Break-in-Access Report

K-10 Highway and Lone Elm Road
Lenexa, Kansas

Prepared for:

City of Lenexa, Kansas

June 2009

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June 1, 2009

Steven R. Schooley, PE, PTOE
Transportation Manager
City of Lenexa
12350 W. 87th Street Parkway
Lenexa, KS 66215-2882

Re: K-10 and Lone Elm Road Break-In Access Study

Dear Mr. Schooley:

In response to your request and authorization, TranSystems Corporation has completed a Break-In Access (BIA) Study for the proposed K-10 Highway and Lone Elm Road interchange. The BIA study follows Kansas Department of Transportation's (KDOT) standard operating manual for requests for new access points. This report documents the eight issues identified by the Federal Highway Administration (FHWA) regarding new access to highway systems.

A number of scenarios were analyzed in this study. In general, the capacity restraints on K-10 are related to mainline capacity restraints for through traffic and not a result of the interchanges. The basic four-lane segment of K-10 is anticipated to exceed capacity somewhere between 2011 and 2013. Widening this facility to a six-lane will accommodate the projected traffic volumes, regardless of this interchange, to approximately 2027 or 2028. An eight-lane facility would provide sufficient capacity to approximately 2040 based on current projected growth trends.

A technical appendix, prepared by TranSystems, is also available with detailed summary results of the analysis. In addition, Burns & McDonnell have prepared a report entitled Supplemental Information for the K-10 Break in Access Report, dated June 1, 2009, which includes more detailed information on the geometric design and alternative considerations for the Lone Elm interchange.

We trust that the enclosed information proves beneficial to you and the Kansas Department of Transportation as you consider the impact of a new interchange at K-10 and Lone Elm. We appreciate the opportunity to be of service to you and we will be available to review the analysis results and this report with you at your convenience.

Sincerely,

By: _____
Jeff D. McKerrow, PE, PTOE

JDM:sp:101070205
Attachments

Table of Contents

Section 1 – Introduction

TranSystems was retained by the City of Lenexa, Kansas, to prepare a Break-In Access Study for K-10 Highway and Lone Elm Road. The proposed Lone Elm Road interchange is located approximately one mile east of K-7 Highway interchange and one mile west of Woodland Avenue interchange. The scope of this BIA Study includes development of a preferred interchange design concept and traffic operational assessment to evaluate improvement alternatives. The study area for the K-10 and Lone Elm Road Final Break-In Access Study includes interchanges along K-10 at K-7, Lone Elm Road and Woodland Avenue located on the border between the cities of Lenexa and Olathe in Johnson County, Kansas. Figure A-1 shows the location of the proposed interchange in relation to the existing major streets and highways in the region.

The information provided in this report addresses the eight major elements recommended by Federal Highway Administration (FHWA) identified in the document "Interchanges, Requests for New or Modified Access Points and Access Planning" prepared by the Kansas Department of Transportation (KDOT) as part of the Standard Operating Manual, dated December 2005.

Additional information on the design alternatives considered for this interchange has been included in a June1, 2009, report by Burns & McDonnell entitled Supplemental Information for the K-*10 Break-in-Access Report, City of Lenexa, Kansas, Lone Elm Interchange*.

Section 2 – Background

The City of Lenexa has a population of 44,708 as per the year 2006 census estimates. This population is expected to grow 50% when all the approved, planned and proposed development occurs in the City. Currently a cold storage warehouse is located on the southeast corner of the K-10 and K-7 interchange and a golf course is located in the northeast corner. There is an elementary school and single family residential development on the west side of Lone Elm Road, north of K-10 Highway. On Lone Elm Road south of the highway, there is a middle school and several single family residences. The cities of Lenexa and Olathe have developed future land use maps as part of their comprehensive plans. Figure A-2 shows proposed future land use in the vicinity of the proposed Lone Elm Road interchange.

K-10 Highway is a major east-west state highway that starts in the Kansas City metro area west of I-435 and ends in Lawrence at I-70. In the metro area, K-10 provides access to the cities of Lenexa and Olathe. Currently, K-10 is a four lane highway with a speed limit of 70 mph. K-7 is also a four lane state highway with a speed limit of 65 mph. Future traffic projections in the metro area suggest that K-10 will be over capacity by year 2011.

Lone Elm Road is classified locally as a thoroughfare with a speed limit of 45 mph and is a two lane road both north and south of the highway. Lone Elm Road connects to Prairie Star Parkway to the north in Lenexa and College Boulevard to the south in Olathe. Lone Elm Road interchange is one the several new interchanges proposed in response to the development related growth in Lenexa, Olathe and other areas in western Johnson County.

Woodland Avenue is classified as a thoroughfare and is a four lane road from the interchange to the north but a two lane road south of the eastbound K-10 Highway ramps. The speed limit on Woodland Avenue is 45 mph.

There were several studies conducted by the City of Lenexa, City of Olathe and KDOT in the study area vicinity. The City of Lenexa submitted an initial break-in access report in 1999. The City of Olathe conducted a K-7 Corridor Study in 2006. KDOT completed the K-10 Interchanges Comprehensive Final Report in 2006. The Comprehensive Report studied interchanges at Lone Elm Road, Clare Road and Prairie Star Parkway collectively on K-10 Highway after considering the recommendations made by all other studies.

Section 3 – Interchange Concept

The Comprehensive Report recommended a single-point urban interchange at Lone Elm Road. This recommended scenario requires Lone Elm Road to be relocated west from its current alignment to avoid right-of-way issues with an existing residential development in the southeast corner of the interchange. However, the initial break-in access report submitted by the City of Lenexa studied a partially folded diamond and a full diamond interchange.

This final break-in access study was performed with a tight diamond interchange at Lone Elm Road. The distance between the ramp terminals is designed to be approximately 430 feet. Two types of intersection control were studied at the ramp terminals – signalized and partial multi-lane roundabouts. This interchange will provide access to all movements at the interchange. Figures A-3 and A-4 shows the proposed layout of the interchange with signalized and roundabout options.

Section 4 – Study Methodology

To assess the traffic conditions in the study area, highway and interchange operations during A.M. and P.M. peak hours of a typical weekday were studied. Two future years were analyzed – 2012 was determined as the construction year and 2032 as the design year.

Traffic Volumes

Existing conditions traffic count data was not collected specifically for this study. The traffic counts conducted in October 2004 that were used for traffic evaluation in the K-10 Interchanges Comprehensive Study were carried over to this study.

Traffic volumes used to analyze future conditions in the K-10 Interchanges Comprehensive Study were reviewed and updated. The City of Lenexa updated their land use projections in December 2007. The City of Olathe also updated their travel demand model in 2006. Future year projections were available from various sources including travel demand models and historical traffic count data. Travel demand models were available from the cities of Lenexa and Olathe as well as the Mid-America Regional Council (MARC). The following sections describe the methodology to estimate traffic volume forecasts for 2012 (Construction year) and 2032 (Design year). This methodology was reviewed with KDOT, Lenexa and Olathe staff. The methodology was approved by all involved team members in April 2008.

Historical Traffic Count Data

The Average Daily Traffic (ADT) count data from KDOT historical maps were summarized for the two highway corridors, K-10 and K-7. The two important segments that were considered include K-10 Highway east of Woodland Avenue and K-7 Highway south of K-10. ADT data for these highway segments was available from 1990 to 2007. Growth analysis of traffic volumes from 1990 to 2007 indicated that the linear trend was not continuous. To further characterize the growth patterns, ADT data was categorized in to three different sets – all available years, 1990 to 2000 and 2000 to 2007. Table B-1 in the separate technical appendix shows three sets of analysis for P.M. peak hour. For each set, using the previous years' linear growth trend, 2012 and 2032 traffic volumes were estimated. The 2004 P.M. peak hour values were obtained from the K-10 Interchanges Comprehensive Study except for P.M. peak hour volume on Northbound K-7 Highway, which was obtained from the more recent Olathe model count.

Lenexa Model

The City of Lenexa developed a travel demand model with a base year of 1994 and a forecast year for full build-out (estimated at 2050). This model was developed in TModel. The migration process from TModel to VISUM software did not achieve valid results. The City of Lenexa conducted a market analysis and updated their land use forecasts in 2007. The updated land use data was used to revise Lenexa traffic analysis zones (TAZs) in the Olathe model.

Olathe Model

The Olathe Model area extends beyond the Olathe city limits and includes the southern portion of Lenexa (including the study area). This four-step model was updated in 2006 and calibrated to a base year of 2004. It is a four-step model with daily and P.M. peak hour model scenarios. The future year scenarios modeled were 2015 and 2050 with a full build-out. Two sets of projections were developed using the Olathe model – with original land use and with revised land use for Lenexa TAZs. Traffic volumes were interpolated for 2012 and 2032 years using 2004 and 2050 model forecasts.

MARC Model

The MARC model includes the entire Greater Kansas City region in both Kansas and Missouri. The future year scenarios modeled were 2010, 2020 and 2030. MARC model forecasts traffic volumes with a regional perspective. The future year forecasts for the study corridors showed a decrease of traffic volumes between 2020 and 2030 model scenarios. After comparing the traffic volumes with other sources, the MARC model projections were discarded for more conservative projections as the traffic volumes were consistently lower than all other sources. The MARC model assumes that Lone Elm Road interchange is constructed in 2030.

K-10 Interchanges Comprehensive Study

The Comprehensive Study included a Break-In Access request for K-10 Interchanges and was conducted in June 2006. The traffic projections used for this study are referred to as Initial Break-In Access Study traffic volumes as shown in Table B-1 in the separate technical appendix. This study evaluated the need for interchanges at Lone Elm Road, Clare Road and Prairie Star Parkway along K-10 and K-7 highways. The design year traffic volume projections were developed for a full build-out scenario. However, the future year to which the full build-out of developments was attributed is year 2030. As mentioned above, the City of Lenexa conducted a market analysis as part of their land use update in November 2007. The analysis indicates that a full build-out will not likely occur by future year 2030, but rather closer to 2050 or 2060. The traffic volumes from the Initial Break-In Access Study forecast conditions on K-7 Highway which may not occur until year 2050 or beyond. Annual growth rates that were used for the Initial Break-In Access Study are shown in Table B-2 in the separate technical appendix.

Comparative Analysis

The average and median traffic volumes from these different sources were calculated and the greater of the two was chosen as a recommended traffic volume for the respective highway corridors. Figures B-2 and B-3 in the separate technical appendix illustrates projections for 2012 and 2032 years during P.M. peak hour using all the above methods. Using this method, the annual growth rates corresponding to the highway traffic volumes were also calculated. For the opening year 2012, the annual growth rates are 4.5% and 3.8% on eastbound and westbound K-10 Highway respectively. For the same year, the annual growth rates are 3.3% and 4.4% respectively on northbound and southbound K-7 Highway.

The annual growth rates for design year 2032 are 2.9% and 2.9% on eastbound and westbound K-10 Highway respectively. On northbound and southbound K-7 Highway, the annual growth rates are 2.35% and 3.0%. These rates compare well with the 3% historic annual growth rate on I-35 south of I-435 from 1990 to 2007.

No-Build Scenario Volumes

To maintain consistency between all the above mentioned sources, the recommended projections methodology was applied to No-Build scenario, without an interchange at Lone Elm Road. To obtain A.M. peak hour traffic volumes for 2012 and 2032, the P.M. traffic volumes on eastbound and westbound K-10 Highway were interchanged. Similarly, northbound and southbound traffic volumes on K-7 Highway were interchanged. Additionally, the northbound traffic volumes on K-7 Highway were increased during 2012 A.M. peak hour from the recommended 1600 vehicles per hour (vph) to 1900 vph. Figures A-5 and A-6 shows the recommended A.M. and P.M. peak hour volumes for the No-Build scenario for year 2012 to be used in the Final Break-In Access Study for Lone Elm Road. Figures A-7 and A-8 shows the recommended traffic volumes for year 2032.

Arterial and Ramp Volumes

The traffic volume projections on Lone Elm Road, Woodland Avenue and at the K-7, Lone Elm Road and Woodland interchanges were developed using projections from the Olathe model. The turning movements were balanced to match the recommended traffic volumes on the highway segments.

Build Scenario Volumes

The Olathe model was used to obtain traffic volumes for 2012 and 2032 years for both No-Build and Build scenarios. The Build scenario assumes the construction of a diamond interchange at Lone Elm Road. The difference in the turning movements between the No-Build and Build model volumes was calculated. This difference in traffic volumes was added to the recommended No-Build scenario to obtain traffic volumes for the Build Scenario. Figures A-9 and A-10 shows the A.M. and P.M. peak hour volumes for the Build scenario for year 2012 to be used in the Final Break-In Access Study for Lone Elm Road. Figures A-11 and A-12 shows the traffic volumes for year 2032.

All the above sources mentioned for 2012 and 2032 P.M. peak hours are shown on Figures B-1 and B-2 in the separate technical appendix with the final annual growth rates used in this study. The final annual growth rates are around 3% for 2030 which is similar to the annual growth rate experienced by I-35 south of I-435 in Johnson County from 1990 through 2007. The resulting peak hour traffic volume projections were approved by KDOT and City of Lenexa to be utilized in traffic operations analyses for this Study.

Traffic Operation Assessment

The highways and arterials in the study area were evaluated using VISSIM, a microscopic simulation tool developed for the analysis of freeway and arterial streets. VISSIM models were created for each of the study alternatives. HiCAP was used to evaluate basic freeway segments, weave segments and ramp junctions using HCM methodologies. VISSIM simulation results provide a progressive indication of densities and speeds where as HiCAP performance measures can be obtained only for certain highway segments. The Synchro software package was used to evaluate signalized and stop controlled intersections. All analyses were performed for A.M. and P.M. peak hours.

Table 1
Level of Service Delay Thresholds

Level of Service (LOS)	Freeway Basic	Freeway Weave	CD Road Weave	Freeway Ramp Junctions	Intersection Signalized	Intersection Unsignalized
	Density pc/mi/ln	*Density* pc/mi/ln	*Density* pc/mi/ln	*Density* pc/mi/ln	*Delay* sec	*Delay* sec
A	0-11	≤10	≤12	≤10	< 10	< 10
B	>11-18	>10-20	>12-24	>10-20	< 20	< 15
C	>18-26	>20-28	>24-32	>20-28	< 35	< 25
D	>26-35	>28-35	>32-36	>28-35	< 55	< 35
E	>35-45	>35-43	>36-40	>35	< 80	< 50
F	>45	>43	>40	–	≥ 80	≥ 50

The results of the analyses were correlated with the Levels of Service defined in the Highway Capacity Manual (HCM), 2000 Edition, published by the Transportation Research Board. The operating conditions at an intersection are graded by the "level of service" experienced by drivers. Level of service (LOS) describes the quality of traffic operating conditions and is rated from "A" to "F". LOS A represents the most desirable condition with free-flow movement of traffic with minimal delays. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in the average density per highway segment and average delay per stopped vehicle. Density is measure in vehicles per hour per lane per mile and is used as criteria for freeway LOS. Delay is measured in seconds per vehicle and is used as LOS criteria for intersections. *Table 3* shows the upper limit of density or delay associated with each level of service for freeway segments, signalized and unsignalized intersections.

The LOS rating deemed acceptable varies by community, facility type and traffic control device. In many communities LOS D for urban/suburban facilities and LOS C for rural facilities are often found to be acceptable.

Section 3 - FHWA Interchange Justification Criteria

This Break-In Access Study report has been prepared to seek approval for an interchange on K-10 Highway at Lone Elm Road in Lenexa, Kansas. The Federal Highway Administration (FHWA) has identified eight issues to be addressed prior to obtaining approval. KDOT requires that these eight issues be addressed in the study report. In the following sections, each section begins with the applicable policy statement from the FHWA regarding new access to the interstate system followed by the results of this study.

1. Existing Facilities

FHWA policy states: *"Existing Facilities: The existing interchanges and/or local roads and streets in the corridor can neither provide the necessary access nor be improved to satisfactorily accommodate the design-year traffic demands while at the same time providing the access intended by the proposal."*

K-10 Highway is a four lane highway with interchanges at K-7 and Woodland Avenue spaced two miles apart. Westbound and southbound traffic on Lone Elm Road needs to travel circuitously to access a highway. The results of the operational analysis for the existing conditions during A.M. and P.M. peak hour are summarized in Table 4. The existing traffic volumes are shown on Figures A-14 and A-15. The existing conditions analysis indicates that in general all the highway segments and intersections operate at reasonable levels of service.

The existing facilities were also evaluated with future year 2012 traffic volumes. The study intersections were evaluated with the lane configurations shown on Figure A-13. Future Year 2012 traffic volumes are shown on Figures A-5 and A-6. The results of the operational analysis for the 2012 No-Build conditions during A.M. and P.M. peak hour are summarized in Table 4. Appendix C contains the analyses output files from VISSIM and HiCAP.

The 2012 No-Build Conditions A.M. and P.M. peak hour traffic analyses indicate that the existing facilities are not sufficient to handle the future traffic demand. VISSIM and HiCAP analysis indicate that the background traffic volume on K-10, not local traffic destined to and from Lone Elm Road, causes congestion on K-10 Highway.

2. Transportation System Management

FHWA policy states: *"Transportation System Management: All reasonable alternatives for design options, location, and transportation system management type improvements (such as ramp metering, mass transit, and HOV facilities) have been assessed and provided for if currently justified, or provisions are included for accommodating such facilities if a future need is identified."*

Ramp metering is not currently used in Johnson County or the Kansas City metro area. Although no plans for ramp metering at this location exist today, the entrance ramps off of K-10 Highway could potentially be modified to accommodate ramp metering in the future. Currently there are no long range plans for High-Occupancy-Vehicle (HOV) lanes along K-10 Highway.

Johnson County Transit currently has a bus route named "K-10 Connector" from KU Edwards Campus in Overland Park to KU in Lawrence that travels along K-10. This bus route stops at KU Edwards Campus, Johnson County Community Center, Carlson Center in Johnson County and 19th Street and Haskell Avenue intersection, 19th Street and Naismith Road intersection and KU campus in Lawrence. Currently there are no plans for this route to stop at Lone Elm Road or Woodland Avenue in Lenexa.

The Kansas City metro area's traffic management and regional ITS system, KC SCOUT, began operations in early 2004. Currently SCOUT includes one location on K-10 east of Ridgeview Road. It could potentially be expanded to K-7 Highway in the future.

The transportation system management type alternatives do not provide sufficient congestion relief to K-10 Highway in the future to offset the need for capacity enhancements. These alternatives also do not provide access to and from Lone Elm Road.

3. Access Connections and Design

FHWA policy states: *"Access Connections and Design: The proposed access connects to a public road only and will provide for all traffic movements, except in only the most extreme circumstances. Less than "full interchanges" for special purpose access for transit vehicles, for HOVs, or into park and ride lots may be considered on a case-by-case basis. The proposed access will be designed to meet or exceed current standards for Federal-aid projects on the Interstate System."*

Several interchange configurations were explored during the preliminary investigation phase. The initial Break-In Access study by City of Lenexa in 1999 explored a partially folded diamond and a full diamond interchange. A single-point urban interchange was proposed by the K-10 Interchanges Comprehensive Study.

