TRAFFIC STUDY AND CONCEPT DESIGN

EAST JEMEZ ROAD AND NM 4 INTERSECTION

DELIVERY ORDER NO. 18

CONTRACT NO. W912PP-15D-0024

DRAFT SUBMITTAL

OCTOBER 11, 2018

Prepared for:

U.S. Army Corps of Engineers
South Pacific Division
Albuquerque District

Prepared by:

3AE GREEN
A Joint Venture

FY19 SEP EAST JEMEZ ROAD AND NM 4 INTERSECTION

LOS ALAMOS, NEW MEXICO

TRAFFIC STUDY AND CONCEPT DESIGN REPORT

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I. INTRODUCTION AND SUMMARY

The US Army Corps of Engineers (USACE), in support of the National Nuclear Security Administration and Los Alamos National Security, LLC (LANS), is evaluating the intersection of NM 4 and East Jemez Road (aka LANL Truck Route). The proposed project will evaluate needed improvements to the intersection, which will widen and reconfigure the existing three-way intersection of East Jemez Road and NM State Road 4 near Los Alamos, NM into a four-way intersection. The fourth leg will provide access to a proposed parking lot to be constructed by the National Park Service for the Tsankawi Ruins Trailhead. Work to be performed under this specific Delivery Order consists of pre-design activities including site survey, geotechnical investigation, and a traffic study.

A. STUDY PURPOSE

The purpose of the study is to evaluate the intersection operations for existing conditions, evaluate the addition of a fourth leg on the east side and identify improvements needed to support current traffic volumes, as well as, future growth expectations. A location / existing conditions map is shown in Figure 1.

A previous study of this intersection was conducted by Los Alamos County (LAC) in 2016. This study will validate and confirm the study prepared by Los Alamos County.

The New Mexico Department of Transportation (NMDOT) is currently conducting a corridor study of NM 4 in the vicinity of the intersection

B. EXECUTIVE SUMMARY

1. SITE LOCATION AND STUDY AREA

The site is located on Los Alamos National Laboratory in Santa Fe County.

The study will focus on the existing T-intersection of NM 4 and East Jemez Road, and the approaches to the intersection.

The intersection evaluations include capacity analysis for the AM and PM peak hours for the following traffic conditions:

- Existing traffic. Currently this study used the 2016 traffic count provided by Los Alamos County. A 2018 traffic count will be performed to verify the data.
- 2038 Horizon Year with 20% increase in background traffic growth assumed based on input from LANS.

2. PRINCIPAL FINDINGS

The traffic analysis found the existing "overall" intersection operates with acceptable delay, however the vehicle queue for southbound-to-westbound in the AM peak hour, and the eastbound-to-northbound queue in the PM peak hour are substantial. In addition, the analysis found that several movements are approaching capacity, and likely occasionally exceed capacity. Therefore, improvements were considered to reduce delay and queue for specific movements, and provide capacity for future traffic growth. These improvements will result in acceptable delay and queues at the intersection.

The recommended improvements include adding a second eastbound left turn lane on East Jemez Road, a second northbound through lane on NM 4 and right and left turn bays for the proposed Tsankawi trailhead parking lot. Acceleration and deceleration lanes will be added to meet the requirements of the State Access Management Manual (SAMM).

Five Options for intersection improvements were evaluated that will accommodate existing, 2028, and 2038 traffic volumes.

Option 1 uses the existing alignments of NM 4 and East Jemez Road with the new lanes added. This Option is SAMM Compliant for the existing posted speeds.

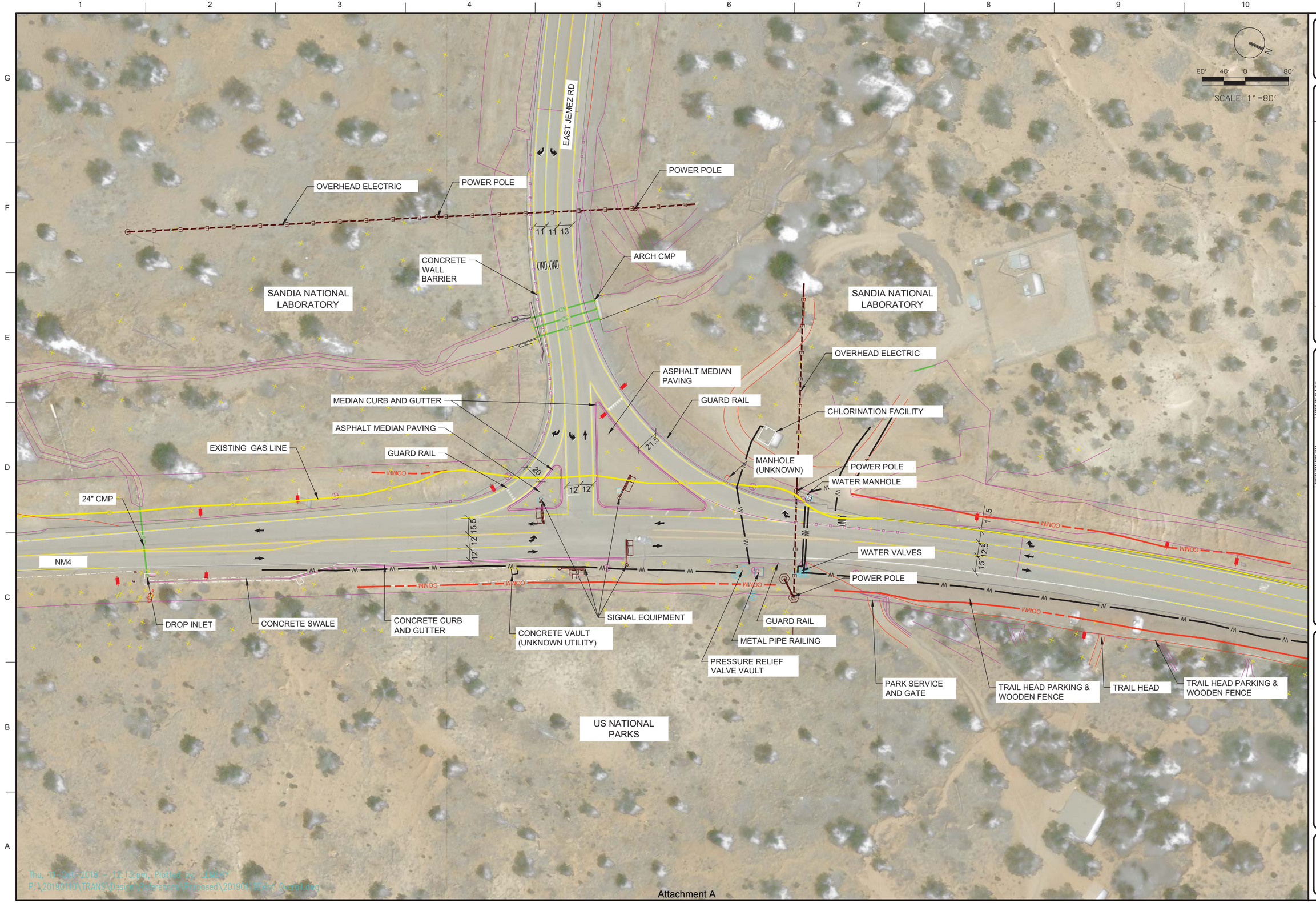
Option 2 has a 5° skewed intersection with shortened acceleration lanes southbound to avoid impacting San Ildefonso Pueblo lands and westbound to avoid impacts to the truck inspection station.

Option 3 has a 5° skewed intersection, with shortened acceleration lanes as described on Option 2 along with dedicated dual lefts on East Jemez Road for eastbound traffic turning North onto NM 4.

Option 4 is the same as Option 3 except that the posted speed northbound and eastbound are reduced to 45 mph and the acceleration and deceleration lengths are reduced accordingly.

Option 5 is the same as Option 4 except that the acceleration lanes northbound has been extended to the project limits to allow more merge time and the westbound acceleration lane is extended to become the right turn bay for the truck inspection station.

Based on input from the study team, the preferred alternative is Option 5, shown in Figure 9, on page 29.



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LOCATION / EXISTING CONDITIONS

SHEET ID

Attachment A

FIGURE 1

II. STUDY AREA CONDITIONS

A. EXISTING ROADWAY AND MULTIMODAL FACILITY DESCRIPTION

1. ROADWAY

See Figure 1 for a graphic of the geometry which is described below.

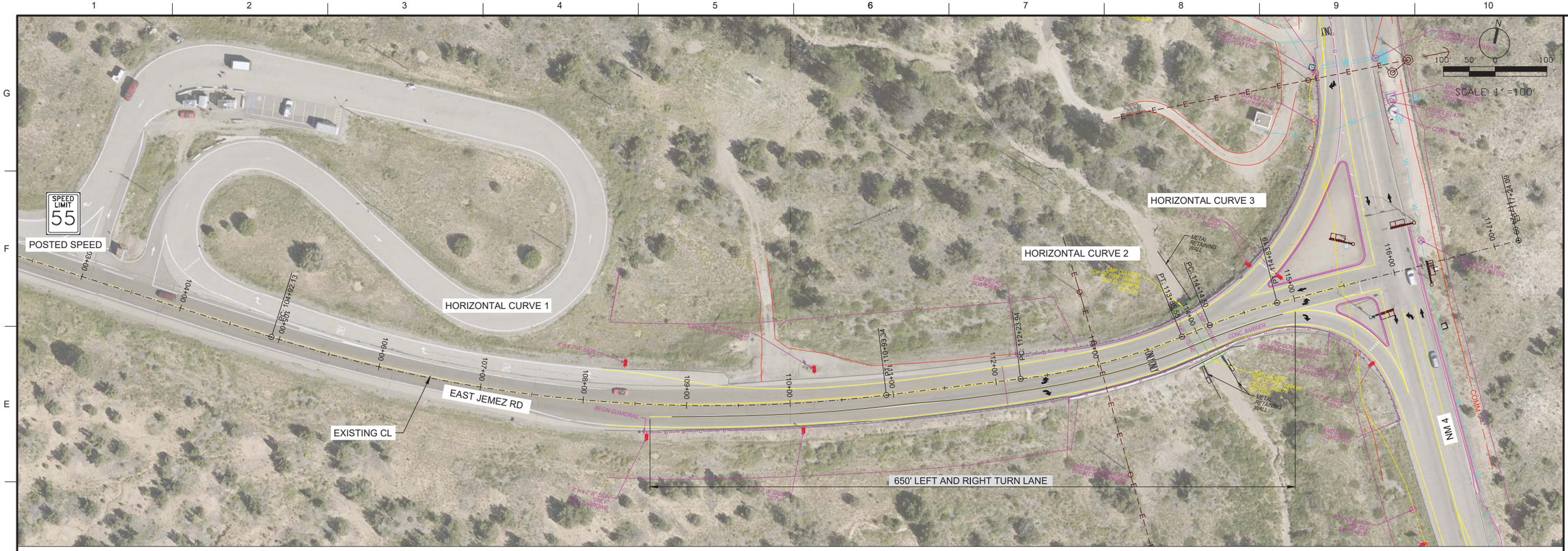
The intersection currently is a 3-legged, signalized T-intersection, with East Jemez Road terminating at NM 4. There is a single eastbound left turn lane and single eastbound right turn lane both of which are approximately 650 feet long, from East Jemez Road onto NM 4. East Jemez road has approximately 8,000 vehicles per day. East Jemez Road is posted 55 mph approaching the intersection. However, realistically the project area is in a transition zone. Traffic will need to start slowing down between 500 and 600 feet prior to the intersection. The vehicular movements through the intersections are estimated to be 15 mph or less.

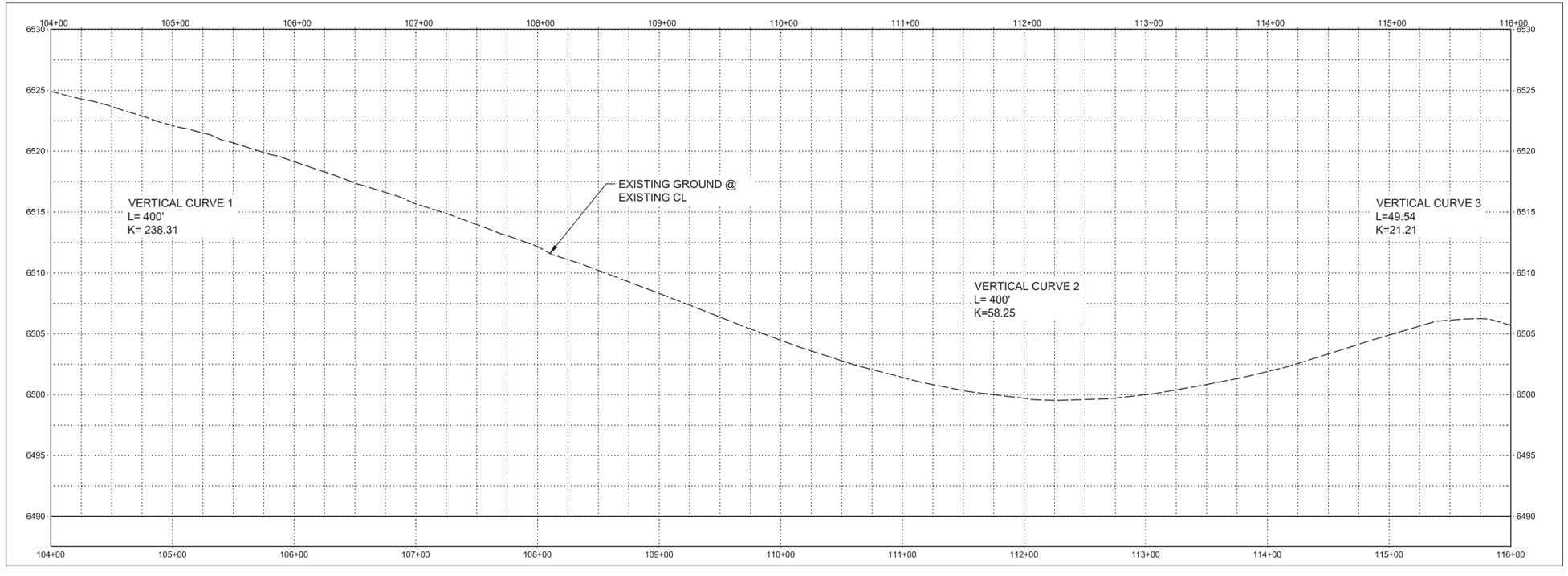
NM 4 is two lanes southbound until approximately 1,100 feet north of the intersection when the outside lane turns into a right turn lane and there is a single southbound lane through the intersection. Close to the intersection there is a raised curb between the lanes with delineators which are recently added by Los Alamos County to prevent last minute weaving maneuvers. There are channelization islands for the southbound and eastbound right turns. Northbound has a single left turn lane approximately 140 feet long and a single northbound through lane. NM 4 carries approximately 10,000 – 12,000 vehicles per day. NM 4 is posted 50 mph south of East Jemez Road and 45 mph north of the intersection.

The National Park Service intends to construct a parking lot for the Tsankawi Ruins Trailhead east of NM 4. The entrance to this parking lot will become the fourth leg of the intersection. This traffic study will consider proposed traffic from the trailhead parking in the analysis.

