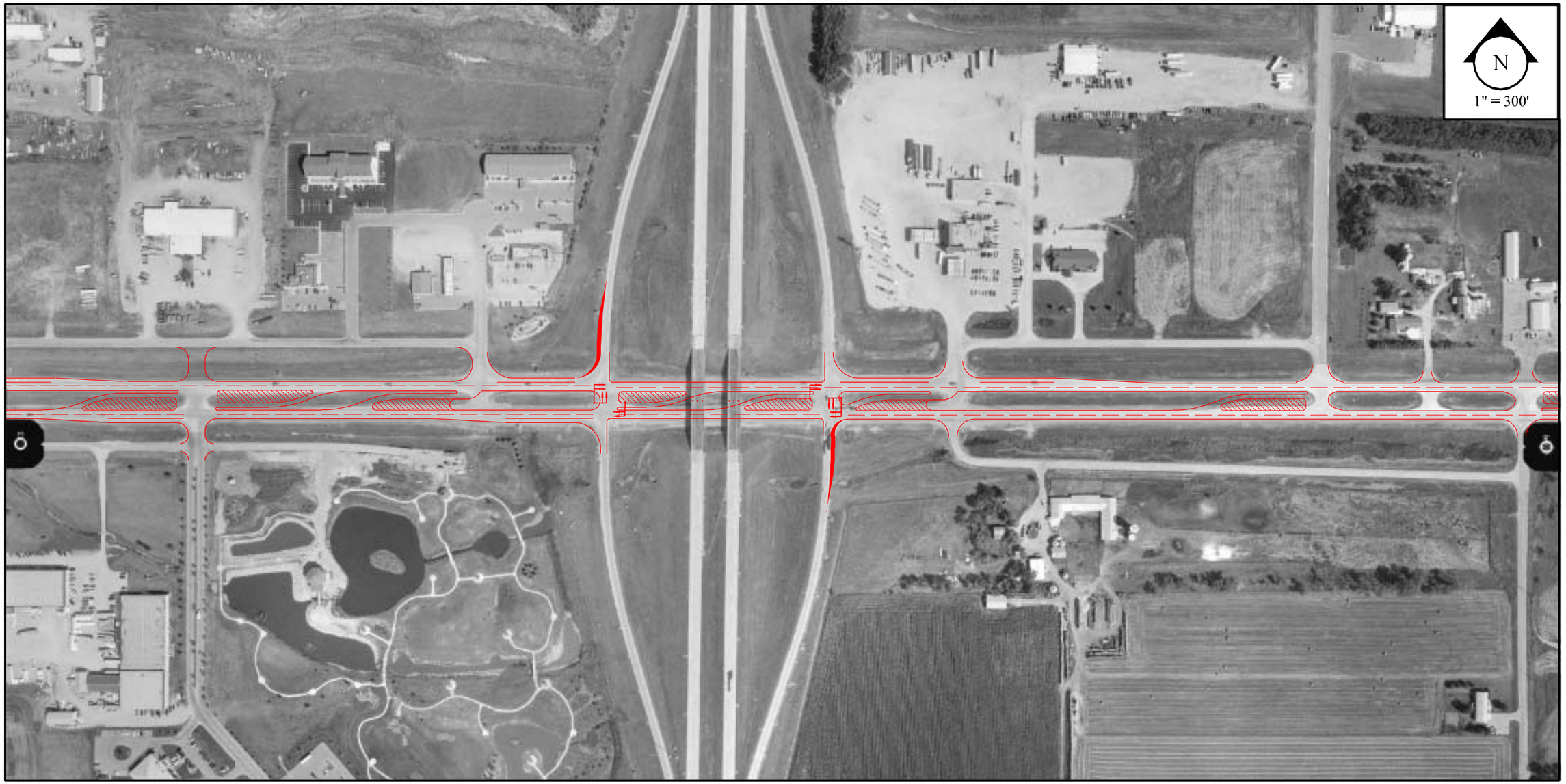


Figure 35
I-29 Exit 177
U.S. 212, Watertown
Traffic Signalization,
NB and SB Right Turn Lanes

Access Control

In addition to the modifications recommended for the left turn lanes on US 212, some restrictions to turning movements at the adjacent intersections should also be considered. Currently, the traffic volumes at these intersections are low enough to function well. However, as traffic volumes grow, it will become more difficult to turn left onto US 212 from these frontage road intersections. On the west side of the interchange, the concept shown in the figure allows eastbound left turns from US 212 into the frontage road connection closest to the interchange. For left turn movements from the frontage road onto US 212, a new connection is proposed approximately 825' to the west. This location provides acceptable spacing should this intersection require signalization in the future.

On the east side of I-29, a similar concept is proposed. The median is reconstructed to allow eastbound left turns to enter the frontage road, however, southbound left turns onto US 212 are restricted. These left turning vehicles will be required to travel 1,050' feet to the east to make that left turn. Furthermore consideration should be given to access issues regarding the farm in the southeast quadrant of the interchange. The restriction of access to this location might be considered now before it is redeveloped, especially since there is excellent access to the highway at the first road east of the interchange.

