McKay Lake/Lambertson Farms Open Lands Traffic Study

1 Introduction

1.1 Purpose

Open lands facilities that provide public recreation and educational opportunities through amenities such as park, trail and environmental enhancements serve to improve the quality of life of a community. One such endeavor is the McKay Lake/Lambertson Farms Open Lands Phase 1 Master Plan (Phase I Plan).

This traffic study is being prepared for the City and County of Broomfield (Broomfield) as part of the Phase I Plan, with the goal to assess the traffic impacts related to a proposed multipurpose recreational and educational facility. The three primary purposes of this study are:

- Identify and assess traffic generated by the proposed development
- Recommend mitigation measures, as necessary, for any roadway deficiencies caused by the traffic generated by this development
- Assess parking needs based on existing and proposed site usage

This study report is organized to present the following information:

Section 1. Introduction – This section provides the study outline and describes the existing site and the proposed development, including site accessibility options.

Section 2. Analysis Methodology – This section describes the methodology and standards used to assess traffic impacts.

Section 3. Existing Area Conditions – This section describes the existing site conditions, roadway network and traffic conditions.

Section 4. Projected Traffic – This section provides information on comparable sites, the proposed site's trip generation, trip distribution and trip assignment along with background traffic growth rates and future demand.

Section 5. Transportation Analysis – This section assesses the impact of the traffic generated by the project site on the surrounding transportation network.

Parking Analysis – An analysis of the proposed parking requirements.

Section 6. Recommendations– A summary of recommended site parking and roadway improvements, if any, are provided.

1.2 Project Location

The McKay Lake/Lambertson Farms Open Lands site is located between W. 136th Avenue and W. 144th Avenue and lies adjacent to Zuni Street. A 43.8 acre undeveloped open lands parcel, this location is being studied as part of the McKay Lake Regional Park with prime goals of park improvements, public recreation opportunities, and open lands preservation. **Figure 1-1** below shows the location of the project site from a regional perspective (**Figure 3-1** shows the study area details).

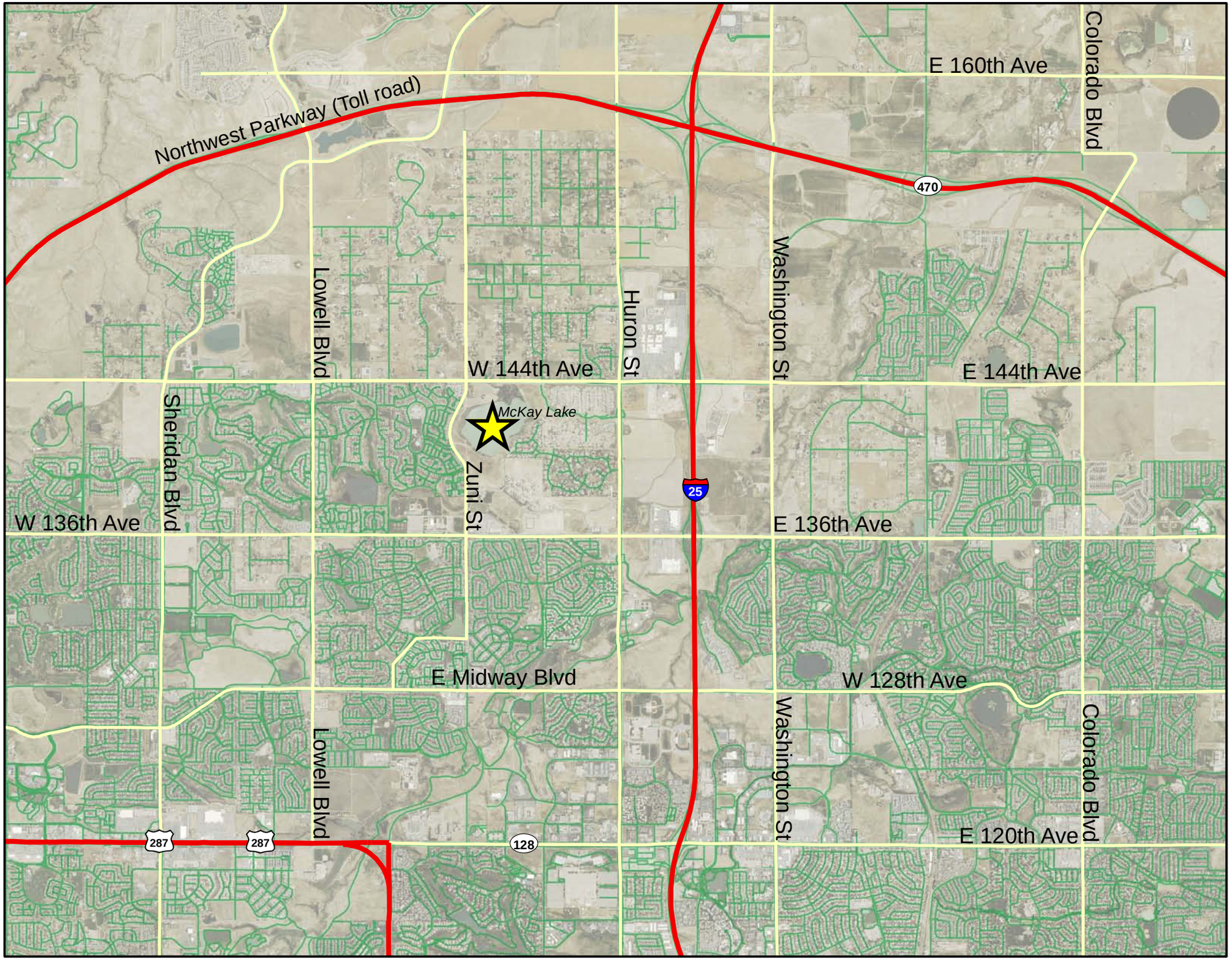

Figure 1-1: Project Location

Legend

Project Location

N
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0 0.2 0.4 0.8 1.2 1.6 Miles

1.3 Site Plan

The proposed site layout follows the McKay Lake's western and southern edge – adjacent to Zuni St, and approximately 675 ft north of W. 138th Ave. The core of the fitness and adventure facilities lie along the southern end, while the bike park and lake overview lie further north along Zuni St.

1.4 Site Accessibility

The site accesses being considered (shown in **Figure 1-2**) as part of this master plan are:

Option 1. Quail Creek Drive intersection: This access would allow patrons direct access from Zuni St at the existing (three-legged) Quail Creek Drive intersection. The site access would serve as the fourth leg of this intersection. Two design considerations at this location are: a two-way-stop-controlled (TWSC) intersection and a roundabout.

Option 2. W. 138th Ave: An access off of W. 138th Ave has also been considered. W. 138th Ave runs east-west between Zuni St. and Huron St. and serves as an access to parks and residential neighborhoods.