2. HORIZONTAL AND VERTICAL GEOMETRY

The existing horizontal and vertical geometry in the intersection area, shown in Figure 2 and Figure 3, was checked to see if it meets design criteria from the *2011 Edition of the Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO Green Book). The design speed was assumed to be 5 mph greater than the posted speed which is a common practice. The assumed maximum super elevation was 6%. Drivers on East Jemez Road





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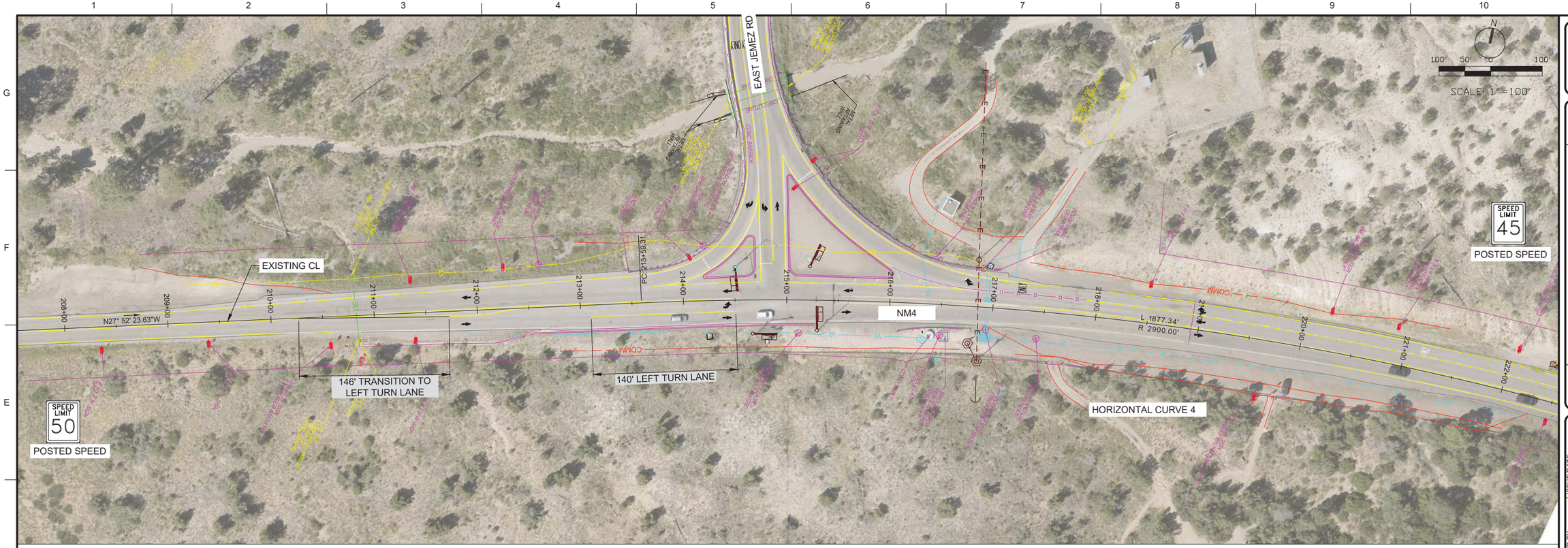
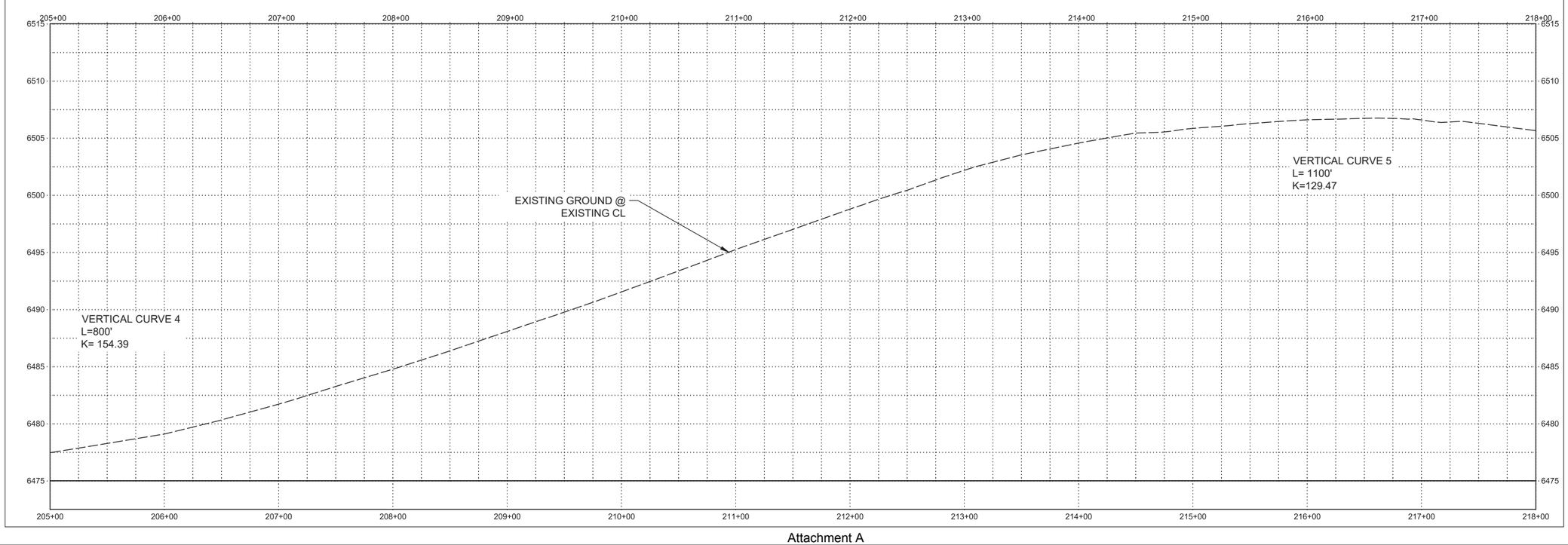
ALBUQUERQUE DISTRICT
4104 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

EAST JEMEZ RD
EXISTING PLAN AND PROFILE

SHEET ID

FIGURE 2





Attachment A

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4101 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

NM 4
EXISTING PLAN AND PROFILE

SHEET ID

FIGURE 3

naturally slow down since it is a T-intersection with no through movements. The existing right and left turn movements are assumed to be 15 mph or less. Traffic into the Tsankawi Ruins Trailhead parking lot is expected to be very low volume but when the intersection is converted to 4 legs there will be the occasional eastbound vehicle that goes through the intersection to the parking lot. The speed limit should be reduced approaching the intersection to account for the through movement as well as the need to slow down for the turning movements at the intersection. Table 1 below shows the existing horizontal curves and the calculated design speed for each using the criteria in the AASHTO Green Book. Curve numbers are shown on the respective existing geometry plan and profile sheet.

Table 1 – Existing Horizontal Geometry

				SUPER ELEVATION emax=6%			
Curve Id	**PC STA**	**PT STA**	**CURVE DIRECTION**	**RADIUS (FT)**	**EXISTING SUPER**	**DESIGN SPEED (mph)**	**Comment**
East Jemez Rd							
1	104+92.13	110+93.34	LT	1400	Varies 3-4%	30	Deficient
2	112+23.94	113+85.55	LT	600	Varies 3-4%	20	Speed transition area
3	114+14.50	114+83.19	RT	500	Varies 1-0.5%	0-15	Speed transition area
NM 4							
4	213+59.31	232+36.65	RT	2900	Varies 4% LT and 7% RT	55	

Curve ID 1 occurs prior to the speed transition area needed for vehicles to slow down to make the turns at the intersection. The curve only has a calculated design speed of 30 mph. Likely the super elevation transition is also deficient. The existing horizontal geometry indicates that the posted speed limit should be 25 mph on East Jemez Road approaching the intersection. Curves 2 and 3 are within the deceleration length needed for a vehicle to comfortably slow to 15 mph.

Table 2 shows the existing vertical curves and the associated design speed for each. Curve numbers are shown on the respective existing geometry plan and profile sheet.

Table 2 – Existing Vertical Geometry						
			K -Value			
CURVE ID	PVC STA	VPT STA	CREST	SAG	DESIGN SPEED (mph)	Comment
East Jemez Rd						
1	103+15	107+15	238.31		65	
2	110+24.22	114+24.22		58.25	35	Speed Transition Area
3	115+08.87	115+58.41	21.21		30	At Intersection
NM 4						
4	200+00	208+00		154.39	60	
5	211+94.83	222+94.83	129.47		55	

Vertical curves 2 and 3 are within the speed transition area needed for vehicles to slow down to make the turns at the intersection. If the posted speed limit is as recommended, then the existing vertical curves would be acceptable on East Jemez Road.

3. DRAINAGE

In general, storm water flows from north to south. East Jemez Road has a deep sag vertical curve with a low point approximately 330' west of the intersection. There are two existing drainage structure crossings within the study area. There is a 24-inch culvert pipe under NM 4 at approximately 390 feet south of East Jemez Road. The pipe has a drop inlet on the east side. There is concrete roll curb on the east side from the center of the intersection for about 130 feet. The curb transitions to a valley gutter / rundown which continues to the drop inlet. There is also a multi-plate pipe under East Jemez Road about 180 feet west of NM 4. The pipe is assumed to be 18.25' x 7.5' arch as estimated in the Los Alamos County study. The multi-plate pipe has a headwall with riprap around it on the outlet. The

Photo 1 – Multi-Plate Pipe

inlet has a headwall with some channelization walls. The inlet headwall is severely eroded with exposed rebar as shown in the picture below. The invert on both sides of the road is buried.

4. UTILITIES

Existing utilities are shown on Figure 1, the Location / Existing Conditions Map. There are water, electric, communication, and gas lines in the project area.

The water facilities in the area are owned by Los Alamos County Department of Utilities. The Pajarito Mesa Well No. 1 is in the northwest quadrant of the intersection. There is a Chlorine Station Building in the same quadrant. These facilities should be far enough away from the road that they are not impacted. The supply line crosses the north approach to the intersection. Water lines head north, south and west after going through the Chlorine Injector Vault and Injector Piping. There are manholes and valves on both sides of NM 4 within the project limits. These lines serve the community of White Rock, Los Alamos National Laboratory (LANL), and the National Park Service.

Photo 2 – Chlorine Station Building

Photo 3 – Chlorine Injection Facilities

There are overhead electric lines on the north and west approaches. These lines are owned by LANL.

There is underground electric for the traffic signal in the intersection. The control cabinet is on the east side of the intersection. There is a signal ahead warning flasher on NM 4 approaching the intersection in both directions.

There are communication lines on both the east and west side of NM 4. There are telephone pedestals in the project area.

There is a gas line on the west side of NM 4. There is a gas valve adjacent to the north approach of the intersection.

5. GEOTECHNICAL INVESTIGATION

A geotechnical investigation was performed by Terracon Consultants, Inc. in September 2018. Four test borings were advanced to depths of 6 to 16 ½ feet below the existing grade. One boring was done on each leg and one additional boring was done in the roadway near the existing multi-plate arch pipe. The results of the investigation are summarized in the following paragraphs. For more information, see the *Geotechnical Engineering Report, FY19 SEP East Jemez Road and NM4 Intersection Improvements.*

The existing pavement thickness is shown Table 3.

Table 3 – Existing Pavement Thickness

Material	Existing Pavement Section Thickness (in)	
	East Jemez Road	NM 4
Hot Mix Asphalt	5.5 to 9.25	6 to 8.75
Aggregate Base Course	6 to 9	7.25 to 8
Total Pavement Section	11.5 to 18.25	13.25 to 16.75

The subsurface soil is generally sand with some silt, clay and gravel content. The material is non-plastic to low in plasticity. There is some fill material in the under the roadway. The remainder of the material is weathered volcanic tuff. No groundwater was observed.

The study concluded that the existing materials are suitable for the proposed reconstruction. The subgrade soils are considered to be relatively fair to good quality for roadway / pavement support. The existing pavement can be reused as engineered fill or be processed and blended into the existing subgrade.

The multi-arch plate pipe can be supported on prepared and compacted subgrade. Structural backfill should consist of imported A-1 or A-3 soils.

The recommended pavement thickness for new construction is 6 ½ inches of Hot Mix Asphalt over 6 inches of Aggregate Base Course.

6. RIGHT-OF-WAY

The existing roadways in the project area are on Department of Energy, Los Alamos National Laboratory property. NM 4 has an easement granted to the New Mexico Department of Transportation (NMDOT). The apparent width of the NM 4 right-of-way is 115 feet based on existing fence lines. The centerline of the existing road is approximately 20 feet closer to the east fence line.

The land immediately east of the right-of-way is owned by the National Park Service. The existing roadside parking for the Tsankawi Ruins Trailhead is within the apparent right-of-way easement.

The border of San Ildefonso Pueblo is located about 1000 feet south of the intersection. NM 4 through the Pueblo is also in an easement granted to NMDOT.

7. MULTI-MODAL

Currently there are no formal pedestrian or bicycle facilities on NM 4 or East Jemez Road, and the shoulders are narrow to non-existent. The NMDOT NM 4 study has plans to add a 5-foot shoulder on both sides of NM 4 to improve safety and provide a place for bicyclists and pedestrians. This study will also consider options for providing bicycle / pedestrian facilities especially on NM 4 since the NMDOT project intends to add 5 ft shoulders to the roadway.

Both the Los Alamos County 2017 Bicycle Master Plan and the National Park Service Bandelier Monument Plan indicate support for shoulders and/or multi-use path along NM 4 through the project intersection.

B. DATA SOURCES

The data used in this report consist of the traffic counts described below, survey and mapping provided by NMDOT, aerial photography from Google Earth®, utility information provided by Los Alamos County, information provided by LANS, and site visits.

III. ANALYSIS OF EXISTING CONDITIONS

A. TRAFFIC COUNTS

During the initial stages of the project, the USACE and LANS were performing a mill and inlay maintenance project on NM 4 near the intersection, as well as improvements to East Jemez Road. This roadway maintenance activity on East Jemez Road and NM 502 will prevent new traffic counts to be collected, as the maintenance projects are likely affecting driver decisions on what route to take to enter LANL property. These maintenance projects will be complete in mid-October. To maintain schedule, the traffic analysis to be performed for this study will initially use the same traffic counts collected with the previous LAC study, with modification for the 10-year and 20-year horizon requested to be evaluated. New traffic counts will be conducted in late October, after traffic can settle back into preferred routes. Please note that if these traffic counts are substantially larger than that collected by LAC, it is possible changes to the recommended improvements will be necessary.

B. EXISTING TRAFFIC CONDITIONS

Figure 4 is a summary of the existing peak hour traffic volumes, existing laneage, turning movements, and intersection level of service. The 2016 traffic counts from the Los Alamos County study are included in Appendix A.

C. EXISTING LEVELS OF SERVICE

The Sixth Edition of the *Highway Capacity Manual* (HCM) defines Level of Service (LOS) for signalized and unsignalized intersections as follows:

Table 4 – LOS Definitions

Level of Service	Definition	Signalized (sec/veh)	Unsignalized (sec/veh)
A	Most vehicles do not stop.	<10	<10
B	Some vehicles stop.	>10 and <20	>10 and <15
C	Significant numbers of vehicles stop.	>20 and <35	>15 and <25
D	Many vehicles stop.	>35 and <55	>25 and <35
E	Limit of acceptable delay.	>55 and <80	>35 and <50
F	Unacceptable delay.	>80	>50

Level of Service D is the generally acceptable level of service in urban areas and when intersections operate below this level, improvements are generally considered, where feasible.

Existing intersection traffic volumes and lane geometry were analyzed using the Synchro version 10 software that uses the signalized intersection analysis methodology from the Sixth Edition of the HCM. Individual intersection output for the existing conditions analysis is included in Appendix B.