Right-of-Way

The proposed improvements for the off-ramps and the median along US 212 will not require any additional right of way.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the right turn lanes, traffic signals and median reconstruction on US 212 is estimated at $465,000. A breakdown of the quantities and construction costs is included in the Appendix.

Alternative # 2 – Single Point Interchange

Although the capacity analysis indicated that the diamond interchange configuration would provide acceptable traffic operations through the Year 2020 with some minor improvements, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 36.

Geometry

Based on the traffic projections, single left turn lanes for the single point interchange will provide acceptable traffic operations. As was the case for the diamond interchange, the left turn storage on the US 212 approaches should be 200'. The configuration of the single point interchange results in approximately 200' of storage for the left and right turn lanes on the off-ramps.

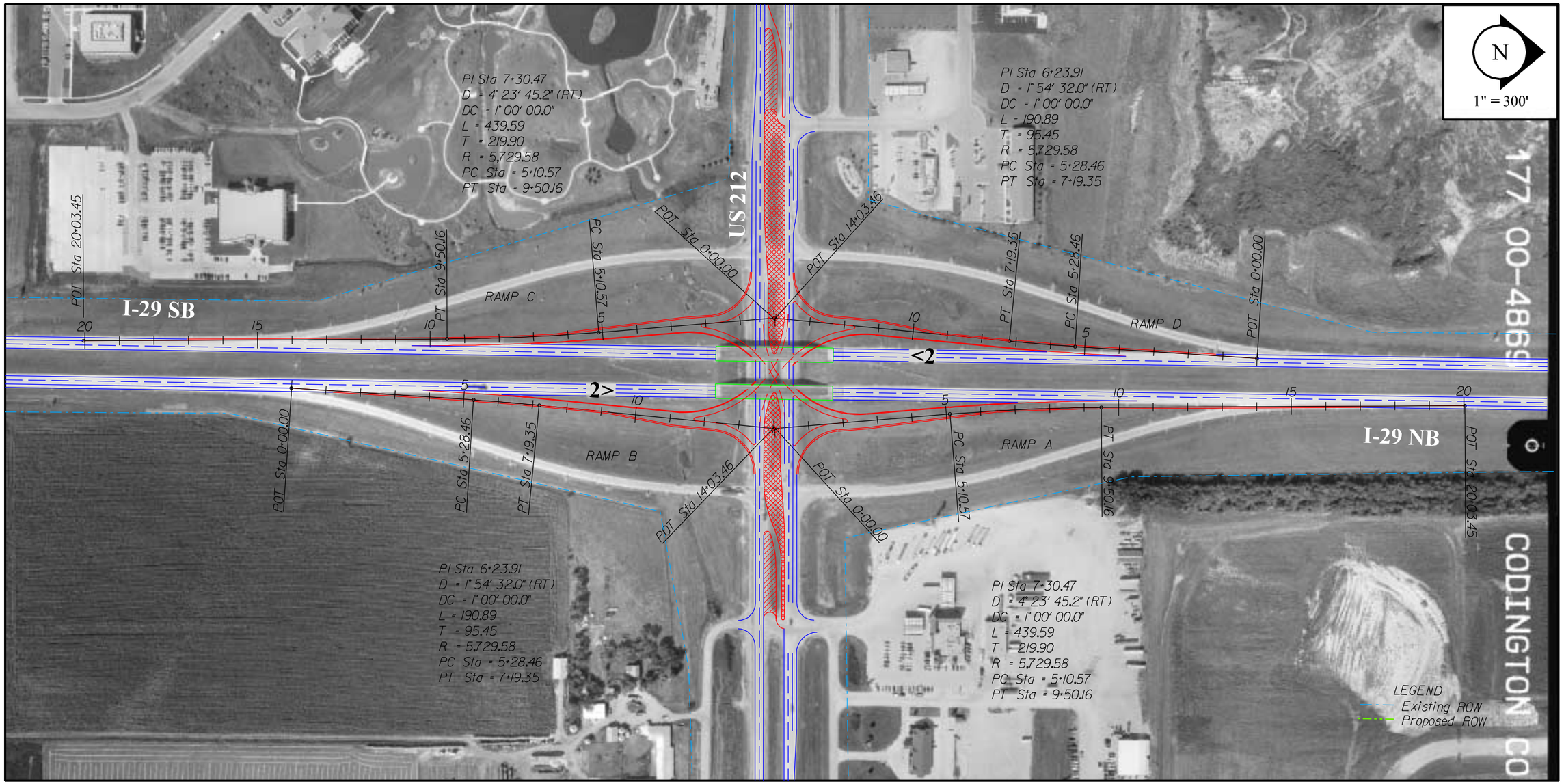


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Figure 36
I-29 Exit 177
U.S. 212, Watertown
Single Point Interchange

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in the following table.