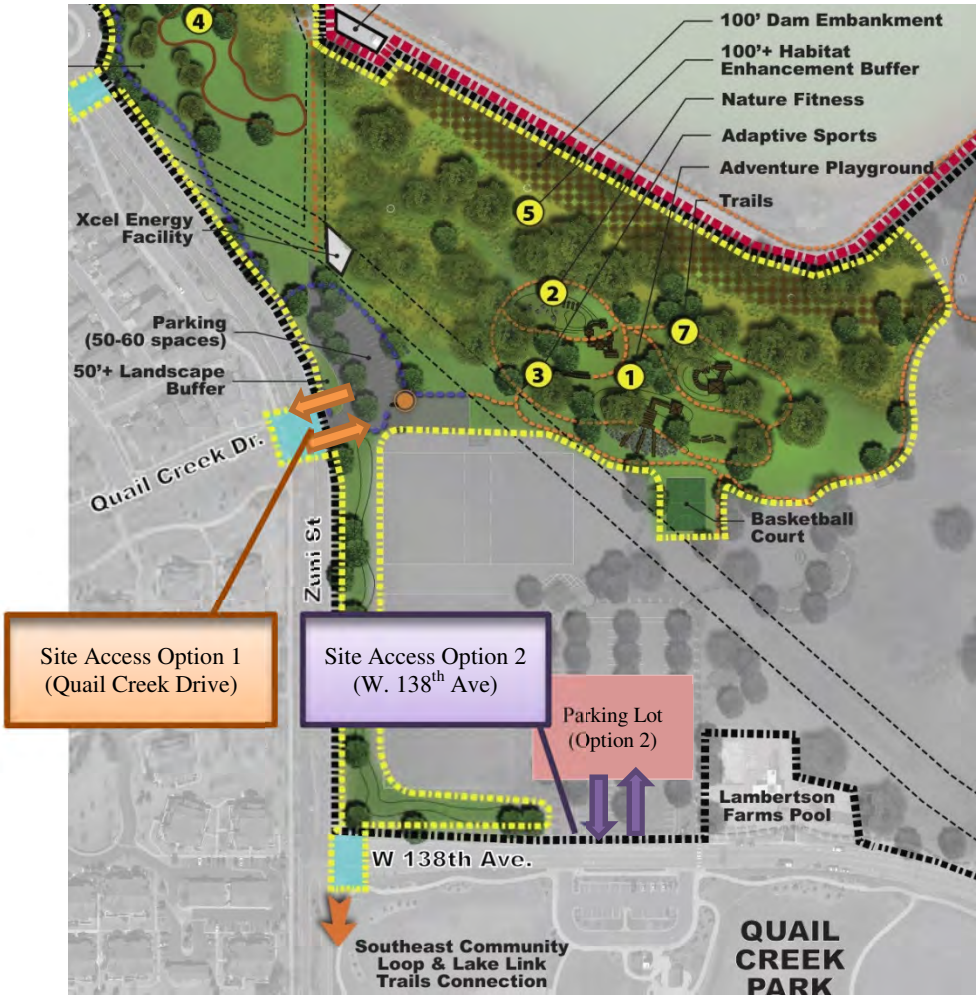


Figure 1-2: Site Access Options

1.4.1 Roundabout at Quail Creek Drive

A TWSC intersection is expected to operate effectively at the site access. However, a roundabout at this location would help in reducing delay for the minor street/parking lot access; in providing a certain level of traffic calming; and in improving aesthetics. A planning level assessment of the roundabout at Quail Creek Drive looked into the type of roundabout that should be used, design vehicle considerations, capacity requirements, land availability and entry speeds.

- Type of Roundabout: The type of roundabout recommended for this location is an Urban Compact Roundabout. A Mini-Roundabout might also be considered but careful considerations need to be given to the characteristics of Zuni St, driver expectancy and the fact that the 85th speed on Zuni St is greater than those recommended for a mini-roundabout.
- Design Vehicle: The design vehicles considered as part of this analysis were Single Unit Truck and Bus.
- Capacity Considerations: The City of Broomfield Transportation Plan projects a buildout AADT of 14-15K on Zuni St in the year 2030. A single lane roundabout can be expected to operate acceptably for a planning level peak hour estimate based on this AADT. (The sum of conflicting and entry volumes will be expected to be less than 1,000 vehicles per hour (vph), making a single land roundabout feasible. This estimate is based on FHWA's NCHRP Report 672.)
- Size of Roundabout: An inscribed diameter of 90 – 150 ft will be adequate for the design vehicle as well as the future demand. A 90' roundabout is recommended for this option.
- Land Availability: Based on CAD files received from Broomfield the ROW width along Zuni St at Quail Creek Drive is 80 ft to the south of the intersection and 100 ft to the north. A 90 ft inscribed roundabout could fit in this area, given that ROW will be required for the access to the parking long. However, it should be noted that the roundabout will potentially impact the storm sewer system along Zuni St as well as the pedestrian facilities near the intersection.

1.4.2 Access from W. 138th St

As an alternative to a Zuni St access, a W. 138th St access has also been considered (**Figure 1-2**). An access at this location would have the following characteristics:

- There seem to be two access stub-outs across from the Quails Creek Park parking lot. These could be used to provide access to a parking lot.
- A parking lot adjacent to W. 138th St might have some detrimental impact on site usage since the proposed facilities would be a 500 ft walking distance from the lot.
- If a parking lot were to be provide closer to the Phase 1 site, it could be placed midway between the site and W. 138th Ave, just south of the utility easement. Considerations will have to be given to this easement (for the buried pipeline) during any future construction.
- A vehicle leaving the facility would have to stop at two TWSC intersections to access Zuni St, making the total delay comparable to an access on Zuni St.
- This configuration would require additional wayfinding signs due to its indirect site access.

Traffic operations implications of this access are discussed in Section 5.

1.5 Timing of Development

This report has considered the timing of the site development as follows:

- 2013 – Existing conditions
- 2015 – Opening year
- 2020 – Analysis horizon year

2 Analysis Methodology

The traffic impact analysis has been completed in accordance to ITE (Institute of Transportation Engineers) guidelines, and the traffic analysis completed as part of this study is in accordance to the HCM – *Highway Capacity Manual* , 2010 (Transportation Research Board, 2010).

This section describes the level of service (LOS) concept – a primary (qualitative) measure of congestion and quality of service – and how it is applied to a traffic impact study.

2.1 What is LOS?

As defined in the *HCM*, LOS is a letter grade corresponding to the amount of congestion a road has when completed to a standard. LOS A is the best or the least congested grade. LOS F indicates failure because the demand for a road is more than its capacity. LOS is measured differently for different road parts, such as unsignalized intersections, signalized intersections, highway lanes between intersections, freeways, and freeway ramps.

2.2 How is LOS determined for signalized and unsignalized intersections?

LOS for signalized and unsignalized intersections is determined based on the amount of delay cars experience going through the intersection. Delay is usually calculated separately for each turning movement or for each lane when that lane is shared by through and turning traffic. For signalized intersections, the average delay of all vehicles entering the intersection can also be calculated to give an overall LOS grade for the intersection.

The thresholds for finding LOS from delay are different between unsignalized and signalized intersections. Unsignalized intersections generally have lower traffic volumes, and drivers stopped at unsignalized intersections may get more anxious waiting for a break in traffic.

Figure 2-1 shows typical congestion levels associated with the delay of each LOS letter grade.