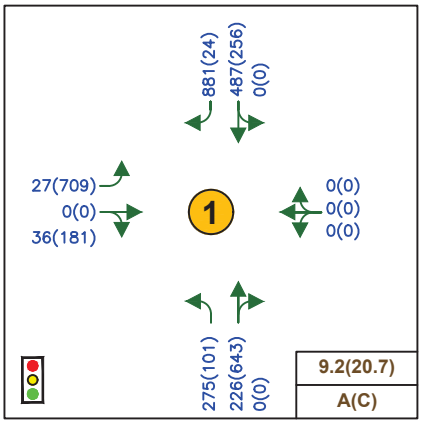
Table 5 shows the results for the signalized analysis for the existing 2016 traffic volumes, with the fourth leg added. The listed results are the average delay in seconds per vehicle, a weighted average of the delay for every vehicle that passes through the intersection in the peak hour evaluated. The table also lists the volume-to-capacity ratio (v/c) for the movement with the highest v/c ratio at the intersection. The v/c ratio is a ratio of the actual volume passing through the intersection (by movement – through, left, right, etc.) compared to the calculated capacity available to serve that movement. Volume-to-capacity ratios above 0.85 – 0.90 indicate that there are likely congestion problems occurring at the intersection. The last column in the table is the LOS, which is derived from Table 4, and is a letter grade that assesses the motorist's perception of delay. Signalized intersections have higher delay thresholds for each letter grade than do unsignalized intersections, as the assumption is that drivers will tolerate a longer delay knowing they will get to proceed within a relatively short period of time.

The results reported below were evaluated as semi-actuated traffic signal with a cycle length of 120 seconds. Figure 4 shows the number of lanes, movement LOS, traffic volumes, and overall intersection level of service for each intersection.

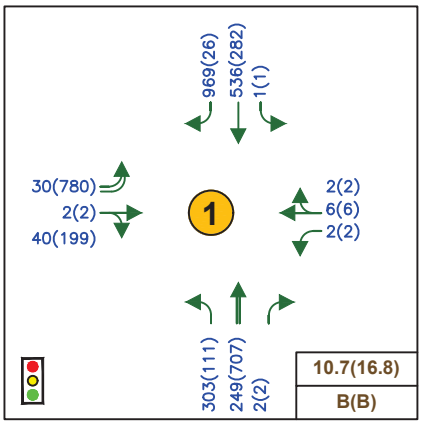
Table 5 – 2016 Existing Signalized Intersection Capacity Analysis Results

Signalized Intersections	2016 AM Peak			2016 PM Peak		
	Delay (sec.)	V/C	LOS	Delay (sec.)	V/C	LOS
NM 4 and East Jemez Road	9.2	0.89	A	20.7	0.87	C
No movements LOS E or F						

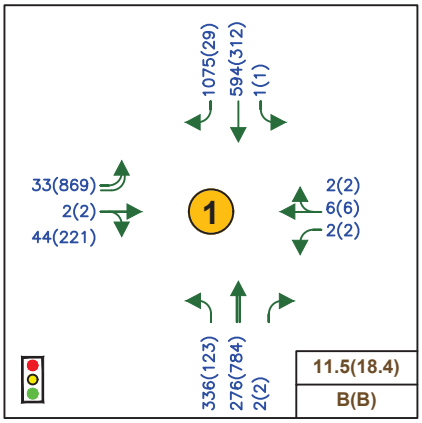
The table indicates the intersection operates at acceptable levels of service, though a review of the queues shown in the Appendix B for the southbound right in the AM peak hour, and the eastbound left in the PM peak hour are substantial, though they do not impact adjacent traffic. Several movements (SB right (AM), EB left (PM) and NB thru (PM)) are also approaching capacity with the existing geometry.



2016 Existing AM(PM)



2028 Proposed AM(PM)



2038 Proposed AM(PM)

LEGEND

- Thru Lanes (# as indicated)
- Turning Lanes (# as indicated)
- 1234(1234) AM(PM) Traffic Counts
- X(X) AM(PM) Level of Service (LOS)

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Bohannan Huston
www.bhinc.com 800.877.5332

East Jemez Road / NM4
Los Alamos, NM
Intersection Analysis
Attachment A

Figure 4
2016, 2028 and 2038
AM(PM) Peak Hour Traffic Volumes

IV. TRAFFIC AND IMPROVEMENT ANALYSIS

The following section will discuss the results of the future year traffic analysis. The project was requested to use an annual growth rate of 1% on the background traffic. For the 10-year analysis, this results in an increase of 10%. For a period of 20 years, the increase is 22%. This growth rate was agreed to by NNSA/LANS, as historical traffic growth on NM 4 has been flat for many years, based on historical NMDOT traffic volume data. As missions change at LANL it was considered appropriate to consider some traffic growth when considering improvements.

As the existing conditions analysis results in substantial congestion, delay and queue, improvements were considered at the intersection.

The analysis assumes the Tsankawi trailhead parking lot has been constructed, and the intersection now has four (4) legs.

A. 2028 BUILD INTERSECTION CAPACITY ANALYSIS

To improve delay, and reduce queue backup at the intersection, improvements are need at the intersection. These improvements include adding a second eastbound left turn lane on East Jemez Road. Another required improvement is a second northbound through lane on NM 4. A right turn bay is added for the Tsankawi trailhead parking lot. The State Access Management Manual (SAMM) requires a right turn bay for traffic volumes greater than five (5) during the peak hour. While traffic volumes are only estimated at this time, it was decided to add the right turn bay to improve the flow on the through lanes.

To convert the intersection to a four-legged intersection, an eastbound through lane or combination turn lane / through lane is needed on East Jemez Road, in addition to the two eastbound left turn lanes and dedicated eastbound right turn lane. A southbound left turn lane is also necessary to allow left turning traffic destined to the trailhead parking lot to slow, get out of the southbound through lane, and wait to enter the parking lot.

Also, due to volume, the southbound-to-westbound right turn lane from NM 4 onto East Jemez Road will have an acceleration lane to allow the entering traffic to accelerate to the posted speed and merge safely onto westbound East Jemez Road. The same is true for the eastbound-to-southbound right turn lane from East Jemez Road to NM 4. It too will have an acceleration lane, so turning traffic can get up to speed and merge safely onto southbound NM 4.

Figure 4 shows the laneage, traffic volumes, and level of service for the 2028 Build condition. Table 6 shows the summary of the results, with the Synchro results included in Appendix C.

Table 6 – 2028 Build Signalized Intersection Capacity Analysis Results

Signalized Intersections	2028 Build AM Peak			2028 Build PM Peak		
	Delay (sec.)	V/C	LOS	Delay (sec.)	V/C	LOS
NM 4 and East Jemez	10.7	0.76	B*	16.8	0.75	B*
* - movements LOS E or F						

The results show the intersection will operate at acceptable delay in the 2028 Build scenario.

A review of the results in Appendix C will find the analysis suggests the LOS for the westbound left exiting the Tsankawi parking lot to operate at LOS E. This is due to this movement being a very low volume movement and operating as a protected-only left turn, due to opposing the dual eastbound left turns on East Jemez Road. Therefore, the movement only gets a small amount of green time, and then must wait as the rest of the movements are served, before the traffic signal cycle comes back around and provides the green arrow. This delay is considered acceptable due to the low volumes for this movement. This will only occur during the peak hours when the cycle length is high to serve the traffic volume. With lower cycle lengths during the day and off-peak, the delay for this movement will be lower.

B. 2038 BUILD INTERSECTION CAPACITY ANALYSIS

The same improvements needed to serve the 2028 traffic volumes will accommodate the 2038 volumes, so additional improvements are not required.

Table 7 shows the results for the signalized analysis for the 2038 traffic volumes with the mitigation improvements discussed above. Synchro results are included in Appendix D.

Table 7 – 2038 Build Signalized Intersection Capacity Analysis Results

Signalized Intersections	2038 Build AM Peak			2038 Build PM Peak		
	Delay (sec.)	V/C	LOS	Delay (sec.)	V/C	LOS
NM 4 and East Jemez Road	11.5	0.80	B*	18.4	0.78	B*
* - movements LOS E or F						

The results indicate the intersection will continue to operate at acceptable levels of service with 2038 traffic volumes. As with the 2028 results, the westbound left exiting the Tsankawi trailhead parking lot is found to operate at LOS E. As described previously, this is acceptable due to the low volume of this movement.

C. EAST JEMEZ ROAD WESTOF NM 4 CONSIDERATIONS

1. IMPACTS WEST OF NM 4

The traffic volume for the headed westbound exiting the intersection is expected to approach 1,400 vehicles per hour in the 2038 scenario. This volume will result in significant congestion along East Jemez Road west of the intersection, as a one-lane uninterrupted flow highway is generally considered capable of carrying 1,640 vehicles per hour at LOS E. Therefore, intersections west of NM 4 may have high delay if the traffic does increase by 20%. This effect is more pronounced in the AM peak hour when the traffic volumes are slightly higher westbound (1,411 vph) than the eastbound PM volume (1,092 vph)

2. WESTBOUND MERGE

Due to the high traffic volume westbound in the AM peak hour, an analysis was conducted to evaluate the merging area from NM 4 to the LANL truck inspection station.

This section was evaluated as both a merge section and a weave section, as the analysis methods are slightly different, and both conditions are present. A merge is when

traffic must enter the through traffic stream, and a weave is when a vehicle must change lanes to reach their destination.

In this case, the southbound-to-westbound right turning traffic must merge into the single westbound through lane. For trucks entering from the south, these northbound-to-westbound trucks must weave in order to enter the truck inspection station (if the southbound-to-westbound lane is extended to the truck inspection station as will be described in some of the options presented below).

Highway Capacity Manual procedures for both weaves and merges require two lanes on the "mainline," i.e., the lanes which are merged into or weaved from. This would be westbound East Jemez Road, which in this case has just a single lane. To attempt to represent the actual condition, the analysis was conducted with twice the northbound-to-westbound left turn volume (the "mainline" traffic volume). Only the AM peak hour was evaluated

Both this modified merge analysis and weave analysis resulted in LOS B and C, with the results included in the 2038 analysis section in the Appendix D.

3. NORTHBOUND MERGE

The northbound merge will not have the same issues as the westbound merge, as the traffic signal will meter the traffic, by preventing the eastbound-to-northbound traffic from entering at the same time as the northbound traffic. In the AM, the free-right allows the southbound-to-westbound traffic to enter the same time as the northbound-to-westbound. That cannot happen at the northbound departure left due to traffic signal operation.

The northbound merge distance has been set to NMDOT and AASHTO design criteria.

D. DESIGN OPTIONS

Five intersection options were developed in conjunction with the study team. All these options achieve the LOS and queue results as discussed above in the traffic analysis, as their geometries are comparable for traffic operations.

All the options have the required laneage discussed previously, however, they have different design speeds, skews, and multi-modal facilities. The options, described in more detail in the sections below, are as follows:

Option 1 uses the existing alignments of NM 4 and East Jemez Road with the new lanes added. This Option is SAMM Compliant for the existing posted speeds.

Option 2 has a 5° skewed intersection with shortened acceleration lanes southbound and to avoid impacting San Ildefonso Pueblo lands and westbound to avoid impacting the truck inspection station.

Option 3 has a 5° skewed intersection, with shortened acceleration lanes as described in Option 2 along with dedicated dual lefts on East Jemez Road for eastbound traffic turning north onto NM 4.

Option 4 is the same as Option 3 except that the posted speed northbound and eastbound are reduced to 45 mph and the acceleration and deceleration lengths are reduced accordingly.

Option 5 is the same as Option 4 except that the acceleration lanes northbound has been extended to the project limits to allow more merge time and the westbound acceleration lane is extended to the right turn bay for the truck inspection station.

. All the options have the following elements:

- NM 4: Dual northbound thru lanes (to accept the dual eastbound left turn lanes), a dedicated northbound to westbound left turn lane, and a dedicated northbound right turn lane to the proposed National Park Service access
- NM 4: A dedicated southbound to westbound channelized free right turn lane, a single southbound thru lane, and a dedicated southbound to eastbound left turn lane to the proposed National Park Service access
- The proposed National Park Service access has a single eastbound lane, a dedicated westbound to southbound left turn lane, and a westbound thru/right turn lane
- 5-foot shoulders are added throughout to match the typical section of the NMDOT NM 4 project and to provide an area for bicycles. Bicycle markings will not be added.
- All options require complete reconstruction of the existing signal and signal flasher on the north approach. The signal flasher on the south approach may need to be replaced do to age and condition. The flasher is within the limits of the NMDOT project and may be updated with that project.
- All turning movements can be made by a WB-67 semi-tractor trailer except the northbound to westbound movement. That movement is only designed for a WB-40, single unit truck, which matches the existing condition. Trucks can currently make the movement by taking some of the on-coming lanes which could continue to happen in non-peak hours. This movement can be improved by using mountable curb on the medians to allow trucks to drive up on the medians. In order to

completely design for a WB-67, a median island would have to be added to NM 4 and the width of the westbound approach would have to be widened.

- The east side of NM 4 north of the intersection has been held to avoid impacting the existing chlorine injection manhole. There is a water manhole and a gas valve in the northwest quadrant that will be impacted with all of the options.

1. OPTION 1

Option 1, shown in Figure 5, is considered the "SAMM" compliant option, as it implements the NMDOT State Access Management Manual requirements for acceleration and deceleration lanes based on existing posted speed limits of the roadways.

This option has the following configuration for East Jemez Road: a dedicated single eastbound thru lane, a westbound left and a thru / right lane, dual eastbound to northbound left turn lanes, a dedicated eastbound to southbound free right turn lane, and a parallel westbound lane (from the southbound to westbound free right) that terminates at the right turn lane into the LANL Delivery Station.

Bicycle traffic would utilize the road shoulder for travel. A bike lane is created between the northbound thru lane and right turn lane.

