

LEGISLATIVE SUMMARY SHEET

Tracking No. 0341-15

DATE: September 24, 2015

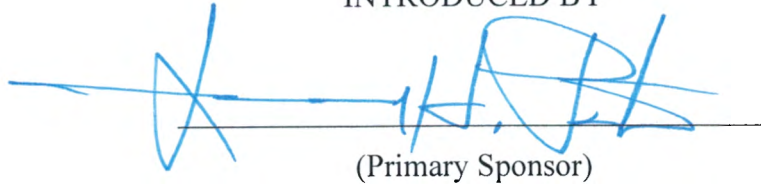
TITLE OF RESOLUTION: PROPOSED STANDING COMMITTEE RESOLUTION; AN ACTION RELATING TO RESOURCES AND DEVELOPMENT; AMENDING THE NAVAJO DIVISION OF TRANSPORTATION 2016 TRIBAL TRANSPORTATION IMPROVEMENT PLAN, RDSC-70-15, TO INCLUDE FUNDING FOR DESIGN WORK FOR THE INTERSECTION OF N12 AND N100 WITHIN WINDOW ROCK, NAVAJO NATION

PURPOSE: If approved this legislation would amend RDSC-70-15, the Fiscal Year 2016 Navajo Nation Tribal Transportation Improvement Plan, to include design work for the intersection of N12 and N100 within Window Rock, Navajo Nation.

This written summary does not address recommended amendments as may be provided by the standing committees. The Office of Legislative Counsel requests each Council Delegate to review each proposed resolution in detail.

PROPOSED STANDING COMMITTEE RESOLUTION
23rd NAVAJO NATION COUNCIL -- First Year, 2015

INTRODUCED BY



(Primary Sponsor)

TRACKING NO. 0341-15

AN ACTION

RELATING TO RESOURCES AND DEVELOPMENT; AMENDING THE NAVAJO
DIVISION OF TRANSPORTATION 2016 TRIBAL TRANSPORTATION
IMPROVEMENT PLAN, RDCS-70-15, TO INCLUDE FUNDING FOR DESIGN
WORK FOR THE INTERSECTION OF N12 AND N100 WITHIN WINDOW ROCK,
NAVAJO NATION

BE IT ENACTED:

SECTION ONE. Findings

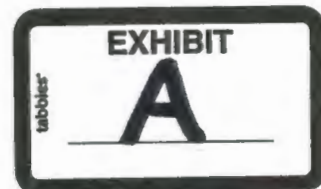
- A. Pursuant to 2 N.N.C. § 500(C)(6), the Resources and Development Committee has oversight authority over matters including planning and coordination of roads and transportation activities of the Navajo Nation.
- B. Pursuant to 2 N.N.C. § 501(B)(2)(b) the Resources and Development Committee has the power to grant final approval for Road and Transportation Plan prioritizing list for road and transportation projects.
- C. Pursuant to 2 N.N.C. § 501(C) the Resource and Development Committee has oversight authority over the Division of Transportation.
- D. The Navajo Nation Division of Transportation with the approval of the Navajo Nation Council's Resources and Development Committee each year submits the Navajo Division of Transportation Tribal Transportation Program update package to the

1 Bureau of Indian Affairs, Navajo Regional Office. The Resources and Development
2 Committee approved the Tribal Transportation Improvement Plan through resolution
3 RDCS-70-15.

- 4 E. The March 2015 Feasibility & Traffic Study Prepared for the Bureau of Indian
5 Affairs, attached as Exhibit A, states: "There are extensive delays and queuing
6 during the morning and afternoon peaks particularly at the intersection of N12 and
7 N100 (Window Rock Boulevard), and at the intersection of SR 264 and N12. There
8 are plans for expansion, growth and development in the Window Rock area. Future
9 developments and growth will significantly and adversely contribute to the existing
10 traffic issues if no action is taken." (Underlining in original) Window Rock
11 Roadways, Prepared for Bureau of Indian Affairs, Navajo Area Office, Division of
12 Transportation, Feasibility & Traffic Study, March 2015, page one.
- 13 F. It is in the best interest of the Navajo Nation for the Resources and Development
14 Committee to amend RDC-70-15 to include funding for the intersection of N12 and
15 N100 (Window Rock Boulevard).

16
17 SECTION TWO. Amending the Navajo Division of Transportation 2016 Tribal
18 Transportation Improvement Plan

19
20 The Resources and Development Committee hereby amends RDCS-70-15, the Fiscal
21 Year 2016 Navajo Nation Tribal Transportation Improvement Plan, attached as
22 Exhibit B, to include funding for design work for the intersection of N12 and N100
23 (Window Rock Boulevard) within Window Rock, Navajo Nation.
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Window Rock Roadways
Prepared for
Bureau of Indian Affairs
Navajo Area Office, Division of Transportation

Feasibility & Traffic Study



March 2015

Prepared by
J2 Engineering & Environmental Design, LLC



Engineering Services Window Rock Roadways
Project Number: N100(1-1)/N12a(1-1)2&4
Task Number: A14PD00560



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1.0 Introduction

Beginning in August of 2014 the Bureau of Indian Affairs (BIA) Navajo Region Division of Transportation (NRDOT) in collaboration with the Navajo Division of Transportation (NDOT) initiated the preparation of a Feasibility and Traffic Study (Study) for Window Rock, Arizona. See **Figure 1-1** for a vicinity map. The intent of this study is to evaluate existing traffic circulation along BIA Navajo Route 12 (N12) and Navajo Route 100 (N100) (Window Rock Boulevard) with a focus on the intersection of these two routes. The study also evaluates the existing and future operation into and out of the Tribal government complex area and will look to recommend a secondary roadway alignment into this area. The future analyses will factor in future proposed and planned developments in the Window Rock area.

Ultimately the study will identify and recommend short-term (5-year), mid-term (10-year), and long-term (20-year) improvements necessary to maintain acceptable traffic operations and levels of service within the study area.

1.1 Study Area

The study area is approximately 2.6 square miles (6.7 km) located on the Navajo Nation in Apache County within Township 16 North and Range 31 East, Sections 5, 6, 7, 8, 17 and 18; and is generally bounded by the Arizona Department of Transportation (ADOT) State Route 264 (SR 264) to the south, the Arizona/ New Mexico state line to the east, Rocky Ridge Road to the north, and Mustang Road to the west. The study area is located in the northeast corner of Arizona, north of Interstate 40 (I-40) near the Arizona and New Mexico state line. See **Figure 1-2** for the study area.

Window Rock is a district within the Saint Michaels Chapter (Tribal administrative district of the Fort Defiance Agency), home to the capital of the Navajo Nation (Nation) and serves as the major seat of government for Tribal and Federal offices including the legislative, executive, and judicial branch of the Nation. The 2010 census reports a population of 2,712 residents. The population has likely increased since the 2010 census. The 2010 census population also does not reflect the major population influx from surrounding communities - such as Saint Michaels to the west, Fort Defiance to the north and Gallup to the east - during the course of governmental operations of the Nation.

1.2 Purpose and Need

This Study is the first step in quantifying the existing traffic congestion experienced by residents and visitors traveling to the Window Rock area. There are extensive delays and queuing during the morning and afternoon peaks particularly at the intersection of N12 and N100 (Window Rock Boulevard), and at the intersection of SR 264 and N12.

There are plans for expansion, growth and development in the Window Rock area. **Future developments and growth will significantly and adversely contribute to the existing traffic issues if no action is taken.** This Study will evaluate future traffic volumes and operations within the study area and identify improvements to accommodate these developments.



VICINITY MAP

FIG 1-1



The Nation has also identified a need to provide a secondary roadway into and out of the Tribal government complex area. Currently, N100 is the only continuous all-weather roadway into and out of this area. The fire and police departments are located off of N100, and therefore along with relieving congestion at the existing intersections of SR 264 and N12, and N12 and N100 (Window Rock Boulevard), this secondary roadway will also serve as an emergency route.

This Study evaluates the need to improve N100 by means of a roadway reconstruction with the addition of two roundabouts along N100, the first at N12 and the second at Navajo Hill Drive. **Roundabouts could potentially increase traffic capacity by 30 to 50 percent compared to traditional signalized intersections according to Federal Highway Administration (FHWA) studies.** Six preliminary alignment alternatives and an N100 extension to the west of N12 will be analyzed.

1.3 Goals and Objectives

The ability of a transportation system to transmit the transportation demand is characterized as its level of service (LOS). Level of service is a rating system from "A", representing the best operation, to "F", representing the worst operation. The *Highway Capacity Manual 2010* published by the Transportation Research Board sets the standards and criteria for determining the LOS.

This manual considers the average delay per vehicle to determine the LOS for both signalized and unsignalized intersections. For signalized intersections and for multi-way stop intersections, the delay and LOS are calculated for the intersection, each approach, and each turning movement. For unsignalized intersections, the LOS is defined for each minor movement and is not defined for the major street approaches or for the intersection as a whole. **Figure 1-3** graphically depicts the LOS for a two-way stop-controlled intersection. With a LOS A there are very short delays, whereas a LOS F has considerable delays.

Figure 1-3 - Level of Service

Level of Service (Two-Way Stop-Controlled Intersection)					
A	B	C	D	E	F
Very Short Delays	Short Delays	Minimal Delays	Minimal Delays	Significant Delays	Considerable Delays



The goals for this Study include:

- Identify necessary improvements for routes N100 and N12, including the intersection, in order to mitigate traffic congestion and to achieve a future LOS B/C as a minimum, with a LOS A as desirable.
- Identify a secondary new roadway alignment to be constructed to achieve the desired LOS A with a LOS B/C as a minimum future (20-year horizon) level of service, and to serve as an emergency ingress/egress to the existing Tribal government complex area.

The specific objectives of the study include:

- Identify improvements for N100 and N12, including the intersection.
- Determine the preferred secondary new roadway alignment from the six potential alternative alignments.
- Evaluate the need for the extension of N100 to the west of N12.
- Develop conceptual construction cost estimates for potential preferred alternatives.
- Identify the short-term (5-Year), mid-term (10-year), and long-term (20-year) improvements necessary to maintain acceptable traffic operations and levels of service for the study intersections for the preferred alternative



2.0 Existing Conditions

The study area is approximately 2.6 square miles (6.7 km), located in the community of Window Rock, Arizona north of SR 264 and continuing for approximately two miles (3.2 km), straddling Route N12. Access to the government buildings located along N100 (Window Rock Boulevard) is of particular focus for this study.

The main transportation spine is comprised of the north-south oriented BIA N12 route and the east-west SR 264 route, both of which operate as a major arterial type roadway. N100 is the only all-weather access to the governmental complex area. The remaining interior roadways in the Window Rock community operate as a collector and local type and have limited access to both N12 and SR 264. Window Rock is designated by the Navajo Nation as a primary growth center for economic development, including the communities of Fort Defiance and Saint Michaels, which are connected directly to the study area via existing roadways. This growth trend will most likely continue along with conceptual and planned future commercial and governmental developments.

2.1 Existing Roadways

The character of the study area can be considered urban in terms of traffic volumes and its distinction as the capital of the Nation. SR 264 runs through the southern portion of the study area. SR 264 continues west to the communities of Saint Michaels, Oak Springs, and Ganado; east to Gallup, New Mexico. N12 intersects SR 264 at its south terminus and continues north to the communities of Fort Defiance, Sawmill and Navajo. The following is a description of the existing conditions of the Study roadways:

N100 (Window Rock Boulevard) provides access to several government offices, the Veterans Memorial and the Window Rock monument composed of an arching sandstone geologic formation. Offices include the President's Office, the Council Chambers, Administration Office Complex (currently being renovated), Division of Public Safety and the fire department. The existing roadway is comprised of two travel lanes in each direction with a striped median two-way left turn lane. Further east and just before the Navajo Hill Drive intersection, N100 tapers down to a two lane road, one travel lane in each direction. Paved street intersections occur at N12, Circle Hill Drive, Navajo Hill Drive, and Morgan Boulevard, in addition 4 connecting paved driveways and 5 dirt driveways exist. The corridor is approximately 0.7 miles (1.1 km) in length from N12 to Morgan Boulevard. The route operates as a major collector. It has relatively level grades with a posted speed limit of 30 mph. The surrounding terrain falls from the east to the west, with a steep side slope off the west edge. A few characteristics include super-elevations on its curved segments, a raised curb median at the approach to the intersection of N12, curb and sidewalk on the west side, and a paved shoulder on the east side. The roadway surface consists of weathered cracking asphaltic concrete and barely distinguishable striping. See photo on the next page. Roadway lighting is provided at the signalized intersection of N12.

**N100, looking north****N12 and N100 intersection, looking northwest**

N12 provides access to the communities located north of Window Rock. The section from the southern terminus at SR 264 to Rocky Ridge Road located north of N100 is comprised of two travel lanes in each direction with a median (raised curb from SR 264 to 300 feet (91 m) north of N100, striped median two-way left turn lane for the remaining portion). Paved street intersections occur at SR 264, Window Rock Loop Road, N100, Shonto Boulevard and Rocky Ridge Road. In addition there are nine (9) connecting paved driveways. The corridor is approximately 2.0 miles (3.2 km) in length from SR 264 to Rocky Ridge Road. North of

N100 an acceleration lane runs several hundred feet (meters) along the north bound direction. The route operates as a major arterial. It has relatively level grades with a posted speed limit of 35 mph and 55 mph north of N100. The surrounding terrain falls from the east to the west, with a steep side slope off the west edge, especially at the intersection of N100. A few characteristics include a detached sidewalk on the east side from SR 264 to N100, and a paved shoulder the entire length. The roadway surface consists of weathered cracking asphaltic concrete and barely distinguishable striping. Roadway lighting is provided at the signalized intersection at SR 264 and N100.



N12, looking south
(Shonto Blvd. in the foreground and the signalized N100 intersection in the background)

The surrounding terrain falls from the east to the west, with a steep side slope off the west edge, especially at the intersection of N100. A few characteristics include a detached sidewalk on the east side from SR 264 to N100, and a paved shoulder the entire length. The roadway surface consists of weathered cracking asphaltic concrete and barely distinguishable striping. Roadway lighting is provided at the signalized intersection at SR 264 and N100.

SR 264 provides access to the communities located west and east of Window Rock. The entire section is comprised of two travel lanes in each direction with a striped median two-way left turn lane. Paved street intersections within the study area occur at N12, Main Street, and Window Rock Loop Road. In addition there are twenty-two (22) connecting paved driveways. The corridor is approximately 1.1 miles (1.8 km) in length from Mustang Road to the state line. ADOT classifies



the route as a rural minor arterial. It has relatively level grades with a posted speed limit of 45 mph. The surrounding terrain falls from the north to the south, with a large wash along the south side. A few characteristics include a detached sidewalk on both sides, and curb edges. The roadway surface consists of weathered cracking asphaltic concrete and barely distinguishable striping. Roadway lighting and continuous sidewalks are provided along both sides of SR 264.

Mustang Road within the vicinity of the study area begins at the intersection of SR 264 and continues north. To the north of SR 264, Mustang Road is paved for a short distance then turns into an unpaved roadway providing one lane for each direction of travel. There is no posted speed limit and no roadway lighting along Mustang Road.

Main Street within the vicinity of the study area begins at the intersection of SR 264 and continues north approximately 1300 feet (396 m) and terminates at the intersection with Window Road Loop Road. The alignment of Main Street continues south of SR 264 as Beacon Road. There are no existing pavement markings on Main Street. With approximately 40 feet (12 m) of pavement width, it operates as one through lane for each direction of travel. There is no posted speed limit and no roadway lighting along Main Street.

Shonto Boulevard within the vicinity of the study area begins at the intersection of N12 and continues west into a residential neighborhood to the intersection with Jeddito Drive. There are no existing pavement markings on Shonto Boulevard. With approximately 56 feet of pavement width, it operates as one through lane for each direction of travel with on-street parallel parking along both sides of the roadway. There is no posted speed limit and no roadway lighting along Shonto Boulevard.

Rocky Ridge Road within the vicinity of the study area begins at the intersection of N12 and continues west. To the west of N12, Rocky Ridge Road is paved for a short distance then turns into an unpaved roadway providing one lane for each direction of travel. To the east of N12, Rocky Ridge Road is a paved roadway. There is no posted speed limit and no roadway lighting along Rocky Ridge Road.