Intersection Based on Vehicle Seconds of Delay			
Delay Description	Level of Service	Signalized Intersection Seconds of Delay	Unsignalized Intersection Seconds of Delay
Minimal or no vehicle delay	A	≤ 10	≤ 10
Slight delay to vehicles	B	> 10 - 20	> 10 - 15
Moderate vehicle delays, traffic flow remains stable	C	> 20 - 35	> 15 - 25
More extensive delays at intersections	D	> 35 - 55	> 25 - 35
Long queues create lengthy delays	E	> 55 - 80	> 35 - 50
Severe delays and congestion	F	> 80	> 50

Figure 2-1: Characteristics of Intersection Level of Service

2.3 How does a traffic impact study apply LOS?

The goal of a traffic impact study is to determine potential impacts of the demand generated by a proposed development, on the surrounding transportation network. The study also recommends roadway improvements, if it is determined that the new demand generated has the potential to have a negative impact on the roadway network.

Demand generated by a site is usually viewed in terms of vehicles entering and leaving the site during peak hours (site and/or roadway peaks), and is combined with the background transportation network flows. The LOS methodology is applied to traffic flows resulting from the combination of these flows to estimate how well the transportation network functions, and whether any roadway/intersection improvements are warranted to maintain a certain minimum roadway quality of service.

2.4 How was the Study area determined?

The study area (**Figure 3-2**) was determined based on guidelines provided by ITE for the determination of the study area. The guidelines followed were a combination of the following:

- First signalized intersection on each street serving the site;
- Intersections where the newly generated traffic represents 5% or more of the roadway's peak hour capacity;
- Residential areas likely to be affected; and
- Professional judgment based on traffic engineering analysis.

It was determined that the traffic expected to be generated by the site warranted studying at most one signalized intersection on either side of the project access. Thus, the study area is **Zuni Street, from W. 144th Ave to the north to W. 136th Ave to the south**. It is not limited by the Broomfield/Adams county boundary, and was determined based on the areas impacted by the proposed development.

2.5 Site Trip Generation

This critical element of traffic impact studies estimates the potential traffic generated by a site's proposed development. The traffic generated is estimated in terms of trips – which is defined by ITE as *a single or one-directional travel movement with either the origin or designation of the trip inside the study site*. Traffic is usually estimated using trip generation rates or equations published by ITE. There are no ITE rates (or other State or Local data sources) for similar sites; therefore, it is proposed in this report to:

- Develop an estimate of the site's off-peak and peak usage based on site capacity and professional judgment; and
- Develop trip generation during a typical off-peak and peak hour based on this usage.

2.6 Parking Needs

Parking needs and required number parking spaces is based on providing adequate parking for all site-generated demands. The parking needs for this study were based on:

- The site usage by activity and duration (developed for each element of the proposed site).
- Assumption of parking occupancy before the peak hour. Inventory and occupancy of existing spaces was not available for this study; therefore, all vehicles entering during the hour before the peak hour are assumed to be the parking occupancy.
- No bike-ped or transit share was considered as part of this study. All traffic is considered to arrive at the site in vehicles that require a parking space.

3 Existing Area Conditions

3.1 Study Area Zoning and Land Use

Figure 3-1 below shows the project area zoning based on Broomfield data. The majority of land use is residential and is zoned PUD with some City/Exempt use for schools and open land. The project site is designated as Open Lands while Westminster's McKay Lake Regional Park is designated as

Open Space. The main developments in the vicinity include are McKay Landing, Lambertson Farms, Legacy High School, Meridian Elementary School and the Shops at Quail Creek commercial development.

3.2 Site Accessibility

3.2.1 Area Roadway System

The project area is served by several arterials and collectors; the key roadways in the study area are:

North-South Facilities

- Zuni Street: A two lane arterial between W. 144th Ave and W. 136th Ave, and a two lane connector to the north of W. 144th Ave. The speed limit on this segment of Zuni St. is 35 mph.
- I-25: A multi-modal regional interstate that serves as a major transportation corridor, lies approximately 1.6 miles to the east of the project site. The speed limit on I-25 in this area is 65 – 75 mph.

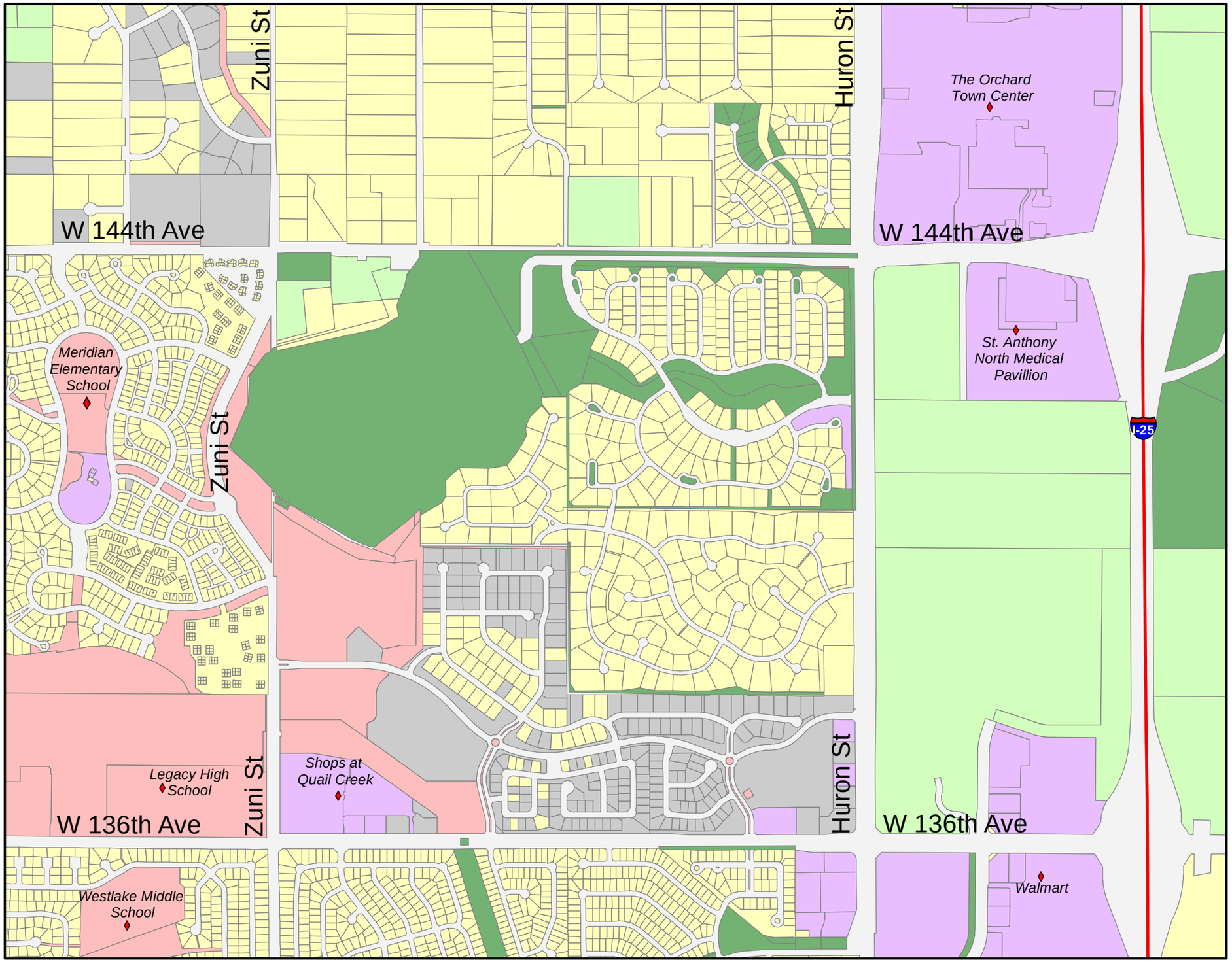
East-West Facilities

- West 144th Avenue: A major east-west arterial that lies north of the project site. It is a two lane facility with turn lanes to the west of Zuni Street and a four lane facility to the east. The speed limit on this facility in the vicinity of Zuni Street is 45 mph.
- West 136th Avenue: A major east-west arterial that lies to the south of the project site. It is also a two lane facility with turn lanes to the west of Zuni Street and a four lane facility to the east. It provides access to several developments such as the Legacy High School and the Shops at Quail Creek commercial development as well as residential developments to the south. . The speed limit on this facility, west of Zuni Street is 35 mph and to the east is 40 mph.