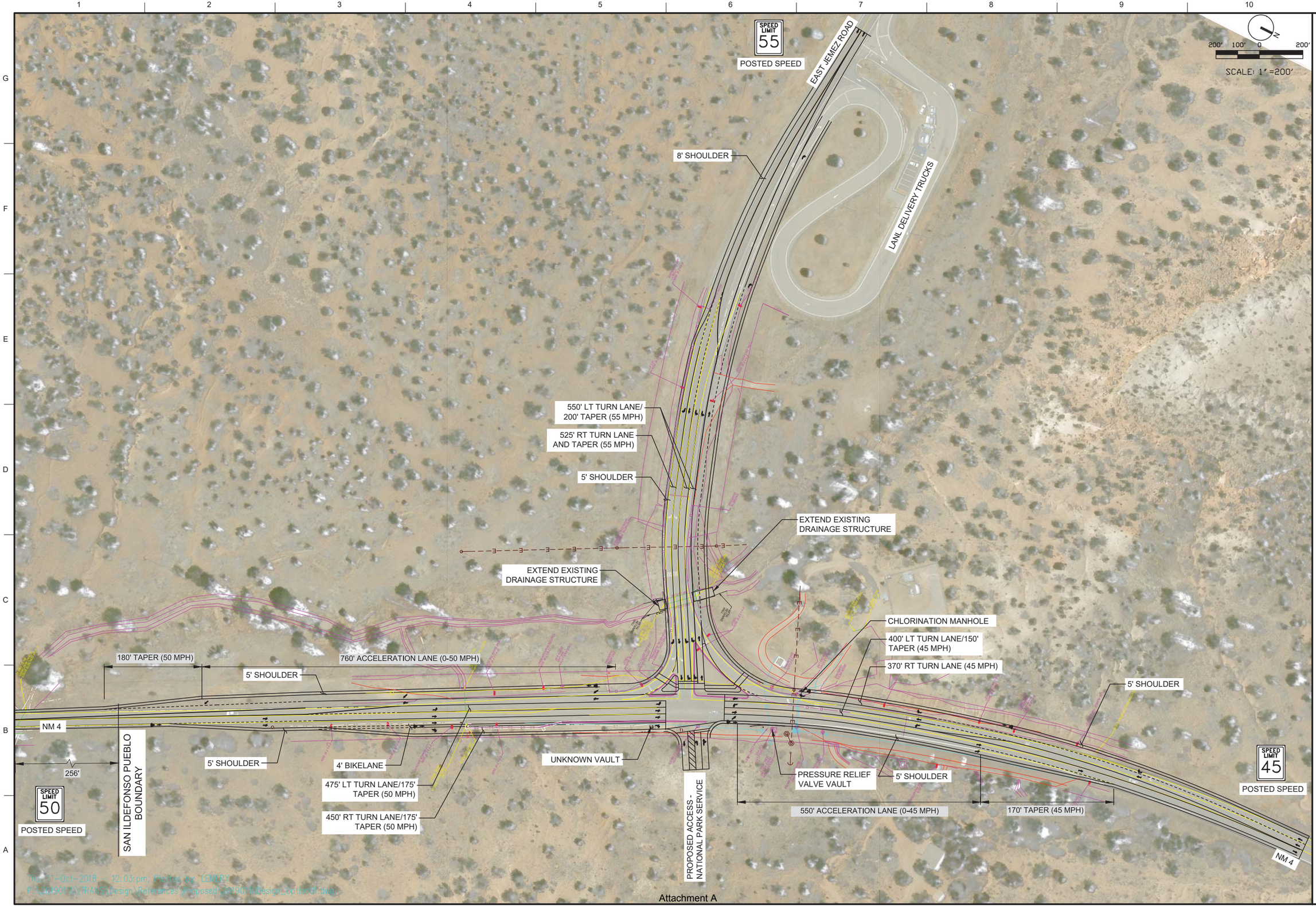
Crosswalks were added to create bicycle crossing of East Jemez Road northbound and southbound.

This option results in approximately 256 feet of construction on San Ildefonso Pueblo lands.

Modifications/extension of the existing multi-plate pipe is required both north and south under East Jemez Road.

The east leg of the intersection will require additional right-of-way if constructed with this project. Horizontally the remainder of this option is within the apparent right-of-way, however, it is likely that the proposed toes of slope will be outside of the existing fence lines, particularly on the east side.

The engineer's opinion of probable construction cost is $4.28 million including New Mexico Gross Receipts Tax. A detailed cost estimate can be found in Appendix E. This does not include design, construction management and testing which is approximately an additional 20% of the cost.



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DESIGNED BY: TMF	ISSUE DATE: OCTOBER 11, 2018
DRAWN BY: TMF	SOLICITATION NO.: W81G6981631315
CHECKED BY: TMF	CONTRACT NO.: W912P-15-D-0024
SUBMITTED BY: TMF	
SIZE:	

U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT
4104 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

OPTION 1

SHEET ID

Thu, 11-Oct-2018 — 12:03:pm, plotted by: LEMERY
P:\219019\PD\TRANS\Design\References\Proposed 219019 Design_Option01.dwg

2. OPTION 2

Option 2, shown in Figure 6, introduces a 5° skew to east/west legs of the intersection to smooth out the approach to the intersection and to move the intersection north, as requested by the National Park Service. The NM 4 alignment remains the same.

This option has the following configuration for East Jemez Road: A shared eastbound thru-left lane, a single dedicated eastbound to northbound left turn lane, single westbound thru lane, and a dedicated eastbound to southbound free right turn lane.

This option reduces the length of the eastbound-to-southbound right turn acceleration lane length and tightens up the transition to the northbound to westbound left turn in order to avoid construction on San Ildefonso Pueblo lands.

The length of the acceleration lane was maximized between the intersection and the Pueblo boundary for a length of 730 feet. It was assumed that vehicles would already be traveling at 15-20 mph due to the free right and did not need the additional length to get up to speed to enter NM 4. Design criteria from the AASHTO Green Book gives a length of 660 feet to get from 15 mph to 50 mph so the length is acceptable.

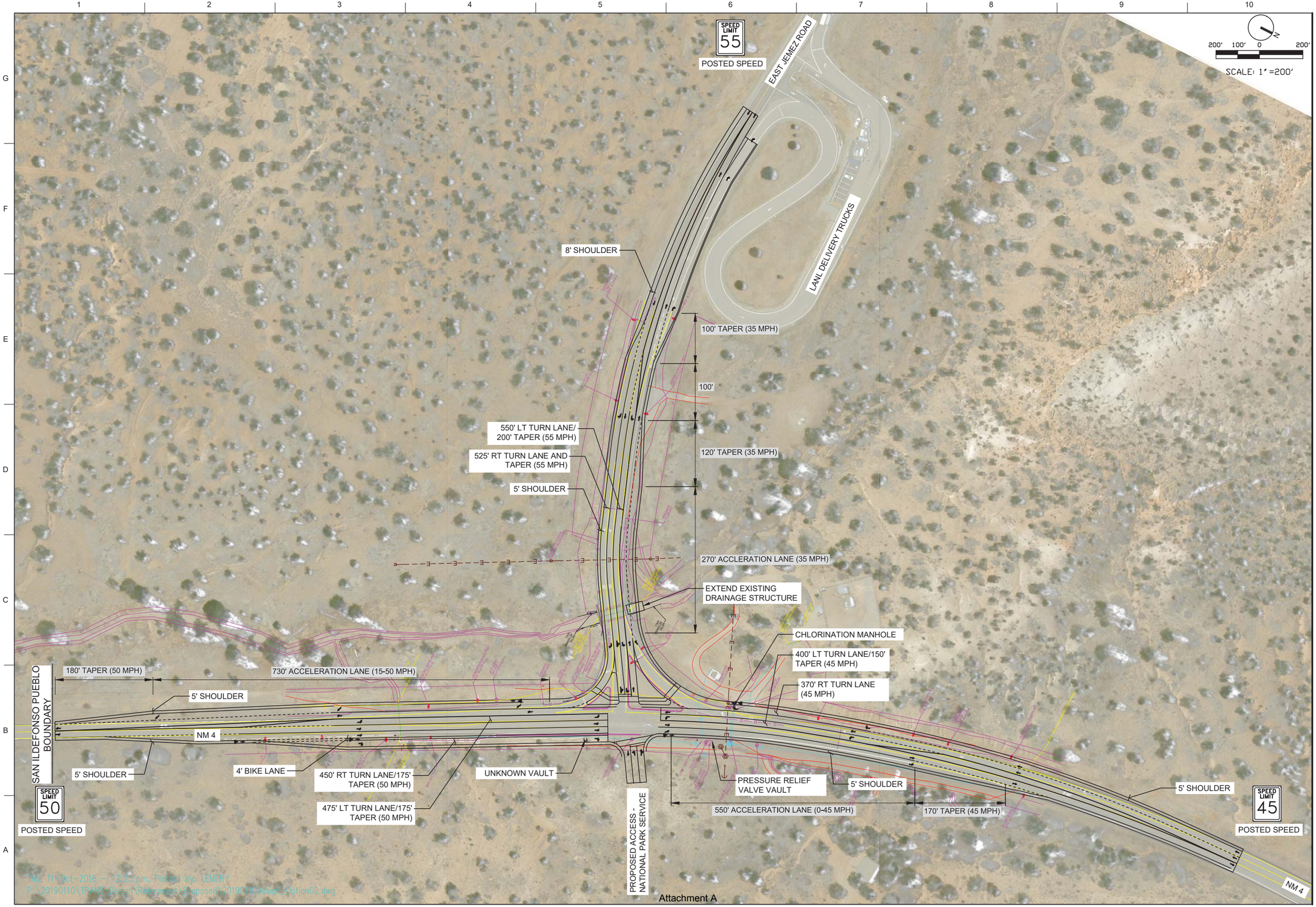
The southbound to westbound acceleration lane was designed at 35 mph since the horizontal and vertical geometry does not allow for a higher design speed. The traffic making this turn is fully merged into the westbound thru lane and then a right turn lane for the LANL Delivery Station is developed.

Bicycle facilities are consistent with Option 1.

This option requires extension of the existing multi-plate pipe to the north under East Jemez Road.

The east leg of the intersection will require additional right-of-way if constructed with this project. Horizontally the remainder of this option is within the apparent right-of-way, however, it is likely that the proposed toes of slope will be outside of the existing fence lines, particularly on the east side. The combined through-left turn on the west leg reduces the roadway footprint by approximately 12 feet.

The engineer's opinion of probably construction cost is $3.86 million including New Mexico Gross Receipts Tax. A detailed cost estimate can be found in Appendix E. This does not include design, construction management and testing which is approximately an additional 20% of the cost.



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U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT
4104 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

OPTION 2

SHEET ID

Attachment A

FIGURE 6

3. OPTION 3

Option 3, shown in Figure 7, has the same skew as Option 2.

This option has the following configuration for East Jemez Road: A shared eastbound thru-right lane, a westbound left and thru / right lane, and dual eastbound to northbound left turn lanes.

The shared eastbound thru-right lane is considered acceptable as the eastbound thru lane will have low volume (to the Tsankawi parking lot) and the channelized right turn lane island provides storage for the one or two vehicles who may proceed east.

Modifications to acceleration lengths are consistent with Option 2.

No construction on San Ildefonso Pueblo lands would be required.

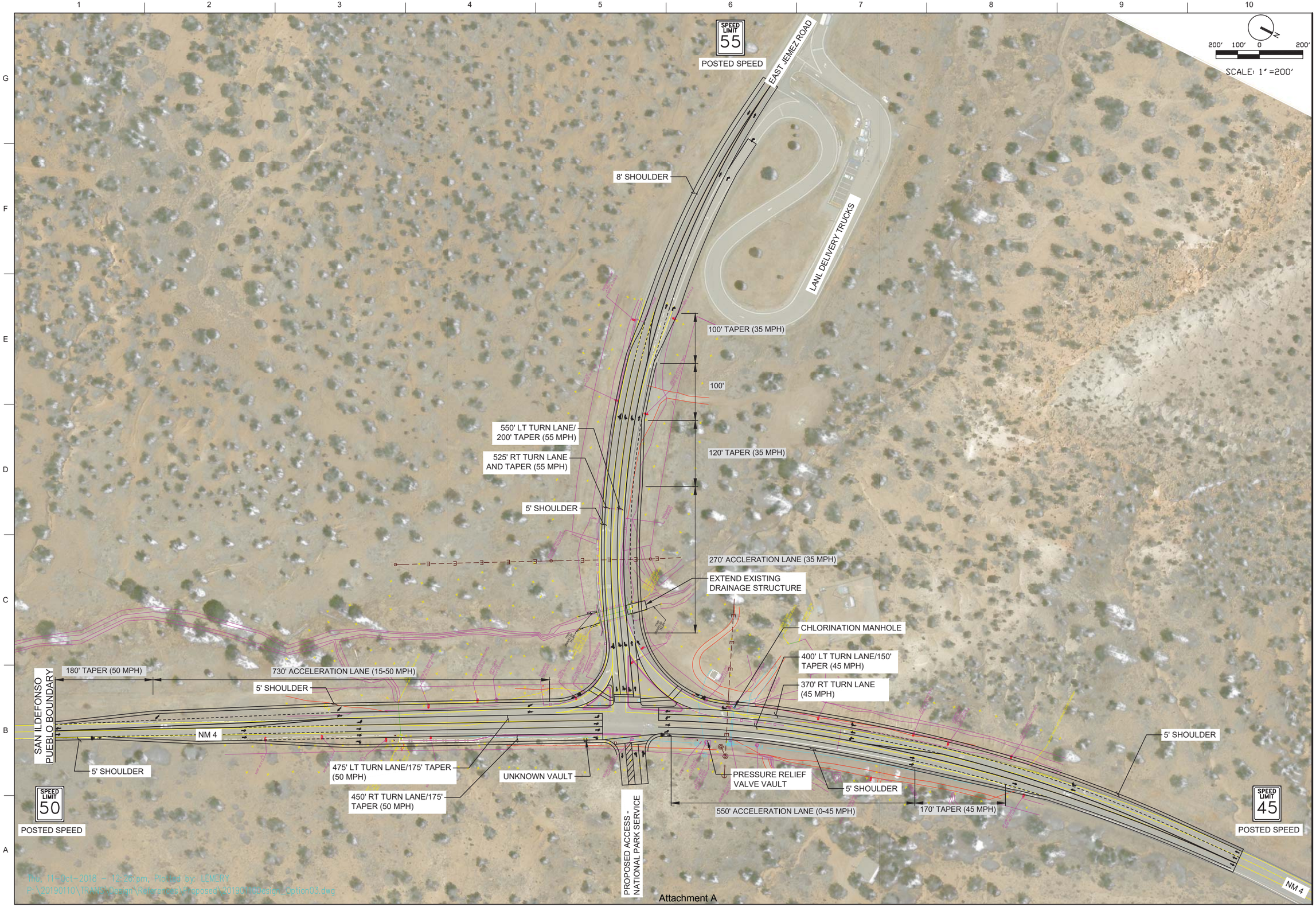
Bicycle traffic will utilize the road shoulders for travel.

Crosswalks are added to create bicycle crossings of East Jemez Road northbound and southbound. Bicyclists can choose to share the lane.

This option requires extension of the existing arch pipe to the north under East Jemez Road.

The east leg of the intersection will require additional right-of-way if constructed with this project. Horizontally the remainder of this option is within the apparent right-of-way, however, it is likely that the proposed toes of slope will be outside of the existing fence lines, particularly on the east side. The combined through-right turn on the west leg increases the footprint of the east leg by approximately 12 feet.

The engineer's opinion of probably construction cost is $3.87 million including New Mexico Gross Receipts Tax. A detailed cost estimate can be found in Appendix E. This does not include design, construction management and testing which is approximately an additional 20% of the cost.



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OPTION 3

SHEET ID

FIGURE 7

4. OPTION 4

Option 4, shown in Figure 8, has the same laneage, intersection skew, bicycle facilities, and impacts to the drainage structure as discussed in Option 3.