Circle Hill Drive within the vicinity of the study area begins at the intersection of N100 (Window Rock Boulevard) and continues northeast to Navajo Hill Dr, where it loops back to Hill Crest Drive. There are no existing pavement markings on Circle Hill Drive. With approximately 24 feet (7.3 m) of pavement width, it operates as one through lane for each direction of travel. There is no posted speed limit and no roadway lighting along Circle Hill Drive.

Morgan Boulevard within the vicinity of the study area begins at the intersection of N100 (Window Rock Boulevard) and continues to Chee Dodge Drive. Morgan Blvd provides access to the Education Center and operates with one through lane in each direction. With approximately 24 feet (7.3 m) of pavement width, it operates as one through lane for each direction of travel. There is no posted speed limit and no roadway lighting along Circle Hill Drive.



Window Rock Loop Road within the vicinity of the study area begins at the intersection of N12 and continues east, loops to the south and intersects with SR 264. There are no existing pavement markings on Window Rock Loop Road. With approximately 30 feet (9.1 m) of pavement width, it operates with one through lane for each direction of travel. There is no posted speed limit and no roadway lighting along Window Rock Loop Road. Sidewalks are provided along the south side of the roadway.

2.2 Existing Intersections

The following is a description of the existing conditions of the Study intersections:

SR 264 and Mustang Road (1) currently operates as a stop-controlled t-intersection, with Mustang Road stopping for SR 264. The striping along SR 264 does not break at Mustang Road. There are two through lanes for each direction of travel along SR 264 with a center two-way left-turn lane. There are no pavement markings on Mustang Road, therefore the southbound approach operates as a single shared right-left turn lane.

SR 264 and N12 (2) currently operates as a signalized intersection. The northbound approach has a dedicated left turn lane, and a shared through-right turn lane. The southbound approach has dual left turn lanes, a through lane, and a dedicated right turn lane. The eastbound approach dual left turn lanes, a through lane, and a shared through-right turn lane. The westbound approach has a dedicated left turn lane, a through lane, and a shared through-right turn lane.

SR 264 and Main Street/Beacon Road (3) currently operates as a two-way stop controlled intersection, with Main Street/Beacon Road stopping for SR 264. The striping along SR 264 breaks at Main Street/Beacon Road. There are two through lanes for each direction of travel along SR 264 with a center two-way left-turn lane. There are no pavement markings on Main Street and Beacon Road, therefore the northbound and southbound approaches operate as a single shared right-through-left turn lane.

N12 and N100 (4) currently operates as a signalized t-intersection. The northbound approach has two through lanes with a free flow right turn lane separated with a raised median. The southbound approach has a dedicated left turn lane and two through lanes. The westbound approach has dual left turn lanes and a free flow right turn lane separated with a raised median.

N12 and Shonto Boulevard (5) currently operates as a stop-controlled t-intersection, with Shonto Boulevard stopping for N12. The northbound approach has a dedicated left-turn lane, two through lanes, and a merging lane from the free flow right-turn lane at the intersection of N12 and N100. The southbound approach has a through lane and a shared through-right turn lane. There are no pavement markings on Shonto Boulevard, therefore the eastbound approach operates as a single shared right-left turn lane.



N12 and Rocky Ridge Road (6) currently operates as a two-way stop controlled intersection, with Rocky Ridge Road stopping for N12. The striping along N12 does not break at Rocky Ridge Road. There are two through lanes for each direction of travel along N12 with a center two-way left-turn lane. There are no pavement markings on Rocky Ridge Road, therefore the eastbound and westbound approach operates as a single shared right-through-left turn lane.

N100 (Window Rock Boulevard) and Circle Hill Drive (Police/Fire driveway) (7) currently operates as a two-way stop controlled intersection, with Circle Hill Drive and the Police/Fire driveway stopping for N100. The striping along N12 breaks at Circle Hill Drive. There are two through lanes for each direction of travel along N12 with a center two-way left-turn lane. There are no pavement markings on Circle Hill Drive and the Police/Fire driveway, therefore the eastbound and westbound approaches operates as a single shared right-through-left turn lane.

N100 (Window Rock Boulevard) and Morgan Boulevard (8) currently operates as a stop-controlled t-intersection, with Morgan Boulevard stopping for N100. There are no pavement markings at this intersection, therefore the northbound approach of N100 operates as a single shared left-through lane, and the southbound approach operates as a single through-right turn lane. The eastbound approach of Morgan Boulevard operates as a shared right-left turn lane.

N100 (Window Rock Boulevard) and N100 (loop) (9) currently operates as a two-way stop controlled intersection, with N100 (loop) and the driveway stopping for N100 (Window Rock Boulevard). There are no pavement markings at this intersection, therefore all approaches operates as a single shared left-through-right turn lane.

SR 264 and Window Rock Loop Road (11) currently operates as a stop-controlled t-intersection, with Window Rock Loop Road stopping for SR 264. There are two through lanes for each direction of travel along SR 264 with a center two-way left-turn lane. There are no pavement markings on Window Road Loop Road, therefore the southbound approach operates as a single shared right-left turn lane.

Window Rock Loop Road and Main Street (12) currently operates as a stop-controlled t-intersection, with Main Street stopping for Window Rock Loop Road. There are no pavement markings at this intersection. Therefore the northbound approach operates as a single shared left-right turn lane. The eastbound approach operates as a single through-right turn lane. The westbound approach operates as a single left-through lane.

N100 (Window Rock Boulevard) and Navajo Hill Drive (19) currently operates as a stop-controlled t-intersection, with Navajo Hill Drive stopping for N100 (Window Rock Boulevard). There are no pavement markings at this intersection. Therefore the northbound approach of N100 operates as a single shared through-right turn lane. The southbound approach of N100 operates as a single left-through lane. The westbound approach of Navajo Hill Drive operates as a single left-right turn lane. See **Figure 2-1** for the Study roadways and intersections.



STUDY
ROADWAYS AND INTERSECTIONS

FIG 2-1



2.3 Existing Land Use, Right of Way, Ownership and Leases

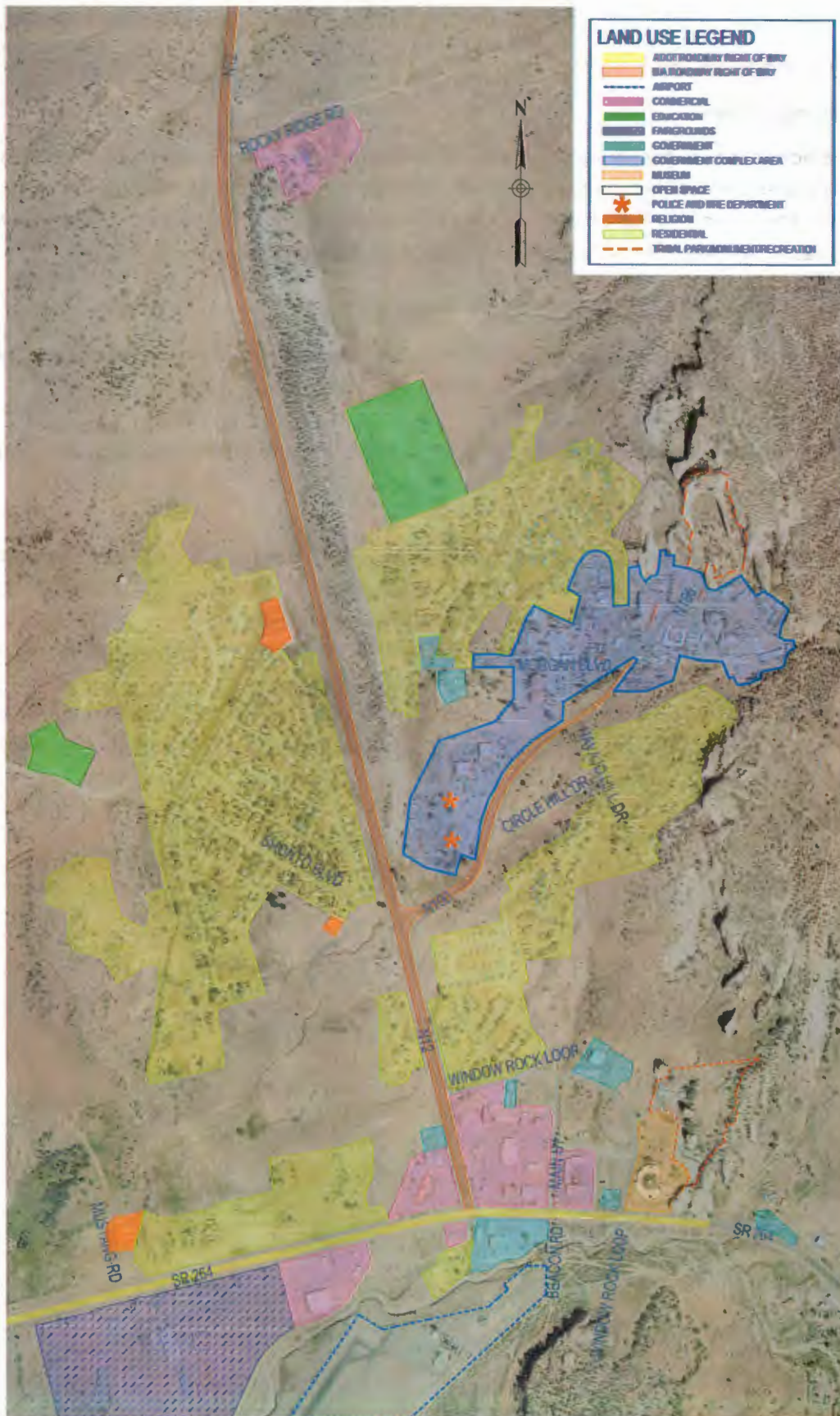
Existing land use in the study area is comprised of a mixture of commercial developments, governmental offices, residential housing subdivisions, home sites, livestock grazing areas and open space.

The existing jurisdiction of land ownership and legal boundaries is complex in the study area. The land is administered by the BIA under the Department of the Interior. The Nation is considered federal trust land and within this framework, the Nation has its own various governmental departments that manage the trust land such as the Navajo Division of Transportation, Navajo Department of Economic Development, Navajo Department of Fish and Wildlife, Navajo Design & Engineering, Navajo Housing Authority, Navajo Forestry Department, and at the local governance level the Saint Michaels Chapter.

An executive order in the early 1900s created the governmental complex area to be the administrative center of the Nation. This area is currently in use today and this status exempts it from the jurisdiction of the Saint Michaels Chapter. The boundaries of this area are unclear, however it would be assumed to cover any existing governmental offices.

Areas outside the executive order domain are comprised of trust land, private land, home site leases, commercial developments, BIA roads right of way, ADOT right of way, and livestock grazing permit areas. The overlapping of all the above land classifications is very complex. Right of way ownership varies within the study area. In some areas full right of way is held by jurisdictional authority such as the BIA and in other areas access is by easement such as utility easements.

N100 has an existing right of way width of 200 feet (61 m) and N12 has an existing right of way width of 175 feet (53 m). See **Figure 2-2** for Existing Land Use and Right of Way. The land use and right of way information presented in this study is based on available information from the Navajo Land Department, BIA Fort Defiance Agency Real Estate Services, ADOT records, and various other sources.



EXISTING LAND USE AND RIGHT OF WAY

FIG 2-2



2.4 Existing Utilities

Overhead power lines, water valves, gas valves, communication markers, manhole covers, telephone pedestals and an enclosed high pressure gas facility indicate the most apparent existing utilities in the study area. There is no blue stake on the Nation, therefore during the design phase, it is essential close communication be maintained with the two companies listed below.

2.4.1 Navajo Tribal Utility Authority (NTUA)

NTUA is a non-profit enterprise supplying multi-utility services including electricity, natural gas, potable water, and sanitary sewer service in the study area.

NTUA Contact Person: Delbert Smith, (928) 729-5727. See **Figure 2-3** for existing utility locations.

2.4.2 Frontier Communications

Frontier handles cable television, telephone (both overhead and buried), high-speed internet and fiber optic communications (typically buried) within the study area. Generally the telephone line is located west of N12 on overhead poles, buried communications in the vicinity of Circle Hill Drive and N100 and north of the intersection of N12/N100. Existing telephone overhead lines also exist along Morgan Boulevard, if widened this will require relocation.

Frontier Contact Person: Charles Bernacchi, (928) 871-3741. See **Figure 2-3** for existing utility locations.



3.0 Future Conditions

3.1 Future Land Use and Planning

It is imperative a land-use plan be developed in the future with governmental and public buy-in for the study area. Input required includes the Saint Michaels Chapter, residents of Window Rock, Apache County, BIA/NDOT and surrounding communities. From this process, areas will be identified for commercial development, governmental office expansions, residential housing, in essence a master plan study is required. This process will then drive the necessary infrastructure aimed at attaining set tourism, infrastructure, and transportation goals, in particular the various types of roadways fronting and accessing the identified areas. Business and commercial development and economic growth at the local and regional levels will require new roadways, utility, and drainage improvements.

For this Study, the existing analysis consisted of the current developments that are in place. Additionally, the Administration Building No. 1 and No. 2 which were under construction, and AZ 1204 Housing which included residents that were temporarily relocated at the time of this Study were factored into the existing analysis.

Extensive research of future plans and currently plans, along with conversations with BIA staff with respect to future developments were conducted and incorporated into this Study. For each of the future developments, approximate size, location and buildout years were estimated.

3.2 Future Opportunities and Constraints

The key opportunity during the land-use planning stage is identifying areas to slate for improvements and foster the growth of economic development and extension of infrastructure to these areas. The obvious key constraint is the weak economic landscape of the Nation and Country in general.

3.3 Future Developments

The future (2034) analysis assumes the build out of the following developments based on research, current plans, and conversations with BIA staff. See **Figure 3-1** for the approximate location of the proposed future developments.

Future Supreme Court Complex (Navajo Nation Justice Complex)

Planning and design for the future Supreme Court Complex is currently underway. The Supreme Court Complex will be located south of N100, southeast of the existing Administration Complex Buildings. It will be made up of three separate buildings that were each assumed to be approximately 20,000 square feet (1858 square meters), totaling 60,000 square feet (5574 square meters). It is assumed that that complex will be built out in five (5) years. See **Appendix N** for current Supreme Court Complex (Navajo Nation Justice Complex) plans.

***Future Administration Complex Building No. 3***

The future Administration Complex Building No. 3 is assumed to be located just east of the current Administration Complex Buildings No. 1 and 2. It is also assumed that the building will be the same size as the current administration buildings, which is approximately 38,700 square feet (3,595 square meters) and will be built out in ten (10) years.

Future Commercial Development (Near Convention Center)

The future Commercial Development is located on the southeast corner of the intersection of Window Rock Loop Road and Main Street. It is assumed that this development will be similar in size to the existing strip mall located on the west side of Main Street, which is approximately 45,000 square feet (4,180 square meters) and will be built out in ten (10) years.

Future Convention Center

The future Convention Center is located on the east side of Main St, just north of the existing Quality Inn. It is assumed that the Convention Center will be approximately 150,000 square feet (13,936 square meters) and will be built out in twenty (20) years.

Future Commercial Development (Along Alternative 2)

The future Commercial Development is located between the Alternative 2 and Alternative 3 alignments. It is assumed that the development will be similar in size to the existing strip mall located on the west side of Main Street, which is approximately 45,000 square feet (4180 square meters) and will be built out in twenty (20) years.

Future Camp/RV Park

The future Camp/RV Park is located on the east side of the Alternative 2 alignment. It is assumed that the park will be approximately 3 acres, with 20 sites per acre and will be built out in twenty (20) years.



FUTURE DEVELOPMENTS

FIG 3-1



4.0 N100 West Extension

An extension of N100 to the west of N12 was also evaluated as part of this Study. The intent of this roadway alignment is to provide a route for drivers coming and going to the west. Although it would not provide a secondary route into the Tribal government complex, this alignment is evaluated as part of this Study to analyze its impacts in improving traffic operations along N12 and N100, and at the intersections of N12 and N100 (Window Rock Loop Road) and SR 264 and N12.

This roadway alignment is a new roadway starting at the N12/N100 intersection and ending at SR 264. This would be an extension of N100 (Window Rock Boulevard) to the west, intersecting with Tse Bonito Road, then route southwesterly with two large radius curves to connect with Mustang Road and terminate at SR 264. See **Figure 5-1**.