The proposed tight diamond interchange at Lone Elm Road connects to a public road and provides all traffic movements. The interchange is designed according to KDOT and AASHTO highway design guidelines.

4. Transportation Land Use Plans

FHWA policy states: *"Transportation Land Use plans: The proposal considers and is consistent with local and regional land use and transportation plans. Prior to final approval, all requests for new or revised access must be consistent with the metropolitan and or statewide transportation plan, as appropriate, the applicable provisions of 23 CFR part 450 and transportation conformity requirements of 40 CFR parts 51 and 93."*

The need for new interchanges has been recognized in several City and Regional long term goals. The City of Lenexa's Comprehensive Plan and Transportation Plan show Lone Elm Road as a future interchange on K-10 Highway. The K-10 Transportation Study (2005) conducted by KDOT, Mid-America Regional Council's Transportation Outlook 2030 and Kansas State Transportation Improvement Program (2006) have identified the need for future interchanges along K-10 Highway to accommodate traffic growth in western part of the region.

5. Comprehensive Interstate Network Study

FHWA policy states: *"Comprehensive Interstate Network Study: In areas where the potential exists for future multiple interchange additions, all requests for new or revised access are supported by a comprehensive Interstate network study with recommendations that address all proposed and desired access within the context of a long-term plan."*

The K-10 Transportation Study (2005) shows Lone Elm Road as a future access point on K-10 Highway. The K-10 Interchange Comprehensive Study was conducted by KDOT in 2006 to analyze three new K-10 interchanges at Lone Elm Road, Clare Road and Prairie State Parkway as well as improvements to K-10 Highway. KDOT has approved the overall concept of providing new access points at proposed locations. This BIA Study evaluates Lone Elm Road independently whether or not other interchanges are approved and constructed concurrently. When the proposed Lone Elm Road interchange is constructed, the Lone Elm Road segments north and south of the highway will be connected.

6. Coordination with Transportation System Improvements

FHWA policy states: *"Coordination with Transportation System Improvements: The request for a new or revised access generated by new or expanded development demonstrates appropriate coordination between the development and related or otherwise required transportation system improvements."*

The future year traffic volume projections were developed by considering several approved, planned and proposed developments in the area. Additional approved roadway improvements were also considered. The city of Olathe's travel demand model was used to forecast future year volumes which considered the roadways and land use as inputs. The Olathe Model included some portions of Lenexa and Overland Park.

The city of Lenexa has planned and programmed local roadway improvements that will support the construction of the proposed interchange through local capital improvement plans and the regional Transportation Improvement Program (TIP)

7. Status and Information on the Planning and National Environmental Policy Act (NEPA) Processes

FHWA policy states: *"Status of Planning and NEPA: The request for new or revised access contains information relative to the planning requirements and the status of the environmental processing of the proposal."*

The K-10 Interchanges Comprehensive Study conducted a cursory review of existing environmental conditions. The Study suggested that "there do not appear to be any environmental constraints that would preclude the constructions of any of the three proposed interchanges." One of the three interchanges evaluated was at Lone Elm Road. A formal procedure on NEPA has not been initiated.

The proposed interchange underwent extensive planning studies involving staff from City of Lenexa and KDOT.

8. Operational Analysis

FHWA policy states: *"Operational Analysis: The proposed access point does not have a significant adverse impact on the safety and operation of the Interstate facility based on an analysis of current and future traffic. The operational analysis for existing conditions shall, particularly in urbanized areas, include an analysis of sections of Interstate to and including at least the first adjacent existing or proposed interchange on each side. Crossroads and other roads and streets shall be included in the analysis to the extent necessary to assure their ability to collect and distribute traffic to and from the interchange with the new or revised access points."*

Traffic operational analyses for existing and future year conditions were performed using VISSIM, HiCAP and Synchro programs as explained in the Study Methodology section of this report. The basic freeway, merge and diverge segments and weave areas were analyzed using VISSIM and HiCAP. HiCAP analysis utilizes Highway Capacity Manual procedures to measure density and report level of service. The ramp terminals with signalized option were analyzed with Synchro and roundabouts were analyzed using SIDRA. The future year conditions were analyzed with six scenarios as described below:

Scenario #1 - 2012 No-Build Conditions

Scenario #2 - 2012 Build Conditions – Adds Lone Elm Road interchange with auxiliary lanes between adjacent interchanges (K-7 and Woodland)

Scenario #3 - 2032 No-Build Condition (6-Lane) – Assumes 6-lanes on K-10 east of K-7, transitioning to 4-lanes at K-7 with the CD concept for the interchange at K-7

Scenario #4 - 2032 No-Build Condition (8-Lane) – Same as Scenario #3, but with 8-lanes on K-10 east of K-7, transitioning to 6-lanes at K-7

Scenario #5 - 2032 Build Condition (6-Lane) – Adds the Lone Elm interchange with auxiliary lanes between adjacent interchanges (K-7 and Woodland) to Scenario #3

Scenario #6 - 2032 Build Condition (8-Lane) – Adds the Lone Elm interchange with auxiliary lanes between adjacent interchanges (K-7 and Woodland) to Scenario #4

Existing Conditions

The results of the operational analyses for the existing conditions during A.M. and P.M. peak hour are summarized in Tables 2a through 2e. The existing traffic volumes are shown on Figures A-14 and A-15. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 2a
Existing Conditions Level of Service – K-10 Highway Eastbound

	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	17	61	B	13	65	B	18	65	B	13	65	B
w/o K-7	17	60	B	13	61	B						
Diverge K7 SB Off Ramp	12	60	B	9	61	A	17	57	B	13	58	B
w/o K7 Weave	15	60	B	11	61	A						
Weave K7	11	58	A	10	56	A	19	45	B	13	50	B
e/o K7 Weave	15	60	B	13	61	B						
Merge K7 NB On Ramp	16	57	B	12	60	B	30	58	D	20	61	B
e/o K-7	24	59	C	18	61	B	29	64	D	18	65	C
At Lone Elm	24	60	C	17	61	B						
e/o Lone Elm	24	59	C	17	61	B						
Diverge Woodland	16	59	B	11	61	B	27	58	C	17	58	B
b/w Woodland Ramps	23	59	C	17	60	B						
Merge Woodland	31	38	D	15	52	B	34	54	D	21	61	C
eastern end	50	35	F	25	48	C	39	57	E	20	65	C

Table 2b
Existing Conditions Level of Service – K-7 Highway Northbound

	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	13	60	B	12	62	B	14	65	B	13	65	B
Diverge K10 EB Off ramp	10	54	A	8	58	A	6	55	A	10	57	A
s/o K10 Weave	4	63	A	8	62	A						

Weave K10	4	54	A	6	56	A	5	53	A	7	53	A
n/o K10 Weave	4	63	A	6	63	A						
Merge K7 WB On ramp	5	61	A	8	61	A	11	62	B	15	61	B
northern end	7	64	A	11	63	A	8	65	A	12	65	B

Table 2c Existing Conditions Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	18	60	B	27	58	D	16	65	B	24	64	C
Diverge Woodland	12	59	B	18	58	B	15	57	B	23	57	C
b/w Woodland Ramps	15	60	B	24	58	C						
Merge Woodland	11	57	A	16	56	B	17	62	B	25	60	C
e/o Lone Elm	17	56	B	25	55	C	18	65	C	27	64.3	D
b/w Lone Elm	17	55	B	26	54	C						
w/o Lone Elm	17	53	B	27	52	D						
Diverge K7 NB Off	17	53	B	17	53	B	15	57	B	22	56	C
e/o K7 Weave	18	55	B	20	56	C						
Weave K7	12	51	B	15	53	B	14	43	B	22	42	C
w/o K7 Weave	13	60	B	16	59	B						
Merge K7 SB On Ramp	10	60	A	11	59	B	0	66	A	6	65	A
e/o link85	8	61	A	17	59	B						
western end	6	61	A	17	58	B	9	65	A	17	65	B

Table 2d Existing Conditions Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	6	63	A	6	63	A	6	65	A	7	65	A
Diverge K7 WB Off ramp	4	60	A	4	59	A	7	58	A	7	58	A
n/o K10 Weave	5	63	A	5	62	A						
Weave K10	7	53	A	8	50	A	18	26	B	16	29	B
s/o K10 Weave	9	63	A	7	63	A						
Merge K10 EB On ramp	8	62	A	6	62	A	11	62	B	13	61	B
southern end	11	63	B	9	64	A	9	65	A	10	65	A

Table 2e Existing Conditions Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps						
Westbound Left-turn	15.3	0.49	C	14.6	0.13	B
Northbound Left-turn	9.7	0.01	A	7.7	0.15	A
Woodland Avenue and K-10 Westbound Ramps						
Eastbound Left-turn	>100	>1.0	F	11.0	0.40	B
Southbound Left-turn	10.9	0.03	B	7.8	0.01	A

Scenario 1

Scenario 1 is the 2012 No-build conditions alternative. The analyses were performed with future year 2012 traffic volumes and existing lane configurations. The only improvements included are on Woodland Avenue. These improvements include exclusive left-turn lanes and installation of traffic signals on Woodland Avenue at the K-10 ramp interchanges. The results of the intersection analysis for Scenario 1, 2012 No-build conditions during A.M. and P.M. peak hour are summarized in Tables 3a through 3e. The traffic volumes used for analyzing 2012 No-build conditions are shown on Figures A-5 and A-6. The highways and streets were evaluated with the lane configurations shown on Figure A-13. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 3a
Scenario 1 – 2012 No-Build Conditions Level of Service – K-10 Highway Eastbound

	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	21	62	C	19	62	C	22	65	C	20	65	C
w/o K7 SB Ramp	21	61	C	19	61	C						
Diverge K7 SB Off	14	61	B	13	61	B	19	56	B	17	61	B
w/o K7 Weave	16	62	B	16	62	B						
Weave K7	15	56	B	16	55	B	23	43	C	21	44	C
e/o K7 Weave	19	61	C	20	61	C						
Merge K7 NB On	20	57	C	17	60	B	32	56	D	27	59	C
e/o K7 NB Ramp	30	60	D	25	61	C						
At Lone Elm	29	61	D	25	61	C						
e/o Lone Elm	29	61	D	25	61	C	33	61	D	25	65	C
Diverge Woodland	19	61	B	16	61	B	29	57	D	23	58	C
b/w Woodland Ramps	27	59	D	23	61	C						
Merge Woodland	44	31	F	27	42	C	-	-	F	29	58	D
eastern end	65	32	F	47	36	F	45	52	E	25	65	C

Table 3b
Scenario 1 – 2012 No-Build Conditions Level of Service – K-7 Highway Northbound

	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	16	61	B	15	62	B	16	65	B	16	65	B
Diverge K10EB Off	12	54	B	11	58	B	7	55	A	13	56	B
s/o K10 Weave	5	63	A	10	63	A						
Weave K10	6	51	A	9	55	A	7	47	A	12	47	B
n/o K10 Weave	5	63	A	9	63	A						
Merge K7 WB On	6	61	A	10	61	B	13	61	B	17	61	B
northern end	9	64	A	15	63	B	10	65	A	16	65	B

Table 3c Scenario 1 – 2012 No-Build Conditions Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	27	61	D	35	59	E	29	64	D	45	52	E
Diverge Woodland	18	60	B	23	59	C	24	57	C	34	57	D
b/w Woodland Ramps	23	61	C	32	59	D						
Merge Woodland	19	53	B	33	41	D	26	60	C	36	52	E
w/o Lone Elm	33	45	D	56	37	F	26	65	C	42	54	E
At Lone Elm	36	41	E	62	33	F						
Diverge K7 NB Off	38	39	E	61	34	F	24	56	C	34	56	D
e/o K7 Weave	22	44	C	32	42	D						
Weave K7	26	46	C	38	44	E	26	39	C	63	22	F
w/o K7 Weave	19	46	B	27	44	C						
Merge K7 SB On	18	52	C	33	45	D	8	65	A	18	62	B
e/o K7 SB Ramp	14	51	B	26	42	C						
western end	22	51	C	40	41	E	19	65	C	29	64	D

Table 3d Scenario 1 – 2012 No-Build Conditions Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	11	63	B	11	63	B	12	65	B	12	65	B
Diverge K7 WB Off	7	58	A	7	58	A	11	57	B	11	57	B
n/o K10 Weave	9	62	A	9	62	A						
Weave K10	12	49	B	12	47	B	26	27	C	23	29	C
s/o K10 Weave	11	61	B	10	61	A						
Merge K10 EB On	11	61	B	8	62	A	19	61	B	17	61	B
southern end	16	63	B	12	64	B	16	65	B	14	65	B

Table 3e Scenario 1 – 2012 No-Build Conditions Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	19.4	0.84	B	11.3	0.57	B
Woodland Avenue and K-10 Westbound Ramps *Signalized*	22.3	0.72	C	17.9	0.46	B

Scenario 2

Scenario 2 is the 2012 Build conditions with Lone Elm interchange alternative. The analyses were performed with future year 2012 traffic volumes and revised lane configurations that include a tight diamond interchange at Lone Elm Road. The ramp terminals at Lone Elm Road were evaluated as signalized and two-lane roundabouts. This analysis recommends two-lane roundabouts at the ramp terminals.

The results of the intersection analysis for Scenario 2, 2012 Build conditions during A.M. and P.M. peak hour are summarized in Tables 4a through 4e. The traffic volumes used for analyzing 2012 Build Conditions are shown on Figures A-9 and A-10. The highways and streets were evaluated with the lane configurations shown on Figure A-16. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 4a
Scenario 2 – 2012 Build Conditions Level of Service – K-10 Highway Eastbound

	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	21	62	C	19	62	C	22	65	C	20	65	C
w/o K7 SB Ramp	21	61	C	19	61	C						
Diverge K7 SB Off	14	61	B	13	61	B	19	56	B	19	57	B
w/o K7 Weave	16	62	B	16	62	B						
Weave K7	16	55	B	15	55	B	30	37	D	23	43	C
e/o K7 Weave	20	61	C	19	61	C						
e/o K7 NB Ramp	20	60	C	16	62	B	33	61	D	25	65	C
b/w Lone Elm	27	61	D	22	62	C						
e/o Lone Elm	27	46	D	27	41	D	34	60	D	29	64	D
b/w Woodland Ramps	56	31	F	44	35	E						
Merge Woodland	64	23	F	41	30	E	-	-	F	32	56	D
eastern end	73	29	F	58	32	F	-	-	F	34	60	D

Table 4b
Scenario 2 – 2012 Build Conditions Level of Service – K-7 Highway Northbound

	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	16	61	B	15	62	B	16	65	B	16	65	B
Diverge K10 EB Off	12	53	B	11	58	B	7	55	A	13	56	B
s/o K10 Weave	5	63	A	10	63	A						
Weave K10	6	51	A	9	55	A	7	47	A	12	47	B
n/o K10 Weave	5	63	A	9	63	A						
Merge K7 WB On	6	61	A	10	60	B	13	61	B	19	61	B
northern end	9	64	A	15	63	B	10	65	A	16	65	B

Table 4c Scenario 2 – 2012 Build Conditions Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	30	60	D	36	59	E	33	61	D	-	-	F
Diverge Woodland	26	49	C	24	59	C	27	57	C	34	57	D
b/w Woodland Ramps	26	60	C	32	60	D						
e/o Lone Elm	20	55	C	29	49	D	26	65	C	42	54	E
b/w Lone Elm	25	53	C	45	42	F						
w/o Lone Elm	21	47	C	34	40	D	29	64	D	45	52	E
e/o K7 Weave	27	43	D	42	40	E						
Weave K7	20	45	B	27	45	C	26	39	C	35	39	D
w/o K7 Weave	18	52	B	30	51	D						
Merge K7 SB On Ramp	14	51	B	24	45	C	8	65	A	18	62	B
e/o K7 SB Ramp	22	50	C	35	47	E						
western end	22	50	C	36	45	E	19	65	C	29	64	D

Table 4d Scenario 2 – 2012 Build Conditions Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	11	63	B	11	63	B	12	65	B	12	65	B
Diverge K7 WB Off ramp	8	58	A	8	58	A	11	57	B	11	57	B
n/o K10 Weave	9	62	A	9	62	A						
Weave K10	13	46	B	12	48	B	26	27	C	23	29	C
s/o K10 Weave	11	61	A	10	61	A						
Merge K10 EB On ramp	10	61	B	9	62	A	19	61	B	17	61	B
southern end	15	63	B	13	63	B	16	65	B	14	65	B

Table 4e Scenario 2 – 2012 Build Conditions Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	24.9	0.78	C	23.4	0.62	C
Woodland Avenue and K-10 Westbound Ramps *Signalized*	32.6	0.73	C	18.8	0.56	B
Lone Elm Road and K-10 Eastbound Ramps *Signalized*	20.5	0.35	C	19.6	0.45	B
Lone Elm Road and K-10 Westbound Ramps *Signalized*	23.9	0.38	C	26.0	0.45	C
Lone Elm Road and K-10 Eastbound Ramps *Two-lane Roundabout*	9.0	0.25	A	9.5	0.45	A
Lone Elm Road and K-10 Westbound Ramps *Two-lane Roundabout*	9.1	0.34	A	9.2	0.39	A

Scenario 3

Scenario 3 is the 2032 No-Build conditions with six lanes on K-10 Highway and CD Roads for eastbound and westbound K-10 at the K-7 interchange. The interchange at Lone Elm Road is not included. The analyses were performed with future year 2032 traffic volumes and revised lane configurations that include eastbound and westbound CD Roads and six lanes on K-10 Highway. The results of the intersection analysis for Scenario 3, 2032 No-Build conditions during A.M. and P.M. peak hour are summarized in Tables 5a through 5e. The traffic volumes used for analyzing 2032 No-Build Conditions with 6 lanes are shown on Figures A-7 and A-8. The highways and streets were evaluated with the lane configurations shown on Figure A-17. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 5a Scenario 3 – 2032 No-Build Conditions Level of Service – K-10 Highway Eastbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	119	14	F	110	15	F	29	63	D	25	65	C
w/o K7 Ramp	118	13	F	112	14	F						
Diverge CD Road	88	12	F	81	12	F	-	-	F	23	57	C
b/w CD Roads	146	8	F	139	8	F						
Merge CD Road	110	9	F	107	9	F	-	-	F	-	-	F
e/o CD Road	97	14	F	98	13	F	27	64	D	20	65	C
e/o Lone Elm	95	21	F	95	21	F						
Diverge Woodland	67	20	F	67	19	F	-	-	F	-	-	F
b/w Woodland Ramps	105	18	F	105	17	F						
Merge Woodland	68	22	F	70	21	F	-	-	F	-	-	F
eastern end	74	30	F	74	30	F	-	-	F	-	-	F
Eastbound CD Road												
e/o Weave	5	49	A	12	29	B						
Weave K-7 Ramps	25	29	C	118	6	F						
w/o Weave	61	16	F	80	11	F						

Table 5b Scenario 3 – 2032 No-Build Conditions Level of Service – K-7 Highway Northbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	23	61	C	23	61	C	24	65	C	24	65	C
Diverge K10 EB Off ramp	16	57	B	16	58	B	12	54	B	21	56	C
s/o K10 Weave	16	62	B	17	62	B						
Weave K10	14	54	B	15	52	B	15	41	B	26	38	C
n/o K10 Weave	14	62	B	16	61	B						
Merge K7 WB On ramp	13	60	B	14	60	B	22	60	C	29	59	D
northern end	19	62	C	21	62	C	20	65	C	26	65	C

Table 5c Scenario 3 – 2032 No-Build Conditions Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	76	29	F	74	30	F	-	-	F	-	-	F
Diverge Woodland	55	26	F	54	27	F	-	-	F			F
b/w Woodland Ramps	94	21	F	92	22	F						
Merge Woodland	68	21	F	67	21	F	-	-	F			F
w/o Woodland	76	29	F	76	29	F	29	64	D			
e/o Lone Elm	32	46	D	31	46	D						
Diverge CD Road	24	46	C	24	46	C	27	55	C	-	-	F
e/o Diverge	27	40	D	27	41	D						
b/w CD Roads	41	39	E	40	40	E						
Merge CD Road	34	32	D	42	28	E	9	63	A			
w/o K7	68	32	F	69	32	F						
western end	63	34	F	64	35	F	21	65	C	43	54	E
Westbound CD Road												
w/o Weave	10	50	A	10	50	A						
Weave K-7 Ramps	11	47	B	11	47	B						
e/o Weave	9	57	A	10	55	A						

Table 5d Scenario 3 – 2032 No-Build Conditions Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	17	62	B	38	37	E	18	65	C	22	65	C
Diverge K7 WB Off ramp	12	56	B	38	23	E	13	56	B	19	56	B
n/o K10 Weave	12	61	B	58	16	F						
Weave K10	15	44	B	74	10	F	38	25	E	34	30	D
s/o K10 Weave	8	61	A	9	56	A						
Merge K10 EB On ramp	8	61	A	8	61	A	25	60	C	25	60	C
southern end	12	63	B	11	63	B	22	65	C	22	65	C

Table 5e Scenario 3 – 2032 No-Build Conditions Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	51.8	1.05	D	24.8	0.81	C
Woodland Avenue and K-10 Westbound Ramps *Signalized*	34.8	0.93	C	24.7	0.83	C

Scenario 4

Scenario 4 is the 2032 No-Build conditions with eight lanes on K-10 Highway and CD Roads for eastbound and westbound K-10 at the K-7 interchange. The interchange at Lone Elm Road is not included. The analyses were performed with future year 2032 traffic volumes and revised lane configurations that include eastbound and westbound CD Roads and eight lanes on K-10 Highway.