I-29/US 212 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	
US 212 Single Point Interchange	2010	Sig.	A	-	-	A	-	-	A	A	-	A	A	-	A
US 212 Single Point Interchange	2020	Sig.	B	-	-	B	-	-	B	B	-	B	B	-	B

Future traffic operations for the ramp movements will be the same as evaluated for the existing conditions, since one-lane on and off ramps will still be provided. The capacity analysis indicated that the level of service for these movements will operate at LOS a for the Year 2020.

Access Control

The modifications to the access points along US 212 discussed for the previous alternative are recommended with the single point concept as well. The increased distance between the interchange and the next full movement access break will help improve traffic operations along the corridor.

Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at Exit 177.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and reconstruction of the medians along US 212 is estimated at $6.98 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-229: Exit 3 – Minnesota Avenue, Sioux Falls

The capacity analysis performed for the Minnesota Avenue interchange with I-229 in the Phase I study indicated that the existing diamond interchange configuration and traffic control will be able to accommodate the Year 2020 traffic volumes.

A single point interchange concept was also developed for this location to determine if it would be an acceptable replacement for the diamond interchange. The advantages of a single point interchange are the elimination of a traffic signal on Minnesota Avenue and the capacity to accommodate heavier traffic volumes. The adjacent full movement accent points located to the north and south of the interchange also impact the traffic operations along Minnesota Avenue.

Existing Interchange Characteristics

Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Minnesota Avenue. The cross section of Minnesota Avenue is a five-lane section, with a two-way left turn lane.

Traffic Safety

This interchange ranked 27th out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 51 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

Capacity

The capacity analysis performed for the existing configuration of the Minnesota Avenue interchange indicates that the ramp intersections are currently operating at level of service A. By the Year 2020, the northbound ramp intersection is projected to operate at LOS B and the southbound ramp intersection at LOS A. The construction of the auxiliary lanes on I-229 between the interchanges will eliminate the current merge and diverge movements onto the I-229 mainline.

Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge (NB I-229)	C	B	-	-	Acceptable
NB Merge (NB I-229)	C	B	-	-	Acceptable
SB Diverge (SB I-229)	C	B	-	-	Acceptable
SB Merge (SB I-229)	C	B	-	-	Acceptable
North Intersection	D	A	A	A	Acceptable
South Intersection	D	A	A	B	Acceptable

Proposed Interchange Concept

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels through the Year 2020. As an alternative to the existing diamond interchange, a single point interchange concept was also developed for this location. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 37.

Geometry

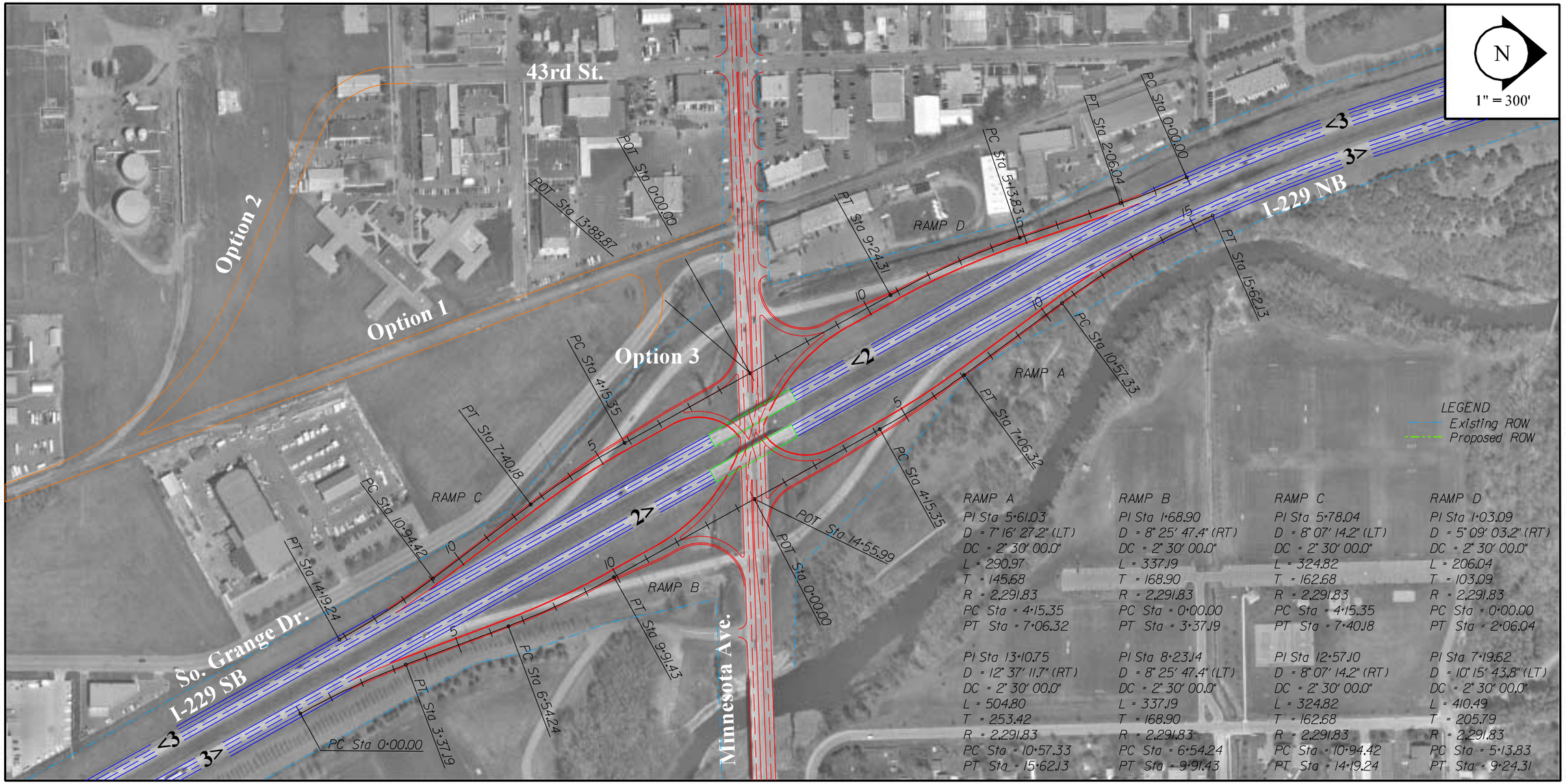
Based on the traffic projections, it appears that single left turn lanes for the single point interchange will provide acceptable traffic operations. However, with the cross section of Minnesota Avenue, the left turn lanes on the off-ramps should be constructed to provide dual left turn lanes in the future. The configuration shown in the figure provides approximately 250' of storage for the left turn lanes and 200' of storage for the right turn lanes. If a raised median is constructed along Minnesota Avenue, 200' of storage should be provided for the northbound and southbound left turn lanes.

Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10th Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.



RAMP A	RAMP B	RAMP C	RAMP D
PI Sta 5+61.03	PI Sta 1+68.90	PI Sta 5+78.04	PI Sta 1+03.09
D = 7° 16' 27.2" (LT)	D = 8° 25' 47.4" (RT)	D = 8° 07' 14.2" (LT)	D = 5° 09' 03.2" (RT)
DC = 2° 30' 00.0"	DC = 2° 30' 00.0"	DC = 2° 30' 00.0"	DC = 2° 30' 00.0"
L = 290.97	L = 337.19	L = 324.82	L = 206.04
T = 145.68	T = 168.90	T = 162.68	T = 103.09
R = 2,291.83	R = 2,291.83	R = 2,291.83	R = 2,291.83
PC Sta = 4+15.35	PC Sta = 0+00.00	PC Sta = 4+15.35	PC Sta = 0+00.00
PT Sta = 7+06.32	PT Sta = 3+37.19	PT Sta = 7+40.18	PT Sta = 2+06.04
PI Sta 13+10.75	PI Sta 8+23.14	PI Sta 12+57.10	PI Sta 7+19.62
D = 12° 37' 11.7" (RT)	D = 8° 25' 47.4" (LT)	D = 8° 07' 14.2" (RT)	D = 10° 15' 43.8" (LT)
DC = 2° 30' 00.0"	DC = 2° 30' 00.0"	DC = 2° 30' 00.0"	DC = 2° 30' 00.0"
L = 504.80	L = 337.19	L = 324.82	L = 410.49
T = 253.42	T = 168.90	T = 162.68	T = 205.79
R = 2,291.83	R = 2,291.83	R = 2,291.83	R = 2,291.83
PC Sta = 10+57.33	PC Sta = 6+54.24	PC Sta = 10+94.42	PC Sta = 5+13.83
PT Sta = 15+62.13	PT Sta = 9+91.43	PT Sta = 14+19.24	PT Sta = 9+24.31

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Figure 37
I-229 Exit 3
Minnesota Avenue, Sioux Falls
Single Point Interchange

I-229/Minnesota Avenue 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	
Minnesota Ave. Single Point Interchange	2020	Sig.	B	A	-	A	A	-	B	-	-	B	-	-	A

Access Control

On the north side of the interchange, an intersection with South Grange Drive to the west is located only 150' north of the ramp intersection. In addition, driveways to the property located on the east side of Minnesota Avenue are only 100' north of the ramp intersection. The *41st Street Corridor Study – Phase II Report*, completed in May 2000, indicates that three options are under consideration for relocation of this intersection. The first option consists of a new roadway connection constructed on the abandoned railroad right of way. This would relocate the intersection approximately 100' further to the north. Option 2 consists of the construction of a new roadway connection that also follows the abandoned railroad alignment, then curves to the north to connect with 43rd Street. The 3rd option is to connect South Grange Drive to the abandoned railroad alignment immediately west of Minnesota Avenue.

While the construction of Option 2 that connects to 43rd Street is the preferred option to improve traffic operations along Minnesota Avenue and provide the maximum distance from the interchange, the City of Sioux Falls has indicated that this option will not be constructed. Option #1 or #3 that connects to Minnesota Avenue at the abandoned railroad line will be coordinated with the SD 115 project identified in the Year 2002 TIP.