5.0 Preliminary Alignment Alternatives

Six preliminary roadway alignment alternatives were developed each with the goal of relieving traffic along N100 and at the intersection of N12 and N100 (Window Rock Boulevard), along with providing a secondary route into and out of the existing Tribal government complex area. See **Figure 5-1**.

Alternative 2 - This alternative looks at a new roadway connecting the Tribal government complex area to Window Rock Loop Road. At its north terminus this route will require a new intersection near the Nation Fleet Management maintenance yard, cross an existing wash and traverse a steep hill to the existing Circle Hill Drive, located in a residential area. The route then progresses along existing Circle Hill Drive, splinters off to open land, connects to an existing asphalt side street located just east of the Post Office and would finally tee at the Window Rock Loop Road. This alternative was proposed based on the potential for future commercial development parcels.

Alternative 3 - This alternative connects N100 (Window Rock Boulevard) to Window Rock Loop Road. It utilizes and extends existing Navajo Hill Drive. A roundabout is proposed to create a new intersection at N100 and Navajo Hill Drive located just south of the Education Center building. The route continues south to create a second roundabout intersection at Window Rock Loop Road just west of the Post Office. The route will then continue east along existing Window Rock Loop Road the intersection of SR 264 near the Navajo Nation Museum. This alternative is located on rolling terrain, and in general the existing pavement is in poor condition.



**Window Rock Loop Road, looking north
North of SR 264
(Navajo Nation Museum on the right)**

Alternative 4 - This alternative alignment begins at the intersection of N12 and Rocky Ridge Road at its north terminus, constructs a new roadway east along existing Rocky Ridge Road (dirt road) for a short distance in order to clear the waste transfer station property, turns south and parallels N12 on the east side of the existing ridge, continues south and connects to an existing asphalt road fronting the old Window Rock Elementary School.



Alternative 5 - This alternative alignment shares the same tie-in location on N12 as Alternative 4 (Rocky Ridge Road). Just east of the intersection, the route turns south and parallels N12 on the west side of both the waste transfer station and the existing ridge, essentially operating as a frontage road for N12. The route goes in an east direction just south of the Education Center and north of the Administration Office Complex then ties into N100 at Navajo Hill Drive.



Existing N12, looking north
South of Rocky Ridge Road
(Terrain includes a large ridge east of N12)



Existing roadway along Alt. 6, looking south
South of N100/Window Rock Boulevard
(Mixture of solid sand stone bedrock and sand)

Alternative 6 - This alternative connects the Tribal government complex area to SR 264 near the state line and port of entry. At its north terminus this route will require a new intersection near the Nation Fleet Management maintenance yard, cross an existing wash and traverse a steep rock outcrop. The route continues in a south direction to SR 264 mainly utilizing an existing dirt road.

Alternative 7 – This alignment improves the existing Morgan Boulevard and extends the roadway to the west to intersect with N12. This option results in a new intersection on to N12.

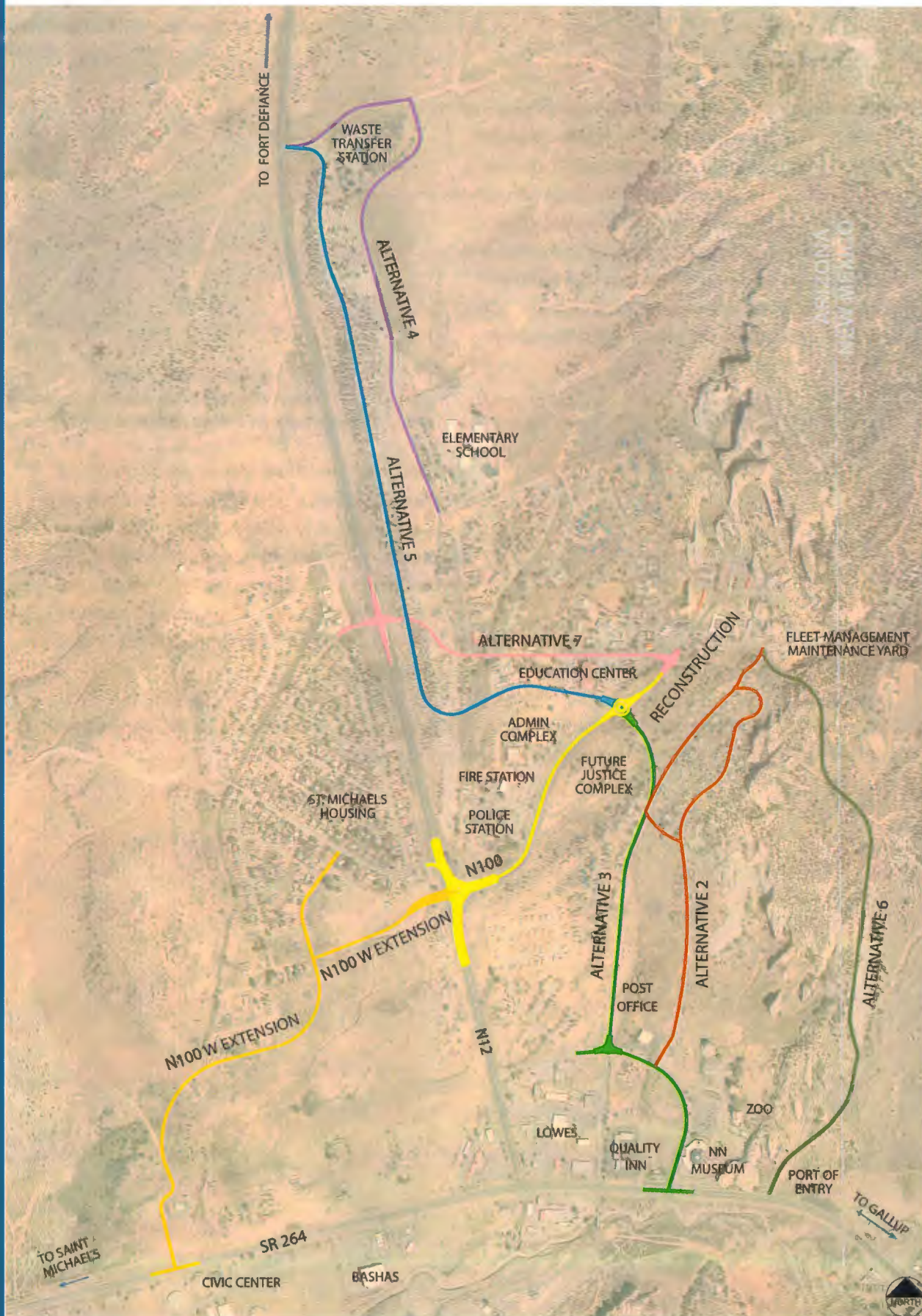


Figure 5-1
N100 W Extension and Preliminary Alternatives

Window Rock, Arizona



6.0 Evaluation Criteria

A set of evaluation criteria were developed and used to compare and contrast the No Build and Preliminary Alternatives in order to identify a Preferred Alternative. The evaluation criteria are the following:

- Public Feedback
 - *Community input and concerns (including lease holders)*
 - *Navajo governmental input and concerns (NNDES, NDOT, etc.)*
- Environmental Considerations and Impacts
- Traffic Analysis
 - *Traffic operations*
 - *Crash analysis*
- Drainage Analysis, Considerations and Impacts
- Constructability
 - *Utility Impacts*
 - *Right of Way Considerations*
 - *Estimated Construction Costs*



7.0 Public Feedback

Public feedback is a critical component of this Study. This includes input from the community, the Navajo government and leaseholders.

Navajo Nation Fair – On Thursday, September 4 and Friday, September 5, 2014, the consultant team hosted a booth at the Navajo Nation Fair. Presentation boards displaying the six proposed alignment alternatives and the N100 west extension were displayed and comment forms were handed out. Over 60 comment forms were filled out over the two day period and are provided in **Appendix A**.

Public Meeting – On Wednesday, September 24, 2014 two public meetings were held at NDOT, one at 9:00 am and another at 1:00 pm. Consultant staff presented the project purpose and description. Meeting attendees were given the opportunity to voice their input and concerns. They were also provided comment cards. The public meetings were advertised on KTNN Radio, KHAC Radio, the Navajo Times Newspaper, Facebook, flyers and invitations mailed to specific government agencies. See **Appendix A** for additional details.



Navajo Nation Fair



Public Meeting

Table 7-1 - Community Input Summary

	Favorable		Unfavorable	
	Number	Percent	Number	Percent
N100 West Extension	5	45%	6	55%
Alternative 2	7	70%	3	30%
Alternative 3	15	88%	2	12%
Alternative 4	3	18%	14	82%
Alternative 5	8	40%	12	60%
Alternative 6	7	54%	6	46%
Alternative 7	15	100%	0	0%
Roundabout	30	73%	11	27%



N100 West Extension – Five in favor and six opposed. The area south of St. Michael housing is fenced off and posted with a “no trespassing” sign. Four impacted families living along this alignment are opposed to this route due to a reduction and bisecting of grazing land. The area is an active livestock grazing land and would require land holder consent, archaeological/cultural clearance and approval from the St. Michaels Chapter and the Grazing Committee.

Alternative 2 – Seven (7) in favor and three (3) opposed. This alternative received seventy percent (70%) support from the community.

Alternative 3 – Fifteen (15) in favor and two (2) opposed. This alternative received eighty-eight percent (88%) support from the community. Alternative 3 received a positive feedback from the public for the following reasons: minimal work with land holders, minimal impact on existing property owners, utilization of existing roadways and a lower construction cost compared to other alternatives.

Alternative 4 – Three (3) in favor and fourteen (14) opposed. Eighty-two percent (82%) of the feedback received were in opposition to this alternative mainly due to existing home site leases along the alignment, existing grazing permits, and an on-going range management plan being conducted. Four families living in the area are opposed to the alignment. This alignment would require land holder consent, archaeological/cultural clearance and approval from the St. Michaels Chapter and Grazing Committee.

Alternative 5 – Eight (8) in favor and twelve (12) opposed. Sixty percent (60%) of the feedback received were in opposition for similar reasons as Alternative 4. This alignment would require land holder consent, archaeological/cultural clearance and approval from the St. Michaels Chapter and Grazing Committee.

Alternative 6 – Seven (7) in favor and six (6) opposed. Two families are opposed to the alignment. However, fifty-four percent of the feedback received was in favor of this alternative. This alignment would require land holder consent and approval from the St. Michaels Chapter and Grazing Committee.

Alternative 7 – Fifteen (15) in favor and none (0) opposed. This alternative received one hundred percent (100%) support from the community. This roadway alignment was viewed favorably by the public for the following reasons: no impact to land holders in terms of grazing permits or home site leases and utilization of existing roadways.

Roundabout – Thirty (30) in favor and eleven (11) opposed. Roundabouts received seventy-three percent (73%) support from the community.

A majority of community members welcome the reconstruction of N100, many favored the approach of improving the existing roads rather than constructing new roads. They also agreed with the benefits of creating a secondary route into and out of the Tribal governmental complex area. The popular opinion holds N100 as a prominent route which needs to be improved as a matter of pride and significance



because the route leads to the Tribal governmental complex area including the Navajo Nation Council Chambers, the office of the Navajo Nation President and Vice President, the veterans and Navajo Code Talkers memorial, and the monument of Window Rock itself.



8.0 Environmental Considerations and Impacts

The environmental considerations and impacts analyzed as part of this Study includes a review of existing biological and cultural resources databases and identification of potentially jurisdictional waters. Following the feasibility study, during the design engineering phase of the project development, the National Environmental Policy Act (NEPA) documentation will be developed, and compliance with all applicable regulations, including, but not limited to the Endangered Species Act (ESA), the National Historic Preservation Act, and the Clean Water Act (CWA) will be demonstrated.

8.1 Analysis Area

The analysis area for the environmental considerations is contained within Township 16 North, Range 31 East, Sections 5, 6, 7, 8, 17, and 18, in Apache County, Arizona, and is defined as:

- State Route 264 (SR 264) as the southern boundary
- two miles (3.2 km) west of Navajo Route 12 (N12) for the western boundary
- two miles (3.2 km) east of N12 for the eastern boundary
- three miles (4.8 km) north of SR 264 as the northern boundary

Following is a summary of the environmental considerations for biological and cultural resources and the efforts to date in identifying potentially jurisdictional waters. A more detailed Records Research Report is included in **Appendix B**.

8.2 Biological Resources

The available literature and database documentation of biological resources within the Analysis Area were reviewed for an initial understanding of compliance with the ESA, the Navajo Natural Heritage Program (NNHP), the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. The review was based on existing information including species abstracts, online review tools, special status species lists by county, and communications with resource experts and agency personnel. The biological review addresses the U.S. Fish and Wildlife Service (USFWS) listed species in Apache County and NNHP listed species.

A determination of the potential for a special-status species to occur in the Analysis Area was made, based on the literature and database review. The potential to occur was identified as present, possible, unlikely, or none.

Currently there are two endangered species, three threatened species, one proposed threatened species, one candidate species, and two species listed as nonessential, experimental populations (EXPN) on the USFWS Special-Status Species list. The listing status, known range, habitat requirements, and the potential for occurrence of each Special-Status Species were evaluated. Results of the screening analysis indicate no USFWS Special-Status Species have potential to occur, and no critical habitat is documented within the Analysis Area.



NNDFW NNHP maintains the list of species identified as endangered on the Navajo Nation, which was last updated September 10, 2008. The NNHP also maintains a list of species considered sensitive by the Navajo Nation. Analysis Area specific data has been reviewed and there are four species or subspecies in danger of being eliminated from all or a significant portion of its range on the Navajo Nation, four species or subspecies likely to become an endangered species within the foreseeable future, and twelve2 species or subspecies for which NNFW does not currently have sufficient information to support their being listed in either of the other two categories but has reason to consider them. Results of the screening analysis indicate one NNDFW NNHP listed species may possibly occur and three are unlikely to occur within the Analysis Area.

A review of the NNDFW biological sensitivity coverage shows the majority of the analysis area is identified as Community Development without an associated sensitivity. In general, the remainder of the area is identified as low sensitivity for biological resources, with a small portion in the north east of the analysis area considered high sensitivity.

A Biological Assessment will be documented in support of the next phase of the project.

8.3 Cultural Resources

A Class I cultural resources review was conducted at the Cultural Resources Compliance Section office in Window Rock on September 2, 2014. For the analysis area and a 100-meter buffer zone, 47 previously conducted projects were identified. The available information for each project was reviewed. During this review, a number of anomalies in the available information were documented and additional information requested of the Cultural Resources Compliance Section. To date, the additional information has not been received.

The review identified two known archaeological sites, one encompassing the Window Rock and the other located in the Tribal government complex near the Window Rock. Alternatives considered should avoid these sites.

Additional pedestrian surveys will be needed in support of the next phase of the project.

8.4 Clean Water Act

Based on preliminary discussion with the U.S. Army Corps of Engineers (Corps), it is likely that the ephemeral drainages in the analysis area may be considered waters of the U.S. subject to regulation by the Corps and waters of the Navajo Nation subject to regulation by the Navajo Nation Environmental Protection Agency (NNEPA). Should any design alternative impact an ephemeral drainage that possesses the characteristics of an Ordinary High Water Mark, it is likely that construction of that alternative will require that BIA obtain a Section 404 permit from the Corps and Section 401 water quality certification from NNEPA.



8.5 National Environmental Policy Act (NEPA)

A review of the BIA NEPA guidance and the environmental considerations undertaken to date, indicate an environmental assessment may be required to demonstrate NEPA compliance. However, this is the purview of the BIA to determine.



9.0 Traffic Analysis

This section presents the assumptions and results of the traffic analyses for the study area bounded by SR 264 to the south, the Arizona/ New Mexico state line to the east, Rocky Ridge Road to the north, and Mustang Road to the west. The objective of the traffic analysis is to evaluate the main roadway network within the study area for both the existing and future conditions focused on traffic operations with a goal of maintaining a level of service of A/B. The study evaluates a secondary access into and out of the Tribal government complex area and provides short-term, mid-term and long-term recommendations to provide acceptable levels of traffic operations.

9.1 Existing Conditions

The study area is approximately 2.6 square miles (6.7 km), located in the community of Window Rock, Arizona north of SR 264 and continuing for approximately two miles (3.2 km), straddling Route N12. Access to the Tribal government buildings located along N100 (Window Rock Boulevard) is of particular focus for this study. **Sections 2.1** and **2.2** provide detailed descriptions of the study roadway segments and intersections. See **Figure 2-1**.