Key Intersections

The project area is located in an urban environment and the adjoining transportation network is associated with numerous unsignalized and signalized intersections. **Figure 3-2** shows the study area roadway network, including intersection configurations (number of through lanes, and permitted and exclusive turn lanes).

Figure 3-1: Project Area Land Use



Legend

- Agricultural
- Commercial
- Residential
- City/Exempt
- Vacant
- Public (Westminster)

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0 0.05 0.1 0.2 0.3 0.4

The (three) key intersections impacted by the proposed site development are:

i. *W. 144th Ave and Zuni St:* A signalized intersection with left and right turn lanes on all approaches except southbound Zuni St, which has no exclusive turn lanes.
ii. *Zuni St and Quail Creek Dr.:* An unsignalized intersection with the stop sign on Quail Creek Dr. This intersection is currently a three legged intersection and the proposed site access would serve as the fourth leg.
iii. *W. 136th Ave & Zuni St.*: A signalized intersection with pedestrian crossing on all four legs (as well as a school crossing). There are left and right turn lanes on each approach expect the eastbound W. 136th Ave approach, which provides only a left turn lane.

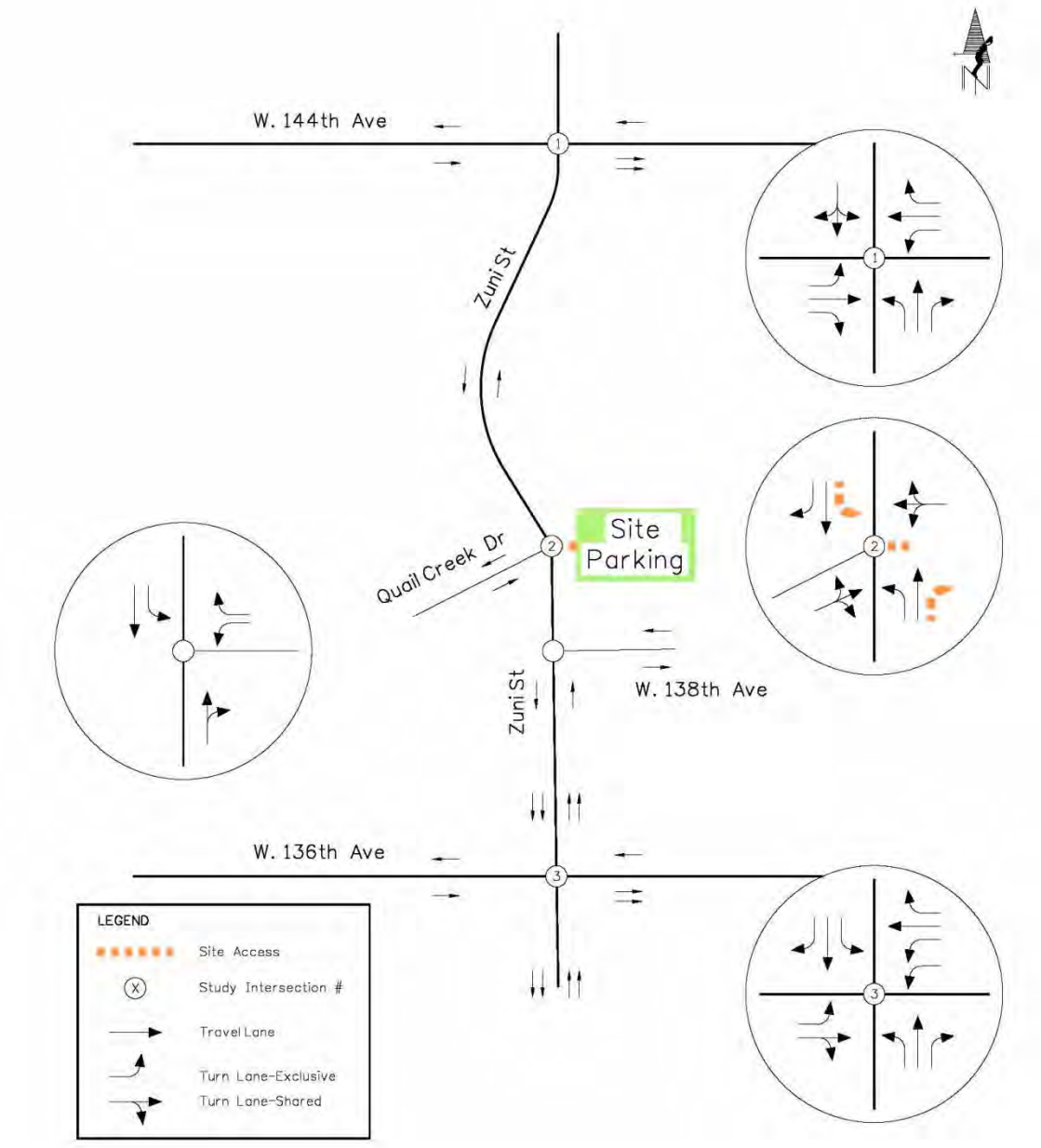

Figure 3-2: Study Area Lane Configuration

3.2.2 Existing Traffic Volumes and Level of Service (LOS)

The project proposes to provide a multitude of recreational opportunities to the community, and is expected to experience peak usage during the weekday evenings and Saturday mornings. Given that the maximum traffic impact is expected during the PM peak hour, this study has focused its analysis on the PM peak hour.

Table 3-1 below summarizes the traffic count data collected in 2013 by Broomfield.

Table 3-1: Existing Traffic Volumes (Year 2013)

Yr.	Int. #	Street Name		Eastbound			Westbound			Northbound			Southbound		
		Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
2013	1	144th Ave	Zuni St	19	729	114	50	457	13	89	27	78	18	18	8
	2	Zuni St	Quail Creek Dr	25	-	55	-	-	-	90	246	-	-	282	45
	3	136th Ave	Zuni St	42	447	125	171	385	91	50	203	154	71	137	130

Sources: City of Broomfield, DRCOG and McKay Landing Traffic Study

The LOS methodology, described briefly in Section 2, was applied to the two signalized and one unsignalized intersection impacted by the new site traffic in the study area. The source of traffic data used to analyze the existing peak hours were the Broomfield traffic counts as well data from a previously completed traffic impact study: McKay Landing Traffic Impact Study.

The intersections in the study area operate at a good LOS, and **Table 3-2** below provides a summary of the existing LOS during a typical week day evening peak hour. It should be noted that since an intersection LOS is not defined for an unsignalized intersection, the movement with the worst LOS is presented (in a lower case letter) for the Quail Creek Dr. and Zuni St. intersection.