The results of the intersection analysis for Scenario 4, 2032 No-Build conditions during A.M. and P.M. peak hour are summarized in Tables 6a through 6e. The traffic volumes used for analyzing 2032 No-Build Conditions with 8 lanes are shown on Figures A-7 and A-8. The highways and streets were evaluated with the lane configurations shown on Figure A-18. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 6a Scenario 4 – 2032 No-Build Conditions (8-Lane) Level of Service – K-10 Highway Eastbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	107	13	F	49	29	F	22	65	C	20	65	C
w/o K7 Ramp	117	11	F	73	18	F						
Diverge CD Road	100	9	F	68	14	F	17	56	B	19	65	C
b/w CD Roads	156	6	F	125	7	F						
Merge CD Road	176	4	F	142	6	F	-	-	F	-	-	F
e/o CD Road	161	6	F	146	7	F	21	65	C	16	65	B
e/o Lone Elm	108	17	F	96	20	F						
Diverge Woodland	75	16	F	68	19	F	-	-	F	-	-	F
b/w Woodland Ramps	116	15	F	106	17	F						
Merge Woodland	77	19	F	70	21	F	-	-	F	-	-	F
eastern end	75	30	F	74	30	F	-	-	F	-	-	F
Eastbound CD Road												
w/o Weave	51	7	F	64	8	F						
Weave K-7 Ramps	166	2	F	141	4	F						
e/o Weave	190	3	F	93	8	F						

Table 6b Scenario 4 – 2032 No-Build Conditions (8-Lane) Level of Service – K-7 Highway Northbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	156	5	F	23	61	C	24	65	C	24	65	C
Diverge K10 EB Off ramp	158	3	F	16	58	B	12	54	B	21	56	C
s/o K10 Weave	6	53	A	17	62	B						
Weave K10	6	50	A	16	51	B	15	41	B	26	38	C
n/o K10 Weave	5	62	A	17	60	B						
Merge K7 WB On ramp	9	60	A	14	60	B	22	60	C	29	59	D
northern end	12	63	B	21	61	C	20	65	C	26	65	C

Table 6c Scenario 4 – 2032 No-Build Conditions (8-Lane) Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	79	27	F	73	31	F	-	-	F	-	-	F
Diverge Woodland	59	23	F	52	28	F	-	-	F			F
b/w Woodland Ramps	105	17	F	91	22	F						
Merge Woodland	78	17	F	66	22	F	-	-	F			F
w/o Woodland	88	23	F	76	29	F	21	65	C	30	63	D
e/o Lone Elm	46	31	F	32	46	D						
Diverge CD Road	36	31	E	22	49	C	23	55	C	-	-	F
e/o Diverge	15	52	B	22	51	C						
b/w CD Roads	14	53	B	21	51	C						
Merge CD Road	11	55	B	16	52	B	9	63	A	-	-	F
w/o K7	18	53	C	30	48	D						
western end	18	53	C	30	48	D	16	65	B	64	27	D
Westbound CD Road												
w/o Weave	78	9	F	13	43	B						
Weave K-7 Ramps	98	5	F	27	29	C						
e/o Weave	5	57	A	8	57	A						

Table 6d Scenario 4 – 2032 No-Build Conditions (8-Lane) Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	60	18	F	95	11	F	18	65	C	22	65	C
Diverge K7 WB Off ramp	54	12	F	74	9	F	13	56	B	19	56	B
n/o K10 Weave	87	8	F	99	7	F						
Weave K10	111	6	F	117	5	F	38	25	E	34	30	D
s/o K10 Weave	11	55	B	8	54	A						
Merge K10 EB On ramp	10	60	B	7	61	A	25	60	C	25	60	C
southern end	15	62	B	11	63	A	22	65	C	22	65	C

Table 6e Scenario 4 – 2032 No-Build Conditions (8-Lane) Level of Service –Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	51.8	1.05	D	24.8	0.81	C
Woodland Avenue and K-10 Westbound Ramps *Signalized*	34.8	0.93	C	24.7	0.83	C

Scenario 5

Scenario 5 is the 2032 Build conditions with six lanes on K-10 Highway and CD Roads for eastbound and westbound K-10 at the K-7 interchange. The interchange at Lone Elm Road is included. The analyses were performed with future year 2032 traffic volumes and revised lane configurations that include eastbound and westbound CD Roads and six lanes on K-10 Highway. The ramp terminals at Lone Elm Road were evaluated as signalized and two-lane roundabouts. This analysis recommends two-lane roundabouts at the ramp terminals.

The results of the intersection analysis for Scenario 5, 2032 Build conditions during A.M. and P.M. peak hour are summarized in Tables 7a through 7e. The traffic volumes used for analyzing 2032 Build Conditions with six lanes are shown on Figures A-11 and A-12. The highways and streets were evaluated with the lane configurations shown on Figure A-19. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 7a Scenario 5 – 2032 Build Conditions (6-Lane) Level of Service – K-10 Highway Eastbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	57	42	F	37	59	E	30	63	D	25	65	C
w/o K7 Ramp	46	52	F	36	59	E						
Diverge CD Road	27	58	C	24	60	C	19	63	B	15	57	B
b/w CD Roads	30	60	D	27	61	D						
e/o CD Road	25	60	C	19	62	C	28	64	D	20	65	C
Diverge Lone Elm	25	60	C	19	61	B	24	62	C	17	63	B
b/w Lone Elm Ramps	31	61	D	23	62	C						
e/o Lone Elm	41	39	E	27	47	D	29	64	D	22	65	C
b/w Woodland Ramps	87	22	F	36	43	E						
eastern end	72	31	F	49	36	F	-	-	F	33	61	D
Eastbound CD Road												
e/o Weave	7	51	A	9	51	A						
Weave K-7 Ramps	12	47	B	11	47	B						
w/o Weave	22	56	C	12	59	B						

Table 7b Scenario 5 – 2032 Build Conditions (6-Lane) Level of Service – K-7 Highway Northbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	24	58	C	23	61	C	24	65	C	24	65	C
Diverge K10 EB Off ramp	19	47	B	16	57	B	11	53	B	20	56	B
s/o K10 Weave	9	62	A	16	62	B						
Weave K10	10	50	A	17	50	B	14	41	B	25	38	C
n/o K10 Weave	9	62	A	17	60	B						
Merge K7 WB On ramp	12	60	B	15	60	B	21	61	C	24	60	C
northern end	16	63	B	22	62	C	18	65	C	25	65	C

Table 7c Scenario 5 – 2032 Build Conditions (6-Lane) Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	29	61	D	96	19	F	31	62	D	-	-	F
Diverge Woodland	21	60	C	80	16	F	26	61	C	33	61	D
b/w Woodland Ramps	25	61	C	112	14	F						
w/o Woodland	23	55	C	128	10	F	22	65	C	31	63	D
b/w Lone Elm	28	53	D	127	11	F						
e/o CD Road	14	50	B	66	13	F	21	65	C	31	63	D
b/w CD Roads	27	48	D	107	15	F						
Merge CD Road	30	41	D	61	25	F	9	63	A	-	-	F
w/o K7	45	41	F	69	33	F						
western end	45	41	E	63	36	F	21	65	C	43	54	E
Westbound CD Road												
w/o Weave	20	48	C	12	50	B						
Weave K-7 Ramps	15	46	B	12	47	B						
e/o Weave	8	58	A	13	45	B						

Table 7d Scenario 5 – 2032 Build Conditions (6-Lane) Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	16	62	B	20	61	C	17	65	B	22	65	C
Diverge K7 WB Off ramp	12	56	B	15	56	B	15	57	B	18	56	B
n/o K10 Weave	12	62	B	14	62	B						
Weave K10	18	43	B	16	49	B	37	25	E	33	30	D
s/o K10 Weave	14	59	B	15	61	B						
Merge K10 EB On ramp	14	60	B	13	61	B	24	60	C	24	60	C
southern end	20	62	C	18	62	C	22	65	C	22	65	C

Table 7e Scenario 5 – 2032 Build Conditions (6-Lane) Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	32.4	1.0	C	17.7	0.70	B
Woodland Avenue and K-10 Westbound Ramps *Signalized*	21.5	0.82	C	20.3	0.73	C
Lone Elm Road and K-10 Eastbound Ramps *Signalized*	24.7	0.45	C	25.9	0.70	C
Lone Elm Road and K-10 Westbound Ramps *Signalized*	22.6	0.37	C	22.8	0.59	C
Lone Elm Road and K-10 Eastbound Ramps *Two-lane Roundabout*	9.8	0.38	A	14.1	0.68	B
Lone Elm Road and K-10 Westbound Ramps *Two-lane Roundabout*	9.3	0.50	A	10.1	0.67	B

Scenario 6

Scenario 6 is the 2032 Build conditions with eight lanes on K-10 Highway and CD Roads for eastbound and westbound K-10 at the K-7 interchange. The interchange at Lone Elm Road is included. The analyses were performed with future year 2032 traffic volumes and revised lane configurations that include eastbound and westbound CD Roads and eight lanes on K-10 Highway. The ramp terminals at Lone Elm Road were evaluated as signalized and two-lane roundabouts.

The results of the intersection analysis for Scenario 6, 2032 Build conditions during A.M. and P.M. peak hour are summarized in Tables 8a through 8e. The traffic volumes used for analyzing 2032 Build Conditions with eight lanes are shown on Figures A-11 and A-12. The highways and streets were evaluated with the lane configurations shown on Figure A-20. The separate technical appendix contains the analyses output files from VISSIM, HiCAP and Synchro.

Table 8a Scenario 6 – 2032 Build Conditions (8-Lane) Level of Service – K-10 Highway Eastbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Eastbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
western end	28	61	D	21	62	C	22	65	C	19	65	C
w/o K7 Ramp	28	61	D	24	62	C						
Diverge CD Road	21	61	C	9	60	A	19	63	B	15	57	B
b/w CD Roads	21	61	C	15	61	B						
e/o CD Road	20	62	C	20	57	C	22	65	C	16	65	B
b/w Lone Elm Ramps	24	62	C	25	58	C						
e/o Lone Elm	24	54	C	14	56	B	22	65	C	17	65	B
b/w Woodland Ramps	29	53	D	25	57	C						
eastern end	42	42	E	27	48	D	32	62	D	23	61	C
Eastbound CD Road												
e/o Weave	8	51	A	73	55	F						
Weave K-7 Ramps	12	47	B	11	52	B						
w/o Weave	22	56	C	8	61	A						

Table 8b Scenario 6 – 2032 Build Conditions (8-Lane) Level of Service – K-7 Highway Northbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Northbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
southern end	24	58	C	24	59	C	24	65	C	24	65	C
Diverge K10 EB Off ramp	19	47	B	14	60	B	11	53	B	20	56	B
s/o K10 Weave	9	62	A	11	54	B						
Weave K10	10	50	A	8	57	A	14	41	B	25	38	C
n/o K10 Weave	9	62	A	21	54	C						
Merge K7 WB On ramp	12	60	B	29	58	D	21	61	C	24	60	C
northern end	17	63	B	23	58	C	18	65	C	25	65	C

Table 8c Scenario 6 – 2032 Build Conditions (8-Lane) Level of Service – K-10 Highway Westbound												
	VISSIM						HiCAP					
K-10 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Westbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
eastern end	21	62	C	34	50	D	22	65	C	31	63	D
Diverge Woodland	17	61	B	23	59	C	26	61	C	33	61	D
b/w Woodland Ramps	19	62	C	18	53	C						
w/o Woodland	18	56	C	26	52	C	18	65	B	23	65	C
b/w Lone Elm	19	58	C	30	48	D						
e/o Diverge	12	58	B	23	51	C	17	65	B	23	65	C
b/w CD Roads	15	58	B	32	51	D						
Merge CD Road	16	57	B	25	54	C	1	67	A	10	62	A
e/o K7	22	56	C	44	47	E						
western end	22	56	C	33	54	D	16	65	B	27	64	D
Westbound CD Road												
w/o Weave	20	49	C	20	55	C						
Weave K-7 Ramps	15	46	B	34	50	D						
e/o Weave	8	58	A	14	59	B						

Table 8d Scenario 6 – 2032 Build Conditions (8-Lane) Level of Service – K-7 Highway Southbound												
	VISSIM						HiCAP					
K-7 Highway	A.M. Peak Hour			P.M. Peak Hour			A.M. Peak Hour			P.M. Peak Hour		
Southbound	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS
northern end	16	62	B	22	61	C	17	65	B	22	65	C
Diverge K7 WB Off ramp	12	56	B	25	53	C	15	57	B	18	56	B
n/o K10 Weave	12	62	B	18	61	B						
Weave K10	18	43	B	13	56	B	37	25	E	33	30	D
s/o K10 Weave	14	59	B	34	55	D						
Merge K10 EB On ramp	14	60	B	12	60	B	24	60	C	24	60	C
southern end	20	62	C	24	62	C	22	65	C	22	65	C

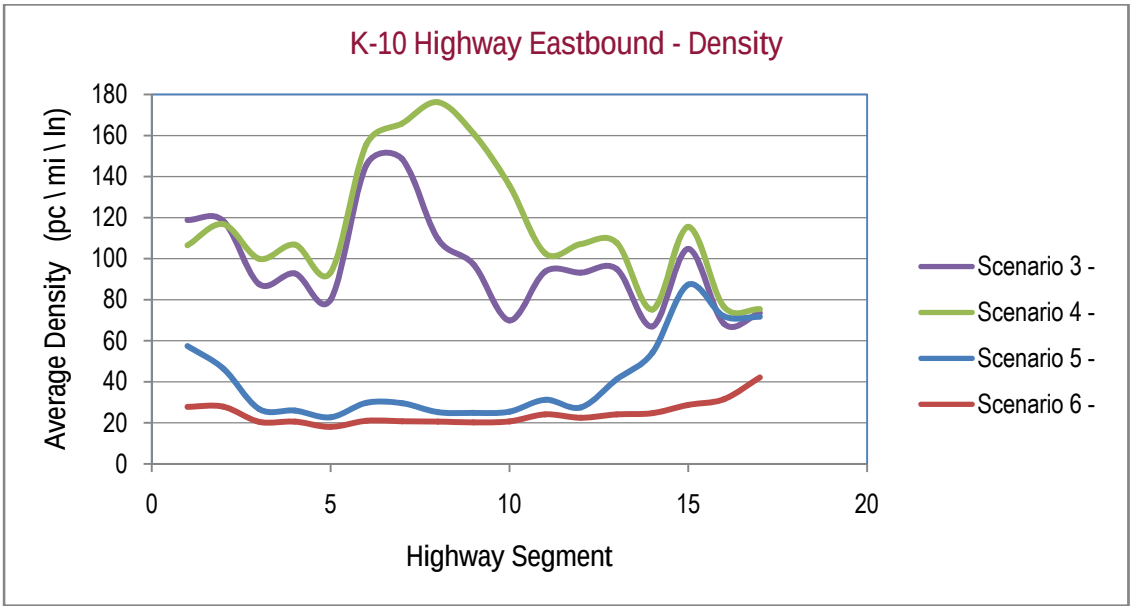
Table 8e Scenario 6 – 2032 Build Conditions (8-Lane) Level of Service – Ramp Intersections						
Intersection	A.M. Peak Hour			P.M. Peak Hour		
Movement	Delay	v/c	LOS	Delay	v/c	LOS
Woodland Avenue and K-10 Eastbound Ramps *Signalized*	32.4	1.0	C	17.7	0.70	B
Woodland Avenue and K-10 Westbound Ramps *Signalized*	21.5	0.82	C	20.3	0.73	C
Lone Elm Road and K-10 Eastbound Ramps *Signalized*	24.7	0.45	C	25.9	0.70	C
Lone Elm Road and K-10 Westbound Ramps *Signalized*	22.6	0.37	C	22.8	0.59	C
Lone Elm Road and K-10 Eastbound Ramps *Two-lane Roundabout*	9.8	0.38	A	14.1	0.68	B
Lone Elm Road and K-10 Westbound Ramps *Two-lane Roundabout*	9.3	0.50	A	10.1	0.67	B

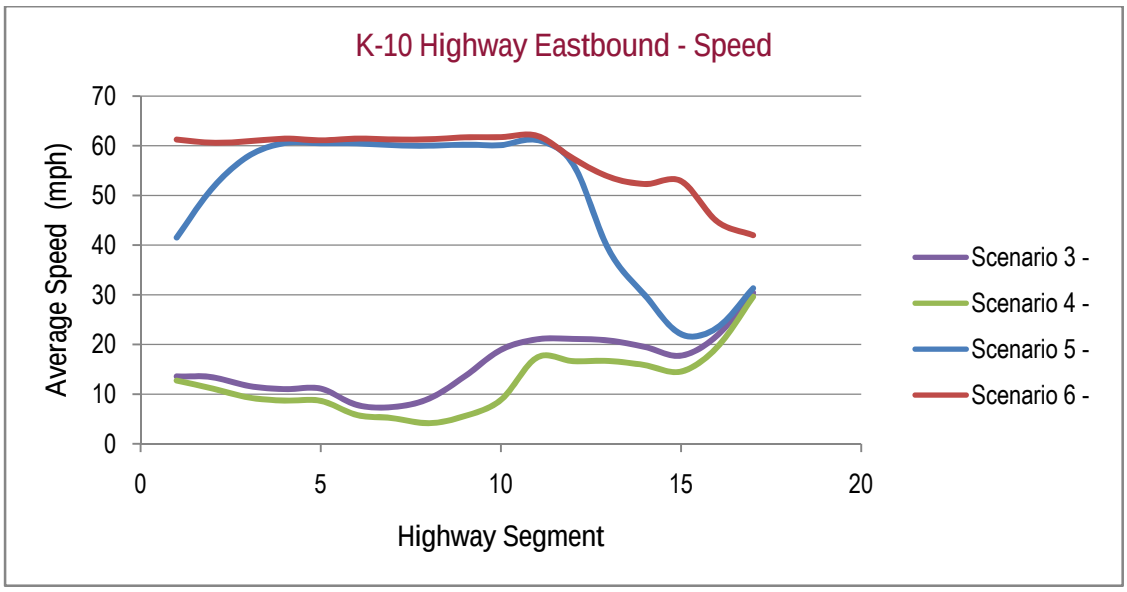
Section 6 – Summary

This Break-In Access Study report has been prepared to seek approval for an interchange on K-10 Highway at Lone Elm Road in Lenexa, Kansas. All the eight FHWA criteria for a new access on freeway systems have been addressed. Future year traffic forecasts were made after reviewing several sources and traffic operational analyses were performed. VISSIM and HiCAP programs were used to obtain results from microsimulation and HCM methodologies respectively. Synchro and SIDRA were used for signalized and roundabout capacity analyses respectively. The study area includes K-10 Highway and interchanges at K-7 Highway, Woodland Avenue and the proposed Lone Elm interchange.