9.1.1 Crash Analysis

Crash data was received from ADOT and the BIA for the six year period from 2007 to 2012 for the following locations:

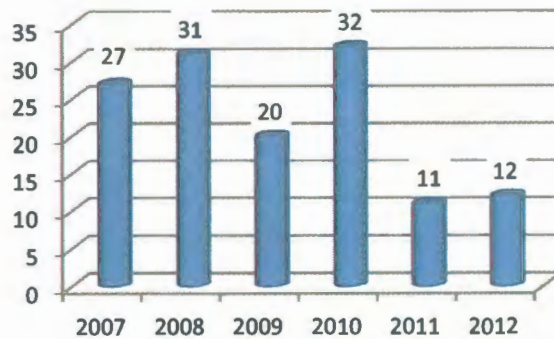
- SR 264, between Mustang Road and Window Rock Loop Road
- N12, from SR 264 to Rocky Ridge Road
- N100, east of N12
- Morgan Road, west of N100

During the six year period there were 133 recorded crashes. The highest number of crashes occurred in 2010, with a total of 32 crashes. A total of 108 (81%) crashes occurred during daylight and 25 (19%) during the night. The highest hour of the day was from 5 pm to 6 pm, where 13 crashes occurred. Of the 133 recorded crashes, 40 (30%) resulted in injuries and 10 (7.5%) resulted in fatalities. The remaining 83 (62.5%) crashes were property damage only. A total of 105 (79%) crashes occurred during clear conditions and **rear ends** were the more common crash type with a total of 39 (29%).

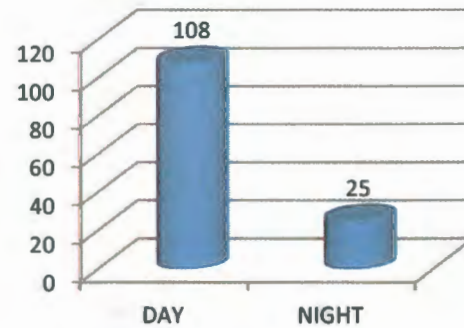
The *N-12 Navajo Nation Road Safety Audit* performed by Opus Hamilton Consultants Ltd. in 2007 reported that the close proximity of the N12 and Shonto Boulevard intersection to the N12 and N100 (Window Rock Boulevard) intersection negatively impacted the operation and increased the risk of conflicts at both of these intersections. This condition may be a contributor to the rear end and other crashes reported at these two intersections. See **Figure 9-1** for a collision diagram and **Appendix C** for detailed crash data.



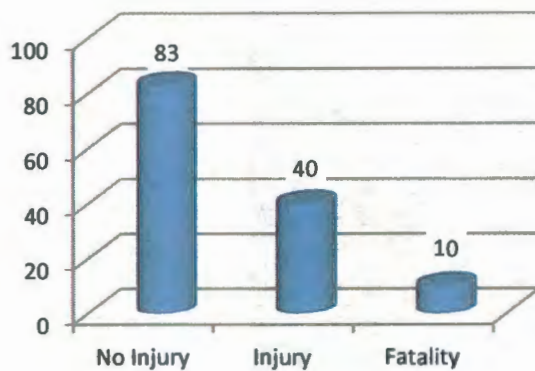
Crash Frequency



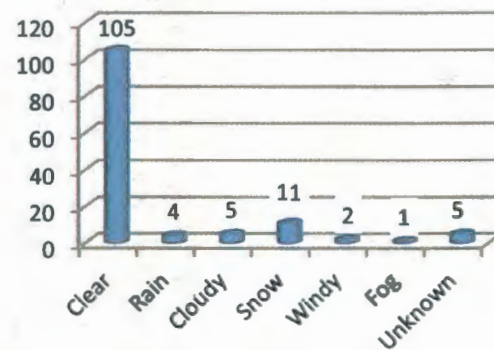
Time of Day



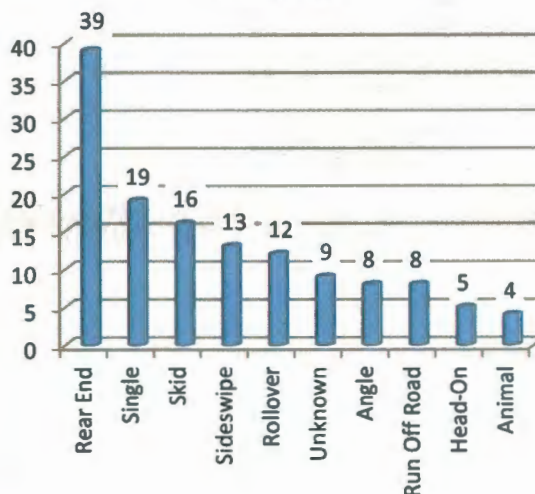
Severity



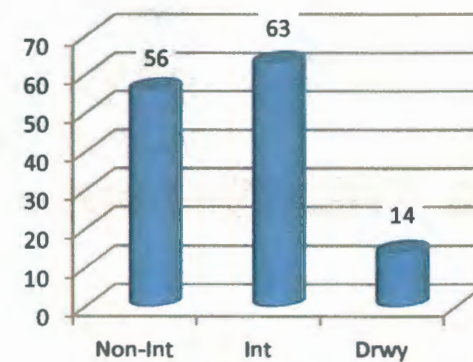
Weather Conditions

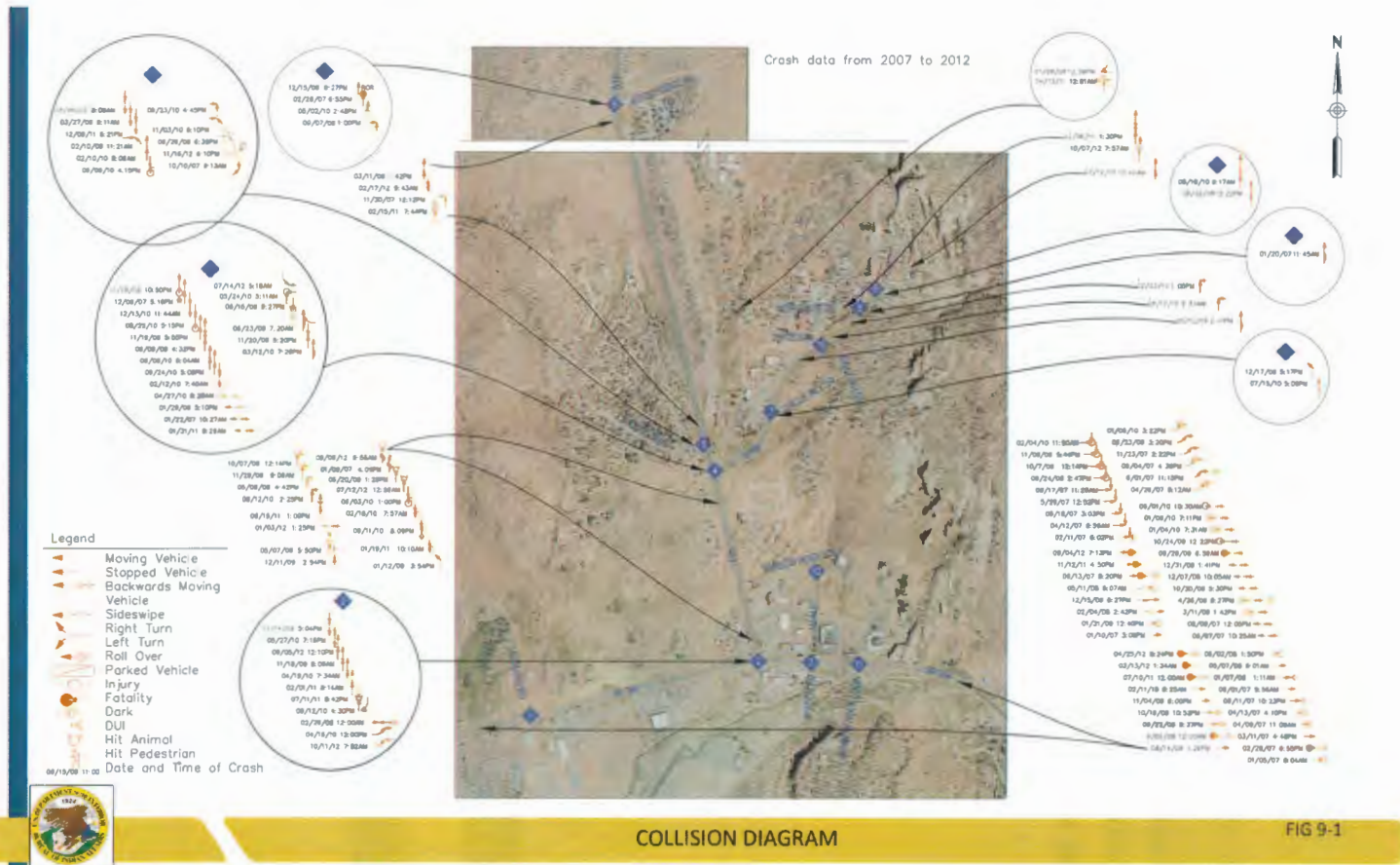


Collision Type



Collision Location







9.1.2 Existing Traffic Counts

An Arizona traffic data collection firm, Traffic Research and Analysis, Inc. (TRA) was utilized to collect traffic counts. Beginning on Saturday, August 16, 2014 and ending on Friday, August 22, 2014, a 7-day classification, bi-directional tube counts for 24-hours in 15-minute intervals was collected at ten (10) locations:

- Mustang Rd north of SR 264
- SR 264 west of N12
- N12 north of SR 264
- Main Street north of SR 264
- N100 east of N12
- Shonto Boulevard west of N12
- Circle Hill Drive east of N100
- N100 (Window Rock Boulevard) north of N100 (loop)
- N100 (loop) east of N100 (Window Rock Boulevard)
- Rocky Ridge Road east of N12

See **Appendix D** for detailed 24-hr count data.

The 7-day counts were then utilized to identify peak days and hours to collect turning movement counts. The count data showed Wednesday to be the highest traffic volume day of the week. Analyzing the count data, the following times were determined for turning movement count data collection:

- | | |
|-----------------------|--------------------|
| • AM Peak Period | 7:30 am – 9:30 am |
| • Mid-Day Peak Period | 11:30 am – 1:30 pm |
| • PM Peak Period | 3:30 pm – 5:30 pm |

Turning movement counts were obtained at the nine (9) study intersections using Miovision cameras on Wednesday, September 10, 2014. See **Appendix E** for detailed turning movement count data.

- SR 264 and Mustang Road (1)
- SR 264 and N12 (2)
- SR 264 and Main Street/Beacon Road (3)
- N12 and N100 (4)
- N12 and Shonto Boulevard (5)
- N12 and Rocky Ridge Road (6)
- N100 (Window Rock Boulevard) and Circle Hill Drive (Police/Fire driveway) (7)
- N100 (Window Rock Boulevard) and Morgan Boulevard (8)
- N100 (Window Rock Boulevard) and N100 (loop) (9)



The turning movement counts were then analyzed for the highest 1-hour within each time period. The AM and PM peak periods had significantly higher traffic counts when compared to the mid-day count. Therefore, the AM and PM peak hours were carried forward for analysis for this study.

- AM Peak Hour 7:30 am – 8:30 am
- PM Peak Hour 4:30 pm – 5:30 pm

The existing turning movement counts for the above peak hours were “balanced” and adjusted to achieve mathematically consistent data. For example, where there are consecutive intersections with no other access points between them, traveling from one intersection to the other must match.

When traffic count data was collected, the existing Administration Building No. 1 and Administration Building No. 2 were under renovation. Therefore all employees were temporarily relocated. Additionally the residents of AZ 1204 Housing were temporarily relocated to treat mold. Therefore, trip generation calculations were utilized to incorporate these trips into the existing traffic volumes. The traffic volumes generated for these facilities were determined from the transportation planning data taken from the Institute of Transportation Engineer’s (ITE) publication titled Trip Generation 9th Edition. This publication is considered to be the standard for the transportation engineering profession. The ITE rates are based on studies that measured the trip generation characteristics for various types of land uses. The rates are expressed in terms of vehicular trips per unit of land use. The following ITE trips rate codes were used:

- Administration Building No. 1 – ITE Code 710 – General Office Building
- Administration Building No. 2 – ITE Code 710 – General Office Building
- AZ 1204 Housing – ITE Code 210 – Single Family Housing

See Table 9-1 for the trip generation calculations.

Table 9-1 - Trip Generation for Existing Traffic

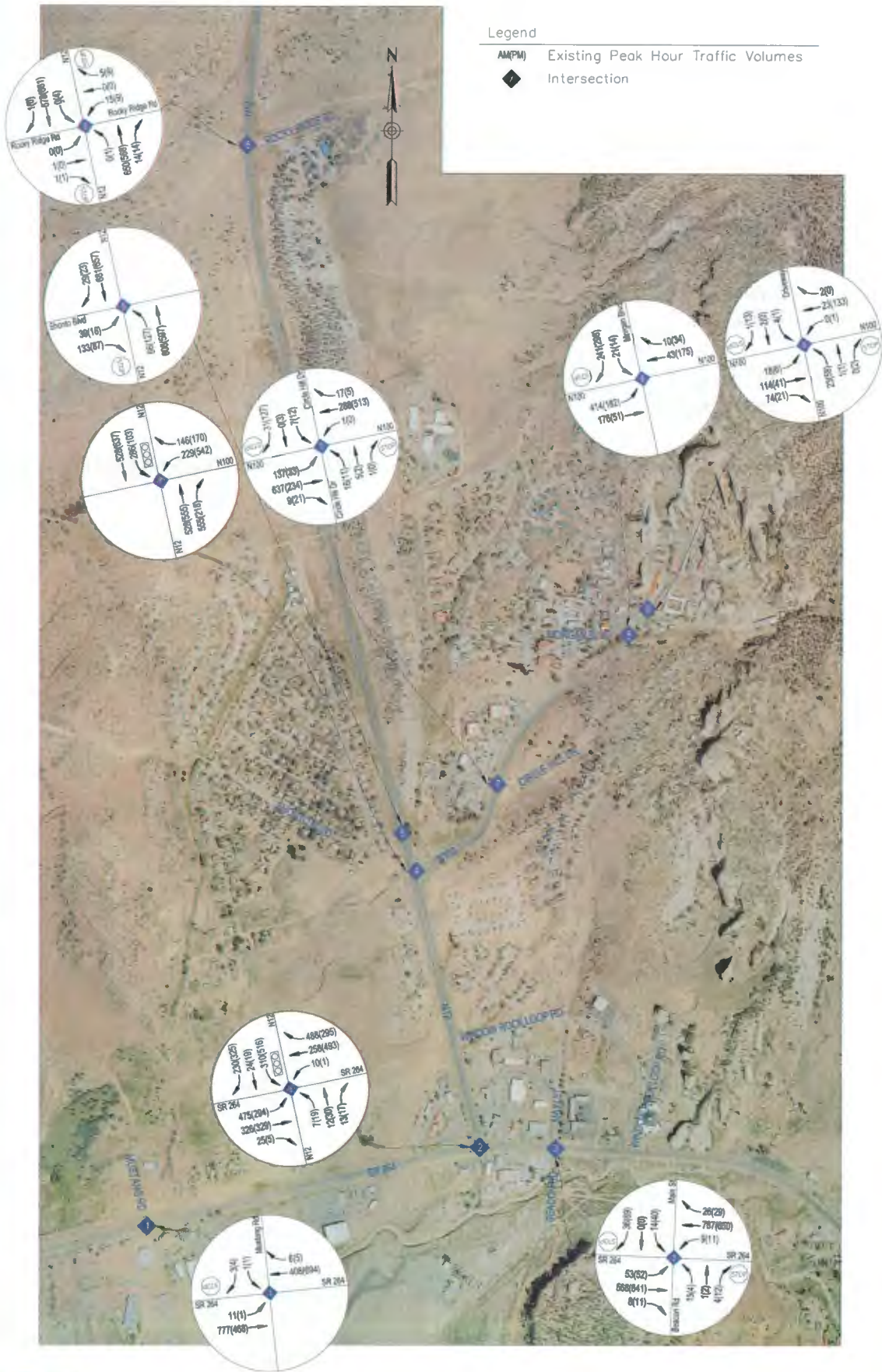
Land Use	ITE Code	Units	AM		PM	
			In	Out	In	Out
Administration Building No. 1	710	38,700 Sq Ft	53	7	10	48
Administration Building No. 2	710	38,700 Sq Ft	53	7	10	48
AZ 1204 Housing	210	40 Units	8	22	25	15
TOTAL			114	36	45	111



These calculated trips were then distributed based on the distribution patterns of the traffic count data. The following distribution was calculated and used for the AM(PM) peak hours:

<u>To North</u>	<u>From North</u>
38%(23%)	34%(28%)
<u>To West</u>	<u>From West</u>
26%(28%)	32%(35%)
<u>To East</u>	<u>From East</u>
36%(49%)	34%(37%)

These trips were added to the peak hour turning movement counts. See **Figure 9-2** for the existing traffic volumes.