The other access control issue is the location of the driveway to the Yankton Trail Park, located in the southwest quadrant of the interchange. This driveway is located approximately 200' south of the interchange ramps. Since the major activities at the park are focused during the evenings and weekends, traffic operations at this intersection should be monitored to determine if access modifications should be constructed. If necessary to improve safety and traffic flow along Minnesota Avenue, the raised median could also be constructed south of the interchange, which would restrict this access to right-in/right-out only. It may be possible to construct the raised median to also allow the northbound left turn from Minnesota Avenue into the park. Full movement access from the park to the arterial street network is provided at 57th Street, via a bridge constructed over the Big Sioux River. While this may result in some adverse travel when exiting the park, it would provide safer and more efficient traffic operations along Minnesota Avenue. The City of Sioux Falls has indicated that the full movement access into the park on Minnesota Avenue should be maintained with the ultimate configuration.

Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at the Minnesota Avenue interchange with I-229.

Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the single point interchange. Design and construction of the interchange is estimated at $6.58 million. A breakdown of the quantities and construction costs is included in the Appendix.

I-229: Exit 5, 26th Street, Sioux Falls

From the Phase I investigation, it was found that Exit 5 on I-229 contains some significant geometric deficiencies. Along with these deficiencies, there exist some physical limitations on what improvements can be made in the vicinity of the interchange. Analysis of the existing interchange for the projected Year 2010 and 2020 traffic volumes result in poor traffic operations. Three concepts were developed in the Phase I study to help address some of the problems associated with the interchange. This Phase II investigation has been performed to further evaluate operational and geometric characteristics of the interchange. The City of Sioux Falls indicated that there is a Federal Emergency Management Agency (FEMA) buyout programmed for the homes located in the northwest quadrant of the interchange. The removal of those homes located immediately adjacent to the interstate mainline creates an opportunity to construct southbound on and off ramps at this interchange, and significantly improve traffic operations at this interchange.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange and many deficiencies were found. Primarily, the radius provided on ramps C, G and F are considerably below the 35 mph design criteria. The superelevation rate on Ramps B and C is only slightly above the 5.0% design criteria. The on-ramp taper rates provided on Ramps C and F are below the 50:1 design criteria. The geometry is very unique in the fact that the I-229 southbound off and on ramps are so close to one another and the length of the ramps are extremely short. The two ramps actually tie into a frontage road that runs parallel along I-229. This configuration causes problems in traffic operations on the frontage road, as well as for those vehicles trying to access I-229. 26th Street allows for left turn lanes to provide access to the I-229 on ramps. The Northbound off ramp has a separate left turn lane and right turn lane.

Traffic Safety

This interchange ranks 14th out of the 62 interchanges evaluated in the Phase I study based on three-year crash rate. Over the three year period from 1997-1999 there were a total of 69 accidents. Since this location was not considered one of the high accident locations in the Phase I study, a more detailed analysis of the accident history was not conducted.

Capacity

The capacity analysis performed for the existing interchange configuration indicates that the intersections on 26th Street are currently operating at acceptable levels of service, however, the intersection with the northbound ramps is operating at LOS D. Traffic counts were not available for the intersection of the southbound ramps and the frontage road. These turning movements were estimated based on the counts provided at the intersection of the frontage road with 26th Street.

In the Year 2010, the traffic operations at this interchange are projected to decrease to LOS F at the intersection with the northbound ramps and LOS E at the intersection of the frontage road with the south ramps. For the Year 2020, both intersections on 26th Street and the intersection of the frontage road with the south ramps are projected to operate at unacceptable levels of service. The main movements where the traffic operations are at unacceptable levels are the northbound right turn movements and the westbound through movements at the northbound ramp intersection. The northbound left turn movements and westbound left turn movements at the frontage road intersection at 26th Street also operate at unacceptable levels of service.

I-229/26th Street 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	
26th Street/ I-229 NB Ramps	1999	Sig.	B	-	F	-	-	-	-	B	-	-	E	-	D
26th Street/ Yeager Road	1999	Sig.	D	-	A	-	-	-	-	C	-	C	A	-	C
26th Street/ I-229 NB Ramps	2010	Sig.	C	-	F	-	-	-	-	C	-	-	F	-	F
26th Street/ Yeager Road	2010	Sig.	E	-	B	-	-	-	-	E	-	F	A	-	D
26th Street/ I-229 NB Ramps	2020	Sig.	C	-	F	-	-	-	-	B	-	-	F	-	F
26th Street/ Yeager Road	2020	Sig.	E	-	D	-	-	-	-	F	-	F	A	-	E

The previous analysis indicated that the construction of the auxiliary lanes on I-229 as a part of the current design build project will provide acceptable traffic operations through the Year 2020.