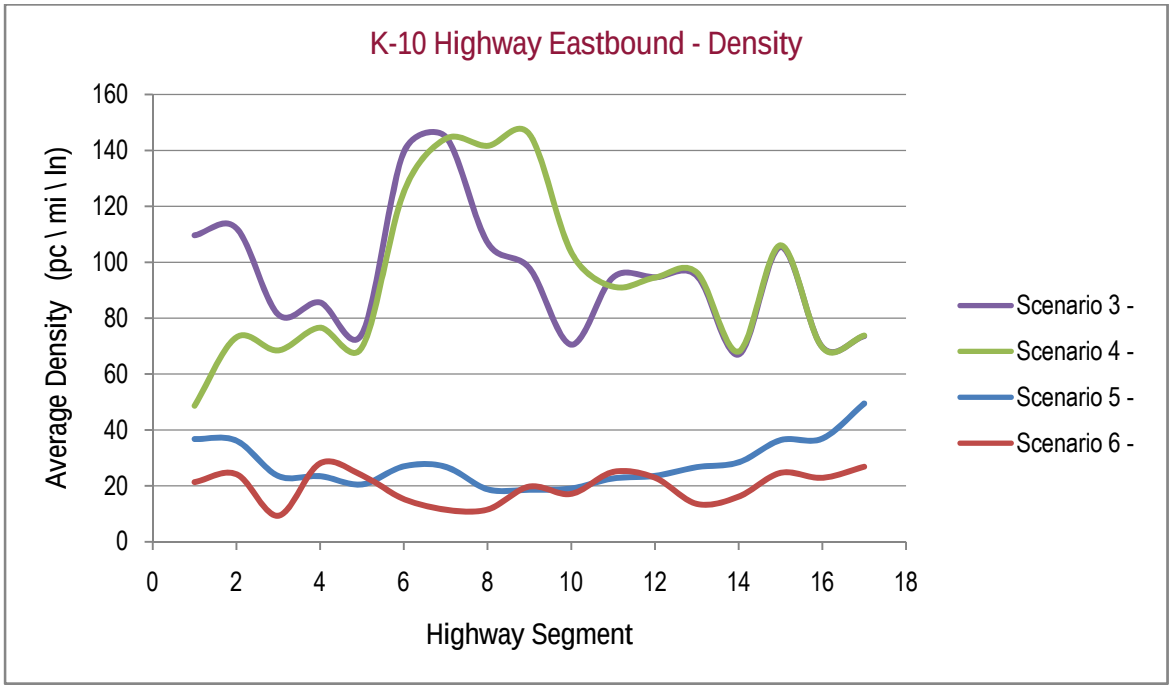
A number of scenarios were analyzed in this study. In general, the capacity restraints on K-10 are related to mainline capacity restraints for through traffic and not a result of the interchanges. The basic four-lane segment of K-10 is anticipated to exceed capacity somewhere between 2011 and 2013. Widening this facility to a six-lane will accommodate the projected traffic volumes, regardless of this interchange, to approximately 2027 or 2028 with the addition of collector-distributor roads at the K-7 interchange. An eight-lane facility would provide sufficient capacity to approximately 2040 based on current projected growth trends. This analysis recommends two-lane roundabouts at the ramp terminals.

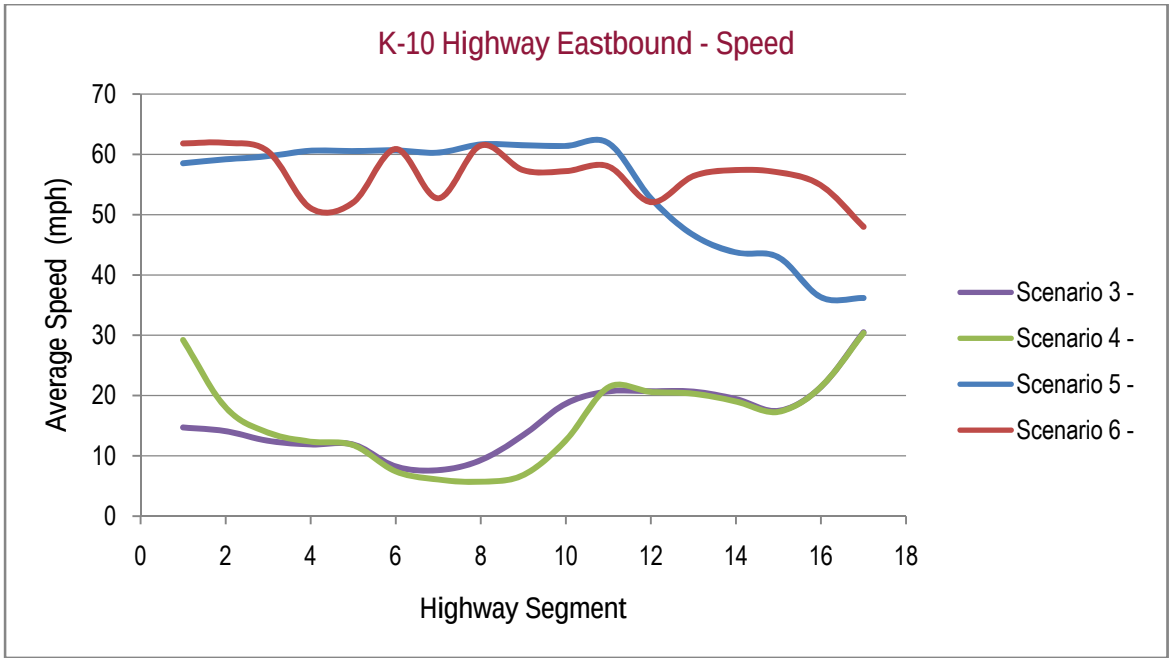
The difference in density and speed between the scenarios 3, 4, 5 and 6 are shown in the following graphs using VISSIM simulation results. As indicated by the graphs, scenario 6 provides highest travel speeds and lowest densities on K-10 Highway.



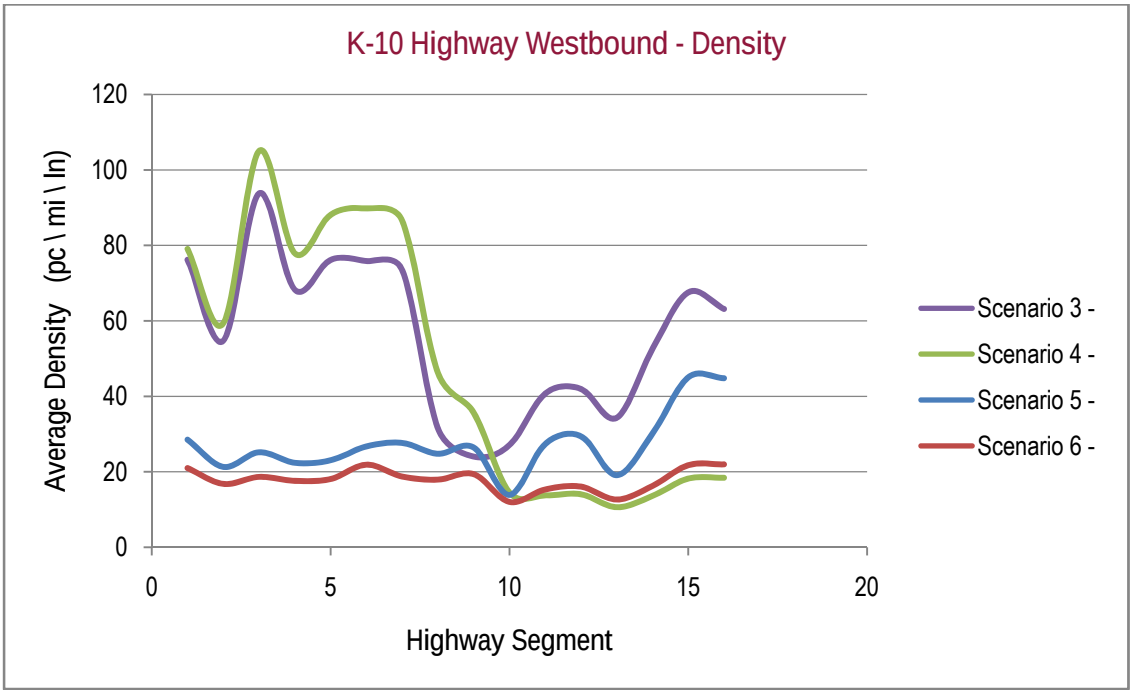


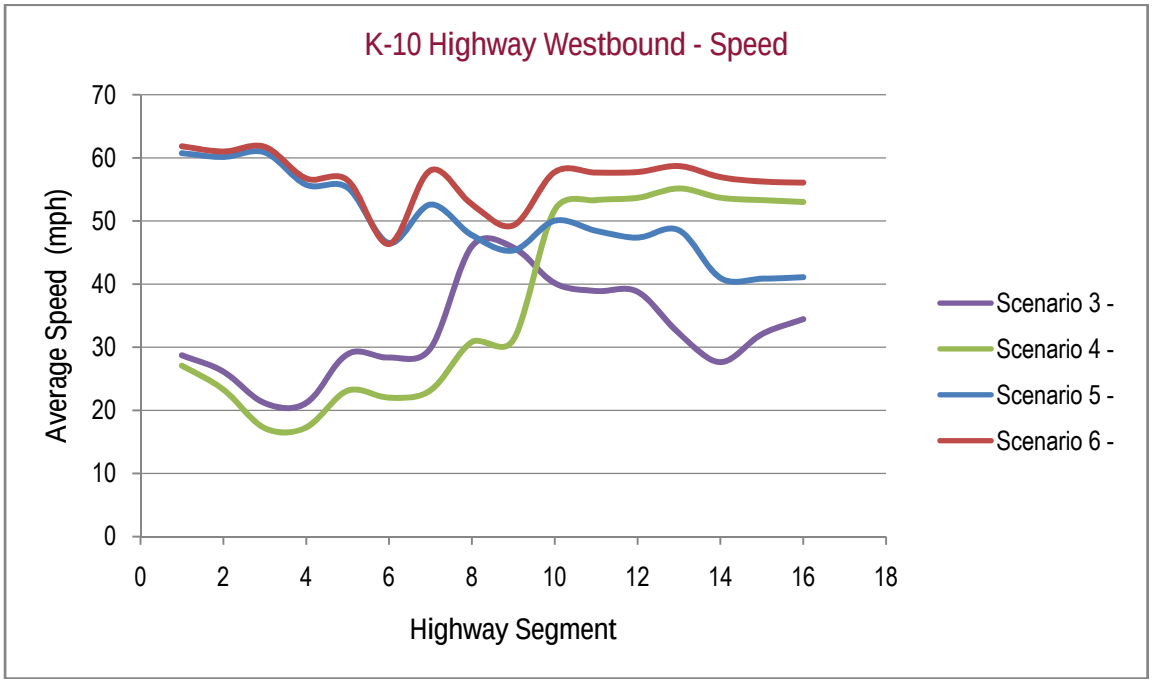
Graph 1. AM Peak Hour VISSIM Simulation Results on K-10 Highway Eastbound



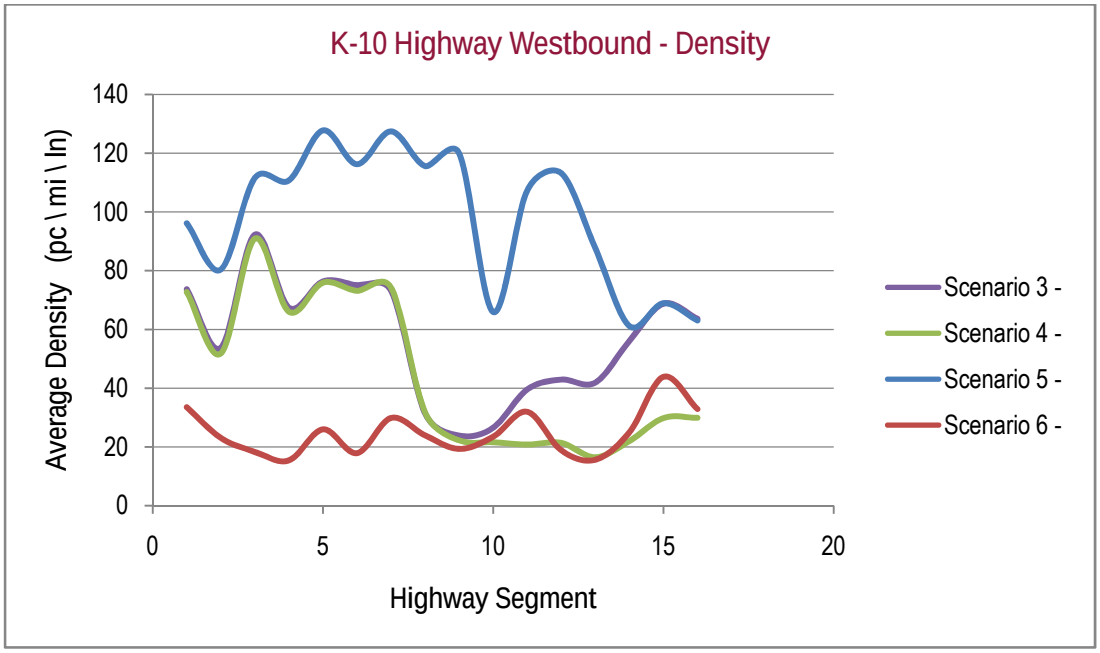


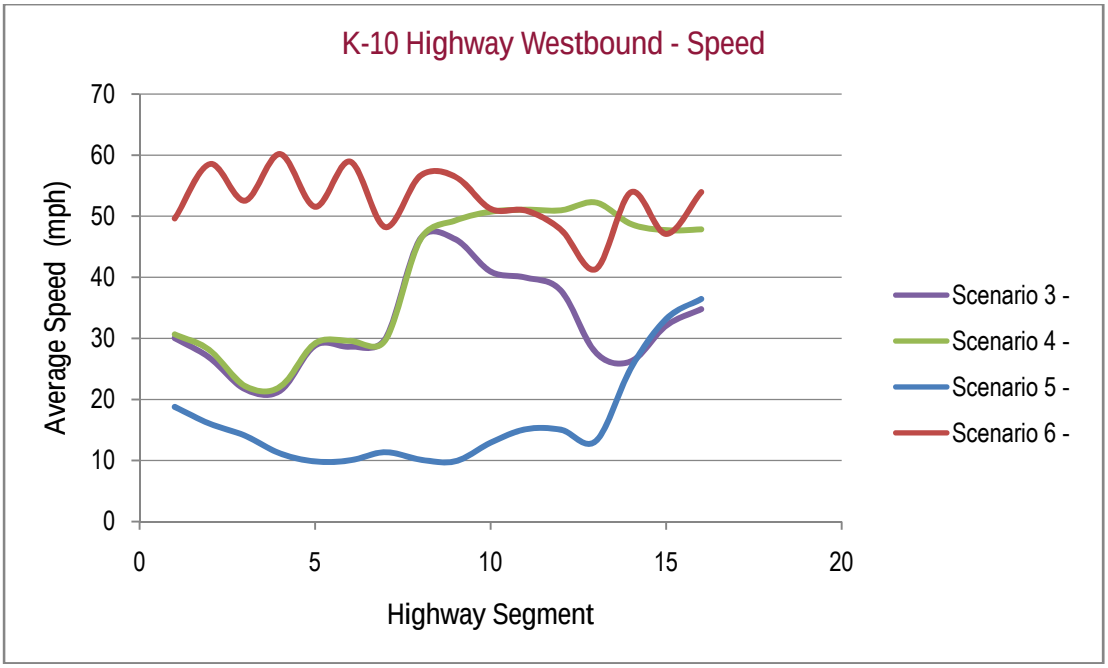
Graph 2. PM Peak Hour VISSIM Simulation Results on K-10 Highway Eastbound