2014 EXISTING TRAFFIC VOLUMES

FIG 9-2



9.1.3 Existing Capacity Analysis

The capacity and level of service for the study area intersections were evaluated for the AM and PM peak hours using the methodology presented in the 2010 Highway Capacity Manual. Traffic analysis software, PTV VISTRO 3.0, was used to perform the analyses. For the signalized intersection of SR 264 and N12 the existing signal timing was provided by ADOT. See **Appendix F** for detailed signal timing sheets. For the signalized intersection of N12 and N100 (Window Rock Boulevard) no signal timing sheets were provided, so a simple single timing sequence was assumed. The results of the capacity analysis reveal the following locations with an existing level of service (LOS) C or worse:

SR 264 and N12 (2)

- NB left AM and PM peak hour operates at LOS E
- NB shared through-right AM and PM peak hour operates at LOS D and E, respectively
- SB left AM and PM peak hour operates at LOS D
- SB through AM and PM peak hour operates at LOS D
- SB right AM and PM peak hour operates at LOS F
- EB left AM and PM peak hour operates at LOS D and E, respectively
- EB through AM and PM peak hour operates at LOS C
- EB shared through-right AM and PM peak hour operates at LOS C
- WB left AM and PM peak hour operates at LOS E and F, respectively
- WB through AM and PM peak hour operates at LOS D and F, respectively
- WB shared through-right AM and PM peak hour operates at LOS F
- **Overall Intersection AM and PM peak hour LOS F**

N12 and N100 (Window Rock Boulevard) (4)

- SB left AM and PM peak hour operates at LOS F
- WB left AM and PM peak hour operates at LOS D and C, respectively
- WB right AM and PM peak hour operates at LOS C
- **Overall Intersection AM and PM peak hour is LOS F and C, respectively**

N12 and Shonto Boulevard (5)

- EB left AM and PM peak hour operates at LOS C

N100 (Window Rock Boulevard) and Circle Hill Drive (Police/Fire driveway) (7)

- NEB shared left-through-right AM peak hour operates at LOS C

See **Figure 9-3** for the AM and PM peak hour capacity analysis. LOS C and D are shown in green, and LOS E and F are shown in red. The detailed capacity analysis sheets can be found in **Appendix G**.



Currently the intersections of SR 264 and N12, and N12 and N100 (Window Rock Boulevard) are operating at a LOS F during the peak hours. This means that there are more vehicles arriving than can be processed through the intersection resulting in delays and queuing at the intersections. This condition will worsen with growth and development. Immediate improvement is necessary to provide acceptable levels of service at these two intersections.



9.2 Future (2034) Conditions

The future (2034) analysis assumes the build out of the developments discussed in detail in Section 3.3 and shown in Figure 3-1.

9.2.1 Future Development Traffic Volumes

The traffic volumes generated by future developments are determined from the ITE publication titled Trip Generation, 9th Edition and previously described in Section 9.1.2. The following ITE trips rate codes were used:

- Supreme Court Complex – ITE Code 710 – General Office Building
- Administration Building No. 3 – ITE Code 710 – General Office Building
- Commercial Development (Near Convention Center) – ITE Code 820 – Shopping Center
- Commercial Development (Along Alternative 2) – ITE Code 820 – Shopping Center
- Camp/RV Park – ITE Code 416 – Campground Recreational Vehicle Park

There is no trip generation data in the ITE manual for a convention center or similar use. Consequently, assumptions were made based on research of other convention center trip generation calculations, and attendance and travel characteristics of the Window Rock area. A rate of 1.4 AM peak hour trips per 1000 square feet (93 square meters) of gross floor area was used with 88% entering, and a rate of 1.65 PM peak hour trips per 1000 square feet (93 square meters) of gross floor area was used with 17% entering.

See [f](#) for the trip generation calculations for the proposed future developments.

Table 9-2 - Trip Generation for Future Developments

Land Use	ITE Code	Units	AM		PM	
			In	Out	In	Out
Supreme Court Complex	710	60,000 Sq Ft	83	11	15	74
Administration Building No. 3	710	38,700 Sq Ft	53	7	10	48
Commercial Development (Near Convention Center)	820	45,000 Sq Ft	27	16	80	87
Commercial Development (Along Alternative 2)	820	45,000 Sq Ft	27	16	80	87
Camp/RV Park	416	60 Sites	5	8	10	6
Convention Center	N/A	150,000 Sq Ft	185	25	46	224
TOTAL			380	83	241	526



9.2.2 Background Growth

The 2008 Navajo Region Road Inventory Field Data Module (RIFDS) estimates a two percent annual traffic growth rate for all Navajo-BIA roads. Similarly ADOT also estimates and uses a two percent annual growth rate for all state routes on the Navajo and Hopi reservations. However, according to the census of 2000 there were 3,059 residents living in the Window Rock area, and the census of 2010 reported a population of 2,712 residents, which is a decrease of approximately 12% over 10-Years. Therefore, for the purposes of this study, it was determined that a one percent annual growth rate was more realistic. The one percent annual growth rate was applied to all traffic volumes along SR 264 and N12.

9.2.3 Future Base Assumptions

N100 Improvements

The proposed improvements along N100 are included in each future analysis, with the exception of the No Build analysis. These improvements consist of the following:

- The intersection of N12 and N100 (Window Rock Boulevard) (4) will be converted from a signalized intersection to a roundabout.
- The intersection of N100 (Window Rock Boulevard) and Navajo Hill Drive (19) will be realigned and constructed as a roundabout.

Optimized Signal Timing

As traffic patterns change, routine modifications to optimize signal timing should occur. The future (2034) analyses incorporate optimized signal timing.

9.3 Future (2034) No Build Alternative

This alternative analyzes the future (2034) traffic volumes if no improvements were made to the Window Rock area, while future development and background growth continued to occur.

9.3.1 Future (2034) No Build Traffic Volumes

The trips for the future developments were distributed based on the existing traffic patterns as previously described in **Section 9.1.2**. These trips were then added to the future (2034) background traffic volumes which were obtained by applying a one percent annual growth rate to the existing traffic volumes along SR 264 and N12. See **Figure 9-4**.



9.3.2 Future (2034) No Build Capacity Analysis

The results of the capacity analysis reveal the following locations with an existing level of service (LOS) C or worse:

SR 264 and N12 (2)

- NB left AM and PM peak hour operates at LOS E
- NB shared through-right AM and PM peak hour operates at LOS E
- SB left AM and PM peak hour operates at LOS D
- SB through AM and PM peak hour operates at LOS D and C, respectively
- SB right AM and PM peak hour operates at LOS F
- EB left AM and PM peak hour operates at LOS F and D, respectively
- EB through AM and PM peak hour operates at LOS C
- EB shared through-right AM and PM peak hour operates at LOS C
- WB left AM and PM peak hour operates at LOS E and F, respectively
- WB through AM and PM peak hour operates at LOS D and F, respectively
- WB shared through-right AM and PM peak hour operates at LOS F
- **Overall Intersection AM and PM peak hour LOS F**

SR 264 and Main Street/Beacon Road (3)

- NB shared left-through-right AM and PM peak hour operates at LOS E and D, respectively
- SB shared left-through-right AM and PM peak hour operates at LOS C and F, respectively

N12 and N100 (Window Rock Boulevard) (4)

- SB left AM and PM peak hour operates at LOS F
- WB left AM and PM peak hour operates at LOS C
- WB right AM and PM peak hour operates at LOS C
- **Overall Intersection AM and PM peak hour LOS F and C, respectively**

N12 and Shonto Boulevard (5)

- EB left AM and PM peak hour operates at LOS E and C, respectively

N12 and Rocky Ridge Road (6)

- WB shared left-through-right AM peak hour operates at LOS C

N100 (Window Rock Boulevard) and Circle Hill Drive (Police/Fire driveway) (7)

- NEB shared left-through-right AM peak hour operates at LOS C
- EB left PM peak hour operate at LOS C



See Figure 9-5 for the AM and PM peak hour future (2034) no build capacity analysis. LOS C and D are shown in green, and LOS E and F are shown in red. The detailed capacity analysis sheets can be found in Appendix H.

Since the intersections of SR 264 and N12, and N12 and N100 (Window Rock Boulevard) currently operate at a LOS F during the peak hours, with future development and growth and no improvements made to the roadway and intersections the conditions worsens. Delays and queuing at these intersections increase.

Additionally, the future (2034) no build analysis shows that the stop-controlled intersection of SR 264 and Main Street/Beacon Road is impacted as drivers look for alternatives routes to avoid the failing intersections. The southbound movement at Main Street/Beacon Road operates at a LOS F during the PM peak hour and the northbound movement operates at a LOS E during the AM peak hour.



9.4 Future (2034) Alternative 3

The existing and future (2034) no build analysis reveal that the greatest area needing improvements and a reliever route is to the south of N100 (Window Rock Boulevard) and to the west of N12. Therefore, of the six (6) alternatives, Alternatives 2, 3 and 6 fall in this area. Alternative 3 provides a direct reliever for traffic along N100 (Window Rock Boulevard) and N12. Therefore, is an appropriate alternative to evaluate.

This alternative analyzes construction of a connector road from the intersection of Window Rock Loop Road and Main Street (12) to N100 (Window Rock Boulevard).

9.4.1 Future (2034) Alternative 3 Traffic Volumes

The trips of the future developments were distributed based on both the existing traffic patterns, along with the new roadway connected provided by Alternative 3. These trips were then added to the future (2034) background traffic volumes which were obtained by applying a one percent annual growth rate to the existing traffic volumes along SR 264 and N12. See Figure 9-6.

9.4.2 Future (2034) Alternative 3 Capacity Analysis

All intersections operate at a LOS D or better for both the AM and PM peak hours.

In addition to the Alternative 3 alignment and improvements described in Section 9.2.3, the following improvements were made to improve the level of service:

SR 264 and N12 (2)

- WB dual right-turn lanes added
- SB through lanes converted to a shared through-right turn lane

SR 264 and Main Street/Beacon Road (3)

- SB dedicated left turn lane added

N12 and Shonto Boulevard (5)

- EB dedicated left turn lane added

N100 (Window Rock Boulevard) and Morgan Boulevard (8)

- SB dedicated right turn lane added
- EB dedicated left turn lane added



SR 264 and Window Rock Loop Road (11)

- WB dedicated right turn lane added
- SB dedicated left turn lane added
- Traffic signal added

Window Rock Loop Road and Main Street (12)

- Roundabout added

All intersections operate at an overall LOS D or better during the AM and PM peak hours, which is often considered an acceptable level of service. The following are locations with a level of service (LOS) C or worse:

SR 264 and N12 (2)

- NB left AM and PM peak hour operates at LOS E
- NB shared through-right AM and PM peak hour operates at LOS E
- SB left AM and PM peak hour operates at LOS E and D, respectively
- SB shared through-right AM and PM peak hour operates at LOS D and E, respectively
- SB right AM and PM peak hour operates at LOS D and E, respectively
- EB left AM and PM peak hour operates at LOS D and E, respectively
- EB through AM and PM peak hour operates at a LOS D and C, respectively
- EB shared through-right AM and PM peak hour operates at LOS D and C, respectively
- WB left AM and PM peak hour operates at LOS E
- WB through AM and PM peak hour operates at LOS D
- WB right AM and PM peak hour operates at LOS D
- Overall Intersection AM and PM peak hour LOS D

SR 264 and Main Street/Beacon Road (3)

- NB shared left-through-right AM and PM peak hour operates at LOS C
- SB left AM and PM peak hour operates at LOS C and D, respectively
- SB shared through-right PM peak hour operates at LOS C

N12 and Shonto Boulevard (5)

- EB left AM and PM peak hour operates at LOS C

N12 and Rocky Ridge Road (6)

- Overall Intersection AM and PM peak hour LOS C



N100 (Window Rock Boulevard) and Morgan Boulevard (Police/Fire driveway) (8)

- SB left AM peak hour operates at LOS C

SR 264 and Window Rock Loop Road (11)

- SB left AM peak operates at LOS C
- WB left PM peak operates at LOS C

See **Figure 9-7** for the AM and PM peak hour capacity analysis. LOS C and D are shown in green, and LOS E and F are shown in red. The changes and improvement necessary are also highlighted in red. The detailed capacity analysis sheets can be found in **Appendix I**.



9.5 Future (2034) N100 West Extension and Alternative 3

This analysis looks at the impacts if both the N100 West Extension and Alternative 3 were constructed.

9.5.1 Future (2034) N100 West Extension and Alternative 3 Traffic Volumes

The trips of the future developments were distributed based on both the existing traffic patterns, along with the new roadway connections provided by N100 West Extension and Alternative 3. These trips were then added to the future (2034) background traffic volumes which were obtained by applying a one percent annual growth rate to the existing traffic volumes along SR 264 and N12. Therefore, adding the extension of the roundabout to the west and tying into SR 264, has little impact to the traffic operations until further development takes place toward the west. See **Figure 9-8**.

9.5.2 Future (2034) N100 West Extension and Alternative 3 Capacity Analysis

All intersections operate at a LOS D or better for both the AM and PM peak hours.

The additional improvements are identical to the Alternative 3 analysis and the capacity analysis is nearly identical. The N100 West Extension alignment serves the west side of N12. However, all future developments are to the east of N12. Therefore adding N100 West Extension does not result in any significant impact to traffic operations.

See **Figure 9-9** for the AM and PM peak hour capacity analysis. LOS C and D are shown in green, and LOS E and F are shown in red. The changes and improvement necessary are also highlighted in red. The detailed capacity analysis sheets can be found in **Appendix J**.



9.6 Preferred Alternative – Alternative 3

Alternative 3 provides the greatest impact to improving traffic operations in and around the Window Rock area. Ultimately, the necessary improvements for this alternative include:

Alternative 3

- Construct roadway alignment with one lane for each direction of travel and a center two-way left-turn lane

SR 264 and N12 (2)

- WB dual right-turn lanes added
- SB through lanes converted to a shared through-right turn lane

SR 264 and Main Street/Beacon Road (3)

- SB dedicated left turn lane added

N12 and N100 (Window Rock Boulevard) (4)

- Two lane roundabout

N12 and Shonto Boulevard (5)

- EB dedicated left turn lane added

N100 (Window Rock Boulevard) and Morgan Boulevard (8)

- SB dedicated right turn lane added
- EB dedicated left turn lane added

SR 264 and Window Rock Loop Road (11)

- WB dedicated right turn lane added
- SB dedicated left turn lane added
- Traffic signal added

Window Rock Loop Road and Main Street (12)

- Construct roundabout

N100 (Window Rock Boulevard) and Navajo Hill Drive (19)

- Construct roundabout



These improvements are to be constructed over the course of 20-years. In an effort to prioritize these improvements, a short-term (5-Year), mid-term (10-year) and long-term (20-year) analysis was conducted.

9.6.1 Short-Term (5-Year)

Short-Term (5-Year) Alternative 3 Traffic Volumes

The trips for the 5-Year future developments were calculated and distributed based on both the existing traffic patterns, along with the new roadway connection provided by Alternative 3. The future Supreme Court Complex is anticipated to be built out in five (5) years. The trips from the future Supreme Court Complex were then added to the future (2019) background traffic volumes which were obtained by applying a one percent annual growth rate for five (5) years to the existing traffic volumes along SR 264 and N12. See **Figure 9-10**.