Proposed Interchange Alternatives

As was mentioned previously, the Exit 5 interchange has many geometric deficiencies. With the projected future traffic, it will also have experience operational deficiencies. The City of Sioux Falls has indicated that a Federal Emergency Management Agency (FEMA) buyout is programmed for the residential neighborhood located in the northwest quadrant of the interchange to address flooding from the Big Sioux River. The removal of the homes located

immediately adjacent to the interstate mainline will provide an opportunity for the construction of a southbound off-ramp with a direct connection to 26th Street.

The City of Sioux Falls indicated that Yeager Road, located in the southwest quadrant of the interchange, must remain in service, with a connection to 26th Street. They also stated that the rail line immediately west of Yeager Road is abandoned, and the bridge on 26th Street over the railroad will be removed. Keeping the intersection of Yeager Road with 26th Street in its present location results in the concept for the southbound off-ramp and on-ramp to be reconstructed as shown in Figure 38. This configuration provides a distance of 300' from Yeager Road to the southbound ramps. A distance of 800' is provided between the ramp intersections. If it is possible to relocate Yeager Road to the west once the bridge is removed, additional distance could be provided from the southbound ramp intersection.

Geometry

With the concept shown, it was assumed that 26th Street would be widened to a four-lane roadway with turn lanes at the ramp intersections and at Yeager Road. 26th Street, to the west of I-229, is a three-lane roadway. As a result, it will be necessary to taper the two westbound through lanes down to one lane west of Yeager Road. The additional eastbound through lane should also begin to the west of the intersection.

It is also recommended that an additional lane be added to the northbound off-ramp. This will allow for one left turn lane and dual right turn lanes to accommodate the projected heavy right turn movement. Since 26th Street tapers to a two-lane section to the east, the additional eastbound through lane must continue far enough to ensure adequate lane utilization of the dual right turn lanes. In addition, the I-229 mainline will be widened to three lanes between the interchanges in the near future as part of the current design build project.

Traffic Safety

The current interchange is not considered a high accident interchange with the accident history over the last three years, but it does have an above average rate of accident occurrence. With the proposed changes in the ramp configuration and the addition of the left turn lanes and the widening of 26th Street, it would be expected that the accident rate at this interchange would decrease in future years.

Capacity

With the half diamond interchange concept shown in Figure 38, the operational efficiency at the interchange would be improved. Analysis of the traffic movements for Year 2010 and 2020 was performed with the new concept. The results are depicted in the table below. The construction of the southbound on and off ramps provides an acceptable level of service of C or better at all of the intersections with 26th Street. Traffic signalization was assumed at all three of the intersections.