Graph 3. AM Peak Hour VISSIM Simulation Results on K-10 Highway Westbound





Graph 4. AM Peak Hour VISSIM Simulation Results on K-10 Highway Westbound

Appendix A - Figures

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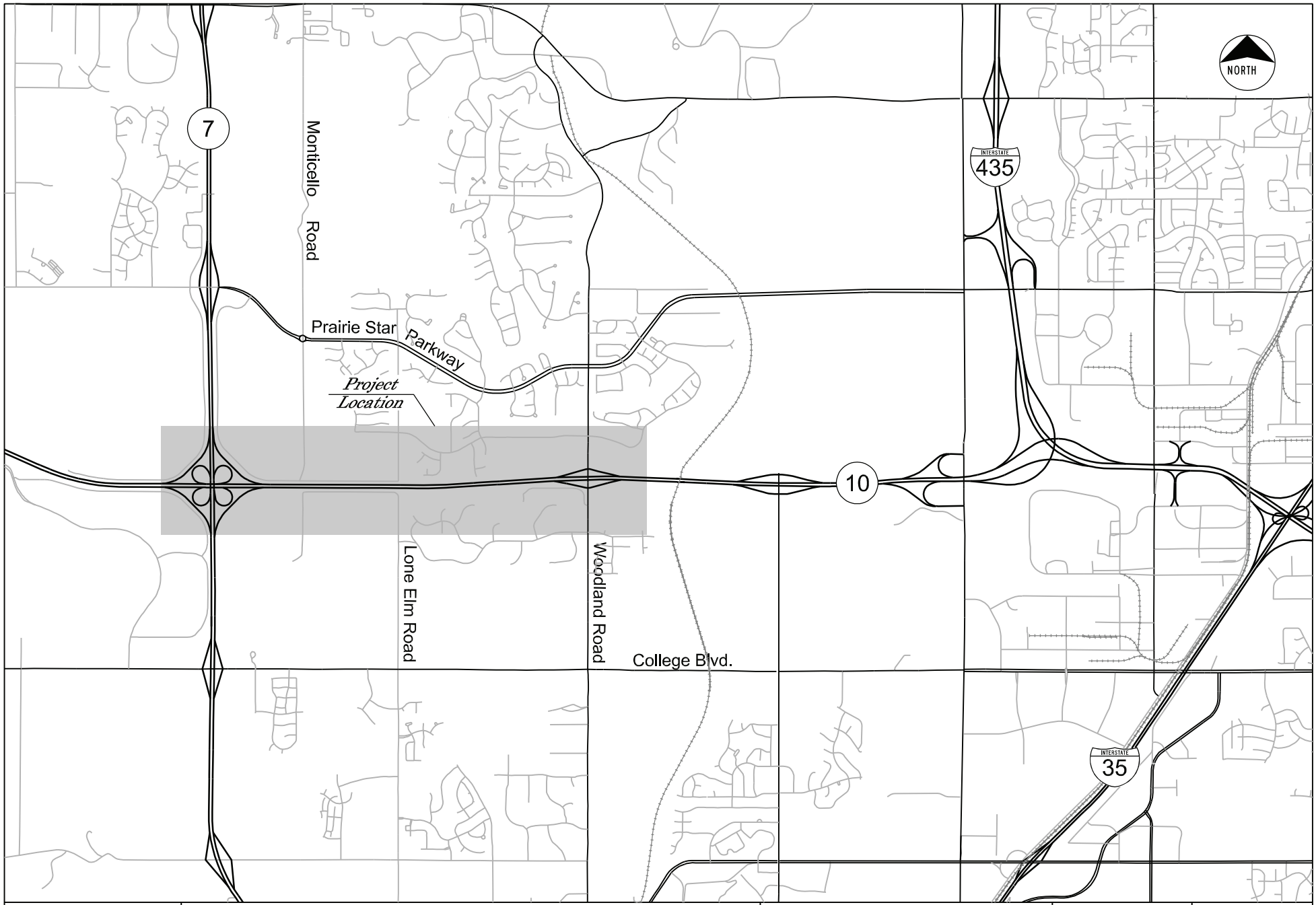

TranSystems	LOCATION MAP	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-1

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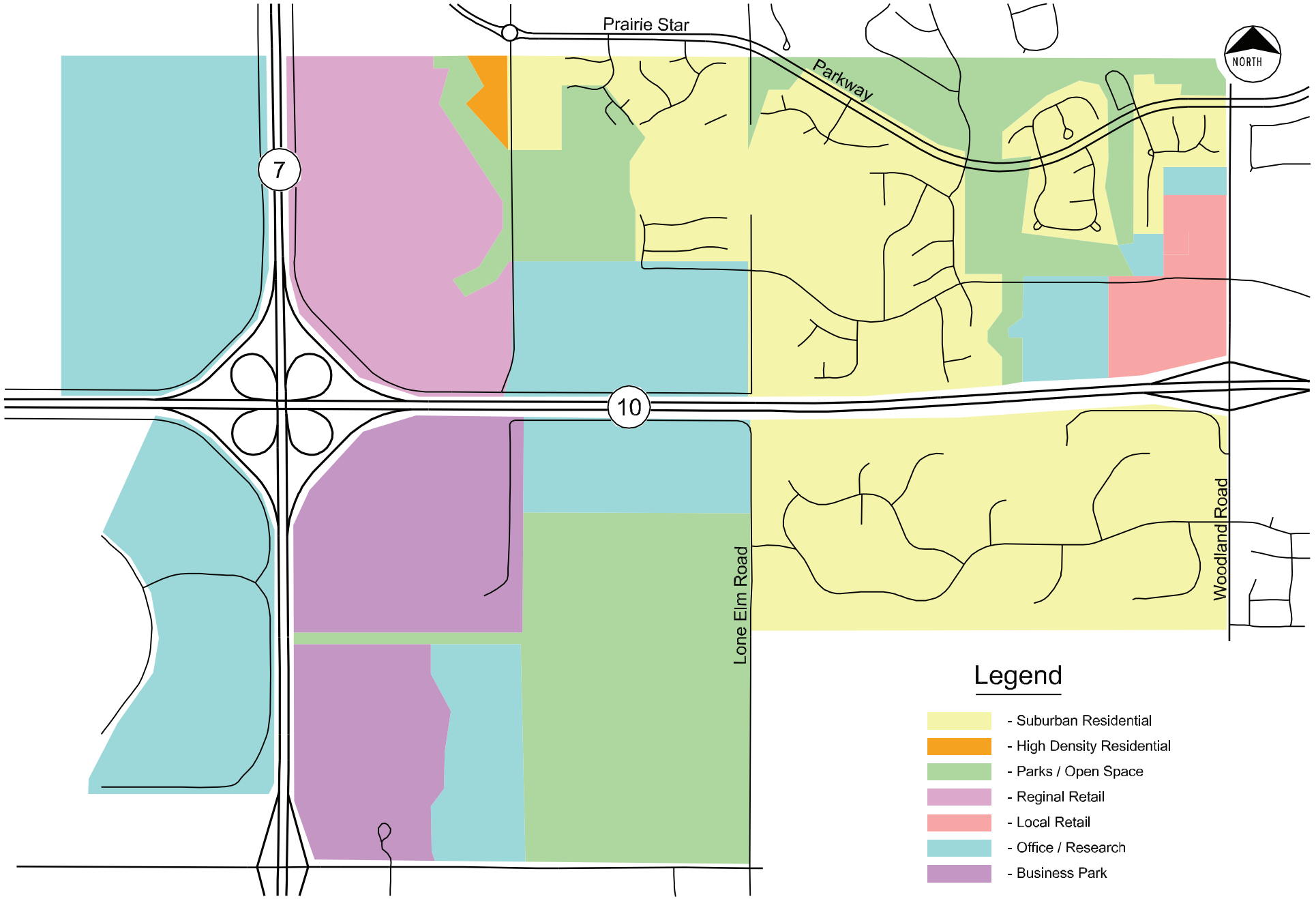

TranSystems	PROPOSED LAND USE	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-2

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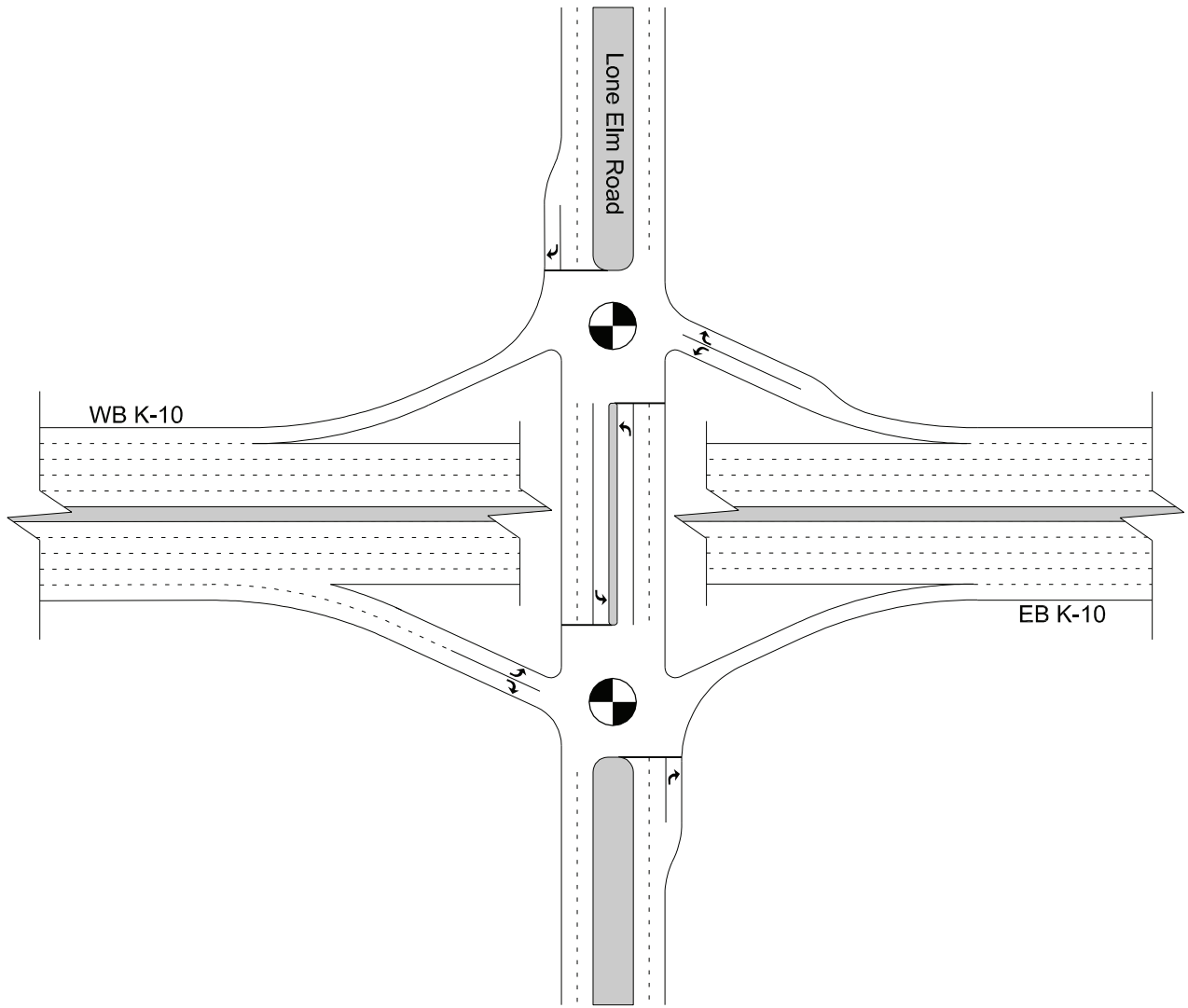

TranSystems	SIGNALIZED INTERCHANGE CONFIGURATION	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-3

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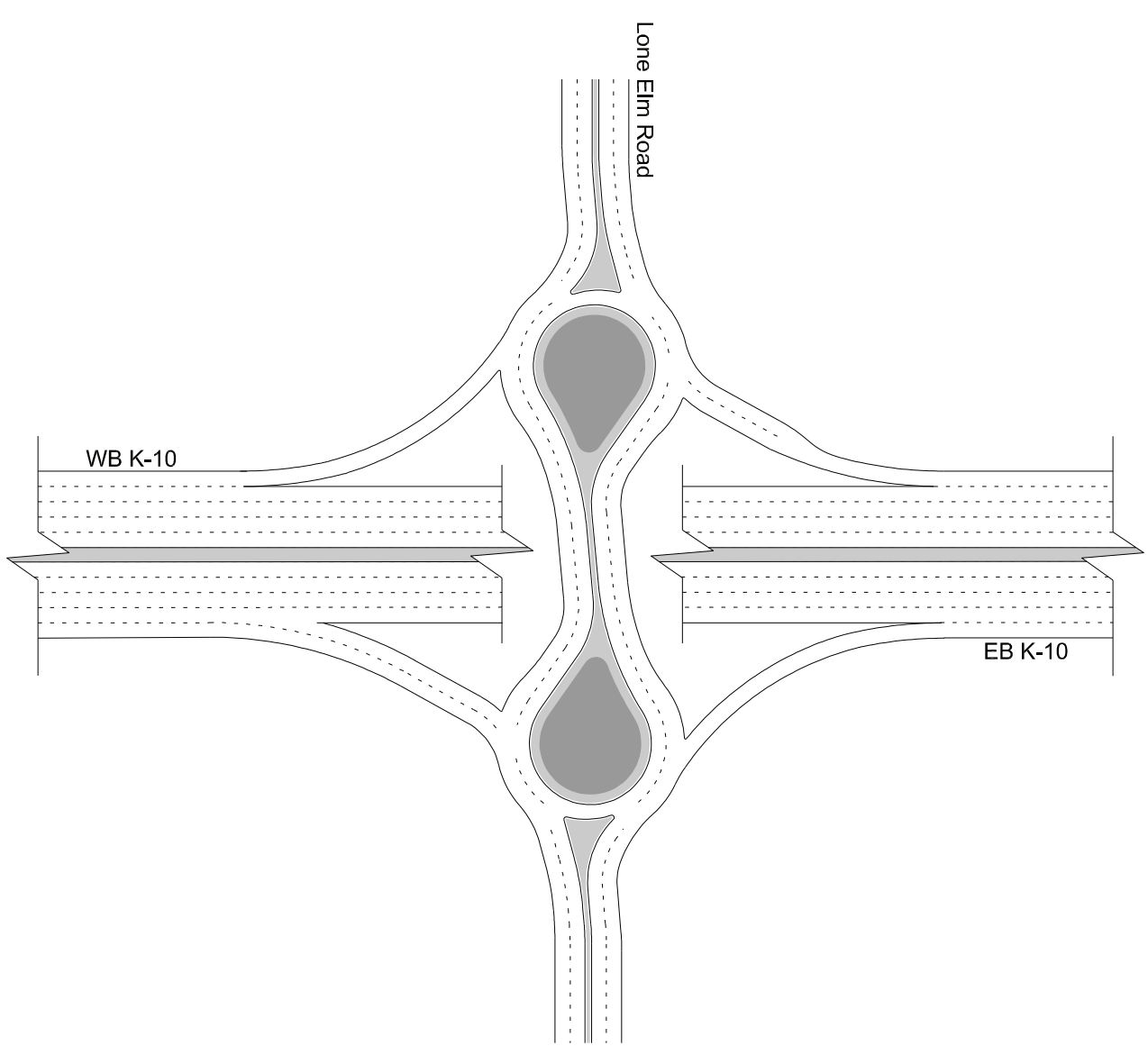

TranSystems

ROUNDABOUT INTERCHANGE CONFIGURATION

K-10 & Lone Elm Road
Break-In-Access Study
Lenexa, Kansas

May 2009

No Scale

Figure A-4

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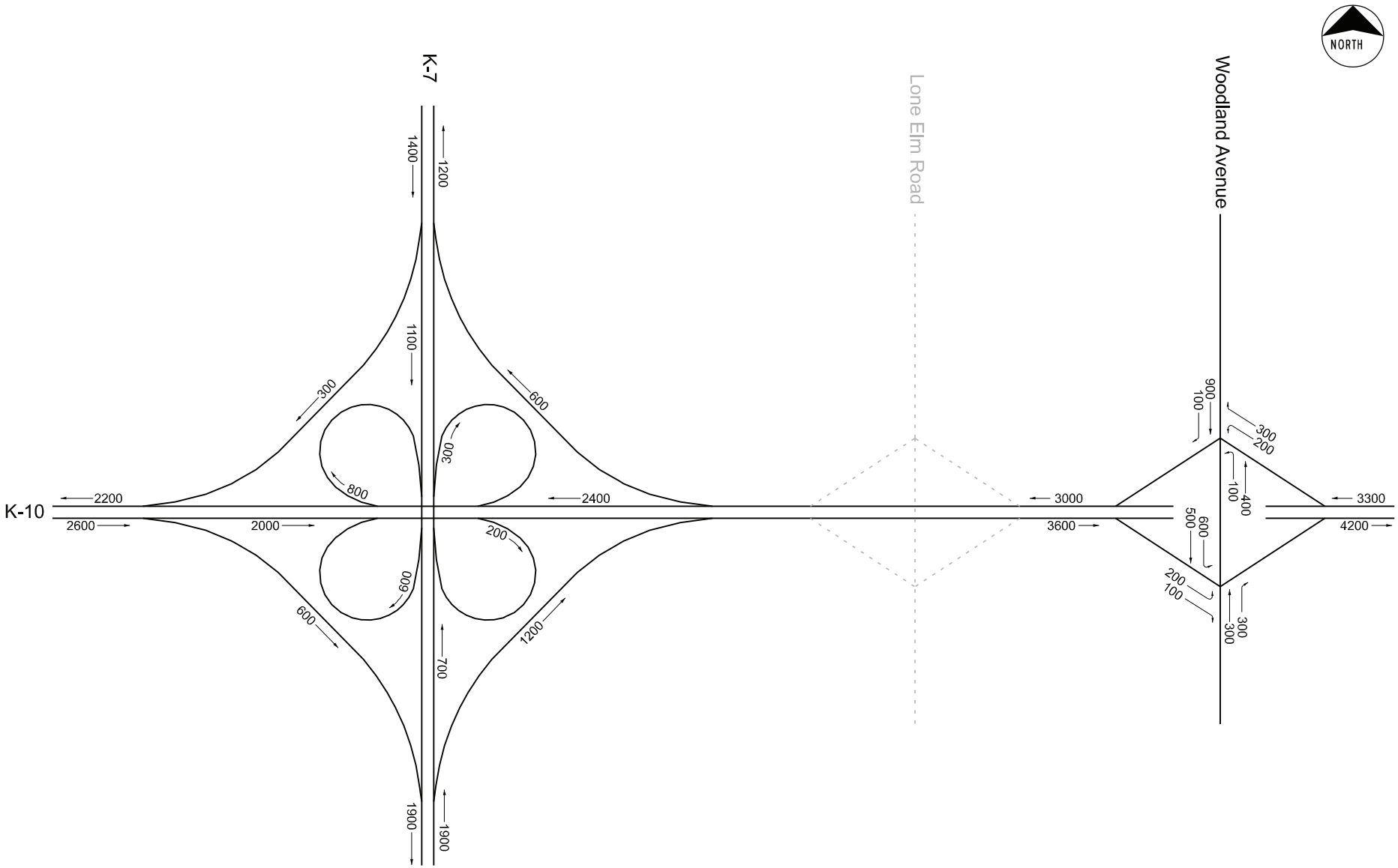

TranSystems	YEAR 2012 NO-BUILD TRAFFIC VOLUMES A.M. PEAK HOUR	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-5