Table 3-2: Current Intersection Delay and Level of Service

Year		Street Name		Average Delay (sec)	LOS
	Int. #	Mainline	Cross Street		
2013	1	144th Ave	Zuni St	13.1	B
	*2	Zuni St	Quail Creek Dr.	13.3	b
	3	136th Ave	Zuni St	12.3	B

** Unsignalized intersection (TWSC)*

4 Projected Traffic

4.1 Site Traffic

This master planning effort involves the development of an existing site as well as improvement of existing facilities such as trails. Due to the unique nature of the proposed site, the traffic generation rates are not available from ITE and have to be determined by site usage.

4.1.1 Project Trip Generation

Trip generation rates, as determined by ITE are based on empirical data, collected following published guidelines. These rates signify is the number trips generated by a site per hour (or day) based on an independent variable such as size of a facility. The project site's usage is unique and no published trip generation rates are available. Therefore, this study determined these rates based on an analytical approach involving a planning level estimate of usage, and expected activity duration for each program.

Section 4.1.2 documents comparable facility parking operations at regional park sites. The intent is to use case studies from existing facilities to provide rationale for the design decisions made at McKay Lake/Lambertson Farms Open Lands Master Plan. The facility descriptions take into account the size of similar facilities, the number of trails, community served, and number of intended users and the recreation opportunities offered at the site.

The parameters influencing the trip generation rate (in this study) are: number of patrons per activity (based on factors such as capacity of the site), activity duration of patrons (based on type of activity) and vehicular occupancy (number of patrons per vehicle).

A summary of the estimated peak site usage is shown below in **Table 4-1**.

Table 4-1: Proposed Site Usage

Activity Center	Peak Use Estimate (# patrons)		Activity Duration Estimate (min)		Avg. Veh. Occupancy (#users/veh)
	Low	High	Low	High	
Bike Park	15	20	45	90	2.0
Trails / Lake Overlook	6	8	30	60	2.0
Adventure Playground / Nature Fitness	12	15	20	45	2.0
Basketball Court	10	12	30	60	2.0

Note:
Peak use and activity duration based on planning level estimates of proposed facilities.
Avg. Veh. Occupancy based on FHWA's National Household Travel Survey data for Recreation/Social Trips

Table 4-2: Trip Generation based on High Peak Use Estimate

Activity Center	Peak Use Estimate (# patrons/hour)		Peak Use Estimate (# veh./hour)	
	Low (off-peak)	High (peak)	Low (off-peak)	High (peak)
Bike Park	10	27	5	14
Trails / Lake Overlook	6	16	3	8
Adventure Playground / Nature Fitness	16	45	8	23
Basketball Court	10	24	5	12
Total			**21**	**57**

4.1.2 Comparable Sites

Valmont Bike Park, Boulder, CO

Valmont Bike Park is a 40-acre facility within a 132-acre city park. The park is located within a metropolitan statistical area with a population of approximately 295,000 people, but mostly serves the approximately 100,000 City of Boulder populous. The park comprises 18 trails of varying difficulty, from beginner level obstacles to an advanced, elite level terrain park.

Valmont Bike Park has two parking lots on either side of the facility. A larger 102-space parking lot is shared with a dog park, and a smaller 44-space lot is designated entirely for bike park users. Both parking lots are only filled to capacity during special events and races, and typically, around 30%-50% of park users travel to the park by bike. 10 parking spaces for the first acre, and 3.5 parking spaces per additional acre of bike park has adequately served the facility, with 46 of those space being shared with dog park users. A more useful number to take into account is perhaps, an average of 8.1 parking spaces per trail.

McKay Lake/Lambertson Farms Bike Park is proposed to include 3-4 trails of varying difficulty from beginner level obstacles and a pump track to intermediate level terrain. The facility is proposed to be approximately 2.5 acres in size. A similar ratio of parking to acreage would assume that McKay Lake/Lambertson Farms Bike Park would only require 16 spaces. However, using 8.1 spaces per trail would require the bike park to provide at least 33 spaces.

Sandstone Ranch, Longmont, CO

Adventure Playground at Sandstone Ranch is a 67-acre community park and district park/nature preserve on 313 acres of land which is part of Longmont (Colorado) Parks and Open Space, of which 103 acres is considered park land. The park is located within a metropolitan statistical area with a population of approximately 295,000 people, but mostly serves the approximately 86,270 citizens in Longmont. The park, which is part of a historic ranch located along a stream, includes manufactured and natural amenities. Features include: Age Separate Play Areas, Custom Play Equipment, Sand Play, Water Play, Splash Pad, Climbing Wall, Wavy Walk, Boulder Labyrinth, and an Agri-Maze.

In addition to the Adventure Park, Sandstone Ranch Park has a visitors' center highlighting the historic aspects of the ranch, as well as four ball fields, six soccer fields, skate park and three shelters. There are a total of 250 parking spots within the 103 acres of developed park space. This is approximately 2.5 parking spots per park acre. The one large and three smaller parking lots are spread throughout the park and serve specific areas near each field, shelter and the visitor center. The parking requirements at Sandstone ranch would be greater than McKay Lake/Lambertson Farms given the more comprehensive recreation offerings and the park's remote location.

Bohn Park, Lyons, CO

Bohn Park offers a multitude of recreational opportunities including multi-use trails, baseball/softball fields, basketball court, multi-use soccer field, playground, bike park, community gardens, shelter facility/picnic areas, and an off-leash dog area. Bohn Park (40 acres) is located near downtown Lyons along St. Vrain Creek. The acreage of park space dedicated to recreation closely matches the amount proposed at McKay Lake/Lambertson Farms. The creek side location and trails network make Bohn Park a popular destination. Although the town's population is rather small (just over 2000), large numbers of tourists visit the community traveling to and from Rocky Mountain National Park.

Originally constructed for the Lyons Outdoor Games with the support and assistance of local businesses and volunteers, the Lyons Dirt Jump Bike Park (4 acres) is located at the south end of the park. The bike park's design allows riders of all skill sets to hone their skills on a facility that combines dirt jump riding, skills riding and a pump track. The Lyons Dirt Jump Bike Park includes natural terrain and materials (large portions of the park are constructed of stone) that mimic the local trails and terrain that riders will encounter on area and regional open spaces.

The park site includes 180 designated parking spaces in five parking lots ranging from 20 to 70 cars. The bike park provides parking for approximately 30 cars. Overflow parking is available in grass areas for large events. Due to the fact that Bohn Park is the Town's primary recreation and event space, parking is provided at a higher ratio (4.5 spaces per acre) than would be required at McKay Lake/Lambertson Farms.

Tony Grampsas Park, Golden, CO

Tony Grampsas Park is a 63-acre park located just east of downtown Golden between Clear Creek and North Table Mountain. The park includes ballfields, playgrounds, volleyball courts, picnic shelters, bike park and off-leash dog area. The bike park facilities include a downhill flow trail, bi-directional access trail, skills area and beginner pump track. The gravity-fed flow park features rollers, berm turns, and table-top jumps that are suitable for beginners, and offer options for advanced riders to launch their bikes. The bike park is very popular with Denver area riders and experiences significant visitation throughout the year.