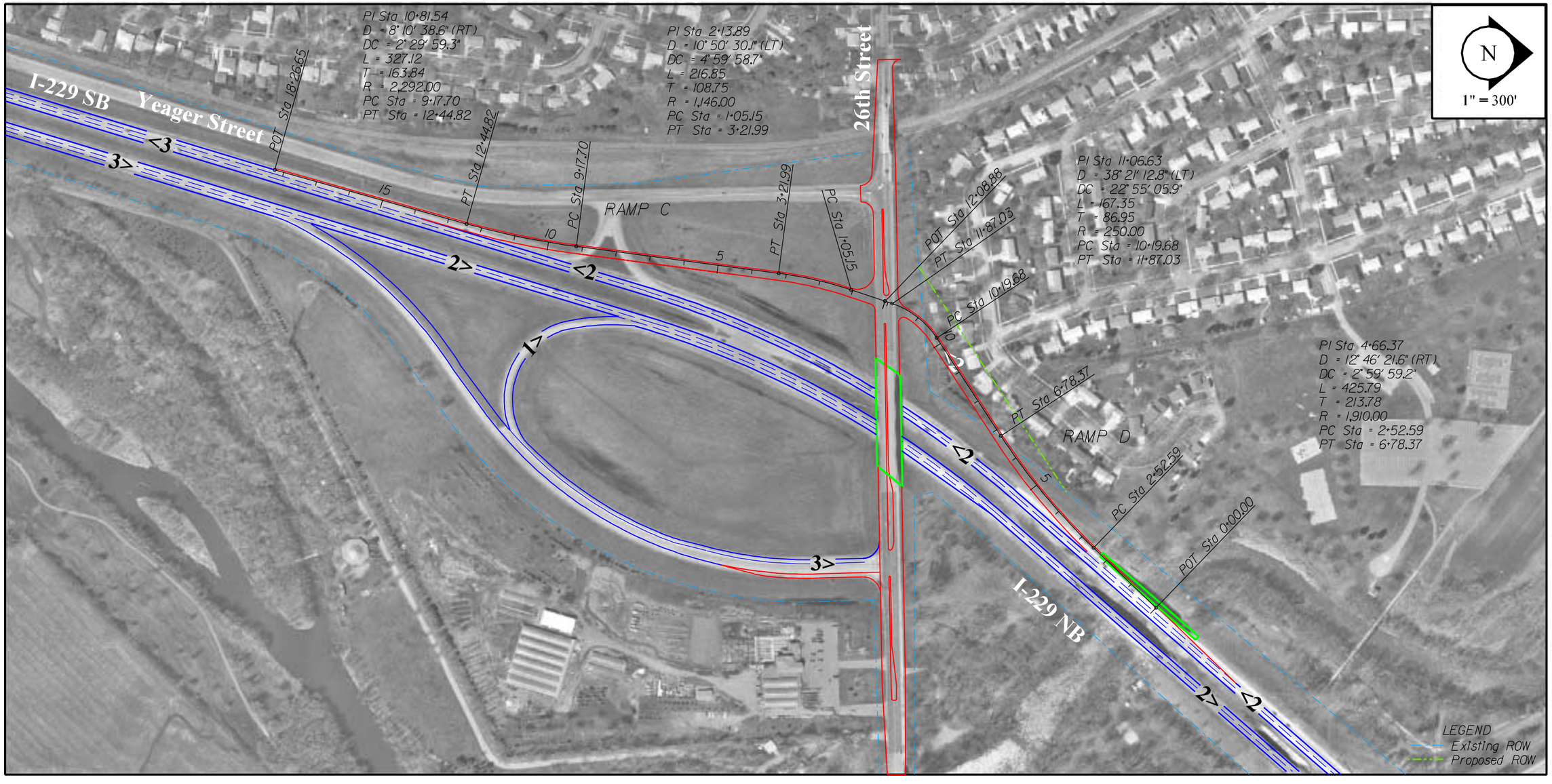

Figure 38
I-229 Exit 5
26th Street, Sioux Falls
Southbound Ramp Improvements

I-229/26th Street 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	
26th Street/ I-229 NB Ramps	2010	Sig.	B	-	C	-	-	-	-	A	-	B	B	-	B
26th Street/ Yeager Road	2010	Sig.	C	-	A	-	-	-	-	A	-	A	A	-	A
26th Street/ I-229 SB Ramps	2010	Sig.	-	-	-	D	-	A	-	B	A	B	A	-	B
26th Street/ I-229 NB Ramps	2020	Sig.	B	-	C	-	-	-	-	C	-	C	C	-	C
26th Street/ Yeager Road	2020	Sig.	C	-	A	-	-	-	-	A	-	A	B	-	A
26th Street/ I-229 SB Ramps	2020	Sig.	-	-	-	D	-	A	-	D	A	C	A	-	C

The I-229 improvement project currently under construction, will provide an auxiliary lane between the Cliff Avenue interchange and the 26th Street interchange. As a result, there will be no northbound diverge or southbound merge movements upon completion of that project. However, a 4 lane section of I-229 will still be provided to the north of 26th Street. Future traffic operations for the northbound merge and the southbound diverge ramp movements were evaluated, and are summarized below. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better.

I-229/26th Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-229 Northbound	2010	Merge	B
		Diverge	-
I-229 Southbound	2010	Merge	-
		Diverge	B
I-229 Northbound	2020	Merge	B
		Diverge	-
I-229 Southbound	2020	Merge	-
		Diverge	C

Access Control

On the east side of the interchange, the nearest driveway location is located further than 300' from the ramp intersection. However, it may be desirable to extend the raised median on 26th Street past this driveway to restrict access to right-in/right-out. The next driveway to the east will provide full movement access to the property. Access control is not required to the west of the interchange.

Right-of-Way

The construction of this concept will require approximately 1.5 acres, located in the northwest quadrant of the interchange. This right of way is necessary to accommodate the southbound off-ramp. Along 26th Street, the widening of the roadway to provide a four-lane section and separate left turn lanes will also require some right of way acquisition.

Probable Construction Costs

A statement of probable construction costs was prepared for the improvements at the interchange. The total probable cost for this concept is estimated at $5.67 million. A more detailed breakdown of the cost for this interchange concept can be seen in the Appendix.

I-229: Exit 7 – Rice Street, Sioux Falls

For the Phase I investigation of Exit 7, current traffic counts were not available. As a result, the capacity analysis for this interchange was not conducted. Current traffic counts for the ramps were obtained in the summer of 2000 and used to develop Year 2010 and 2020 traffic forecasts. This subsequent investigation has been performed to further evaluate geometric and operational characteristics of the interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 7 Phase I analysis.

Existing Interchange Characteristics

Geometry

Existing geometric features were reviewed using the as-built plans for this interchange, with deficiencies found on all four of the ramps. The superelevation rate on all of the ramps is 6.0%, which is above the 4.0% criteria. The minimum horizontal radius provided on the loop ramps is only 160', which is well below 30 mph design. The on-ramp tapers for Ramps A and H do not meet the 50:1 design criteria. The K values on the crest vertical curves for Ramps A and D are below the 50 mph design criteria, which correlates to inadequate stopping sight distances.

Traffic Safety

This interchange ranks 31st out of the 62 interchanges evaluated in the study based on three 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. It is unlikely that interchange deficiencies are the primary contributing factor to the occurrence of traffic accidents at this interchange.