Short-Term (5-Year) Alternative 3 Capacity Analysis

The following improvements are needed to be constructed in the short-term (between now and 5-Years):

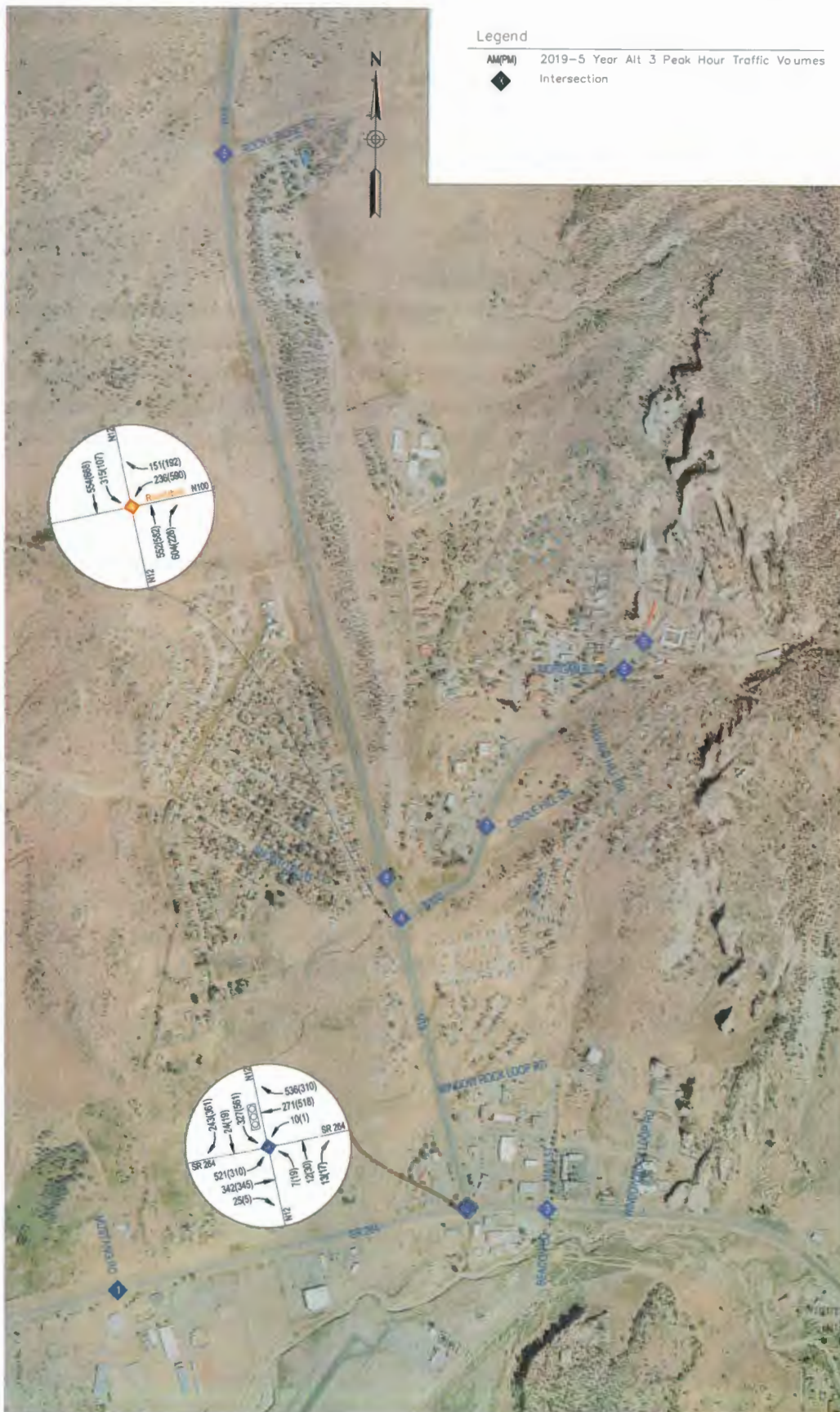
SR 264 and N12 (2)

- WB dual right-turn lanes added
- SB through lanes converted to a shared through-right turn lane

N12 and N100 (Window Rock Boulevard) (4)

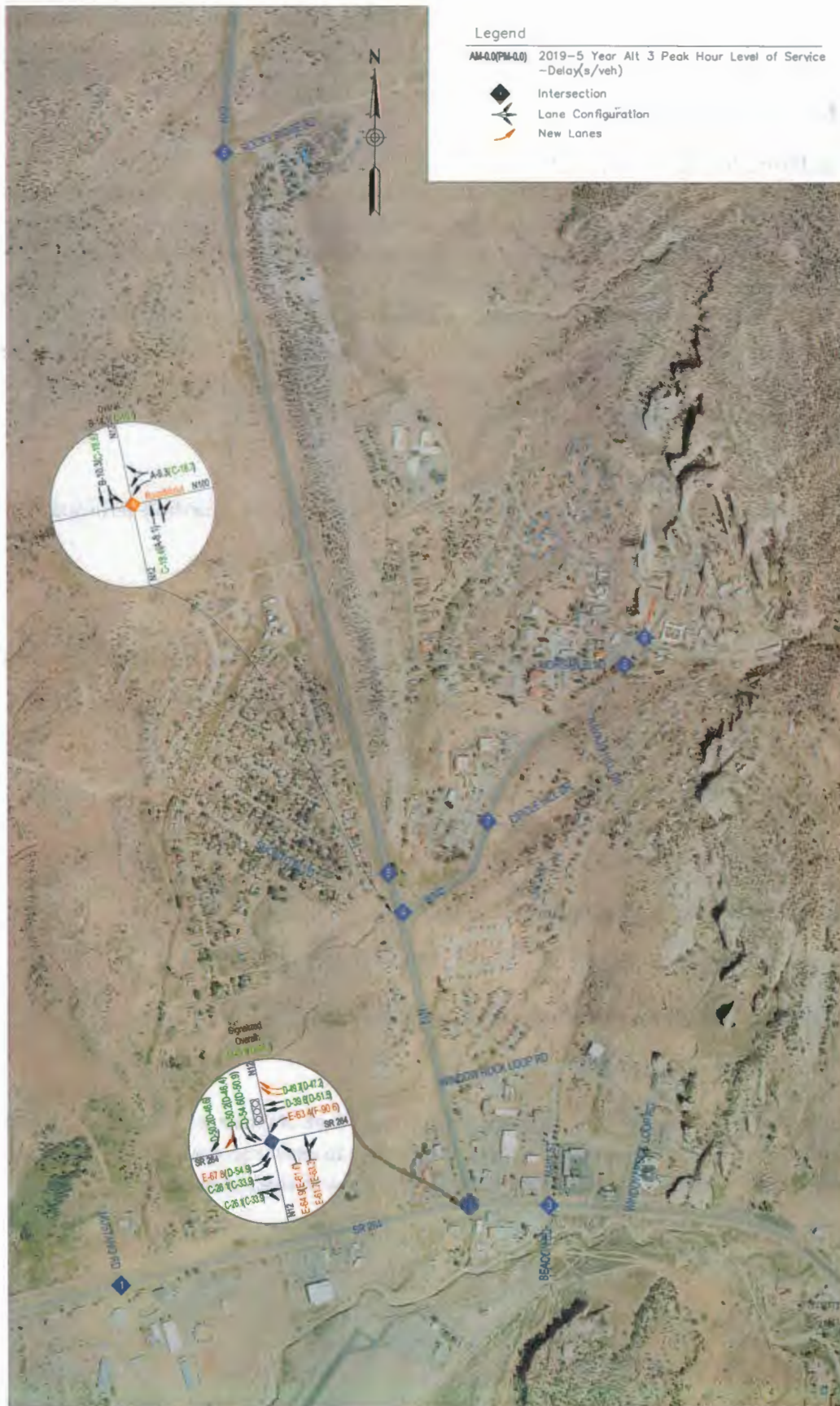
- Two lane roundabout

These two intersections are currently operating with overall intersection LOS F during the AM and/or PM peak hours. Therefore, these improvements are currently necessary. See **Figure 9-11** for the short-term (5-Year) capacity analysis with these improvements.



FUTURE (2019) 5-YEAR ALTERNATIVE 3 TRAFFIC VOLUMES

FIG 9-10





9.6.2 Mid-Term (10-Year)

Mid-Term (10-Year) Alternative 3 Traffic Volumes

The trips for the 10-year future developments were calculated and distributed based on both the existing traffic patterns, along with the new roadway connected provided by Alternative 3. The future Commercial Development (near the Convention Center) and the future Administration Complex Building No. 3 are anticipated to be built out in ten (10) years. The trips from the future Supreme Court Complex, Commercial Development (near the Convention Center) and Administration Complex Building No. 3 were then added to the future (2019) background traffic volumes which were obtained by applying a one percent annual growth rate for ten (10) years to the existing traffic volumes along SR 264 and N12. See **Figure 9-12**.

Mid-Term (10-Year) Alternative 3 Capacity Analysis

The following improvements are needed to be constructed between the short-term and mid-term (between 5-Years and 10-years):

Alternative 3

- Construct roadway alignment with one lane for each direction of travel and a center two-way left-turn lane

SR 264 and Window Rock Loop Road (11)

- WB dedicated right turn lane added
- SB dedicated left turn lane added
- Traffic signal added

Window Rock Loop Road and Main Street (12)

- Construct roundabout

N100 (Window Rock Boulevard) and Navajo Hill Drive (19)

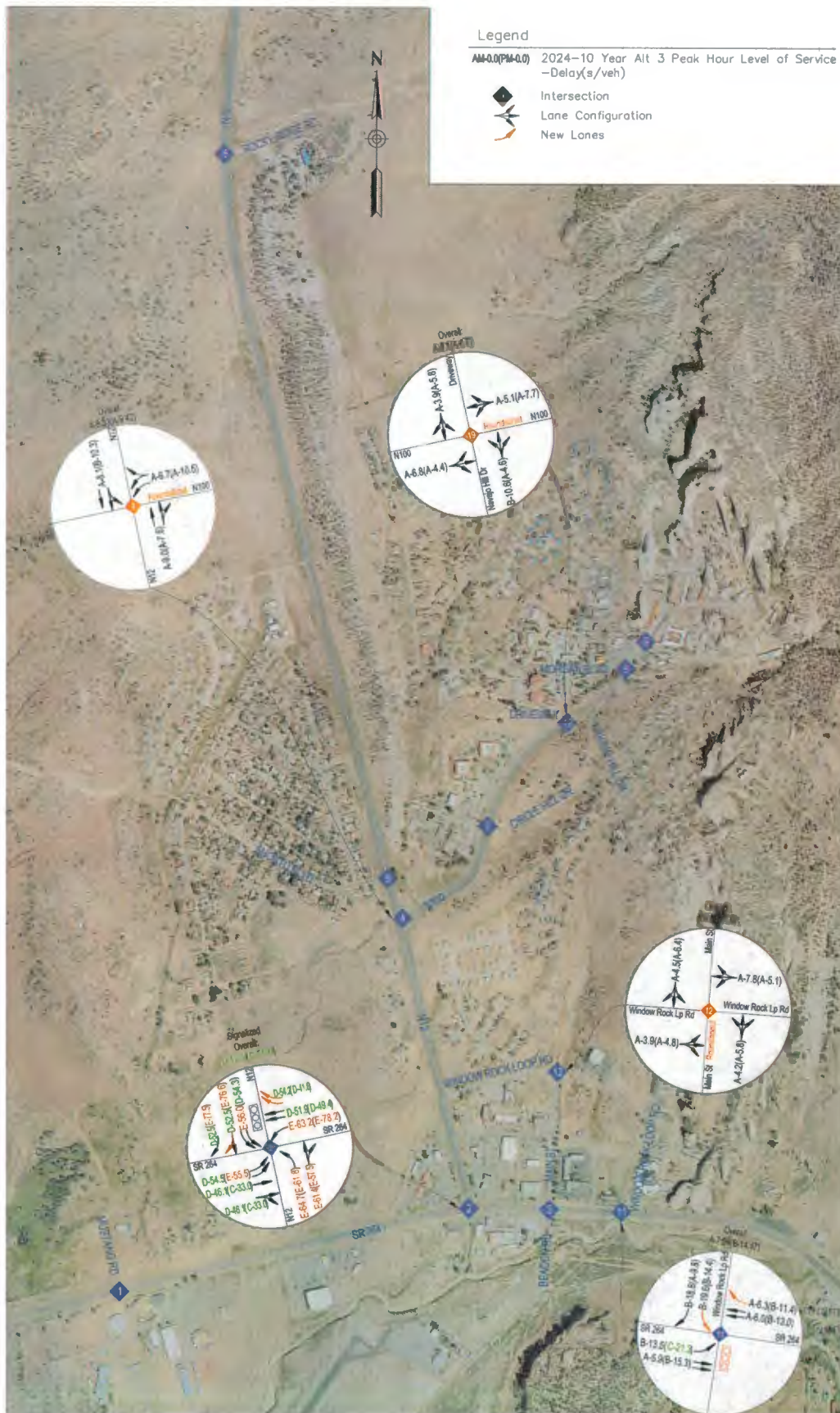
- Construct roundabout

Between the short-term (5-Year) and mid-term (10-year), all of the improvements associated with the Alternative 3 alignment will need to be constructed to ensure acceptable levels of service. See **Figure 9-13** for the mid-term (10-year) capacity analysis with these improvements.



FUTURE (2024) 10-YEAR ALTERNATIVE 3 TRAFFIC VOLUMES

FIG 9-12





9.6.3 Long-Term (20-Year)

Long-Term (20-Year) Alternative 3 Traffic Volumes

The long-term traffic volumes are shown in **Figure 9-6**. Traffic volumes from all future developments were added to the future (2034) background traffic volumes which were obtained by applying a one percent annual growth rate for twenty (20) years to the existing traffic volumes along SR 264 and N12.

Long-Term (20-Year) Alternative 3 Capacity Analysis

The remaining improvements are needed to be constructed between the mid-term and long-term (between 10-years and 20-years):

SR 264 and Main Street/Beacon Road (3)

- SB dedicated left turn lane added

N12 and Shonto Boulevard (5)

- EB dedicated left turn lane added

N100 (Window Rock Boulevard) and Morgan Boulevard (8)

- SB dedicated right turn lane added
- EB dedicated left turn lane added

Between the mid-term (10-year) and long-term (20-year), all of the remaining improvements will need to be constructed to ensure acceptable levels of service. See **Figure 9-7** for the long-term (20-year) capacity analysis with these improvements.



9.6.4 Multi-Modal

As part of the turning movement count data collection conducted on Wednesday, September 10, 2014, the pedestrian crossings were collected at the nine (9) intersections. See **Table 9-3**.

Table 9-3 - Pedestrian Count Data

Intersection		AM Peak Period	Mid-Day Peak Period	PM Peak Period
		7:30 – 9:30 am	11:30 am – 1:30 pm	3:30 – 5:30 pm
1	SR 264 and Mustang Road	0	4	7
2	SR 264 and N12	1	17	7
3	SR 264 and Main Street/Beacon Road	8	9	6
4	N12 and N100 (Window Rock Boulevard)	1	2	8
5	N12 and Shonto Boulevard	4	0	1
6	N12 and Rocky Ridge Road	0	1	2
7	N100 (Window Rock Boulevard) and Circle Hill Drive (Police/Fire driveway)	3	2	4
8	N100 (Window Rock Boulevard) and Morgan Boulevard	0	0	0
9	N100 (Window Rock Boulevard) and N100 (loop)	4	5	6

There are a number of advantages to creating a pedestrian and bike friendly environment including:

- **Health Benefits** – Regular physical activity provides the opportunity for healthier living, and can help to preventing heart disease, obesity, high blood pressure and diabetes.
- **Economic Benefits** – Walking and bicycling are a more affordable form of transportation over driving. In addition to reduced spending, studies show that bicycle and pedestrian facilities can increase home values, drive spending at local businesses and spur economic development.
- **Environmental Benefits** – Motor vehicles create air pollution. Walking and bicycling helps to reduce these harmful emissions.



Pedestrian and bicycle friendly improvements should be considered with these roadway improvement projects. A few improvements include:

- **Sidewalks** – Provide continuous sidewalks and ADA compliant ramps at intersections. This increases the attractiveness of walking and biking along a roadway. Roadways without sidewalks are also more than twice as likely to have pedestrian crashes as sites with sidewalks on both sides of the street.
- **Pedestrian and/or Roadway Lighting** – Install continuous pedestrian lighting or roadway lighting that will also provide lighting for pedestrians. Lighting can significantly help to reduce pedestrian related crashes. Furthermore, lighting encourages walking during dark or dusk and improves safety and comfort.
- **Bike Lanes** – Provide bike lanes along roadways. Bike riding is safer and more enjoyable with a rideable surface and designated area for bicycles.
- **Multi-Use Paths** – A multi-use path serves as part of a transportation circulation system and supports multiple recreation opportunities, such as walking, bicycling, and inline skating.