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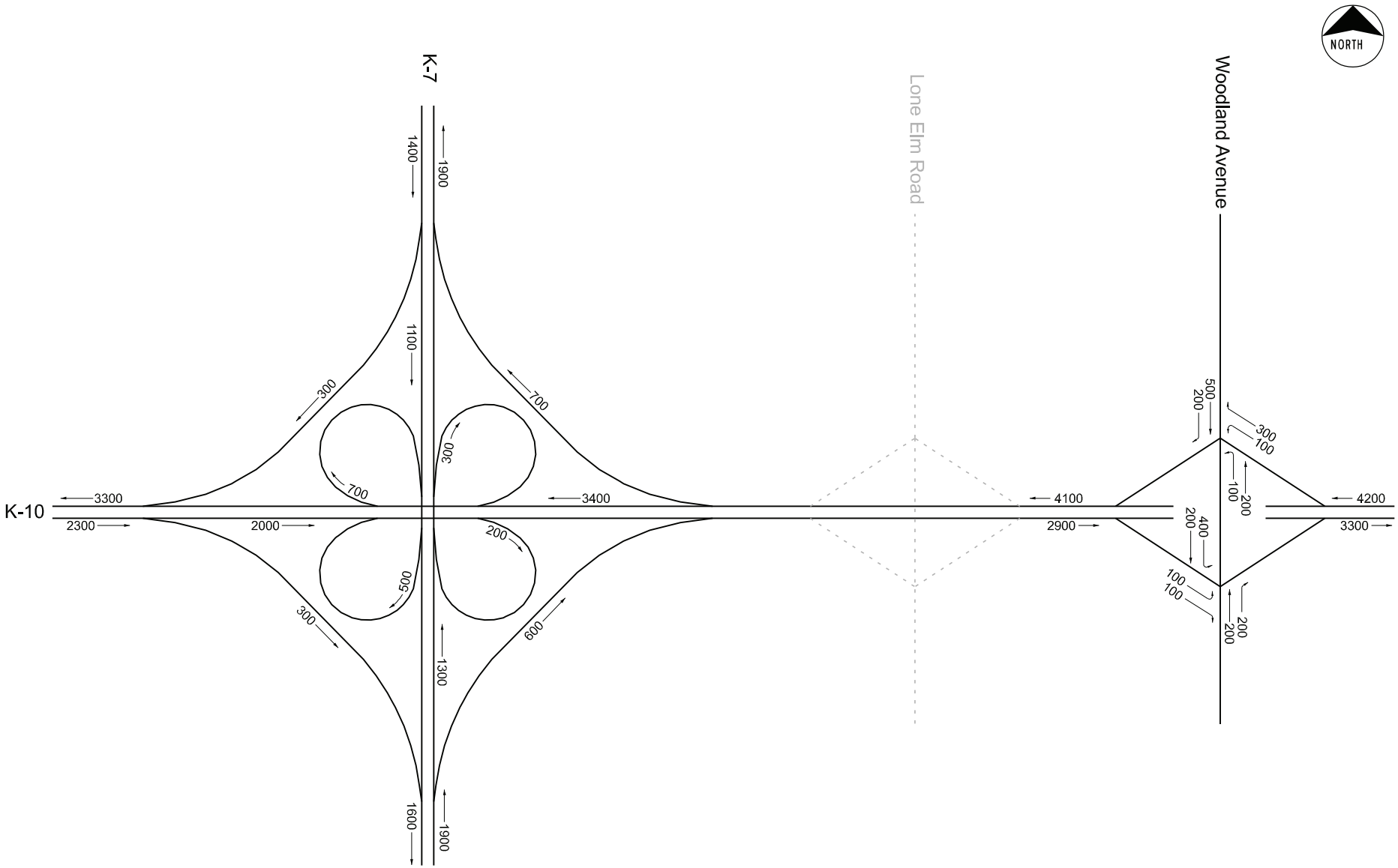

TranSystems	YEAR 2012 NO-BUILD TRAFFIC VOLUMES P.M. PEAK HOUR	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-6

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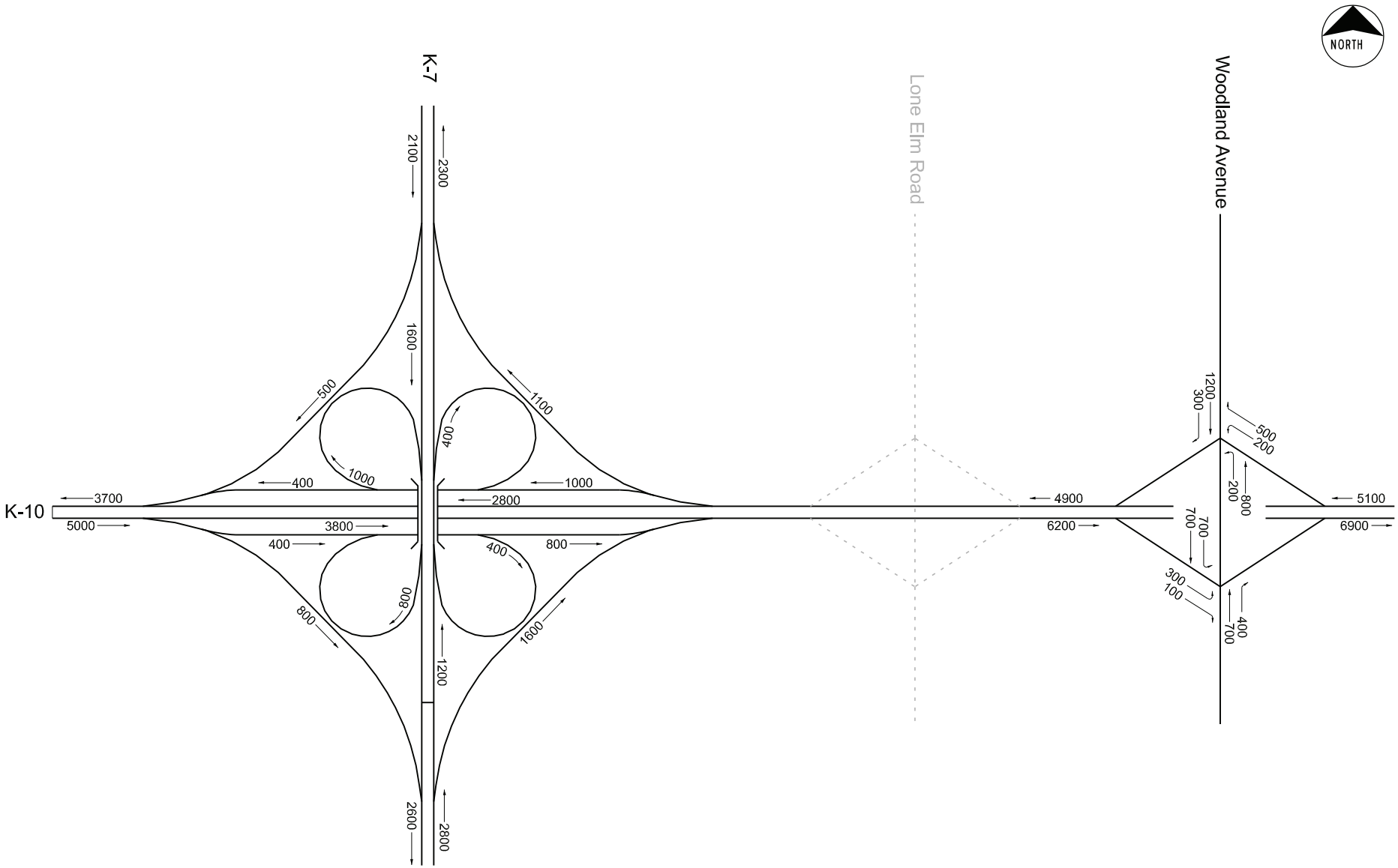

TranSystems	YEAR 2032 NO-BUILD CONDITIONS A.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-7

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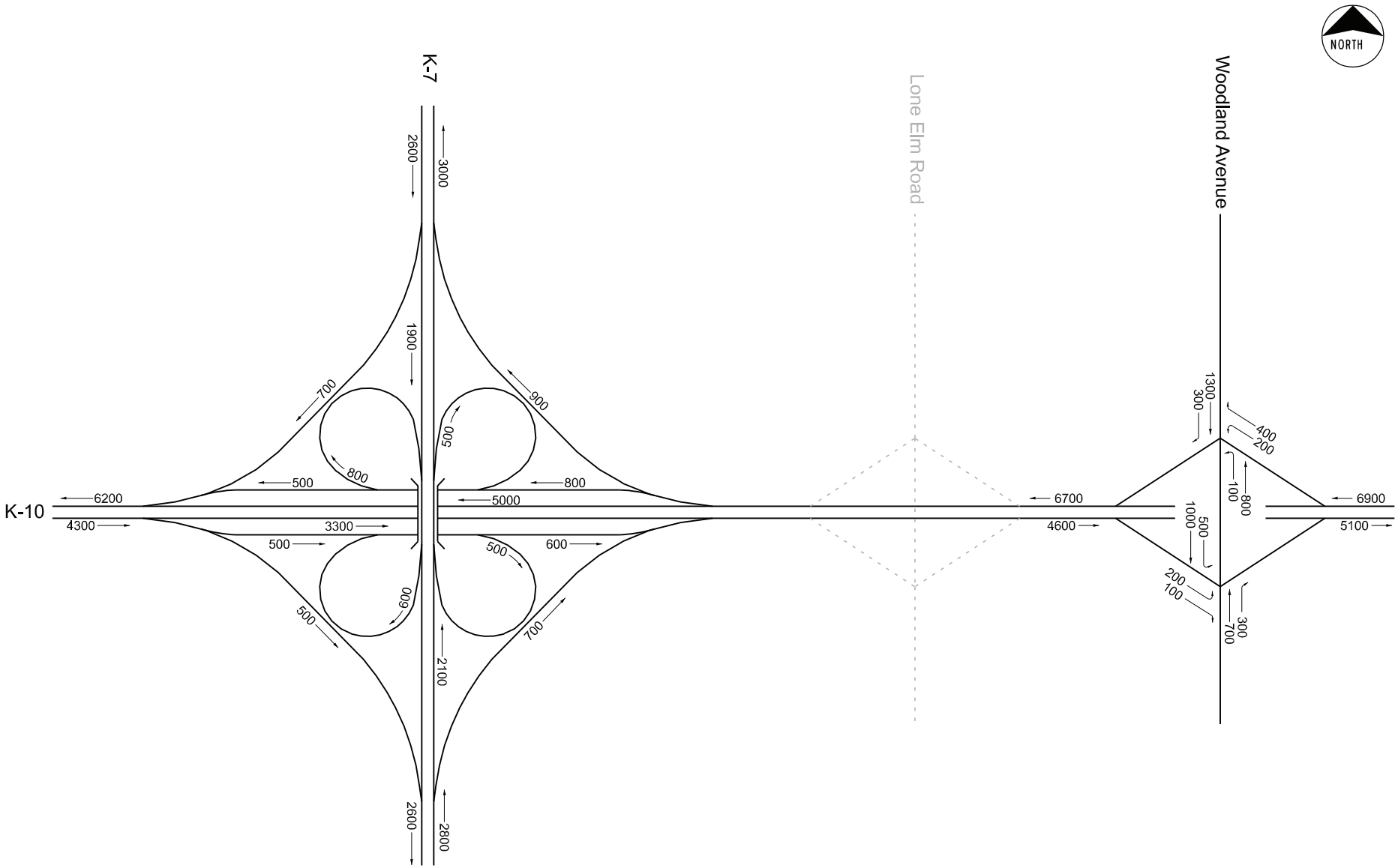

TranSystems	YEAR 2032 NO-BUILD CONDITIONS P.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-8

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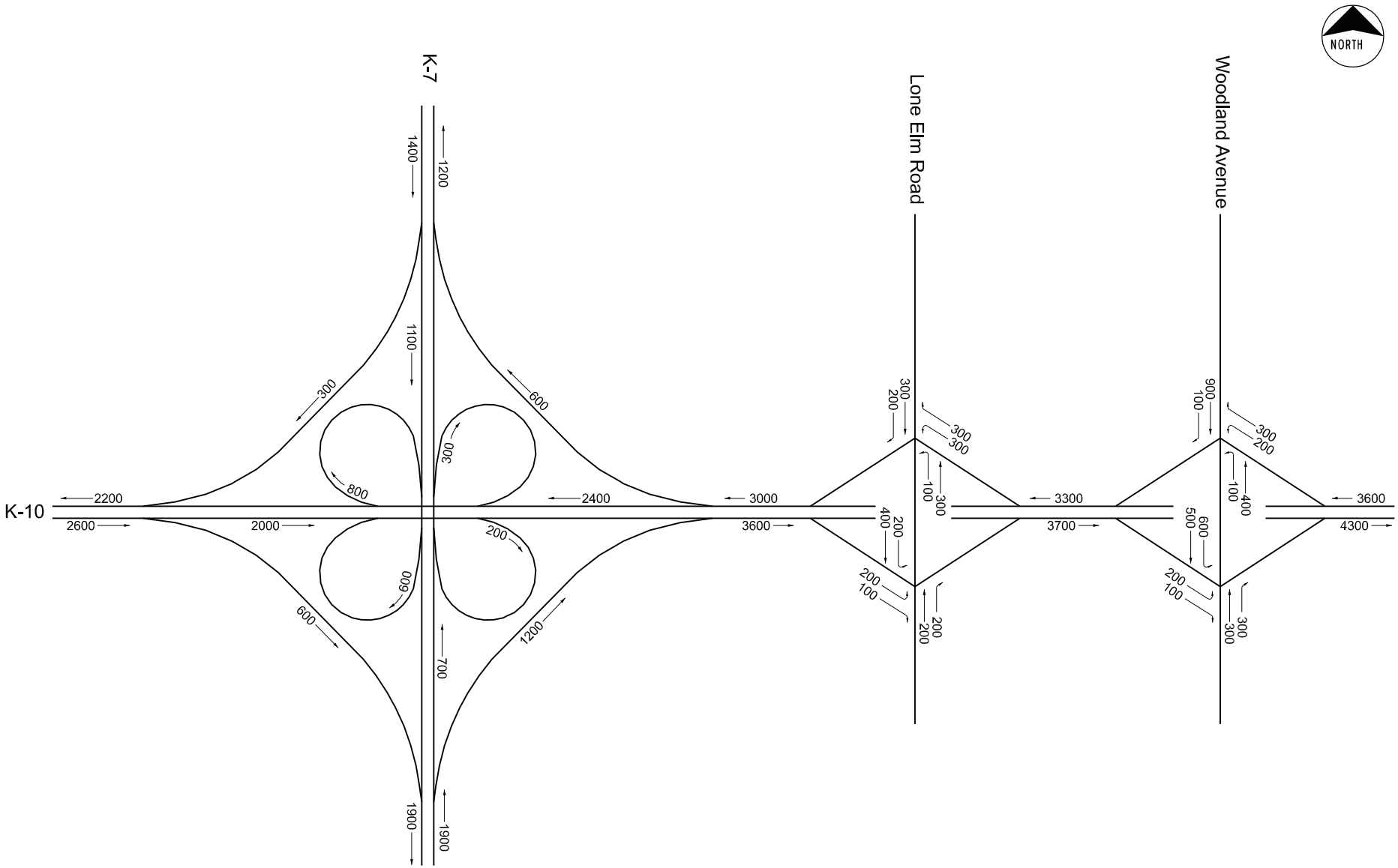

TranSystems	YEAR 2012 BUILD TRAFFIC VOLUMES A.M. PEAK HOUR	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-9

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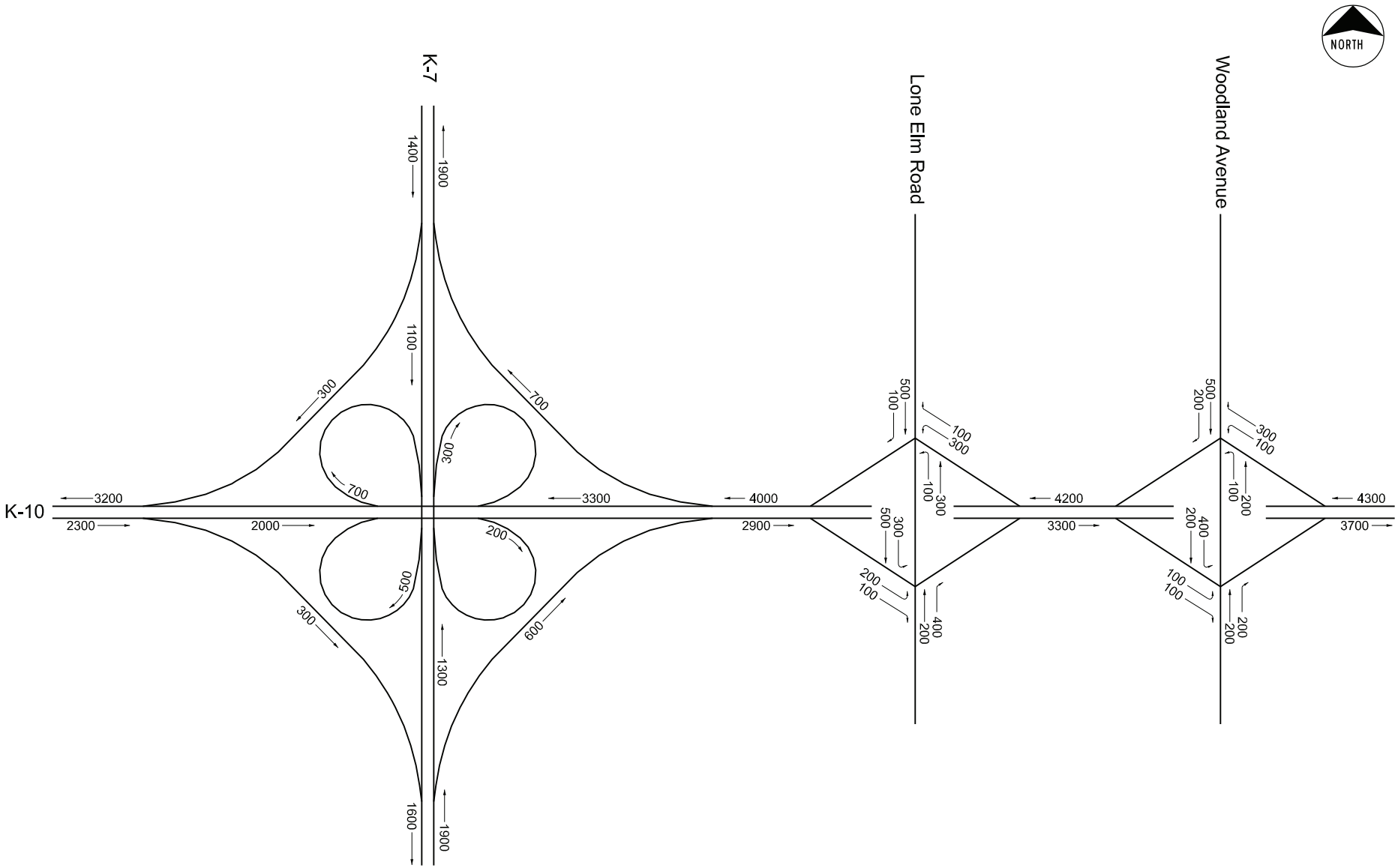

TranSystems	YEAR 2012 BUILD TRAFFIC VOLUMES P.M. PEAK HOUR	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-10