Parking facilities include a large central parking lot that accommodates approximately 90 vehicles. Additional event parking is located along the park access drive. Parking is provided at approximately 1.4 spaces per acre. Due to the park's central location the majority of park users walk for ride their bikes to the facility.

4.1.3 Project Trip Distribution

The study area trip distribution i.e. the directional distribution of generated traffic, was developed based on current travel patterns and those evident in the DRCOG model. The travel patterns developed for existing/current conditions are also used for the future year (2020) scenario. Project trip distribution is shown in **Figure 4-1** below.

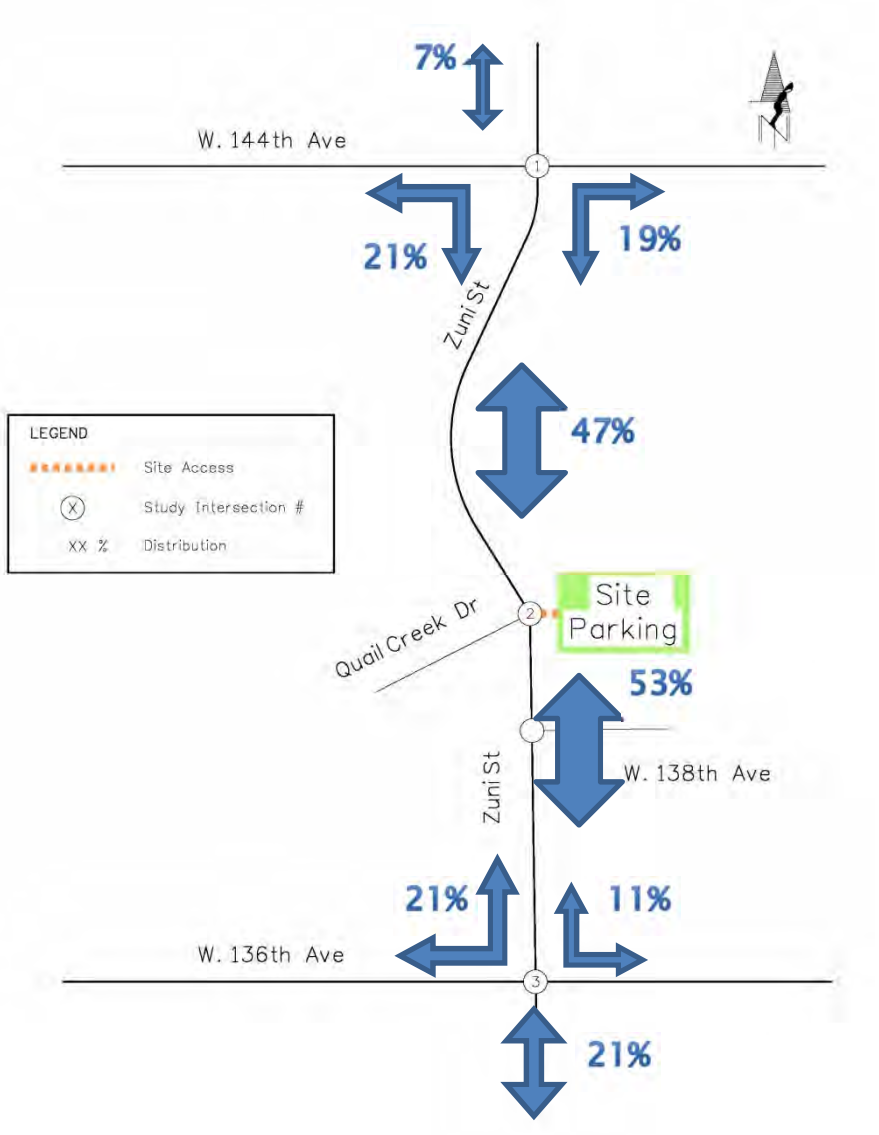

Figure 4-1: Trip Distribution

4.1.4 Project Trip Assignment

Project trip assignment involves the routing of site generated traffic on the surrounding roadway network based on the project trip distribution. The project trip assignments corresponding to each turning movement are summarized in **Table 4-3** and the intersections are shown in **Figure 4-2**.

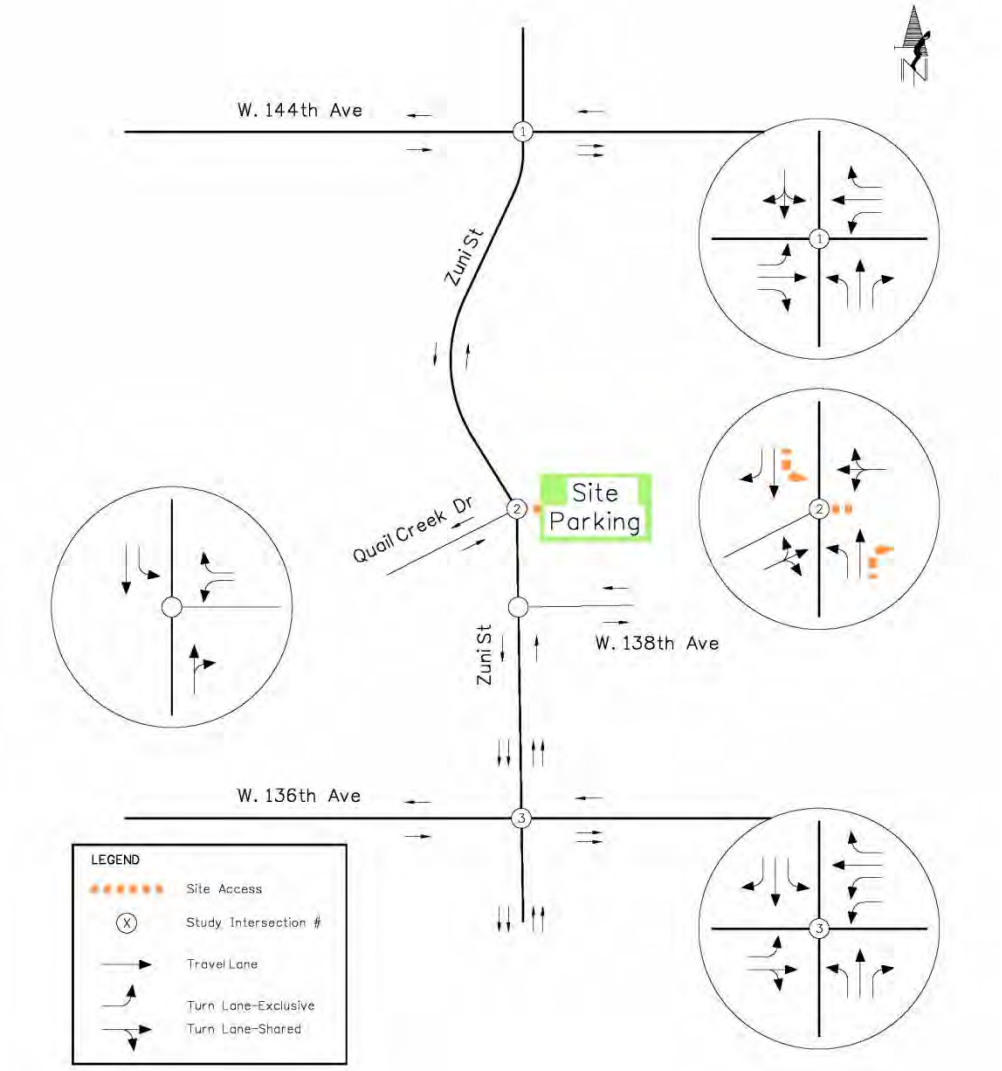

Figure 4-2: Trip Assignment Reference

Table 4-3: PM Peak Project Generated Traffic (veh/hr)