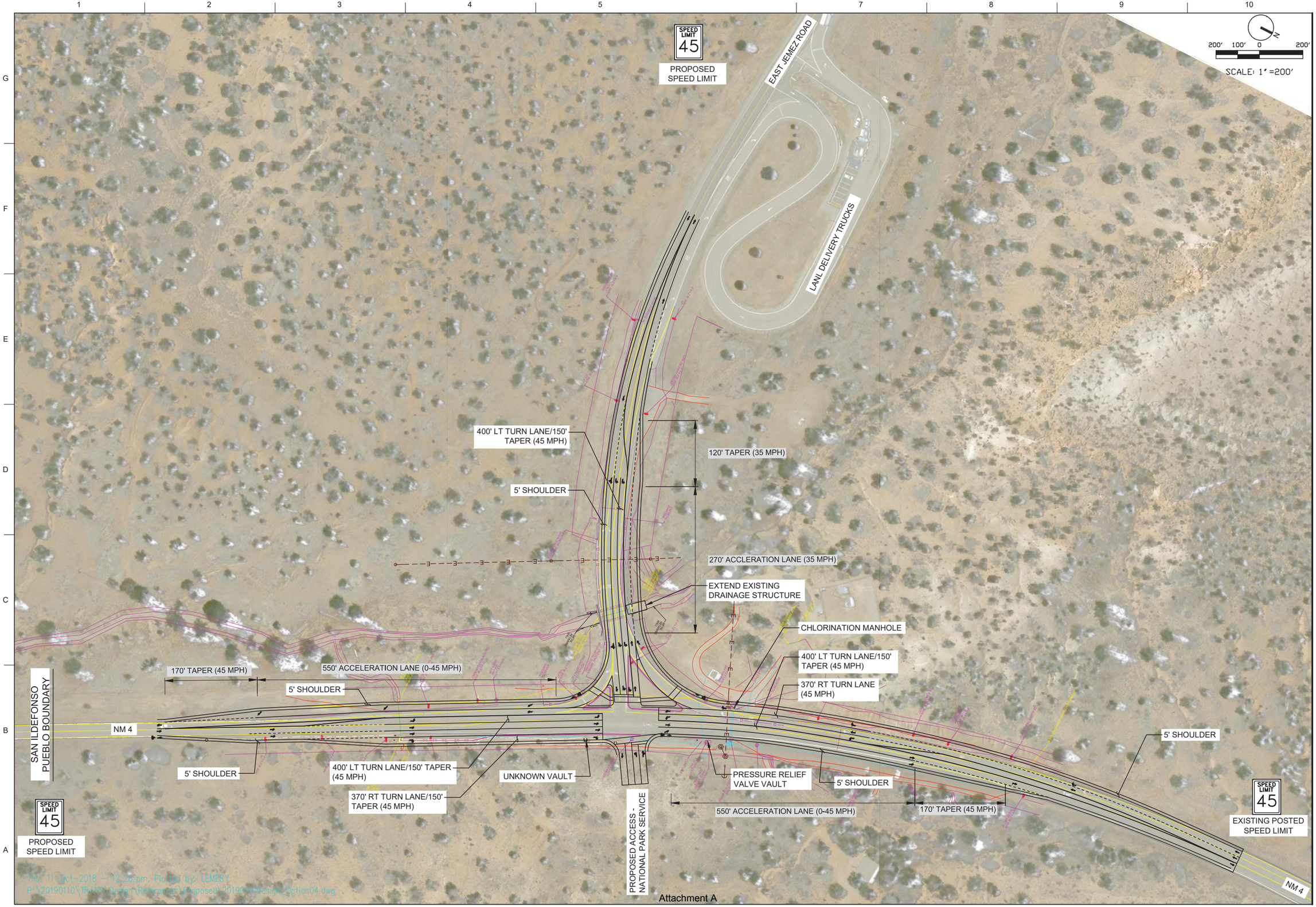
This option reduces the posted speed limit on northbound NM 4 to 45 mph. This allows a reduction of the acceleration and deceleration lane lengths to limit impacts and reduce construction costs.

This option would require a speed study to justify to the NMDOT that the speed limit on NM 4 south of the intersection could be reduced to 45 mph from the present 50 mph.

LANL would also be required to do a speed study to justify the reduction in speed on East Jemez Road.

The east leg of the intersection will require additional right-of-way if constructed with this project. Horizontally the remainder of this option is within the apparent right-of-way, however, it is likely that the proposed toes of slope will be outside of the existing fence lines, particularly on the east side. The shorter acceleration and deceleration lane lengths will reduce the roadway footprint.

The engineer's opinion of probably construction cost is $3.56 million including New Mexico Gross Receipts Tax. A detailed cost estimate can be found in Appendix E. This does not include design, construction management and testing which is approximately an additional 20% of the cost.



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ALBUQUERQUE, NM 87109-3435

OPTION 4

SHEET ID

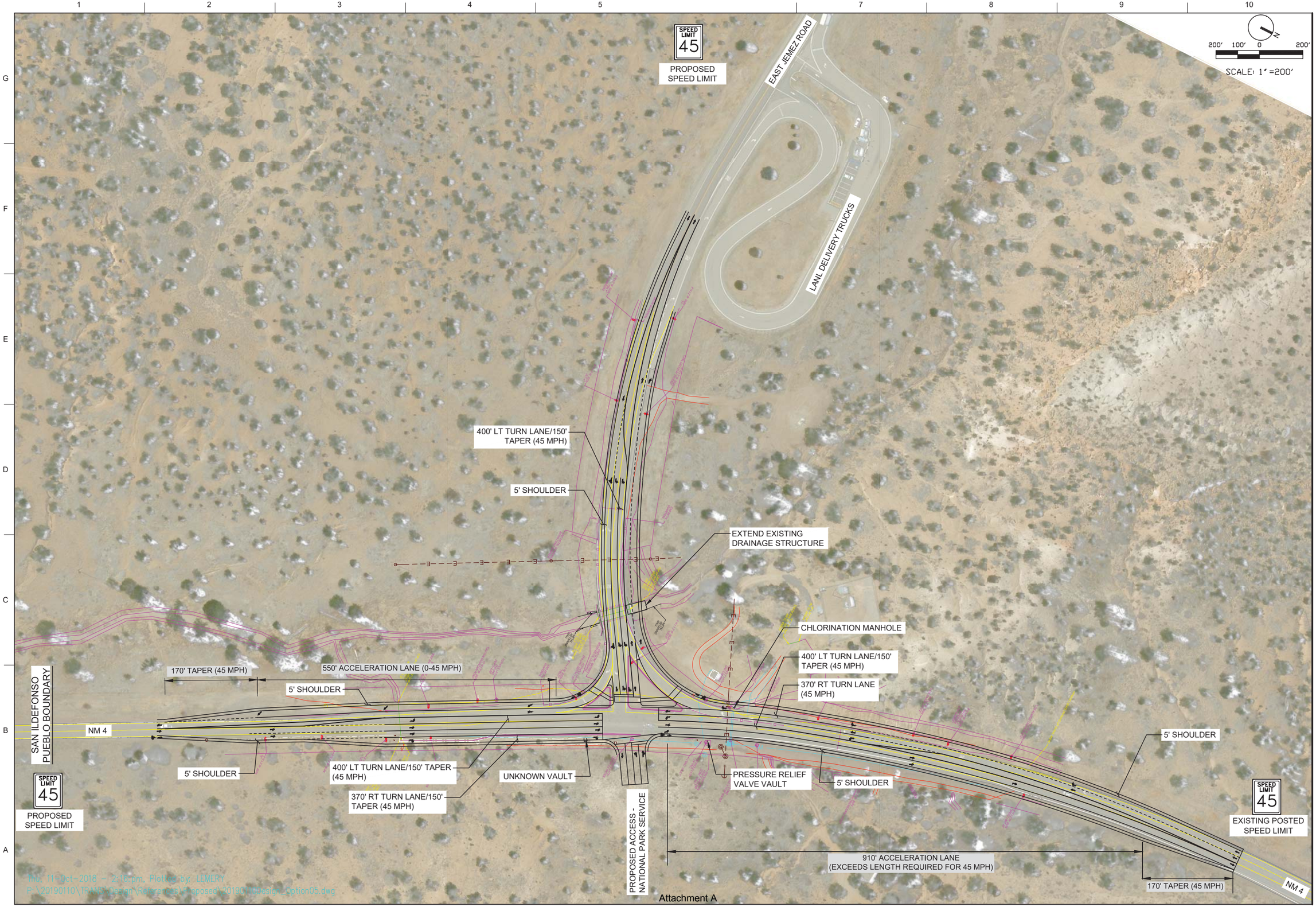
FIGURE 8

5. OPTION 5

Option 5, shown in Figure 9, is consistent with Option 4 except that the northbound acceleration lane on NM 4 would be extended to the northernmost limits of construction, increasing the length from 550 feet to 910 feet to provide a longer merge for traffic turning left on East Jemez Road. In addition, the westbound acceleration lane on East Jemez Road would be extended to the truck inspection station and become a right turn only lane.

The east leg of the intersection will require additional right-of-way if constructed with this project. Horizontally the remainder of this option is within the apparent right-of-way, however, it is likely that the proposed toes of slope will be outside of the existing fence lines, particularly on the east side. The longer acceleration lane lengths will increase the roadway footprint.

The engineer's opinion of probably construction cost is $3.6 million including New Mexico Gross Receipts Tax. A detailed cost estimate can be found in Appendix E. This does not include design, construction management and testing which is approximately an additional 20% of the cost.



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ALBUQUERQUE DISTRICT
4104 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

OPTION 5

SHEET ID

FIGURE 9

V. CONCLUSIONS

A. CONCLUSIONS

The traffic analysis found the existing “overall” intersection operates with acceptable delay, however the vehicle queue for southbound-to-westbound in the AM peak hour, and the eastbound-to-northbound queue in the PM peak hour are substantial. In addition, the analysis found that several movements are approaching capacity, and likely occasionally exceed capacity. Therefore, improvements were considered to reduce delay and queue for specific movements, and provide capacity for future traffic growth. These improvements will result in acceptable delay and queues at the intersection.

It should be noted, that during the peak hour, the traffic signal cycle length is 120 seconds to provide time to clear the majority of the waiting traffic. Due to this cycle length, and that the westbound left exiting the Tsankawi parking lot has low volume and will be operating as a protected-only left turn, the westbound left will have high delay and LOS E during these periods. This is because, as the westbound left turning volume is low, the green time provided to this movement is also low. This will only occur during the peak hours when the cycle length is high to serve the traffic volume. With lower cycle lengths during the day and off-peak, the delay for this movement will be lower.

B. RECOMMENDED IMPROVEMENTS

To improve delay, and reduce queue backup at the intersection, improvements are needed at the intersection. The recommended improvements include adding a second eastbound left turn lane on East Jemez Road, a second northbound through lane on NM 4 and right and left turn bays for the proposed Tsankawi trailhead parking lot. Acceleration and deceleration lanes will be added to meet the requirements of the State Access Management Manual (SAMM).

Based on input from the study team, the preferred alternative is Option 5, the 5° skewed intersection with reduced posted speeds and a longer acceleration lane northbound and two lanes westbound. To convert the intersection to a four-legged intersection, an eastbound through lane is added on East Jemez Road which is a combined eastbound through / right movement with a channelized right turn at the intersection. In addition, two eastbound left turn lanes are needed. A southbound left turn lane is necessary on NM 4 to allow left turning traffic destined to the trailhead parking lot to slow, get out of the southbound through lane, and wait to enter the parking lot.

Also, due to volume, the southbound-to-westbound right turn lane from NM 4 onto East Jemez Road will have an acceleration lane to allow the entering traffic to accelerate to speed and merge safely with the northbound to westbound traffic on East Jemez Road. This acceleration lane will be extended to the truck inspection station and become a right turn only lane. The eastbound-to-southbound right turn lane from East Jemez Road to NM 4 will also have an acceleration lane so turning traffic can get up to speed and merge safely onto southbound NM 4.

C. NEXT STEPS

A traffic count will be completed In October 2018 to validate the 2016 count provided by Los Alamos County.

A speed study is needed to support the recommended reduction in speed limit to 45 mph.

Retaining walls may be needed to minimize impacts to any archaeological sites, however it is considered that these walls will apply equally to each option.

A cultural resource survey, biological survey and environmental clearance are needed to examine the impacts of the roadway footprint. There are known cultural sites in the southwest quadrant of the intersection. There is also the potential for cultural sites on the east side of the right-of-way. Adjustments such as shifting the roadway or adding walls may need to be considered during final design.

Since the existing multi-plate pipe appears to be heavily sedimented, hydrology and hydraulic analysis should be done during preliminary design to verify the capacity of the pipe. The pipe should be cleaned out in order to function properly. If the analysis shows that the pipe meets capacity with a limited factor of safety, then analysis should be performed to evaluate the sediment load and determine if additional capacity is needed.

APPENDIX A
EXISTING TRAFFIC COUNTS

Los Alamos County
101 Camino Entrada
Bldg 1, Rm 216
Los Alamos, New Mexico, United States 87544
505-662-8176
Public Works/Traffic & Streets

Count Name: NM4/EJemez 3_16
Site Code:
Start Date: 03/17/2016

Turning Movement Data

Start Time	NM 4 Southbound				NM 4 Northbound			E. Jemez Rd. Eastbound				
	Right	Right on Red	Thru	App. Total	Thru	Left	App. Total	Right	Right on Red	Left	App. Total	Int. Total
6:00 AM	73	0	86	159	10	18	28	0	2	3	5	192
6:15 AM	115	4	134	253	24	28	52	0	1	11	12	317
6:30 AM	189	15	154	358	31	31	62	0	6	7	13	433
6:45 AM	251	2	154	407	34	31	65	1	2	8	11	483
Hourly Total	628	21	528	1177	99	108	207	1	11	29	41	1425
7:00 AM	227	15	119	361	49	54	103	0	5	5	10	474
7:15 AM	175	44	103	322	70	91	161	6	2	6	14	497
7:30 AM	151	16	111	278	73	99	172	19	1	8	28	478
7:45 AM	131	12	95	238	61	60	121	19	6	6	31	390
Hourly Total	684	87	428	1199	253	304	557	44	14	25	83	1839
8:00 AM	88	11	88	187	72	48	120	1	18	7	26	333
8:15 AM	74	11	53	138	86	54	140	4	10	16	30	308
8:30 AM	65	7	48	120	60	52	112	1	22	11	34	266
8:45 AM	43	4	45	92	72	32	104	2	19	13	34	230
Hourly Total	270	33	234	537	290	186	476	8	69	47	124	1137
9:00 AM	30	0	41	71	49	32	81	5	5	11	21	173
9:15 AM	41	2	52	95	37	35	72	7	10	7	24	191
9:30 AM	23	1	42	66	56	34	90	2	16	6	24	180
9:45 AM	18	0	45	63	41	27	68	6	5	10	21	152
Hourly Total	112	3	180	295	183	128	311	20	36	34	90	696
10:00 AM	16	0	41	57	45	14	59	4	13	9	26	142
10:15 AM	11	0	43	54	31	23	54	4	9	4	17	125
10:30 AM	11	2	50	63	33	17	50	5	12	7	24	137
10:45 AM	14	2	51	67	45	25	70	2	12	7	21	158
Hourly Total	52	4	185	241	154	79	233	15	46	27	88	562
11:00 AM	8	5	51	64	47	24	71	1	15	17	33	168
11:15 AM	8	6	55	69	45	23	68	2	13	15	30	167
11:30 AM	10	2	57	69	45	32	77	5	13	8	26	172
11:45 AM	7	2	50	59	42	19	61	7	16	15	38	158
Hourly Total	33	15	213	261	179	98	277	15	57	55	127	665
12:00 PM	9	2	48	59	47	26	73	3	20	19	42	174
12:15 PM	6	3	52	61	46	20	66	3	21	22	46	173
12:30 PM	14	2	62	78	59	24	83	0	26	10	36	197
12:45 PM	11	1	34	46	44	17	61	8	25	11	44	151
Hourly Total	40	8	196	244	196	87	283	14	92	62	168	695
1:00 PM	7	3	51	61	44	27	71	4	6	9	19	151
1:15 PM	5	5	39	49	42	24	66	8	14	13	35	150
1:30 PM	8	3	27	38	37	28	65	4	17	12	33	136
1:45 PM	6	5	53	64	54	18	72	11	9	18	38	174
Hourly Total	26	16	170	212	177	97	274	27	46	52	125	611
2:00 PM	12	1	49	62	58	19	77	9	7	24	40	179
2:15 PM	8	0	43	51	46	20	66	4	15	18	37	154
2:30 PM	16	1	48	65	31	22	53	4	19	23	46	164
2:45 PM	9	4	36	49	54	23	77	13	24	37	74	200
Hourly Total	45	6	176	227	189	84	273	30	65	102	197	697
3:00 PM	5	1	65	71	54	22	76	19	18	45	82	229
3:15 PM	3	1	65	69	65	22	87	13	23	49	85	241
3:30 PM	0	4	43	47	99	29	128	23	17	83	123	298
3:45 PM	3	0	51	54	110	26	136	13	22	97	132	322
Hourly Total	11	6	224	241	328	99	427	68	80	274	422	1090
4:00 PM	4	8	63	75	124	21	145	25	8	192	225	445
4:15 PM	4	2	59	65	163	24	187	27	11	206	244	496
4:30 PM	1	7	66	74	159	20	179	29	14	170	213	466
4:45 PM	3	1	57	61	147	34	181	30	25	197	252	494
Hourly Total	12	18	245	275	593	99	692	111	58	765	934	1901
5:00 PM	3	3	74	80	174	23	197	22	23	136	181	458
5:15 PM	3	6	71	80	146	31	177	29	38	171	238	495
5:30 PM	5	4	80	89	167	22	189	29	28	112	169	447
5:45 PM	1	2	78	81	126	32	158	35	31	99	165	404
Hourly Total	12	15	303	330	613	108	721	115	120	518	753	1804
6:00 PM	1	0	51	52	67	23	90	12	34	68	114	256