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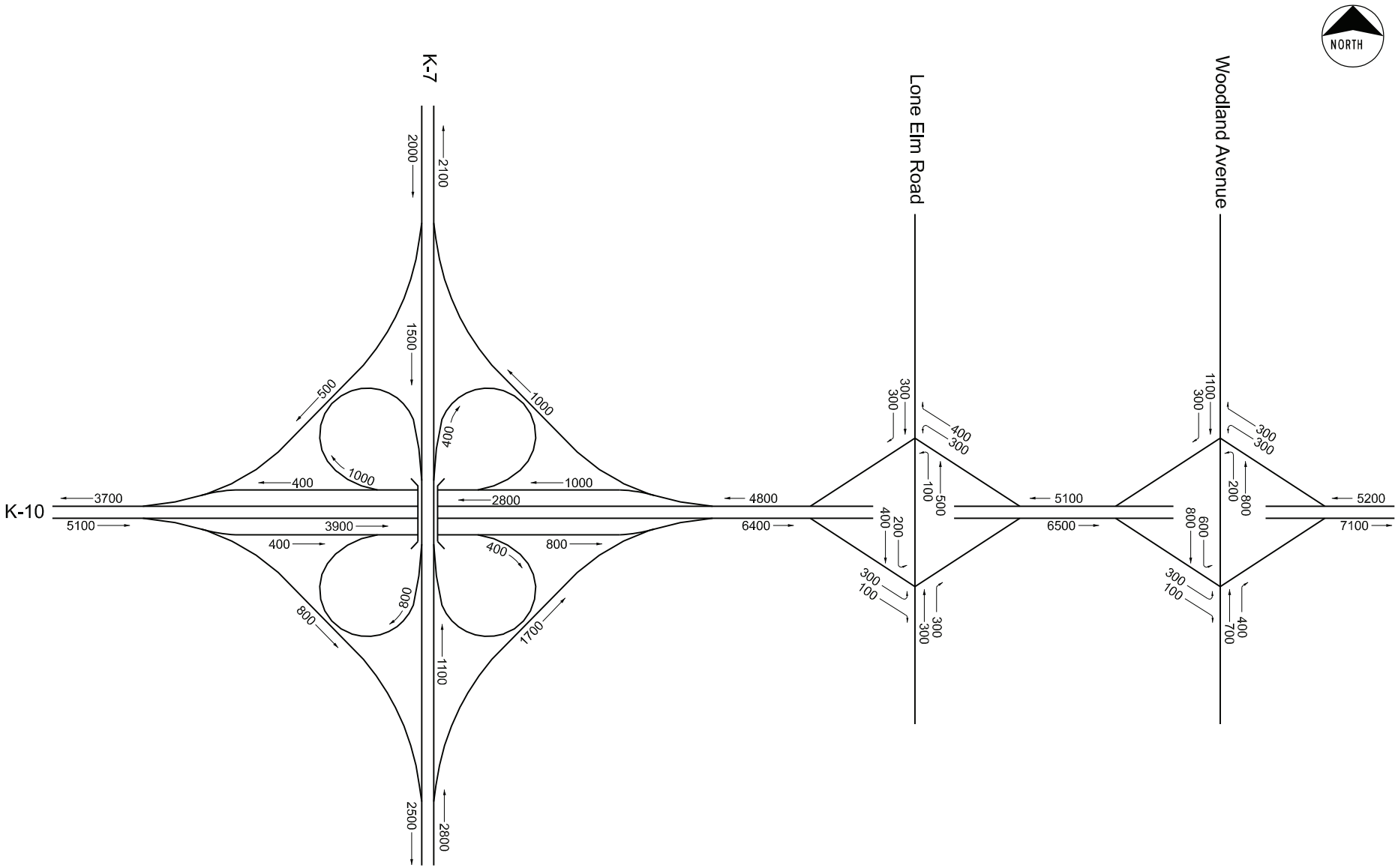

TranSystems	YEAR 2032 BUILD CONDITIONS A.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-11

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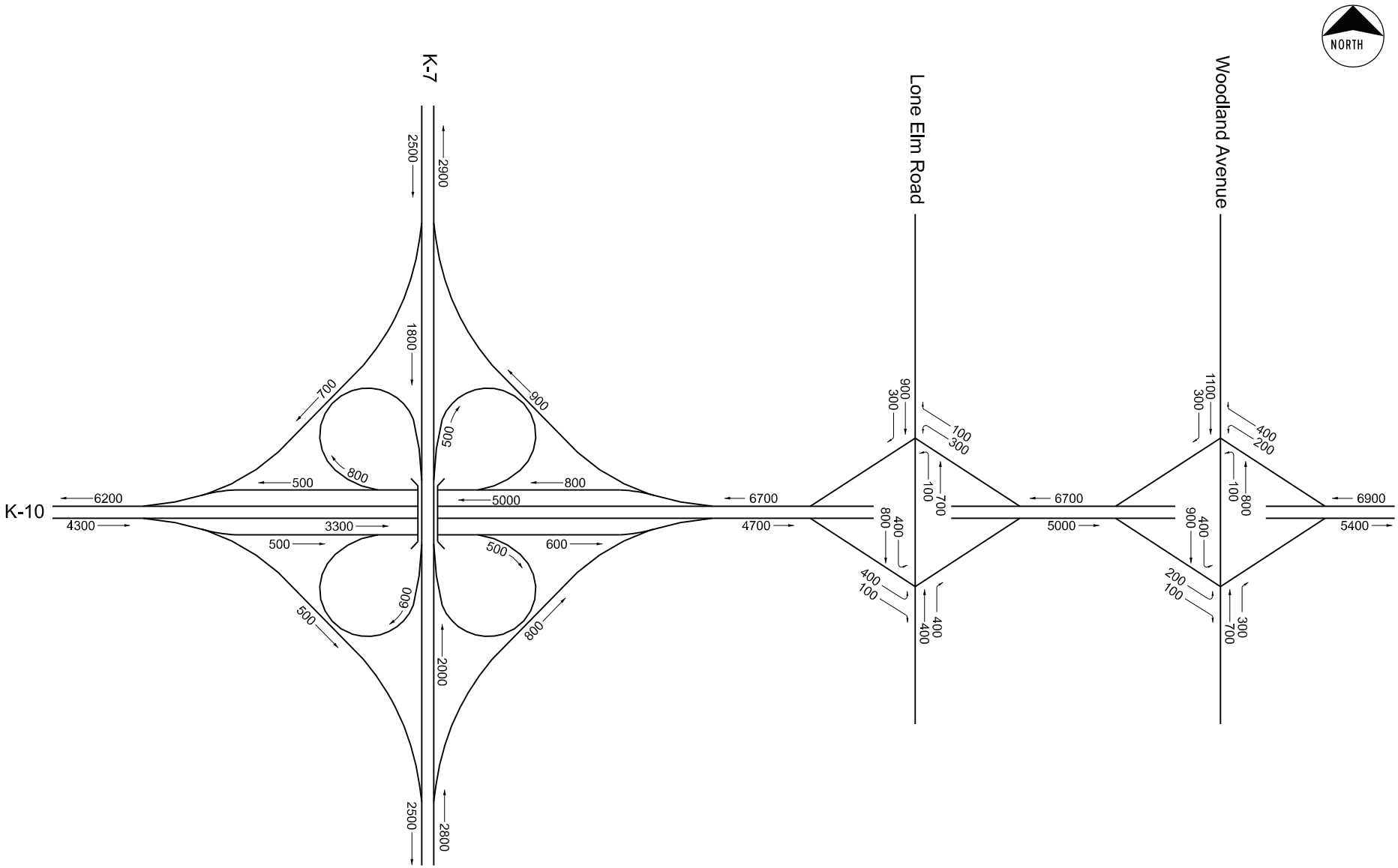

TranSystems	YEAR 2032 BUILD CONDITIONS P.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 No Scale	Figure A-12

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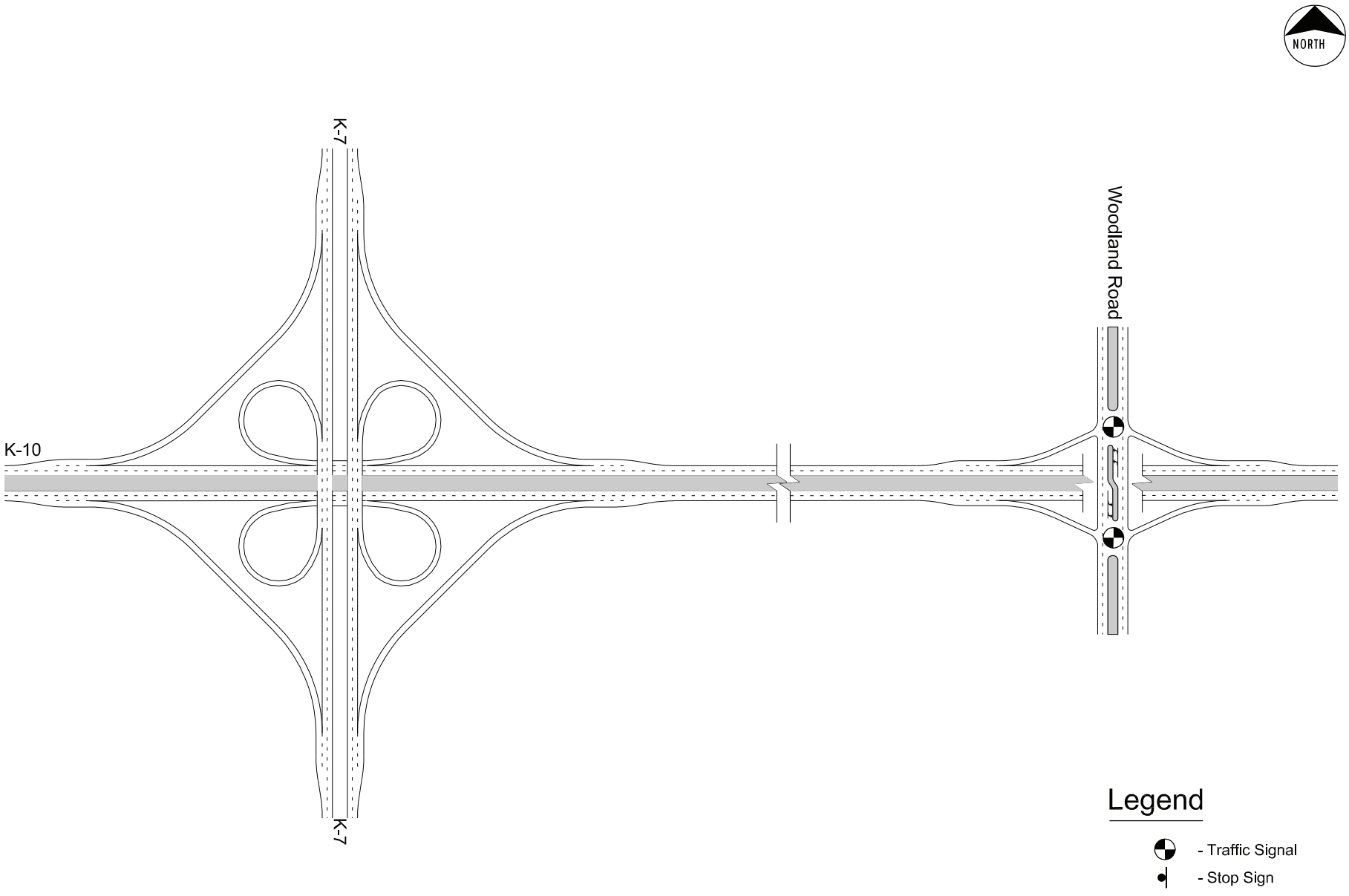

TranSystems	2012 NO-BUILD LANE CONFIGURATIONS (SCENARIO #1)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 / No Scale	Figure A-13

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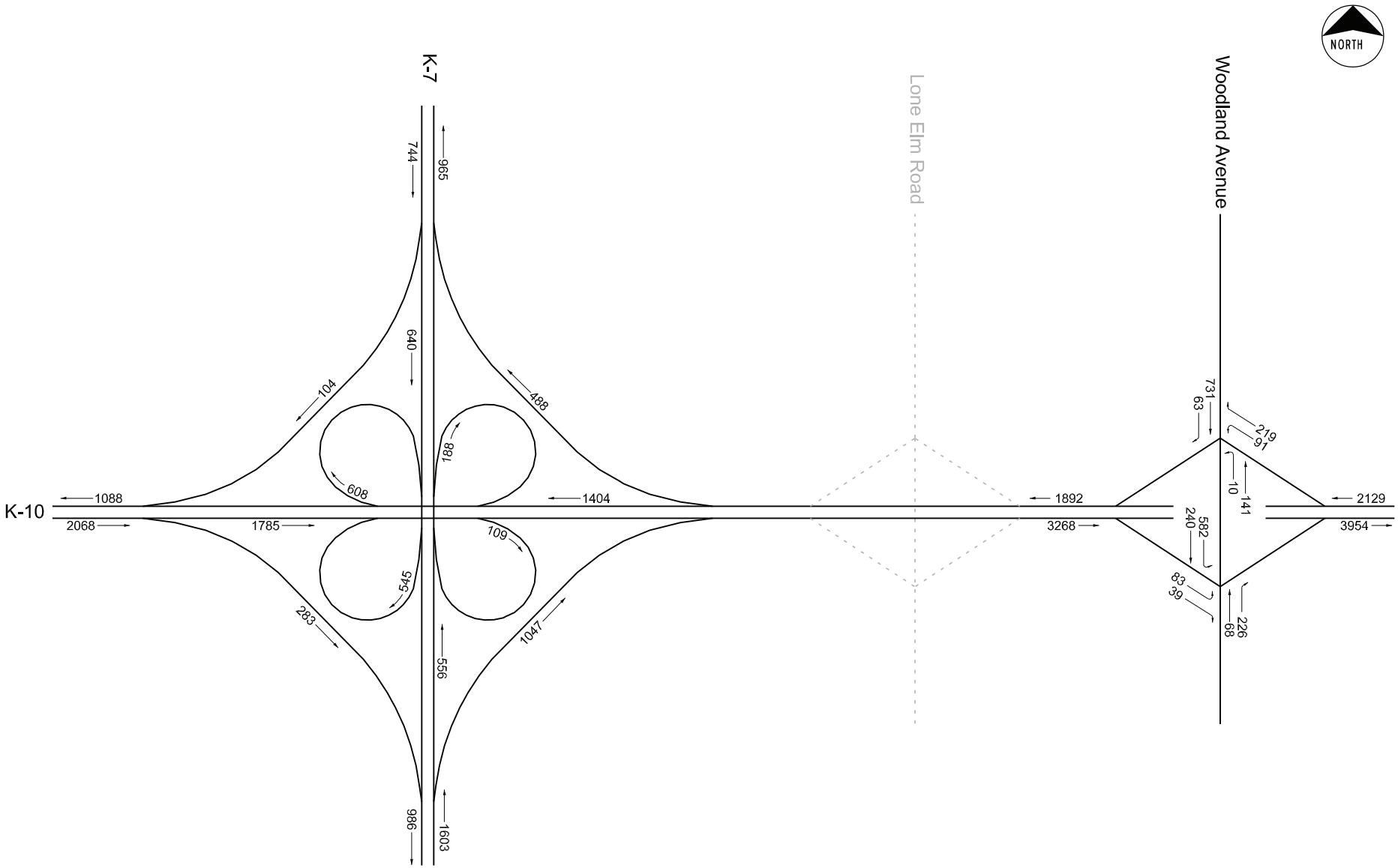

TranSystems	EXISTING A.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 / No Scale	Figure A-14

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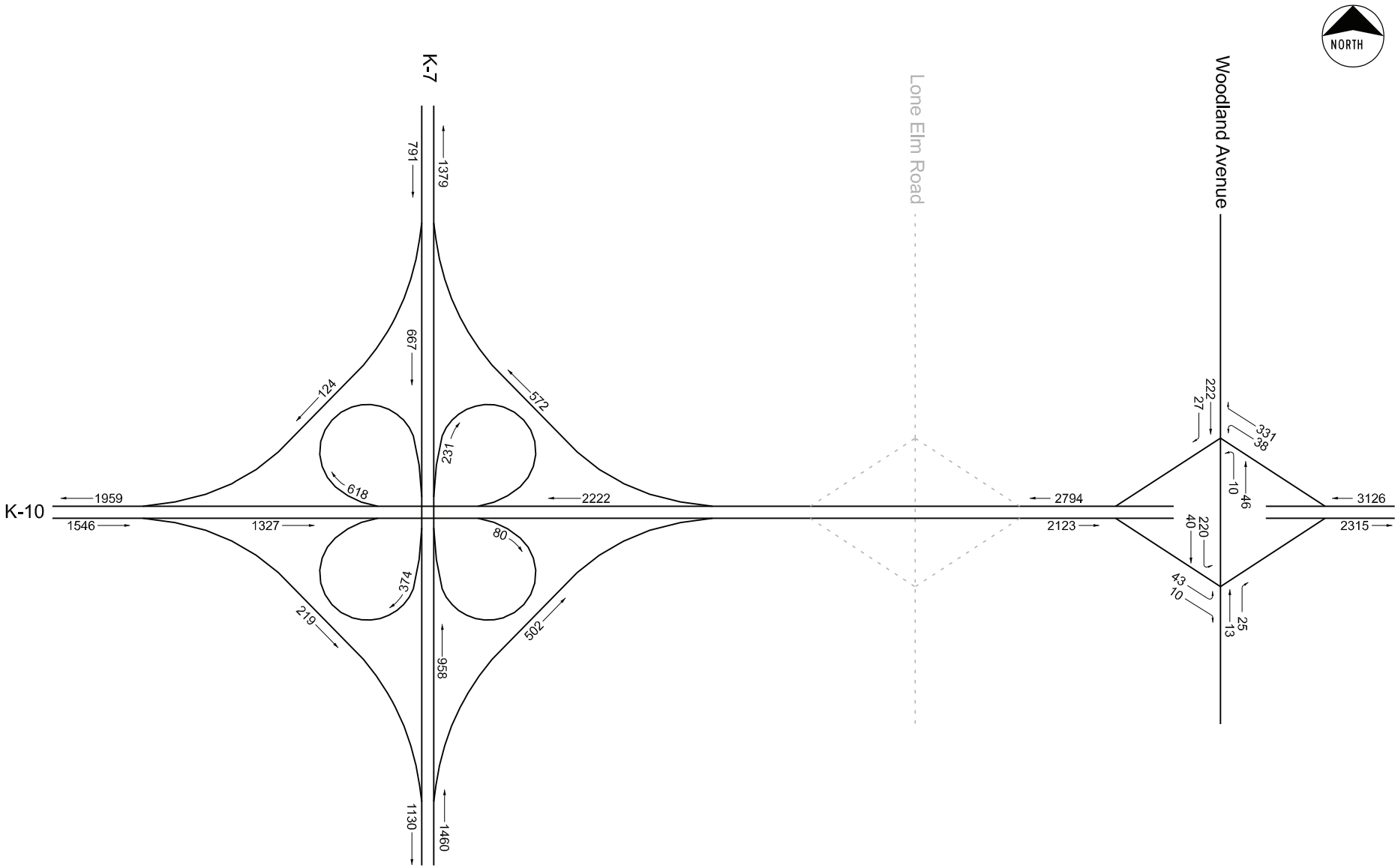

TranSystems	EXISTING P.M. PEAK HOUR TRAFFIC VOLUMES	K-10 & Lone Elm Road Break-In-Access Study Lenexa, Kansas	May 2009 / No Scale	Figure A-15