	Street Name		Eastbound			Westbound			Northbound			Southbound		
Int. #	Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
1	144th	Zuni St	-	-	9	4	-	-	14	5	13	-	2	-
2	Zuni St	Quail	-	0	-	30	0	27	-	-	15	14	-	-
3	136th	Zuni St	2	-	-	-	-	4	-	9	-	6	11	11

4.2 Through Traffic

4.2.1 Traffic Projection

The study area roadway network traffic data used for this planning study was obtained from Broomfield and DRCOG. This data was used in conjunction with DRCOG's (TransCAD) travel demand model to develop estimates of the yearly growth factor; and thus, future travel demand in study area. (There are no known planned developments in the study area that would need to be accounted for in this traffic impact analysis.)

The twenty-five year growth factor for the area was developed by analyzing well calibrated links within the study area in the TransCAD model. This factor was converted to a yearly growth rate by assuming a straight line increase in demand. It was determined that the expected yearly growth rate in this area lies between 2.8% - 3.0%.

The 2005 Broomfield Transportation Plan anticipates a very similar demand growth rate between 2005 and 2030, with a yearly growth of 2.6% for Zuni St, 2.5% growth for W. 144th Ave, and a 3.2% growth for W. 136th Ave (averaging W. 136th Ave on either side of Zuni St).

Thus, based on the available information, a yearly growth of 3% was chosen for this study.

Non-Site Traffic for Anticipated Development

There are no developments planned in the project area that would impact the traffic volumes on the study roadway network. Therefore, only the site existing and future traffic in combination with projected background traffic volumes were used in the transportation analysis (section 5).

4.3 Total Traffic

4.3.1 2015 and 2020 Background Demand

The study area network background volumes for the years 2015 and 2020 are shown in **Table 4-4** below.

Table 4-4: 2015 and 2020 Background Demand (PM Peak Hour)

Yr.	Int. #	Street Name		Eastbound			Westbound			Northbound			Southbound		
		Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
2015	1	144th Ave	Zuni St	21	773	121	53	485	14	95	29	83	20	20	9
	2	Zuni St	Quail Creek Dr	25	-	55	-	-	-	90	261	-	-	299	45
	3	136th Ave	Zuni St	45	474	133	182	409	97	53	216	164	76	146	138
2020	1	144th Ave	Zuni St	24	897	141	62	563	16	110	34	96	23	23	10
	2	Zuni St	Quail Creek Dr	25	-	55	-	-	-	90	303	-	-	347	45
	3	136th Ave	Zuni St	52	550	154	211	474	112	62	250	190	88	169	160

4.3.2 2015 and 2020 Demand plus Project Traffic

The study area network volumes combined with site generated traffic for the years 2015 and 2020 are shown in **Table 4-5** below.

Table 4-5: 2015 and 2020 Total Project Demand (PM Peak Hour)

Yr.	Int. #	Street Name		Eastbound			Westbound			Northbound			Southbound		
		Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
2015	1	144th Ave	Zuni St	21	773	131	58	485	14	108	33	94	20	22	9
	2	Zuni St	Quail Creek Dr	25	1	55	30	1	27	90	261	15	14	299	45
	3	136th Ave	Zuni St	47	474	133	182	409	102	53	226	164	83	159	150
2020	1	144th Ave	Zuni St	24	897	151	67	563	16	123	38	107	23	25	10
	2	Zuni St	Quail Creek Dr	25	1	55	30	1	27	90	303	15	14	347	45
	3	136th Ave	Zuni St	54	550	154	211	474	117	62	260	190	95	182	172

5 Transportation Analysis

5.1 Traffic Operations

The transportation analysis was based on the LOS methodology mentioned in Section 2. The study area intersections were analyzed for opening year (2015) and future (2020) background traffic as well as for total project demand (site + background). The Synchro results presented in **Table 5-1** and **Table 5-2** indicate that:

- The demand added by the project to surrounding roadway network doesn't impact the traffic operations of any of the signalized intersections.
- The worst movement for the unsignalized intersection is the parking lot exit (LOS C).
- The parking lot exit assessed from a queuing perspective indicates a 95th percentile queuing of one vehicle (Synchro indicates a length of 22 ft, which is less than the length of a vehicle)

Table 5-1: 2015 and 2020 Background LOS (PM Peak Hour)

Year		Street Name		Average Delay (sec)	LOS
	Int. #	Mainline	Cross Street		
2015	1	144th Ave	Zuni St	13.8	B
	2	Zuni St	Quail Creek Dr	13.7	b
	3	136th Ave	Zuni St	12.3	B
2020	1	144th Ave	Zuni St	17.1	C
	2	Zuni St	Quail Creek Dr	14.8	b
	3	136th Ave	Zuni St	14.7	B

Table 5-2: 2015 and 2020 Total Project LOS (PM Peak Hour)

Year		Street Name		Average Delay (sec)	LOS
	Int. #	Mainline	Cross Street		
2015	1	144th Ave	Zuni St	13.8	B
	2	Zuni St	Quail Creek Dr	17.5	c
	3	136th Ave	Zuni St	12.3	B
2020	1	144th Ave	Zuni St	17.2	C
	2	Zuni St	Quail Creek Dr	18.8	c
	3	136th Ave	Zuni St	14.7	B

5.2 W. 138th St Considerations

As part of the W. 138th St access analysis, the parking lot access is a TWSC intersection, and no intersection changes are assumed at Zuni St and W. 138th St. No traffic counts were available for this intersection; therefore, the counts presented in **Table 5-3** below are based on those developed in Section 3 in conjunction with turning movements projected in the Lambertson Farms PUD, Traffic Impact Study (Lambertson Study).

The turning movements at this intersection are based on the site generated traffic in the Lambertson Study; thus, these volumes are not subject to through traffic growth rates developed in this study.

Table 5-3: Existing Traffic Volumes at W. 138th Ave

Street Name		Eastbound			Westbound			Northbound			Southbound		
Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
Zuni St	W. 138th Ave	-	-	-	27	-	13	-	323	47	24	313	-

Sources: City of Broomfield, DRCOG, McKay Landing Traffic Study and Lambertson Farm PUD Traffic Impact Study

Table 5-4 and **Table 5-5** provide 2015 and 2020 background demand and total project demand for this alternative. Given its proximity to Zuni St, all site traffic is assumed to use the traffic distribution developed in Section 4.

Table 5-4: Background Demand at W. 138th Ave (2015 and 2020)

Yr.	Street Name		Eastbound			Westbound			Northbound			Southbound		
	Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
2015	Zuni St	W. 138th Ave	-	-	-	27	-	13	-	351	47	24	354	-
2020	Zuni St	W. 138th Ave	-	-	-	27	-	13	-	393	47	24	402	-

The project demand in **Table 5-5** is a combination of the background demand in **Table 5-4** and the site generated traffic, and for the purpose of this intersection it is assumed that East-West distribution of traffic at the access is: 14%-86%, i.e. 51 vehicles – 8 vehicles (during the peak hour). This distribution is based on the demand on Zuni St. vs W. 138th Ave.