6:15 PM	3	0	60	63	47	25	72	4	18	41	63	198
6:30 PM	2	0	52	54	49	18	67	17	20	25	62	183
6:45 PM	4	0	40	44	49	22	71	9	24	22	55	170
Hourly Total	10	0	203	213	212	88	300	42	96	156	294	807
Grand Total	1935	232	3285	5452	3466	1565	5031	510	790	2146	3446	13929
Approach %	35.5	4.3	60.3	-	68.9	31.1	-	14.8	22.9	62.3	-	-
Total %	13.9	1.7	23.6	39.1	24.9	11.2	36.1	3.7	5.7	15.4	24.7	-
All Vehicles (no classification)	1935	232	3285	5452	3466	1565	5031	510	790	2146	3446	13929
% All Vehicles (no classification)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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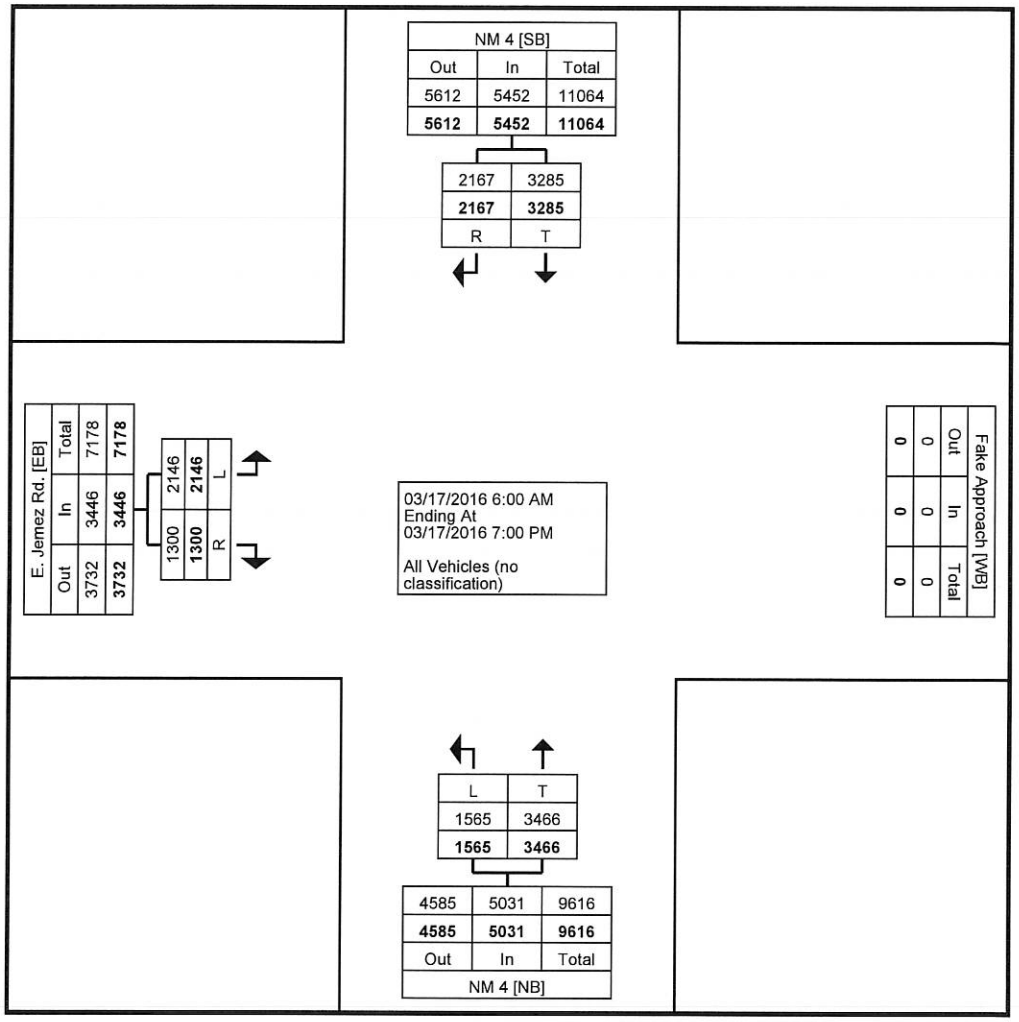


Turning Movement Data Plot

Los Alamos County
101 Camino Entrada
Bldg 1, Rm 216
Los Alamos, New Mexico, United States 87544
505-662-8176
Public Works/Traffic & Streets

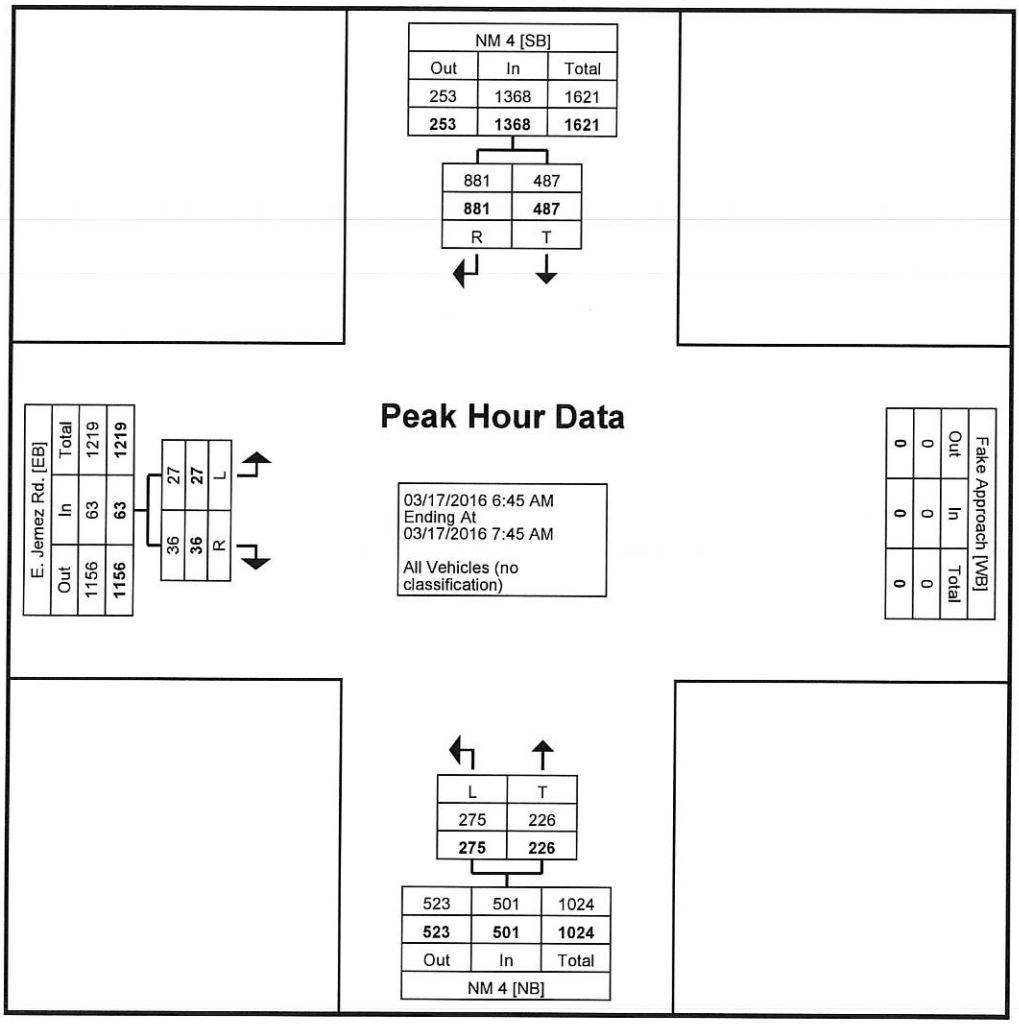
Count Name: NM4/EJemez 3_16
Site Code:
Start Date: 03/17/2016

Turning Movement Peak Hour Data (6:45 AM)

Start Time	NM 4 Southbound				NM 4 Northbound			E. Jemez Rd. Eastbound				
	Right	Right on Red	Thru	App. Total	Thru	Left	App. Total	Right	Right on Red	Left	App. Total	Int. Total
6:45 AM	251	2	154	407	34	31	65	1	2	8	11	483
7:00 AM	227	15	119	361	49	54	103	0	5	5	10	474
7:15 AM	175	44	103	322	70	91	161	6	2	6	14	497
7:30 AM	151	16	111	278	73	99	172	19	1	8	28	478
Total	804	77	487	1368	226	275	501	26	10	27	63	1932
Approach %	58.8	5.6	35.6	-	45.1	54.9	-	41.3	15.9	42.9	-	-
Total %	41.6	4.0	25.2	70.8	11.7	14.2	25.9	1.3	0.5	1.4	3.3	-
PHF	0.801	0.438	0.791	0.840	0.774	0.694	0.728	0.342	0.500	0.844	0.563	0.972
All Vehicles (no classification)	804	77	487	1368	226	275	501	26	10	27	63	1932
% All Vehicles (no classification)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Los Alamos County
101 Camino Entrada
Bldg 1, Rm 216
Los Alamos, New Mexico, United States 87544
505-662-8176
Public Works/Traffic & Streets

Count Name: NM4/EJemez 3_16
Site Code:
Start Date: 03/17/2016



Turning Movement Peak Hour Data Plot (6:45 AM)

Los Alamos County
101 Camino Entrada
Bldg 1, Rm 216
Los Alamos, New Mexico, United States 87544
505-662-8176
Public Works/Traffic & Streets

Count Name: NM4/EJemez 3_16
Site Code:
Start Date: 03/17/2016

Turning Movement Peak Hour Data (4:15 PM)

Start Time	NM 4 Southbound				NM 4 Northbound			E. Jemez Rd. Eastbound				
	Right	Right on Red	Thru	App. Total	Thru	Left	App. Total	Right	Right on Red	Left	App. Total	Int. Total
4:15 PM	4	2	59	65	163	24	187	27	11	206	244	496
4:30 PM	1	7	66	74	159	20	179	29	14	170	213	466
4:45 PM	3	1	57	61	147	34	181	30	25	197	252	494
5:00 PM	3	3	74	80	174	23	197	22	23	136	181	458
Total	11	13	256	280	643	101	744	108	73	709	890	1914
Approach %	3.9	4.6	91.4	-	86.4	13.6	-	12.1	8.2	79.7	-	-
Total %	0.6	0.7	13.4	14.6	33.6	5.3	38.9	5.6	3.8	37.0	46.5	-
PHF	0.688	0.464	0.865	0.875	0.924	0.743	0.944	0.900	0.730	0.860	0.883	0.965
All Vehicles (no classification)	11	13	256	280	643	101	744	108	73	709	890	1914
% All Vehicles (no classification)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Los Alamos County
101 Camino Entrada
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Los Alamos, New Mexico, United States 87544
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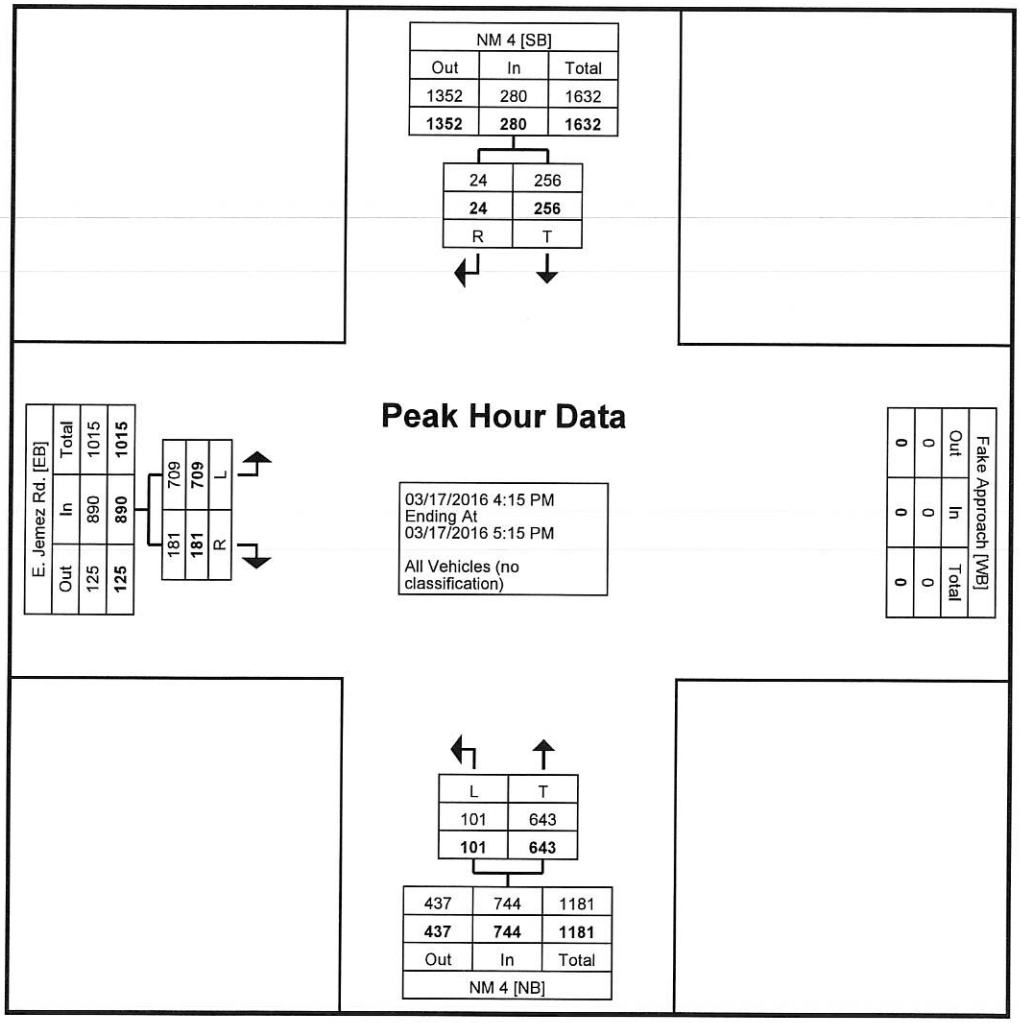
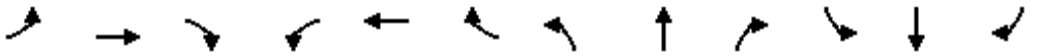
Count Name: NM4/EJemez 3_16
Site Code:
Start Date: 03/17/2016