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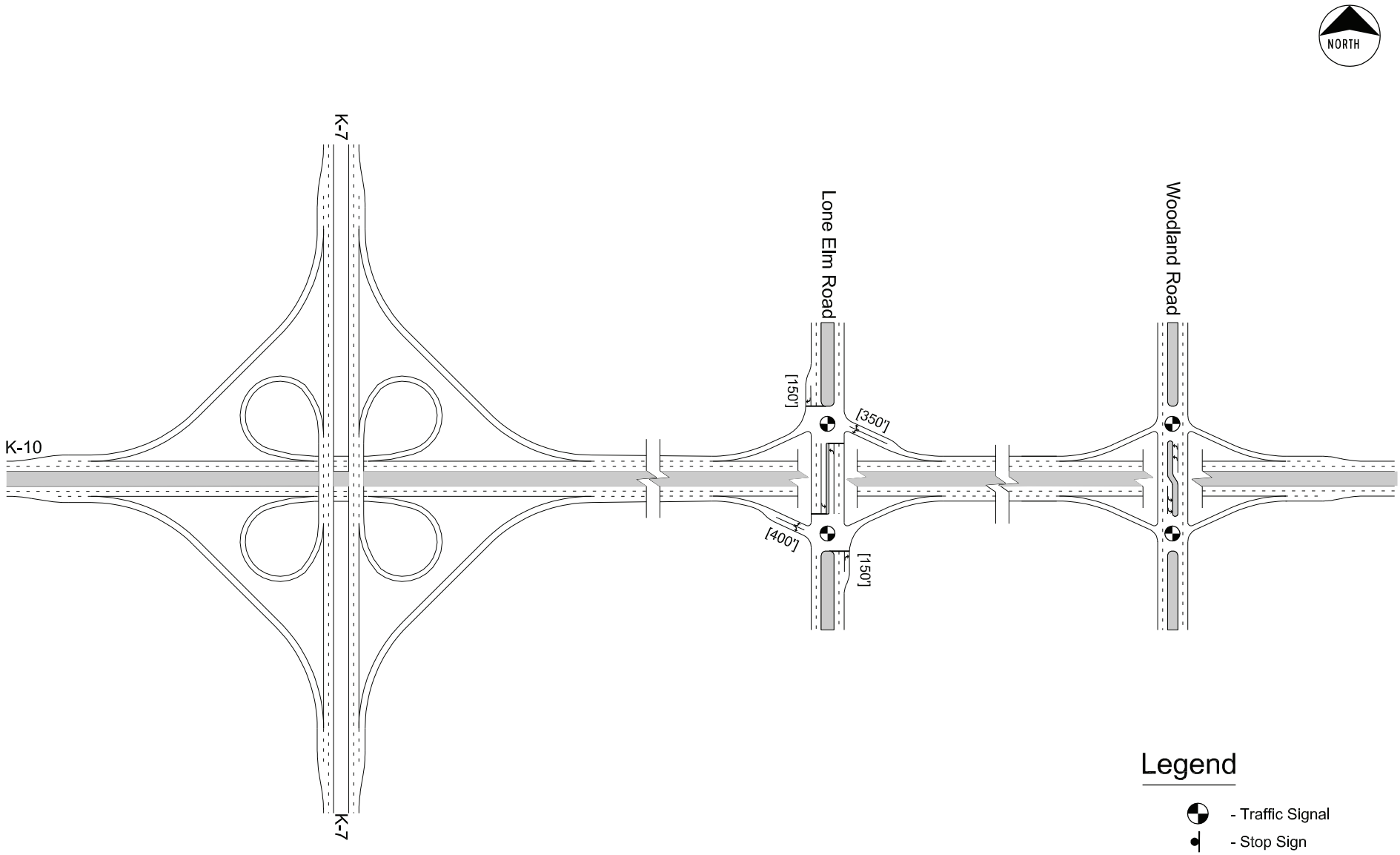

TranSystems	2012 BUILD CONDITIONS LANE CONFIGURATIONS (SCENARIO #2)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 / No Scale	Figure A-16

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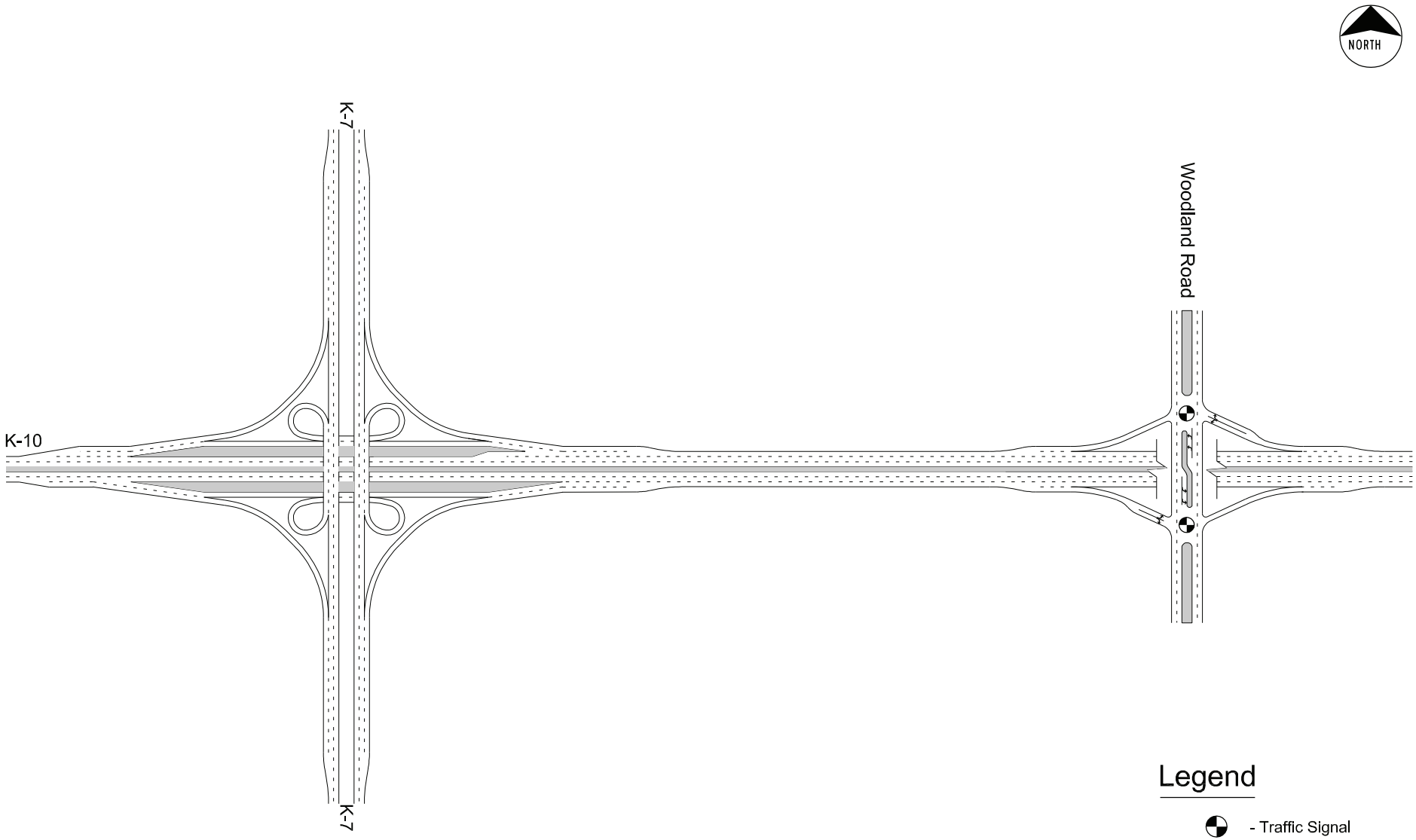

TranSystems	2032 NO-BUILD CONDITIONS (6-LANE) LANE CONFIGURATIONS (SCENARIO #3)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 No Scale	Figure A-17

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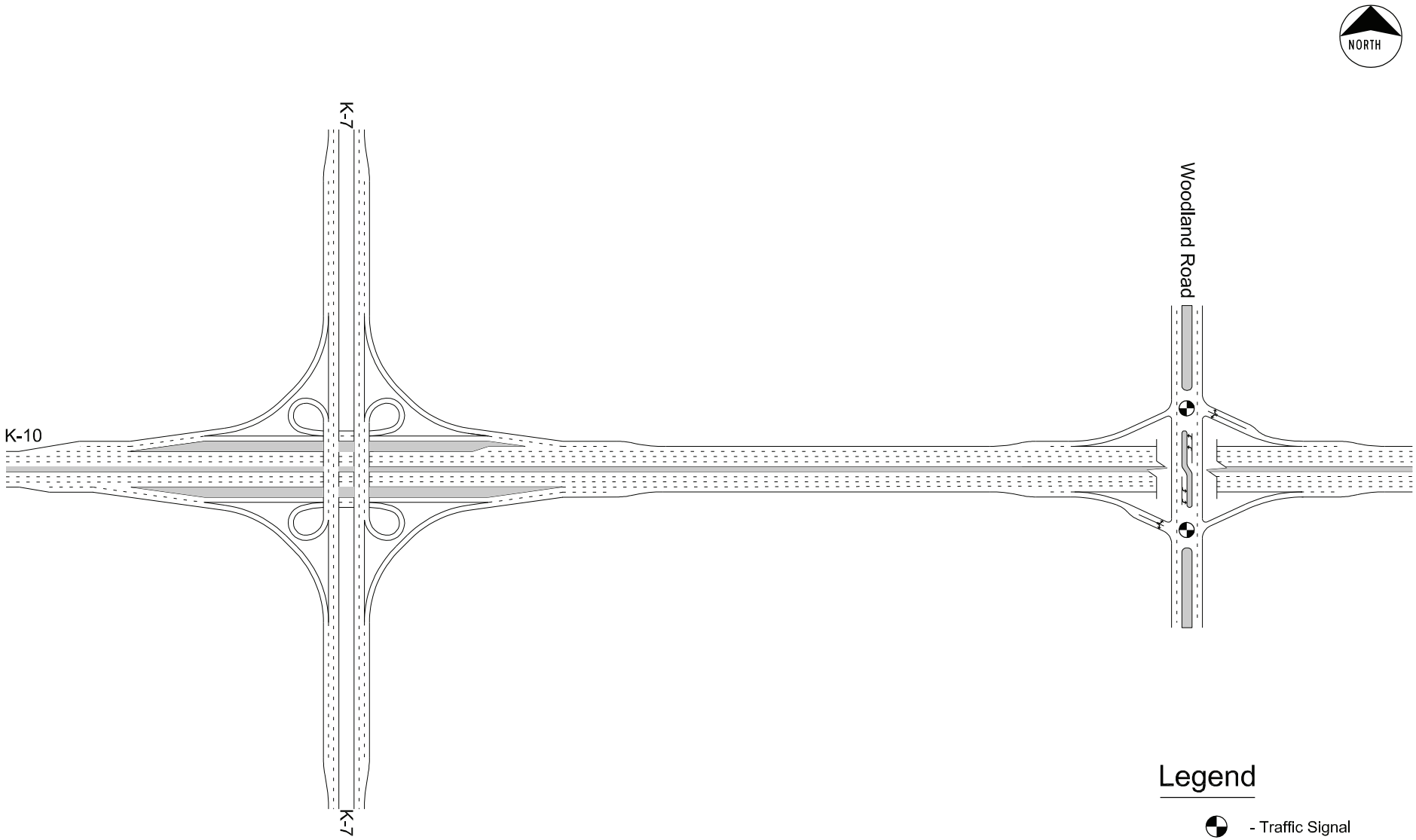

TranSystems	2032 NO-BUILD CONDITIONS (8-LANE) LANE CONFIGURATIONS (SCENARIO #4)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 No Scale	Figure A-18

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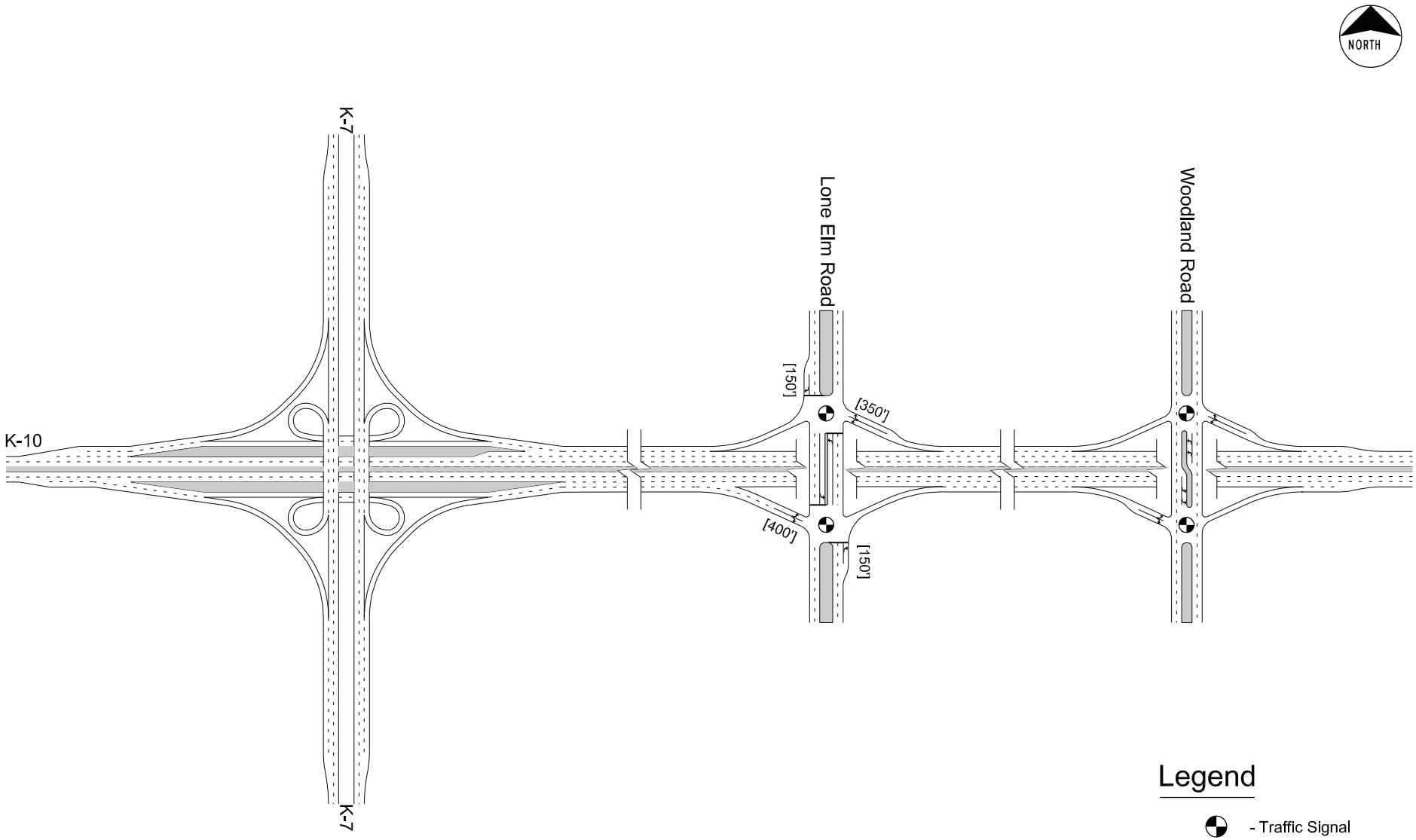

TranSystems	2032 BUILD CONDITIONS (6-LANE) LANE CONFIGURATIONS (SCENARIO #5)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 No Scale	Figure A-19

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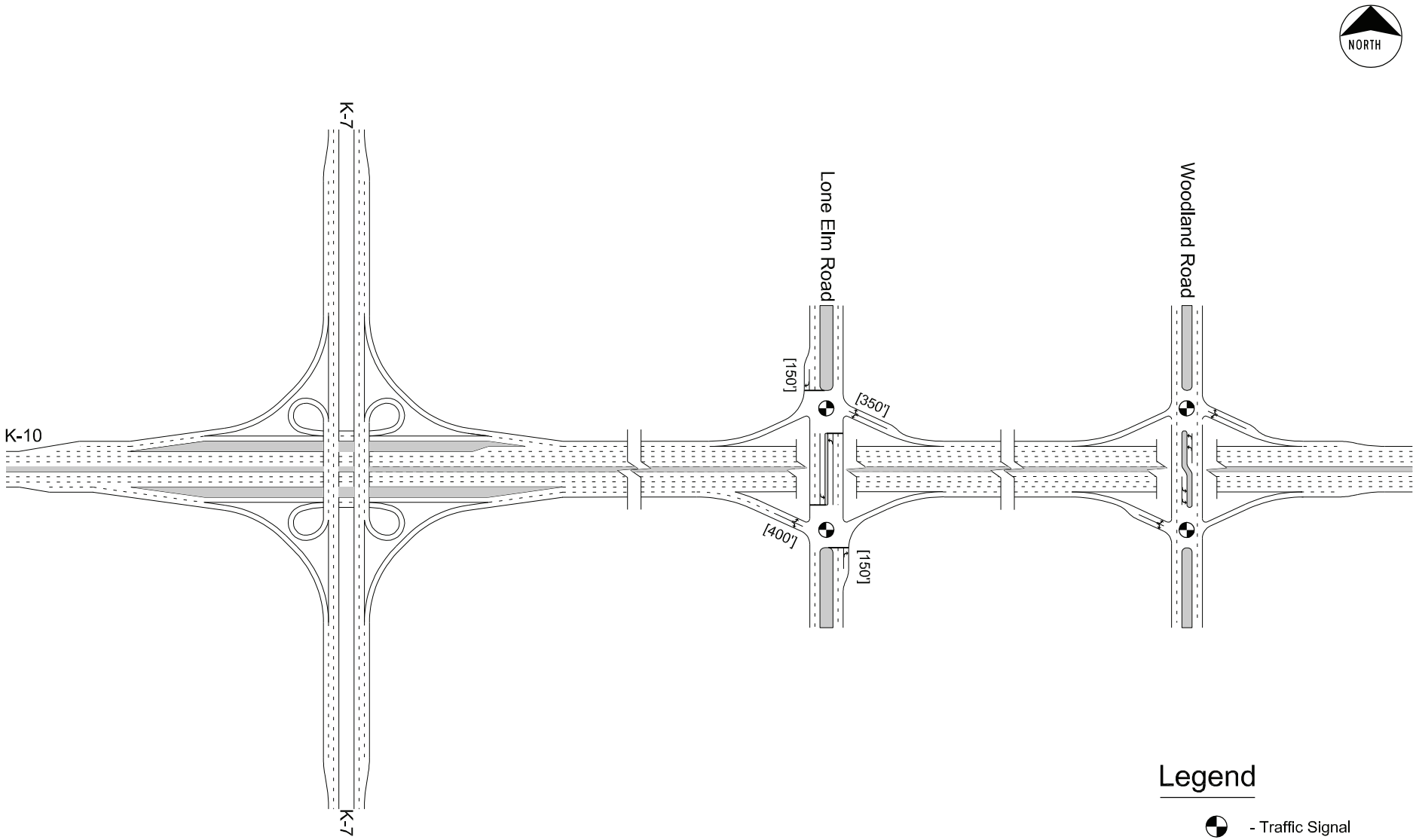

TranSystems	2032 BUILD CONDITIONS (8-LANE) LANE CONFIGURATIONS (SCENARIO #6)	K-10 & Lone Elm Road Break-In-Access Study Olathe, Kansas	May 2008 No Scale	Figure A-20