Capacity

Updated ramp counts were provided by SDDOT for the interchanges along I-229, prior to the beginning of the reconstruction project. Turning movement counts were previously provided for the northbound ramp intersection and Cleveland Avenue with Rice Street. The current traffic counts for the southbound ramps were used to develop the peak hour turning movement counts for this intersection. The through movements on Rice Street were then balanced through the intersection.

Based on these traffic forecasts, it appears that the unsignalized intersection of the southbound off-ramp with Rice Street has movements that are operating at unacceptable levels. All of the movements at the Rice Street and Cleveland Avenue intersection are operating at LOS A. Future

traffic operations are expected to be problematic if no other traffic improvements are made. As shown in the table below, analysis of projected future traffic conditions at the Exit 7 interchange indicate that the southbound left turn lane will operate at unacceptable levels.

I-229/Rice Street 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	
Rice Street/ I-229 NB Ramps	2000	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2000	Unsig.	-	-	-	F	-	B	A	-	-	-	-	-	-
Rice Street/ I-229 NB Ramps	2010	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2010	Unsig.	-	-	-	F	-	B	A	-	-	-	-	-	-
Rice Street/ I-229 NB Ramps	2020	Sig.	A	A	-	B	A	-	-	A	-	-	B	-	A
Rice Street/ I-229 SB Ramps	2020	Unsig.	-	-	-	F	-	B	B	-	-	-	-	-	-

Along with the analysis performed on the intersection movements, the movements on the interchange ramps were also analyzed. All of the existing ramp movements and future projected ramp movements operate at an acceptable LOS of C or better. The results of the ramp analysis are shown below.

I-229/Rice Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-229 Northbound	2000	Merge	A
		Diverge	A
I-229 Southbound	2000	Merge	B
		Diverge	A
I-229 Northbound	2010	Merge	A
		Diverge	A
I-229 Southbound	2010	Merge	B
		Diverge	B
I-229 Northbound	2020	Merge	B
		Diverge	A
I-229 Southbound	2020	Merge	C
		Diverge	C

Proposed Interchange Alternatives

Although the present interchange has geometric deficiencies and capacity problems stated previously, a complete reconstruction of the interchange is not warranted. There are several physical constraints in the vicinity of the Rice Street interchange with I-229. The railroad located immediately south of Rice Street limits the ability to construct direct ramps to the south. The geometric deficiencies can be corrected with minor modifications, and the present structure can remain. As a result, the proposed improvements recommended for this interchange consist of minor improvements to the interchange and surrounding area. The installation of traffic signals at the ramp intersections with Rice Street would help alleviate many of the anticipated capacity problems.

Geometry

The existing interchange does contain some geometric deficiencies that can be addressed when it is time for the ramp pavement to be reconstructed. The driving lane and shoulder widths can be corrected, as well as the superelevation rate. As for the minimum horizontal radius and low K values on the crest vertical curve, the entire interchange would have to be reconstructed. These deficiencies would have to have a severe affect on the safety to warrant total reconstruction of the interchange. It is believed that the present design provides large enough turning radii to accommodate truck movements on and off the interstate. Rice Street will remain a four-lane section with no left or right turn lanes on the roadway in the area of the interchange.

Traffic Safety

The current interchange is not considered a high accident interchange with the accident history over the last three years. The installation of traffic signals on Rice Street at the southbound ramp intersection would represent a change from the existing conditions and may result in a slight increase in some types of accidents. While the occurrences of accidents may go up on Rice Street with the new signalized intersection, the accidents should not be as severe. It is anticipated that adding the traffic signal should not ultimately have an adverse affect on the safety at and around this interchange.

Capacity

The installation of a traffic signal at the intersection of the I-229 southbound ramps with Rice Street will improve traffic operations at this intersection. Analysis of the traffic movements for Year 2010 and 2020 was performed with the addition of the signal. The results are depicted in the table below. With the traffic signal installed, the analysis shows that the southbound left turn movement would improve to LOS B in 2010 and LOS C in 2020. The overall levels of service for the ramp intersections are LOS A or better for the projected future volumes.

I-229/Rice Street 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	
Rice Street/ I-229 NB Ramps	2010	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2010	Sig.	-	-	-	B	-	A	-	A	-	-	A	-	A
Rice Street/ I-229 NB Ramps	2020	Sig.	A	A	-	B	A	-	-	A	-	-	B	-	A
Rice Street/ I-229 SB Ramps	2020	Sig.	-	-	-	C	-	A	-	A	-	-	A	-	A

Since no changes are recommended for the ramps and the interstate mainline through this interchange, the future traffic operations for the ramp movements will remain as previously discussed.

Access Control

The addition of traffic signals at the intersections with Rice Street will improve traffic operations through the interchange area. Access management along Rice Street is not proposed at this time.

Right-of-Way

Since only minor modifications will be made to the interchange, it will be not be necessary to acquire extra right-of-way. The installation of the two traffic signals should be within the existing right-of-way limits.

Probable Construction Costs

A construction cost estimate for the installation of a traffic signal at the intersection of the southbound ramps and Rice Street is approximately $100,000.