Turning Movement Peak Hour Data Plot (4:15 PM)

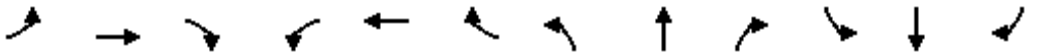
APPENDIX B
2016 EXISTING INTERSECTION CAPACITY ANALYSIS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	27	0	36	0	0	0	275	226	0	0	487	881
Future Volume (veh/h)	27	0	36	0	0	0	275	226	0	0	487	881
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	28	0	37	0	0	0	284	233	0	0	502	908
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	206	0	85	0	100	0	462	1507	0	0	1219	1017
Arrive On Green	0.05	0.00	0.05	0.00	0.00	0.00	0.08	0.81	0.00	0.00	0.65	0.65
Sat Flow, veh/h	1753	0	1585	0	1870	0	1781	1870	0	0	1870	1560
Grp Volume(v), veh/h	28	0	37	0	0	0	284	233	0	0	502	908
Grp Sat Flow(s),veh/h/ln	1753	0	1585	0	1870	0	1781	1870	0	0	1870	1560
Q Serve(g_s), s	1.0	0.0	1.4	0.0	0.0	0.0	2.8	1.8	0.0	0.0	8.2	31.1
Cycle Q Clear(g_c), s	1.0	0.0	1.4	0.0	0.0	0.0	2.8	1.8	0.0	0.0	8.2	31.1
Prop In Lane	1.00		1.00	0.00		0.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h	206	0	85	0	100	0	462	1507	0	0	1219	1017
V/C Ratio(X)	0.14	0.00	0.44	0.00	0.00	0.00	0.61	0.15	0.00	0.00	0.41	0.89
Avail Cap(c_a), veh/h	608	0	448	0	529	0	730	2714	0	0	2144	1789
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	29.1	0.0	29.4	0.0	0.0	0.0	5.2	1.4	0.0	0.0	5.3	9.3
Incr Delay (d2), s/veh	0.3	0.0	3.5	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.2	3.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	0.7	0.0	1.1	0.0	0.0	0.0	0.6	0.0	0.0	0.0	3.3	10.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	29.4	0.0	32.9	0.0	0.0	0.0	6.6	1.4	0.0	0.0	5.5	12.5
LnGrp LOS	C	A	C	A	A	A	A	A	A	A	A	B
Approach Vol, veh/h		65			0			517			1410	
Approach Delay, s/veh		31.4			0.0			4.3			10.0	
Approach LOS		C						A			A	

Timer - Assigned Phs		2		4	5	6		8				
Phs Duration (G+Y+Rc), s		56.1		7.9	9.9	46.2		7.9				
Change Period (Y+Rc), s		4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s		92.9		18.1	15.0	73.4		18.1				
Max Q Clear Time (g_c+I1), s		3.8		3.4	4.8	33.1		0.0				
Green Ext Time (p_c), s		1.3		0.1	0.6	8.7		0.0				

Intersection Summary												
HCM 6th Ctrl Delay			9.2									
HCM 6th LOS			A									

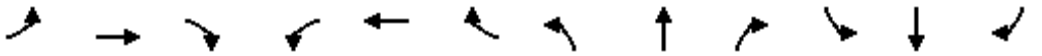


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	709	0	181	0	0	0	101	643	0	0	256	24
Future Volume (veh/h)	709	0	181	0	0	0	101	643	0	0	256	24
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	739	0	189	0	0	0	105	670	0	0	267	25
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	915	0	740	0	873	0	393	772	0	0	547	456
Arrive On Green	0.47	0.00	0.47	0.00	0.00	0.00	0.06	0.41	0.00	0.00	0.29	0.29
Sat Flow, veh/h	1753	0	1585	0	1870	0	1781	1870	0	0	1870	1560
Grp Volume(v), veh/h	739	0	189	0	0	0	105	670	0	0	267	25
Grp Sat Flow(s),veh/h/ln	1753	0	1585	0	1870	0	1781	1870	0	0	1870	1560
Q Serve(g_s), s	29.0	0.0	5.4	0.0	0.0	0.0	2.9	24.4	0.0	0.0	8.8	0.9
Cycle Q Clear(g_c), s	29.0	0.0	5.4	0.0	0.0	0.0	2.9	24.4	0.0	0.0	8.8	0.9
Prop In Lane	1.00		1.00	0.00		0.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h	915	0	740	0	873	0	393	772	0	0	547	456
V/C Ratio(X)	0.81	0.00	0.26	0.00	0.00	0.00	0.27	0.87	0.00	0.00	0.49	0.05
Avail Cap(c_a), veh/h	1756	0	1500	0	1770	0	447	1268	0	0	987	823
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	18.3	0.0	12.0	0.0	0.0	0.0	16.1	20.0	0.0	0.0	21.7	18.9
Incr Delay (d2), s/veh	1.8	0.0	0.2	0.0	0.0	0.0	0.4	3.8	0.0	0.0	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	15.2	0.0	3.0	0.0	0.0	0.0	1.9	14.9	0.0	0.0	6.4	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.1	0.0	12.2	0.0	0.0	0.0	16.5	23.8	0.0	0.0	22.4	19.0
LnGrp LOS	C	A	B	A	A	A	B	C	A	A	C	B
Approach Vol, veh/h		928			0			775			292	
Approach Delay, s/veh		18.5			0.0			22.8			22.1	
Approach LOS		B						C			C	

Timer - Assigned Phs		2		4	5	6		8				
Phs Duration (G+Y+Rc), s		35.2		39.3	8.9	26.3		39.3				
Change Period (Y+Rc), s		4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s		50.5		70.5	6.7	39.3		70.5				
Max Q Clear Time (g_c+I1), s		26.4		31.0	4.9	10.8		0.0				
Green Ext Time (p_c), s		4.3		3.8	0.0	1.5		0.0				

Intersection Summary												
HCM 6th Ctrl Delay			20.7									
HCM 6th LOS			C									

APPENDIX C
2028 BUILD INTERSECTION CAPACITY ANALYSIS



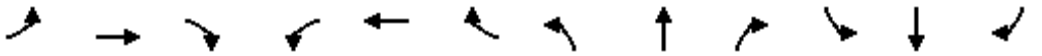
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	27	2	36	2	5	2	275	226	2	1	487	881
Future Volume (veh/h)	27	2	36	2	5	2	275	226	2	1	487	881
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	39	2	0	2	6	2	312	256	2	1	502	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	148	105		5	21	7	554	1836	14	575	664	
Arrive On Green	0.04	0.06	0.00	0.00	0.02	0.02	0.15	0.51	0.51	0.00	0.36	0.00
Sat Flow, veh/h	3401	1870	1585	1781	1342	447	1781	3614	28	1781	1870	1560
Grp Volume(v), veh/h	39	2	0	2	0	8	312	126	132	1	502	0
Grp Sat Flow(s),veh/h/ln	1700	1870	1585	1781	0	1790	1781	1777	1865	1781	1870	1560
Q Serve(g_s), s	0.5	0.0	0.0	0.0	0.0	0.2	3.9	1.6	1.6	0.0	9.9	0.0
Cycle Q Clear(g_c), s	0.5	0.0	0.0	0.0	0.0	0.2	3.9	1.6	1.6	0.0	9.9	0.0
Prop In Lane	1.00		1.00	1.00		0.25	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	148	105		5	0	28	554	903	948	575	664	
V/C Ratio(X)	0.26	0.02		0.41	0.00	0.29	0.56	0.14	0.14	0.00	0.76	
Avail Cap(c_a), veh/h	2405	1906		214	0	772	1026	2109	2213	784	1659	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	19.3	18.6	0.0	20.8	0.0	20.3	7.5	5.4	5.4	8.6	11.9	0.0
Incr Delay (d2), s/veh	0.9	0.1	0.0	46.8	0.0	5.5	0.9	0.1	0.1	0.0	1.8	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	0.3	0.0	0.0	0.1	0.0	0.2	1.3	0.5	0.6	0.0	5.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.2	18.7	0.0	67.5	0.0	25.8	8.4	5.5	5.5	8.6	13.6	0.0
LnGrp LOS	C	B		E	A	C	A	A	A	A	B	
Approach Vol, veh/h		41	A		10			570			503	A
Approach Delay, s/veh		20.2			34.2			7.1			13.6	
Approach LOS		C			C			A			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	4.6	25.7	4.6	6.9	10.9	19.3	6.3	5.1
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	49.5	5.0	42.5	17.5	37.0	29.5	18.0
Max Q Clear Time (g_c+I1), s	2.0	3.6	2.0	2.0	5.9	11.9	2.5	2.2
Green Ext Time (p_c), s	0.0	1.4	0.0	0.0	0.7	2.9	0.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	10.7
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	709	2	181	2	5	2	101	643	2	1	256	24
Future Volume (veh/h)	709	2	181	2	5	2	101	643	2	1	256	24
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	812	2	0	2	6	2	116	737	2	1	293	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	1078	616		5	21	7	377	1107	3	240	422	
Arrive On Green	0.32	0.33	0.00	0.00	0.02	0.02	0.08	0.30	0.30	0.00	0.23	0.00
Sat Flow, veh/h	3401	1870	1585	1781	1342	447	1781	3636	10	1781	1870	1560
Grp Volume(v), veh/h	812	2	0	2	0	8	116	360	379	1	293	0
Grp Sat Flow(s),veh/h/ln	1700	1870	1585	1781	0	1790	1781	1777	1869	1781	1870	1560
Q Serve(g_s), s	10.7	0.0	0.0	0.1	0.0	0.2	2.3	8.8	8.8	0.0	7.2	0.0
Cycle Q Clear(g_c), s	10.7	0.0	0.0	0.1	0.0	0.2	2.3	8.8	8.8	0.0	7.2	0.0
Prop In Lane	1.00		1.00	1.00		0.25	1.00		0.01	1.00		1.00
Lane Grp Cap(c), veh/h	1078	616		5	0	27	377	541	569	240	422	
V/C Ratio(X)	0.75	0.00		0.41	0.00	0.29	0.31	0.67	0.67	0.00	0.69	
Avail Cap(c_a), veh/h	2700	1973		179	0	647	581	1410	1483	416	1308	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	15.3	11.2	0.0	24.8	0.0	24.2	12.6	15.1	15.1	15.1	17.7	0.0
Incr Delay (d2), s/veh	1.1	0.0	0.0	47.0	0.0	5.7	0.5	1.4	1.3	0.0	2.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	5.9	0.0	0.0	0.2	0.0	0.2	1.3	5.3	5.6	0.0	4.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.3	11.2	0.0	71.8	0.0	29.9	13.1	16.5	16.4	15.1	19.7	0.0
LnGrp LOS	B	B		E	A	C	B	B	B	B	B	
Approach Vol, veh/h		814	A		10			855			294	A
Approach Delay, s/veh		16.3			38.3			16.0			19.7	
Approach LOS		B			D			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	4.6	19.7	4.6	20.9	8.5	15.7	20.3	5.3
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	39.5	5.0	52.5	9.7	34.8	39.5	18.0
Max Q Clear Time (g_c+I1), s	2.0	10.8	2.1	2.0	4.3	9.2	12.7	2.2
Green Ext Time (p_c), s	0.0	4.4	0.0	0.0	0.1	1.5	3.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	16.8
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX D
2038 BUILD INTERSECTION CAPACITY ANALYSIS

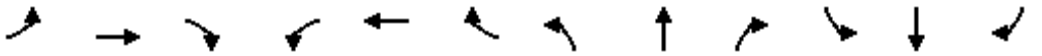
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	27	2	36	2	5	2	275	226	2	1	487	881
Future Volume (veh/h)	27	2	36	2	5	2	275	226	2	1	487	881
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	34	3	0	3	6	3	346	284	3	1	613	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	130	99		7	22	11	523	2020	21	604	767	
Arrive On Green	0.04	0.05	0.00	0.00	0.02	0.02	0.15	0.56	0.56	0.00	0.41	0.00
Sat Flow, veh/h	3401	1870	1585	1781	1176	588	1781	3602	38	1781	1870	1560
Grp Volume(v), veh/h	34	3	0	3	0	9	346	140	147	1	613	0
Grp Sat Flow(s),veh/h/ln	1700	1870	1585	1781	0	1764	1781	1777	1864	1781	1870	1560
Q Serve(g_s), s	0.5	0.1	0.0	0.1	0.0	0.2	4.5	1.8	1.8	0.0	13.6	0.0
Cycle Q Clear(g_c), s	0.5	0.1	0.0	0.1	0.0	0.2	4.5	1.8	1.8	0.0	13.6	0.0
Prop In Lane	1.00		1.00	1.00		0.33	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	130	99		7	0	33	523	997	1045	604	767	
V/C Ratio(X)	0.26	0.03		0.41	0.00	0.27	0.66	0.14	0.14	0.00	0.80	
Avail Cap(c_a), veh/h	1964	1594		188	0	672	914	1943	2038	788	1547	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.1	21.2	0.0	23.5	0.0	22.9	8.6	4.9	4.9	8.2	12.2	0.0
Incr Delay (d2), s/veh	1.1	0.1	0.0	33.3	0.0	4.3	1.4	0.1	0.1	0.0	2.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	0.3	0.1	0.0	0.2	0.0	0.2	1.6	0.6	0.7	0.0	7.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.2	21.4	0.0	56.8	0.0	27.1	10.0	5.0	5.0	8.2	14.2	0.0
LnGrp LOS	C	C		E	A	C	B	A	A	A	B	
Approach Vol, veh/h		37	A		12			633			614	A
Approach Delay, s/veh		23.0			34.5			7.8			14.2	
Approach LOS		C			C			A			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	4.6	31.0	4.7	7.0	11.7	23.9	6.3	5.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	51.7	5.0	40.3	17.6	39.1	27.3	18.0
Max Q Clear Time (g_c+I1), s	2.0	3.8	2.1	2.1	6.5	15.6	2.5	2.2
Green Ext Time (p_c), s	0.0	1.5	0.0	0.0	0.8	3.8	0.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	11.5
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	709	2	181	2	5	2	101	643	2	1	256	24
Future Volume (veh/h)	709	2	181	2	5	2	101	643	2	1	256	24
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1841
Adj Flow Rate, veh/h	901	3	0	3	6	3	128	817	3	1	325	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	2	2	2	2	2	2	2	4
Cap, veh/h	1148	658		7	22	11	357	1163	4	214	457	
Arrive On Green	0.34	0.35	0.00	0.00	0.02	0.02	0.08	0.32	0.32	0.00	0.24	0.00
Sat Flow, veh/h	3401	1870	1585	1781	1176	588	1781	3631	13	1781	1870	1560
Grp Volume(v), veh/h	901	3	0	3	0	9	128	400	420	1	325	0
Grp Sat Flow(s),veh/h/ln	1700	1870	1585	1781	0	1764	1781	1777	1868	1781	1870	1560
Q Serve(g_s), s	13.3	0.1	0.0	0.1	0.0	0.3	2.8	11.0	11.0	0.0	8.9	0.0
Cycle Q Clear(g_c), s	13.3	0.1	0.0	0.1	0.0	0.3	2.8	11.0	11.0	0.0	8.9	0.0
Prop In Lane	1.00		1.00	1.00		0.33	1.00		0.01	1.00		1.00
Lane Grp Cap(c), veh/h	1148	658		7	0	33	357	569	598	214	457	
V/C Ratio(X)	0.78	0.00		0.41	0.00	0.27	0.36	0.70	0.70	0.00	0.71	
Avail Cap(c_a), veh/h	2467	1792		160	0	569	490	1225	1288	370	1172	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	16.7	11.7	0.0	27.7	0.0	27.0	13.8	16.6	16.6	16.3	19.3	0.0
Incr Delay (d2), s/veh	1.2	0.0	0.0	33.6	0.0	4.4	0.6	1.6	1.5	0.0	2.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	7.7	0.0	0.0	0.2	0.0	0.3	1.7	6.9	7.3	0.0	6.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	17.9	11.7	0.0	61.3	0.0	31.5	14.4	18.2	18.2	16.3	21.4	0.0
LnGrp LOS	B	B		E	A	C	B	B	B	B	C	
Approach Vol, veh/h		904	A		12			948			326	A
Approach Delay, s/veh		17.9			38.9			17.7			21.3	
Approach LOS		B			D			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	4.6	22.4	4.7	24.2	8.8	18.1	23.3	5.5
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	38.5	5.0	53.5	8.5	35.0	40.5	18.0
Max Q Clear Time (g_c+I1), s	2.0	13.0	2.1	2.1	4.8	10.9	15.3	2.3
Green Ext Time (p_c), s	0.0	4.9	0.0	0.0	0.1	1.7	3.5	0.0