Table 5-5: Project Demand at W. 138th Ave (2015 and 2020)

Yr.	Street Name		Eastbound			Westbound			Northbound			Southbound		
	Mainline	Cross Street	L	T	R	L	T	R	L	T	R	L	T	R
2015	Zuni St	W. 138th Ave	-	-	-	53	-	36	-	351	59	37	354	-
	W. 138th Ave	Parking Access	25	71	-		40	4	-	-	-	8	-	49
2020	Zuni St	W. 138th Ave	-	-	-	53	-	36	-	393	59	37	402	-
	W. 138th Ave	Parking Access	25	71	-		40	4	-	-	-	8	-	49

Table 5-5: LOS for W. 138th Ave Alternative

Street Name		LOS/Average Delay (sec)				
Mainline	Cross Street	Existing	Background		Project Total	
		2013	2015	2020	2015	2020
Zuni St	W. 138th Ave	c / 15.9	c / 17.1	c / 19.1	c / 19.5	c / 22.1
W. 138th Ave	Parking Access	-			a / 8.9	a / 8.9

5.2.1 Zuni St vs. W. 138th St Access

Traffic Operations: In comparing the two access alternatives there are no clear traffic operations advantages (or disadvantages) of either one. Each alternative results in minimal delay; however, since W. 138th Ave access requires users to navigate two TWSC intersections, the total delay for certain movements will be marginally higher.

Safety: The proposed W. 138th Ave access would be a three-legged intersection, which can be considered 'safer' than the four-legged intersection at Quail Creek Dr due to fewer points of conflict (however, given the low volume, these safety benefits will be expected to be intangible). Additionally, there is the possibility of inadequate sight distance at a TWSC intersection at Quail Creek Dr, which would make a TWSC intersection there undesirable. However, if a roundabout were to be provided at the Zuni St access, this sight distance issue would be mitigated.

Site Accessibility: Zuni St has a clear advantage in this aspect since most patrons would be expected to reach the site via Zuni St. Additionally, unlike a parking lot at W. 138th Ave; the Zuni St lot would be centrally located for the Phase 1 site design.

Parking Lot Design: A parking lot off of W. 138th Ave will have more space available without interfering with future site plans. The Zuni St access will require adjustments to the currently proposed parking lot to ensure adequate number of spaces and proper circulation.

5.3 Parking Requirements

The parking requirement was determined based on the proposed site usage data presented in **Table 4-1** and by assuming a constant demand for the full hour as a conservative measure. The steps involved in this analysis were:

i. Determine Site Trip Generation: There are no published trip generation rates that can be used for this site. Land Use 417 (Regional Park) in the ITE handbook seems similar but the data provided is for different activities and has been collected for a very small data set. In addition, the smallest site in this dataset is approximately 75 acres. Given the lack of ITE trip generation or parking generation rates for similar sites, trip generation for the pear hour was determined analytically based on the capacity of the site and duration of activities.

ii. Determine average vehicle trips generated per parking space: This parking generation rate was developed by calculating an average of the number activities per hour (weighted by the number of patrons in each activity). This means that the number of times a parking space is utilized by a unique patron depends on the duration of each patron's activity. The weighted average allows us to develop an average for the entire group of activities.

The off-peak hour generation rate assumes the lower number of patrons engaging in activities for the lower duration (Low Activity Duration), as shown in **Table 5-6** (and **Table 4-1**), while the peak hour generation rate (**Table 5-7**) assumes high number of patrons engaging in activities for an amount of time that is an average of the low and high estimate (High/Low Activity Duration Estimate).

Table 5-6: Parking Generation Rate (Off-peak Hour)

Activity Duration Estimate (min)		Number of Activities per hour		No. of Patrons/Activity (Low Estimate)	Weighted Average Activities per Hour
Low	High	High	Low		
45	90	1.3	0.7	15	2.0
30	60	2.0	1.0	6	
20	45	3.0	1.3	12	
30	60	2.0	1.0	10	

Table 5-7: Parking Generation Rate (Peak Hour)

Activity Duration Estimate (min)		Number of Activities per hour		No. of Patrons/Activity (High Estimate)	Weighted Average Activities per Hour
Low	High	High	Low		
45	90	1.3	0.7	20	1.5
30	60	2.0	1.0	8	
20	45	3.0	1.3	15	
30	60	2.0	1.0	12	

iii. Vehicle Occupancy: The trip generation data based on activity duration results in person trips per hour. In order to convert this to vehicular demand occupancy data is required. Recreation trips have higher vehicle occupancy than work trips, and the average vehicle occupancy based on

FHWA's National Household Travel Survey data for Recreation/Social Trips is 2.3. A lower (more conservative) occupancy of 2.0 was used for this analysis.

iv. Determine Parking Lot Occupancy: This is the number parking spaces occupied before the start of peak hour usage. This was determined using the off-peak trip generation rate, and assuming all those vehicles present at the beginning of the peak hour.

v. The required parking spaces were determined by dividing vehicles generated by parking generation. This calculation is shown below in **Table 5-7**.

Table 5-7: Parking Requirement Steps

S. No.	Calculation	Off-Peak	Peak	Comment
1	Total Trips Generated	21 veh/hr	57 veh/hr	Table 4-2
2	Average Trips Generated per Space	2.0 veh/space	1.5 veh/space	Table 5-6
3	Parking Spaces Needed for Peak Use	10.5 spaces/hr	38 space/hr	#1 ÷ #2
4	Parking Spaces Occupied before Peak Hr	-	10.5 spaces	#3 Off-Peak Value
5	Total Parking Spaces Needed	10.5 spaces	48.5 spaces	#3 + #4

6 Summary and Recommendation

The development proposed at McKay Landing/Lambertson Farms is not expected to cause any deficiencies in the existing roadway network. The traffic generated by the site will be adequately accommodated within the existing (available) roadway/intersection capacities. The recommendations of this study are:

- The parking lot should provide for **48 parking spaces** to accommodate the peak demand.
- If an unsignalized (TWSC) intersection is provided at Zuni St / Quail Creek Dr for site access, exclusive left and right turn bays should be considered on Zuni St.
- A TWSC intersection at Zuni St / Quail Creek Dr could have potential sight distance issues.
- Careful consideration should be given to the parking lot layout with respect to stacking at the access as well as internal circulation.
- Expected traffic delays and queuing are comparable for both design options – a TWSC intersection and a roundabout – at Zuni St / Quail Creek Dr.
- A roundabout will not require any exclusive turn bays.
- A roundabout will be helpful in traffic calming on Zuni St. It would be expected to work in conjunction with the existing roundabout at McKay Landing Pkwy in reducing running speeds.
- If a roundabout is considered at Quail Creek Dr, a 90' inscribed diameter is recommended. This size roundabout is better suited to the fleet mix expected on Zuni St, which includes school buses, as well as the expected approach speeds.
- A roundabout will be expected to have some minor ROW impacts and some potential utility impacts.
- An access road on W. 138th Ave does not provide any significant advantages over the Zuni St access. In addition, this access will require the development of an access road/trail to the site, which will increase costs.
- Based on the ease of access from Zuni St and the central location of the parking lot – the Quail Creek Drive/Zuni St access is preferable.