10.0 Preliminary Alternatives Screening

Based on the public feedback and the traffic analysis, the N100 West Connector, the six Preliminary Alternatives, along with a no build alternative were screened and narrowed down.

10.1 No Build Alternative

The traffic analysis for the existing conditions show that the intersections of SR 264 and N12, and N12 and N100 (Window Rock Boulevard) currently operate at a LOS F during the peak hours. Therefore, with future development and growth and no improvements made to the roadway and intersections the conditions worsen and Delays and queuing at these intersections increase. Additionally, the future (2034) no build analysis shows that the stop-controlled intersection of SR 264 and Main Street/Beacon Road is impacted as drivers look for alternative routes to avoid the failing intersections. The southbound movement at Main Street/Beacon Road operates at a LOS F during the PM peak hour and the northbound movement operates at a LOS E during the AM peak hour.

The No Build Alternative will amplify the existing failing traffic operations. Residents and other commuters in the area will experience extensive delays. The No Build Alternative is eliminated from further evaluation.

10.2 N100 West Extension

The N100 West Extension received some opposition (55%) from the public since it would result in a reduction and bisecting of grazing land. The intent of this roadway alignment is to provide a route for drivers coming and going to the west. The future (2034) no build traffic analysis showed that greatest area needing improvements and a reliever route is to the south of N100 and to the west of N12. Therefore, for the traffic analysis, the N100 West Extension was paired with the Alternative 3 alignment, which supports the area that requires traffic relief. **Although it would not provide a secondary route into the Tribal government complex and the traffic analysis did not result in significant impacts to traffic operations, the N100 West Extension is carried forward for evaluation based on the request of the BIA.** All of the future developments are to the east of N12, if in the future developments are planned to the west of N12, this roadway alignment should be re-evaluated as well.

10.3 Alternative 2

Alternative 2 was proposed based on the potential for future commercial development parcels adjacent to this roadway alignment. **Because there are no concepts or plans for future development adjacent to this roadway alignment in the near or distant (20-year) future, Alternative 2 is eliminated from further evaluation.**

10.4 Alternative 3

Alternative 3 received strong support from the public and showed to provide acceptable levels of service and traffic operation for the 20-year forecast (2034), therefore Alternative 3 is carried forward for further evaluation.



10.5 Alternative 4

Alternative 4 received much opposition (88%) from the public and would not significantly improve traffic operations. Therefore, Alternative 4 is removed from further evaluation.

10.6 Alternative 5

This alternative, similar to Alternative 4, and received much opposition (60%) from the public and would not significantly improve traffic operations. Therefore, Alternative 5 is removed from further evaluation.

10.7 Alternative 6

Alternative 6 received somewhat favorable public response (54%), however, this alignment is further east of Alternative 3 and 2. Therefore although it could improve traffic operations, Alternative 3 which is located adjacent to existing businesses and residents is the most effective and relevant alternative in this area. Therefore, Alternative 6 is removed from further evaluation.

10.8 Alternative 7

Alternative 7 received very (100%) favorable response from the public. Although the traffic study indicates that this alignment would not significantly improve traffic operations Alternative 7 is carried forward for further evaluation.



11.0 Drainage Analysis, Considerations and Impacts

The goal of the project is to develop alternatives for transportation corridors to relief congestion within Window Rock, Arizona. As part of this process, team members have developed hydrologic models (HEC-1) to quantify design discharges and volumes at key concentration points within Window Rock. This information will be utilized to develop preliminary cost estimates for the proposed roadway improvements. The models may be further refined during the final design process. It is anticipated that the models may be utilized by the BIA/NDOT for planning future development and/or roadways.

FEMA Flood Insurance Rate Maps (FIRM) is not available for the Navajo Reservation within the State of Arizona. Therefore, the flood hazards have not been quantified for the Window Rock area. This study will quantify drainage improvements required for future projects within Window Rock.

11.1 Existing Drainage

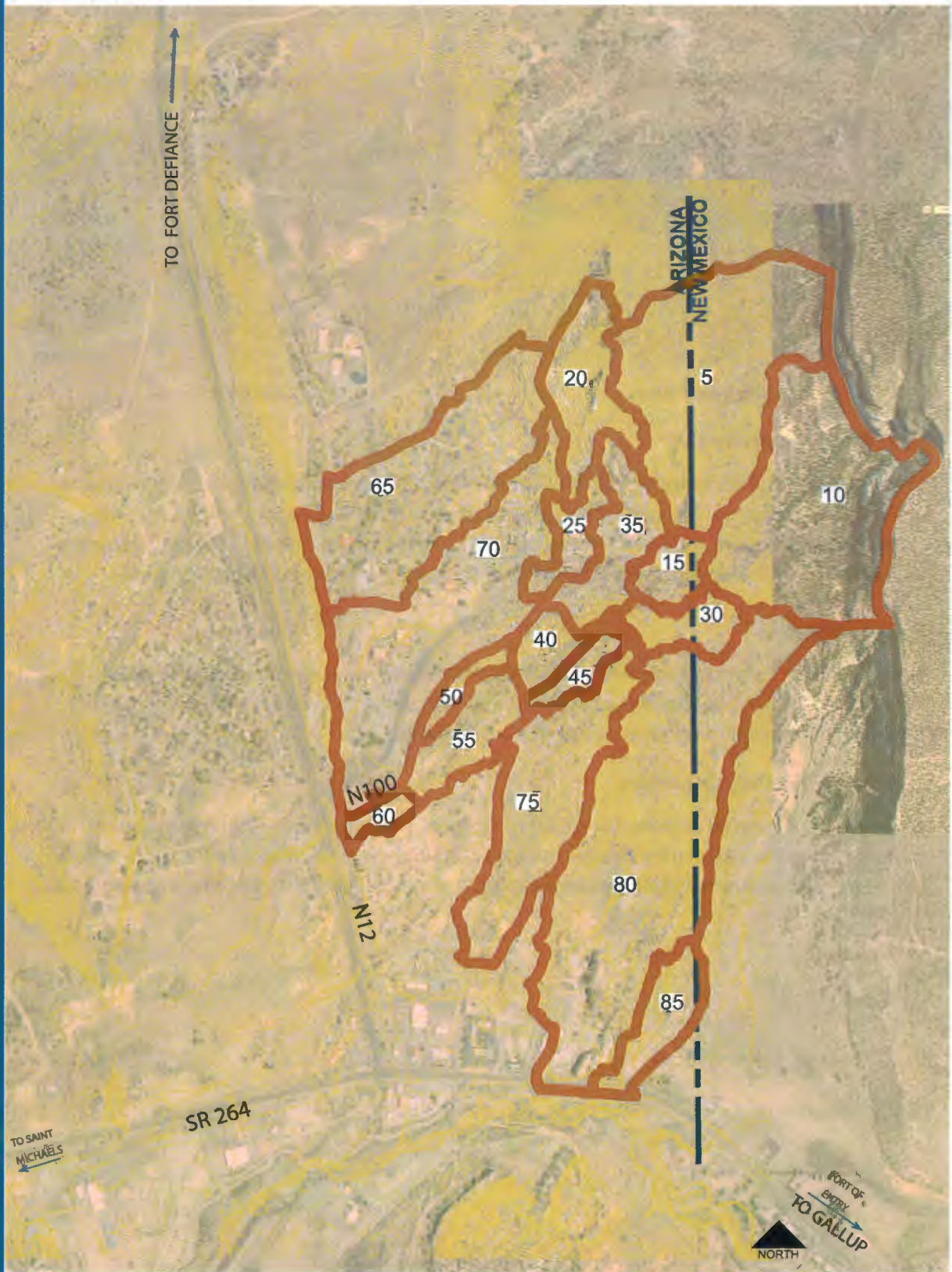
Storm water runoff within the project area flows from the bluff east of town in a westerly/southwesterly direction toward N12 and/or SR-264. The watershed contributing to Window Rock was delineated to identify flow parameters at key concentration points along the potential roadway alignments. Drainage **Figure 11-1** titled Subbasin Location Map, is a topographic map which identifies each watershed.

The project area contains culverts at the following locations:

- 2 -48" pipes at N12 and N100 (Window Rock Boulevard) intersection;
- 36" pipe crossing N100 (Window Rock Boulevard) between N12 and Circle Hill Drive;
- 24" pipe west of N100 (Window Rock Boulevard) and Morgan Boulevard Intersection.

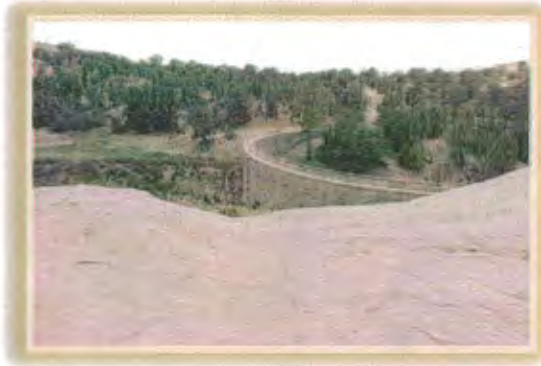
These culverts will be inspected during the final design to determine if they may remain in place (be extended), or if they need to be replaced.

Drainage Area 10 (DA10) is approximately 93.6 acres (37.89 hectares) and consists of undeveloped mountain ranges and scattered vegetation. This drainage area has been eliminated from the drainage analysis, DA10 includes a rock dam structure which would contain upstream runoff and prevent this watershed from entering the Town of Window Rock. The structural stability of the dam was not evaluated as part of this study.



Subbasin Location Map

Figure 11-1



DA10 Rock Dam



DA10 Rock Dam

11.2 Hydrologic Parameters

Arizona Department of Transportation (ADOT) procedures and methodologies were utilized for this project. The procedures and methodologies are outlined in ADOT publications entitled Highway Drainage Design Manual, Volume I, – Hydrology and Highway Drainage Design Manual, Volume II, - Hydraulics. The following paragraphs define the hydrologic parameters utilized for the study.

11.3 Precipitation

Precipitation for the project was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. The CoE hypothetical 6-hour rainfall distribution was utilized for this project. A summary of the rainfall distribution is shown in **Appendix P**.

11.4 Green Ampt Soil Parameters

Green Ampt soil parameters were utilized for this project. The Green Ampt procedures requires identification of five parameters for each soil classification (surface retention loss (IA), soil moisture (DTHETA), capillary suction (PSIF), saturated hydraulic conductivity (XKSAT), effective impervious area (RTEMP).

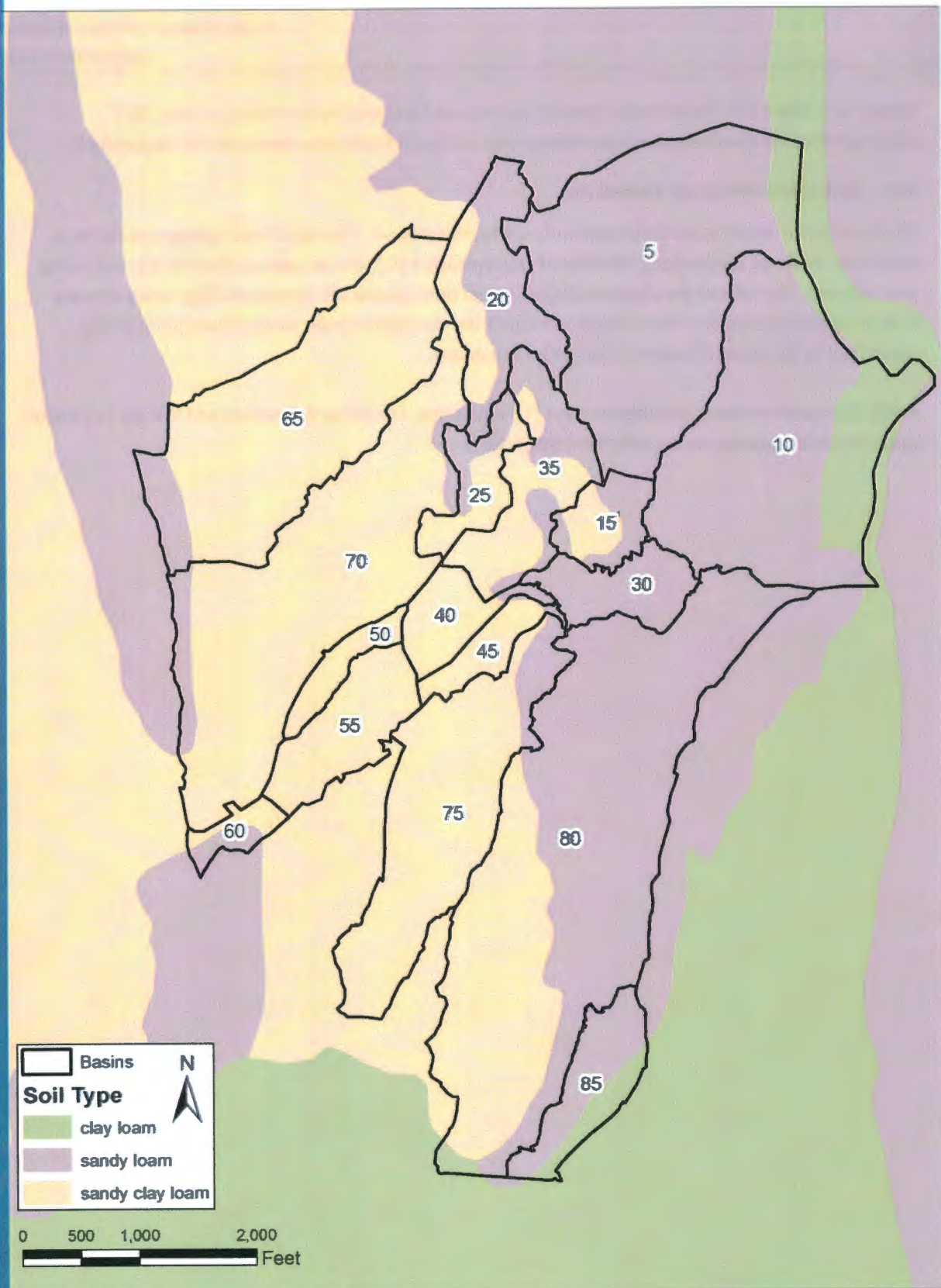


Figure 11-2, titled Soil Classification Map shows the soil types within the drainage areas. Soil classifications and the Green Ampt parameters for each sub-basin are summarized in **Appendix P**.

11.5 Clark Unit Hydrograph Parameters

Clark Unit Hydrograph procedures were utilized for this project. The Clark Unit Hydrograph requires estimation of three parameters; the time of concentration (T_c), the storage coefficient (R), and a time area relation. The time of concentration is the travel time, during the corresponding period of most intense rainfall excess, for a flood wave to travel from the hydraulically most distant point in the watershed to the point of interest (concentration point).

ADOT defines three times of concentration (T_c) equations. The desert/mountain and the urban time of concentration equation were utilized for this project.