Intersection Summary	
HCM 6th Ctrl Delay	18.4
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCS7 Freeway Merge Report

Project Information

Analyst	EJW	Date	10/2/2018
Agency	BHI	Analysis Year	2016
Jurisdiction	LANL	Time Period Analyzed	2016 AM Peak
Project Description	NM 4 / East Jemez Road Westbound Merge		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	45.0	25.0
Segment Length (L) / Acceleration Length (L_A), ft	500	270
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i), veh/h	452	881
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	0.00	10.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	1.000	0.909
Flow Rate (v_i), pc/h	481	1031
Capacity (c), pc/h	3800	1900
Volume-to-Capacity Ratio (v/c)	0.40	0.54

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	15.2
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.325
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	44.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	481	Ramp Junction Speed (S), mi/h	44.0
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	1512	Average Density (D), pc/mi/ln	17.2
Level of Service (LOS)	B		

Attachment A

HCS7 Freeway Merge Report

Project Information

Analyst	EJW	Date	10/2/2018
Agency	BHI	Analysis Year	2038
Jurisdiction	LANL	Time Period Analyzed	2016 AM Peak
Project Description	NM 4 / East Jemez Road Westbound Merge		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	45.0	25.0
Segment Length (L) / Acceleration Length (L_A), ft	500	270
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (V_i), veh/h	563	1097
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	0.00	10.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	1.000	0.909
Flow Rate (v_i), pc/h	599	1284
Capacity (c), pc/h	3800	1900
Volume-to-Capacity Ratio (v/c)	0.50	0.68

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	18.0
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.333
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	44.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	599	Ramp Junction Speed (S), mi/h	44.0
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	1883	Average Density (D), pc/mi/ln	21.4
Level of Service (LOS)	B		

Attachment A

HCS7 Freeway Weaving Report

Project Information

Analyst	EJW	Date	10/2/2018
Agency	BHI	Analysis Year	2016
Jurisdiction	LANL	Time Period Analyzed	0216 AM Peak
Project Description	NM 4 / East Jemez Intersection Improvements		

Geometric Data

Number of Lanes (N), ln	2	Segment Type	Highway/CD Roadway
Short Length (L_S), ft	270	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.10	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	452	881	0	0
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	0.00	10.00	0.00	0.00
Heavy Vehicle Adjustment Factor (f_{HV})	1.000	0.909	1.000	1.000
Flow Rate (v_i), pc/h	481	1031	0	0

Weaving Flow Rate (v_w), pc/h	1031	Freeway Max Capacity (c_{IFL}), pc/h/ln	2200
Non-Weaving Flow Rate (v_{NW}), pc/h	481	Density-Based Capacity (c_{IWL}), pc/h/ln	1453
Total Flow Rate (v), pc/h	1512	Demand Flow-Based Capacity (c_{IW}), pc/h	3519
Volume Ratio (VR)	0.682	Weaving Segment Capacity (c_W), veh/h	2906
Minimum Lane Change Rate (LC_{MIN}), lc/h	1031	Adjusted Weaving Area Capacity, pc/h	3098
Maximum Weaving Length (L_{MAX}), ft	10030	Volume-to-Capacity Ratio (v/c)	0.49

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	1	Average Weaving Speed (S_W), mi/h	33.2
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	0	Average Non-Weaving Speed (S_{NW}), mi/h	33.9
Weaving Lane Change Rate (LC_W), lc/h	1031	Average Speed (S), mi/h	33.4
Total Lane Change Rate (LC_{All}), lc/h	1031	Density (D), pc/mi/ln	22.6
Weaving Intensity Factor (W)	0.650	Level of Service (LOS)	B

HCS7 Freeway Weaving Report

Project Information

Analyst	EJW	Date	10/2/2018
Agency	BHI	Analysis Year	2040
Jurisdiction	LANL	Time Period Analyzed	2040 AM Peak (25% growth)
Project Description	NM 4 / East Jemez Intersection Improvements		

Geometric Data

Number of Lanes (N), ln	2	Segment Type	Highway/CD Roadway
Short Length (L_S), ft	270	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	0
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	0.10	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	563	1097	0	0
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	0.00	10.00	0.00	0.00
Heavy Vehicle Adjustment Factor (f_{HV})	1.000	0.909	1.000	1.000
Flow Rate (v_i), pc/h	599	1284	0	0

Weaving Flow Rate (v_w), pc/h	1284	Freeway Max Capacity (c_{IFL}), pc/h/ln	2200
Non-Weaving Flow Rate (v_{NW}), pc/h	599	Density-Based Capacity (c_{IWL}), pc/h/ln	1453
Total Flow Rate (v), pc/h	1883	Demand Flow-Based Capacity (c_{IW}), pc/h	3519
Volume Ratio (VR)	0.682	Weaving Segment Capacity (c_W), veh/h	2906
Minimum Lane Change Rate (LC_{MIN}), lc/h	1284	Adjusted Weaving Area Capacity, pc/h	3099
Maximum Weaving Length (L_{MAX}), ft	10030	Volume-to-Capacity Ratio (v/c)	0.61

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	2	Average Weaving Speed (S_W), mi/h	31.9
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	0	Average Non-Weaving Speed (S_{NW}), mi/h	31.2
Weaving Lane Change Rate (LC_W), lc/h	1284	Average Speed (S), mi/h	31.7
Total Lane Change Rate (LC_{All}), lc/h	1284	Density (D), pc/mi/ln	29.7
Weaving Intensity Factor (W)	0.773	Level of Service (LOS)	C

APPENDIX E
CONSTRUCTION COST ESTIMATES

9/26/2018
US CORP OF ARMY ENGINEERS
EAST JEMEZ RD/NM4 INTERSECTION MPROVEMENTS, LOS ALAMOS COUNTY

STUDY- ESTIMATE PROBABLE CONSTRUCTION COST

CONTRACT ITEM NO.	CONTRACT ITEM	UNIT	UNIT BID PRICE	OPTION 1		OPTION 2		OPTION 3		OPTION 4		OPTION 5	
				QTY	TOTAL	QTY	TOTAL	QTY	TOTAL	QTY	TOTAL	QTY	TOTAL
201000	CLEARING AND GRUBBING	L S	$14,700.00	1	$20,000.00	1	$20,000.00	1	$20,000.00	1	$20,000.00	1	$20,000.00
203100	BORROW	CY	$30.00	3,790.00	$113,700.00	2,165.00	$64,950.00	2,165.00	$64,950.00	2,165.00	$64,950.00	2,165.00	$64,950.00
207000	SUBGRADE PREPARATION	SY	$3.00	29,400.00	$88,200.00	25,600.00	$76,800.00	25,800.00	$77,400.00	22,000.00	$66,000.00	22,700.00	$68,100.00
303000	BASE COURSE	TON	$30.00	9,300.00	$279,000.00	8,100.00	$243,000.00	8,200.00	$246,000.00	7,000.00	$210,000.00	7,200.00	$216,000.00
403700	OPEN GRADED FRICTION COURSE COMPLETE	TON	$99.00	917.00	$90,783.00	800.00	$79,200.00	804.00	$79,596.00	686.00	$67,914.00	709.00	$70,191.00
407000	TACK COAT MATERIAL	TON	$830.00	10.00	$8,300.00	9.00	$7,470.00	9.00	$7,470.00	8.00	$6,640.00	8.00	$6,640.00
408100	PRIME COAT	TON	$700.00	56.00	$39,200.00	48.00	$33,600.00	49.00	$34,300.00	42.00	$29,400.00	43.00	$30,100.00
423282	HMA SP III COMPLETE	TON	$112.00	10,400.00	$1,164,800.00	9,100.00	$1,019,200.00	9,100.00	$1,019,200.00	7,800.00	$873,600.00	8,000.00	$896,000.00
570024	24" CULVERT PIPE	LF	$120.00	110.00	$13,200.00	110.00	$13,200.00	110.00	$13,200.00	110.00	$13,200.00	110.00	$13,200.00
570025	24" CULVERT PIPE END SECTION	LF	$761.00	1	$761.00	1	$761.00	1	$761.00	1	$761.00	1	$761.00
601000	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L S	$35,000.00	1	$35,000.00	1	$35,000.00	1	$35,000.00	1	$35,000.00	1	$35,000.00
601110	REMOVAL OF SURFACING	SY	$6.00	17,994.33	$107,966.00	16,553.52	$99,321.13	16,833.74	$101,002.47	14,812.78	$88,876.67	14,812.78	$88,876.67
603281	SWPPP PLAN PREPARATION AND MAINTENANCE	L S	$5,000.00	1	$5,000.00	1	$5,000.00	1	$5,000.00	1	$5,000.00	1	$5,000.00
606001	SINGLE FACE W-BEAM GUARDRAIL	LF	$35.00	1,346.00	$47,110.00	1,346.00	$47,110.00	1,346.00	$47,110.00	1,346.00	$47,110.00	1,346.00	$47,110.00
606052	END TREATMENT TL-3 END TERMINAL	EACH	$2,500.00	2.00	$5,000.00	2.00	$5,000.00	2.00	$5,000.00	2.00	$5,000.00	2.00	$5,000.00
606053	END TREATMENT W-BEAM END ANCHOR	EACH	$1,200.00	3.00	$3,600.00	3.00	$3,600.00	3.00	$3,600.00	3.00	$3,600.00	3.00	$3,600.00
606055	END TREATMENT DRIVEWAY END ANCHOR	EACH	$1,387.50	1	$1,387.50	1	$1,387.50	1	$1,387.50	1	$1,387.50	1	$1,387.50
606061	DRAINAGE STRUCTURE PROTECTION SYSTEM	LF	$45.00	187.50	$8,437.50	187.50	$8,437.50	187.50	$8,437.50	187.50	$8,437.50	187.50	$8,437.50
607200	REMOVE AND REBUILD BARBED WIRE FENCE	LF	$3.60	500.00	$1,800.00	500.00	$1,800.00	500.00	$1,800.00	500.00	$1,800.00	500.00	$1,800.00
608204	CONCRETE MEDIAN PAVEMENT 4"	SY	$65.00	399.78	$25,985.56	443.33	$28,816.67	401.67	$26,108.33	401.67	$26,108.33	401.67	$26,108.33
609318	CONCRETE SLOPED CURB AND GUTTER 6" X 18"	LF	$13.00	400.00	$5,200.00	441.00	$5,733.00	408.00	$5,304.00	407.00	$5,291.00	407.00	$5,291.00
609330	CONCRETE SLOPED CURB AND GUTTER 6" X 30"	LF	$22.00	366.00	$8,052.00	380.00	$8,360.00	387.00	$8,514.00	387.00	$8,514.00	387.00	$8,514.00
618000	TRAFFIC CONTROL MANAGEMENT	L S	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00	1	$25,000.00
621000	MOBILIZATION	L S	$240,000.00	1	$240,000.00	1	$240,000.00	1	$240,000.00	1	$240,000.00	1	$240,000.00
623011	MEDIAN DROP INLET TYPE I (RURAL) H=0'0" TO 3'0"	EACH	$5,385.75	1	$5,385.75	1	$5,385.75	1	$5,385.75	1	$5,385.75	1	$5,385.75
701030	REMOVE AND RESET PANEL SIGN	EACH	$130.91	21.00	$2,749.11	21.00	$2,749.11	21.00	$2,749.11	21.00	$2,749.11	21.00	$2,749.11
702810	TRAFFIC CONTROL DEVICES FOR CONSTRUCTION	LS	$50,000.00	1	$50,000.00	1	$50,000.00	1	$50,000.00	1	$50,000.00	1	$50,000.00
704000	RETROREFLECTORIZED PAINTED MARKINGS 4"	LF	$0.24	80,148.00	$19,235.52	77,418.00	$18,580.32	75,675.00	$18,162.00	65,706.00	$15,769.44	67,938.00	$16,305.12
715015	REMOVE AND RESET TRAFFIC WARNING ASSEMBLY	EACH	$698.00	1	$698.00	1	$698.00	1	$698.00	1	$698.00	1	$698.00
716XXX	TRAFFIC SIGNAL/LIGHTING COMPLETE	LS	$300,000.00	1	$300,000.00	1	$300,000.00	1	$300,000.00	1	$300,000.00	1	$300,000.00
801000	CONSTRUCTION STAKING BY THE CONTRACTOR	LS	$36,000.00	1	$36,000.00	1	$32,000.00	1	$32,000.00	1	$29,000.00	1	$29,000.00
5712XX	18.25'SX7.5'R STRUCTURAL PIPE ARCH	LF	$1,200.00	55.00	$66,000.00	32.00	$38,400.00	36.00	$43,200.00	36.00	$43,200.00	36.00	$43,200.00
XXXX	UTILITY RELOCATES (ALLOWANCE)	LS	$250,000.00	1	$250,000.00	1	$250,000.00	1	$250,000.00	1	$250,000.00	1	$250,000.00
	SUBTOTAL				$3,067,550.94		$2,770,559.98		$2,778,335.66		$2,550,392.30		$2,584,404.98
	MISCELLANEOUS ITEMS- 30%				$920,265.28		$831,167.99		$833,500.70		$765,117.69		$775,321.49
	NEW MEXICO GROSS RECIEPTS TAX 7.125%				$284,131.91		$256,623.12		$257,343.34		$236,230.09		$239,380.51
	TOTAL				$4,271,948.12		$3,858,351.09		$3,869,179.70		$3,551,740.08		$3,599,106.99
	USE				$4,280,000.00		$3,860,000.00		$3,870,000.00		$3,560,000.00		$3,600,000.00

This estimate of construction cost is only an opinion. BHI cannot & does not guarantee that proposals, bids, or actual Construction Costs will not vary from this opinion. Unit bid prices were obtained from recent project information provided by LANL and LAC. NMDOT Unit Bid Prices were used where that data was not available.

Items that may effect this estimate are potential time of day restrictions, night work and LANL permitting requirements.