Soil Classification Map

Figure 11-2



These equations are defined as follows:

- Desert/mountain

$$T_c = 2.4 A^{-1} L^{.25} L_{ca}^{.25} S^{-.2}$$

- Urban

$$T_c = 3.2 A^{-1} L^{.25} L_{ca}^{.25} S^{-.14} RTIMP^{-.36}$$

where	T_c	=	time of concentration, in hours
	A	=	area, in square miles
	S	=	watercourse slope, in ft/mile
	L	=	length of the watercourse to the hydraulically most distant point, in miles
	L_{ca}	=	length measured from the concentration point along L to a point n L that is perpendicular to the watershed centroid, in miles, and
	$RTIMP$	=	effective impervious area, in percent

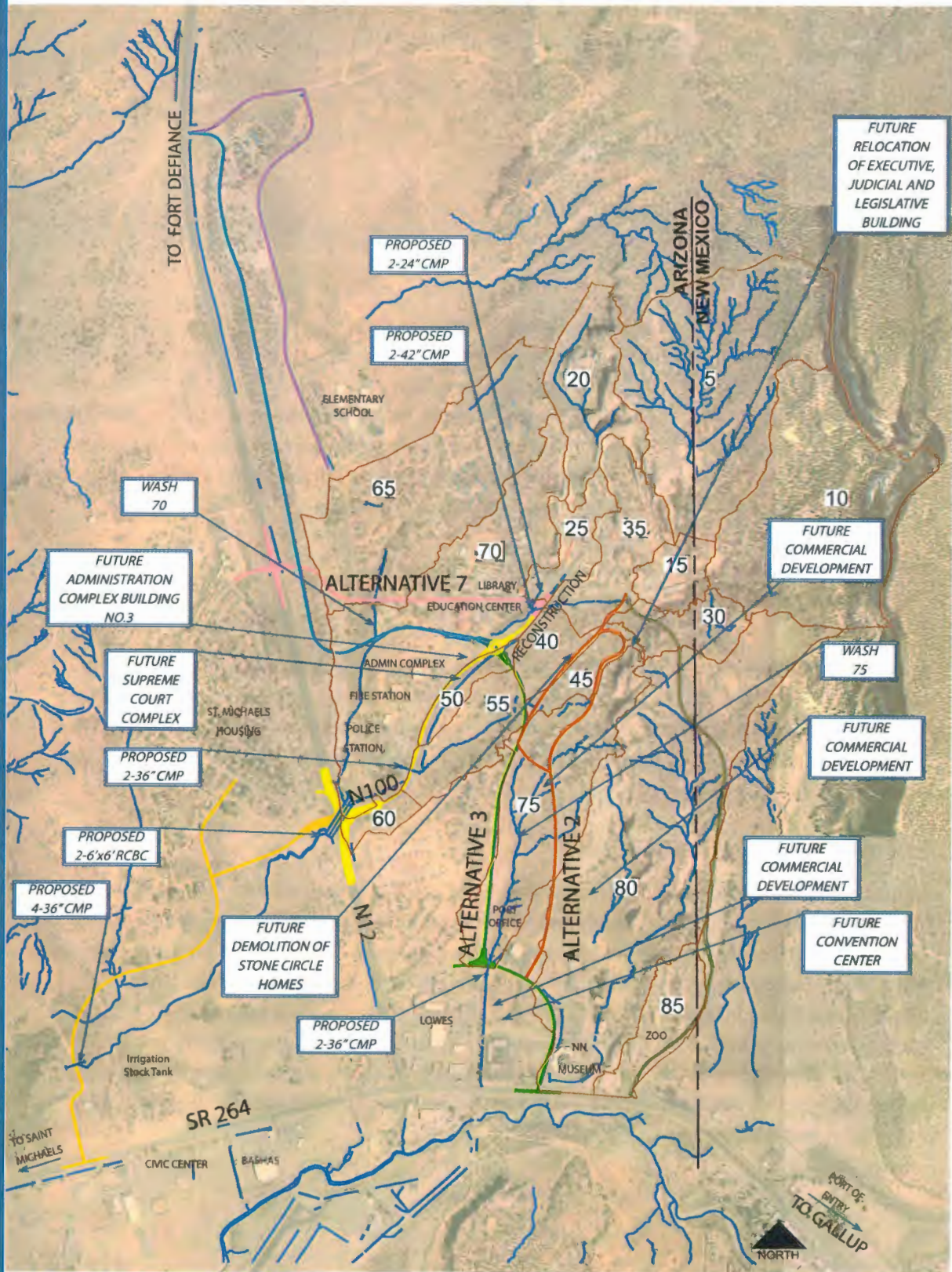
The Clark Unit Hydrograph parameters are defined in **Appendix P**.

11.6 Routing

Normal depth routing procedures were utilized for the project. Channel geometries, Manning's coefficient (roughness), and longitudinal slopes were estimated based on field investigations and topographic mapping developed for the project. The topographic mapping was supplemented with USGS 7.5 minute quadrangles for areas outside of the mapping limits. The routing parameters are summarized in **Appendix P**.

11.7 Summary of Hydrologic Analyses

Results of the hydrologic analyses are summarized in Table 8-1, in **Appendix P**. Since there was limited streamflow data available in the project area, calibration of the model was not possible. However, the results were verified through the use of regional regression equations. The USGS publications entitled Methods for Estimating the Magnitude and Frequency of Floods in the Southwestern United States, Water Supply Paper 2433 and Analysis of the Magnitude and Frequency of Peak Discharges for the Navajo Nation in Arizona, Utah, Colorado, and New Mexico Scientific Investigations Report 2006- 5306 were utilized for model verification. Table 8-2, in **Appendix P**, shows the comparison of peak discharge values. Table 8-3, **Appendix P**, summarizes the drainage areas described above along with their hydrologic characteristics and resulting flows.



Drainage Exhibit

Figure 11-3



11.8 Proposed Drainage Improvements

11.8.1 N100 (N12 to Morgan Boulevard)

Roadway improvements for N100 (Window Rock Boulevard) will occur between N12 and extend north to Morgan Boulevard. Currently N100 is a five lane roadway with a dual left turn lane between N12 and approximately Navajo Hill Drive. The five lane roadway section transitions to a two lane roadway at Navajo Hill Drive. A single lane roundabout is proposed at the intersection of Navajo Hill Drive and N100; these roadway improvements will affect the existing flow pattern of drainage area 40. Reference **Figure 11-3**.

N100 and Morgan Boulevard: Currently runoff from DA40 runs off the ridge, overtops the N100 roadway and makes its way into Wash 70. Roadside ditches parallel to N100 along the east side of N100 will be constructed with improvements to convey this flow southerly to DA50. Drainage Area 35 has concentrated flows which also cross N100. The construction of the roadway improvements and roundabout would require drainage improvements as well. Pipe culverts would be constructed to convey runoff from DA35, including upstream contributing subbasins underneath roadway N100 into Wash 70, this would maintain the existing flow pattern. The 25-Year flows exiting DA35 and required to pass N100 were calculated to be 196 cfs. This would require triple 42" pipe culverts, this is depicted in **Figure 11-3**.

N12 and N100 (Window Rock Boulevard): Southbound N100 at the intersection with N12 currently provides one designated right turn lane and dual left turn lanes onto N12. Northbound 100 at the intersection of N12 provides two northbound lanes. The construction of a two lane roundabout at this intersection would require corresponding drainage improvements. Existing conditions convey overland flow from DA70 underneath N12 via two 48" diameter CMPs. Roadway improvements could potentially impact the existing drainage structures. These structures (2 -48" CMPs and roadside ditches) will need to be re-installed to accommodate the new roadway configuration. The 50 year contributing flows reaching the existing pipe culverts was calculated to be 562 cfs. The existing double 48" CMP pipe flow capacity is approximately 200 cfs, the existing pipes are grossly undersized. Drainage improvements for this alternative will require a double barrel 6'x6' concrete box culvert, this is depicted in **Figure 11-3**.

N100 and Police Station: There is an additional wash crossing along N100 near the existing Police station. The contributing flows for this crossing exit DA55 and were calculated to be 87 cfs for the 25-Year storm event. Double 36" CMPs will be required for this pipe crossing underneath N100, this is depicted on **Figure 11-3**.

11.8.2 N100 West Extension

Roadway improvements for the N100 west extension will consist of a roundabout at the intersection of N100 and N12, constructing a roadway segment connecting this intersection to Tse Bonito Road, extending Tse Bonito Road to SR264. Roadway improvements for this alternative



could potentially impact a major wash crossing at N100 and N12. Currently Drainage Area 70 crosses N12 via two 48" CMPs. Improvements for the N100 West Extension will require culvert improvements to maintain the existing flow pattern across N12, this is discussed in section 8.8.1. The proposed roadway segment connecting Window Rock to the St. Michaels Housing development will be in proximity to an existing wash, Black Creek Wash, in order to fit roadway improvements between the wash and existing homes without adverse impacts retaining walls may be required adjacent to Black Creek Wash. Black Creek Wash crosses alternative alignment 1 at approximately 300 feet north of the SR264 connection. Black Creek Wash migrates into an existing stock irrigation tank which attenuates the peak flows, the excess flows will cross the proposed alignment. It is anticipated that a 4-36" CMP crossing is required for this alternative option.

11.8.3 Alternative 3

Roadway improvements for Alternative 3 will consist of extending the existing Circle Hill Drive to the south to Window Rock Loop Road, extending Circle Hill Drive to the north to intersect N100 Loop, and improving existing segments of Circle Hill Drive. Roadway improvements for Alternative 3 fall within Drainage Areas DA75, DA35, and DA40. Within Drainage Area 35, pipe culverts or an At-Grade crossing with concrete cut off walls will be necessary where proposed alignment 3 intersects N100 loop (the northern terminus of alternative 3). Within Drainage Area 75 another wash crossing occurs at Window Rock Loop Road and the proposed Alternative 3 alignment (southern terminus). Roadway improvements could potentially impact the existing drainage flow patterns pipe culverts may be required at this crossing in order to maintain existing flow patterns. The contributing flows for this location were calculated to be 74 cfs and would require double 36" CMP's underneath Window Rock Loop Road this is depicted on **Figure 11-3**.

11.8.4 Alternative 7

Roadway improvements for Alternative 7 will consist of improving the existing Morgan Blvd, creating a roundabout at the intersection of Morgan and N100 and connecting this alignment to N12 (near Jeddito Drive). Roadway improvements for this option fall within Drainage Areas 70 and 65. Currently overland flows exit DA 25 cross Morgan Blvd and enters Wash 70. The construction of a roundabout at the intersection of Morgan and N100 will impact this existing wash crossing. Pipe culverts may be necessary under Morgan Blvd to allow overland flow to continue its natural flow pattern. The contributing flows were calculated to be 58 cfs for the 25-Year storm event. This would require double 24" CMPs underneath Morgan Blvd. Pipe culverts will be used to convey the runoff underneath the roadway (N100), allowing it to resume its natural flow pattern, and enter Wash 70. These pipe culverts were calculated for the alternative outlined in **Section 11.8.1** and are depicted on **Figure 11-3**.



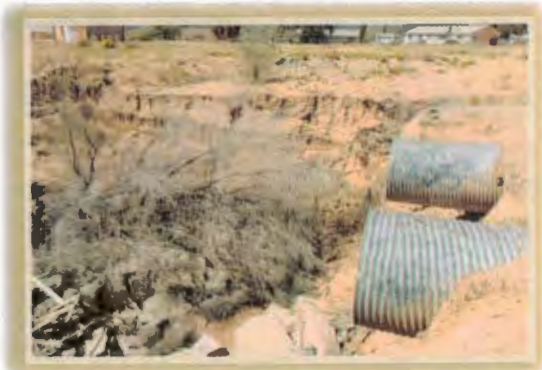
12.0 Constructability & Cost Estimate

The constructability and costs estimates are discussed for the Preliminary Alternatives that were screened and carried forward for further evaluation. See Section 10.0. This includes the N100 West Extension and Alternatives 3 and 7.

12.1 N100 West Extension

The roadway will require significant earth fill at the N12 and N100 intersection due to a large drop in elevation of 20 plus feet (6 m) on the west edge of N12. The N100 west extension will require a large drainage drop structure to facilitate the drainage pipe culverts crossing N12. Existing drainage flows in a southwesterly direction, therefore this route will require a second drainage crossing near SR 264. Portions of this alternative will be located in a flood plain.

The N100 west extension will have significant construction cost due to the length of roadway, earth fill at N12 and flood plain area, relocation of overhead power west of N12, relocation of a fence enclosed high pressure gas facility west of N12, drainage improvements, and probable traffic signal at the intersection of SR 264 which will require ADOT approval. See Table 12-1 for the detailed conceptual cost estimate for the N100 west extension, totaling approximately \$3.2 million.



Drainage pipe culverts west of
N12 and N100 intersection
(Looking north, scour at the pipe outlets)



West roadway side slope at the
N12 and N100 intersection
(Looking North, existing utilizes include overhead
power, communications, water vault, chain link
enclosed high pressure gas facility)



Table 12-1 - N100 West Extension Conceptual Cost Estimate

N100 West Extension Conceptual Cost Estimate 1 Lane In Each Direction, Striped Median, No Curb, Sidewalk on One Side (Improvements Include a New Signalized Intersection at SR264 and Connection to St. Michaels Housing)				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$20,000.00	\$20,000
FILL CONSTRUCTION	CY	31,391	\$8.00	\$251,125
SUBGRADE PREPARATION	SY	34,172	\$2.00	\$68,344
PAVEMENT STRUCTURAL SECTION	SY	34,172	\$26.00	\$888,472
CONSTRUCT SIDEWALK AND RAMPS	SF	42,715	\$5.00	\$213,575
CONSTRUCT DRIVEWAY ENTRANCE	EA	5	\$5,000.00	\$25,000
REMOVE PAVEMENT	SY	985	\$3.00	\$2,955
PAVEMENT MARKING	LF	51,258	\$0.75	\$38,444
TRAFFIC SIGN ASSEMBLY	EA	20	\$200.00	\$4,000
INTERSECTION TRAFFIC SIGNALS (SR 264)	LS	1	\$250,000.00	\$250,000
STREET LIGHTING IMPROVEMENTS/RELOCATION	LS	1	\$25,000.00	\$25,000
LANDSCAPING IMPROVEMENTS	LS	1	\$7,000.00	\$7,000
DRAINAGE IMPROVEMENTS (NEW BOX CULVERT & DRAINAGE PIPES)	LS	1	\$90,000.00	\$90,000
UTILITY RELOCATION (GAS FACILITY & OVERHEAD POWER)	LS	1	\$130,000.00	\$130,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$63,934.00	\$63,934
MOBILIZATION (7%)	LS	1	\$223,768.00	\$223,768
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$95,901.00	\$95,901
CONTINGENCY (25%)	LS	1	\$799,173.00	\$799,173
			TOTAL	\$3,196,691



12.2 Alternative 3

Approximately two thirds of the Alternative 3 alignment utilizes existing roadways to be improved with a new asphalt pavement section and if necessary, street widening. A negative aspect of this alignment is the close proximity to existing homes and multiple tie-ins with existing cross streets. A new traffic signal is necessary at the intersection of SR 264 and Widow Rock Loop Road. This helps to encourages traffic to use Window Rock Loop Road rather than Main Street which improves traffic operations in the area and reduces the traffic volumes at the intersection of SR 264 and N12. An existing overhead power line will need to be relocated or placed underground along this route. The traffic analysis determines this route will have a significant impact on improving the traffic issues and it also provides a secondary emergency ingress/egress for the Tribal governmental complex area. ADOT approval will be necessary for work at SR 264. Saint Michaels Chapter approval is not necessary and there are no grazing permits. See **Table 12-2** for the detailed conceptual cost estimate for the N100 west extension, totaling approximately \$2.4 million.

Currently a separate project by the Nation is in progress for the design of a new Navajo Nation Justice Complex (also referred to as the Supreme Court Complex). The Justice Complex site is bounded by N100, Navajo Hill Drive and Circle Hill Drive. The architectural design is being performed by VCBO Architects out of Salt Lake City, UT. See **Appendix M** for the Navajo Nation Justice Complex Architectural Concept. As a part of the Justice Complex project Circle Hill Drive fronting the complex is to be reconstructed. An engineering design has been performed by Bighorse Engineers for the Navajo Nation Design & Engineering Services (NNDES). A joint work effort to further coordinate this existing design at connecting points will be very beneficial to all parties. See **Appendix N** for the Navajo Nation Justice Complex Civil Design Plans.

As a part of another separate NNDES effort, Navajo Hill Drive essentially Alternative 3 has been preliminarily designed by Bighorse Engineers. The plans are very preliminary and marked "Draft". See **Appendix O** for Window Rock Road Preliminary Civil Design Plans. Coordination on a joint work effort on this portion will also be beneficial and a design cost savings may be achieved.

VCBO Architecture Contact Person: Phil Haderlie, (801) 575-8800

Bighorse Engineers Contact Person: Max Bighorse, (505) 870-7395



Proposed Alt. 3 Alignment, looking north
North of Window Rock Loop Road
(Existing overhead power)



Alternative 3 Alignment, looking south
(Residential homes on the right)

Table 12-2 - Alternative 3 Conceptual Cost Estimate

Alternative 3 Conceptual Cost Estimate				
1 Lane In Each Direction, Striped Median, No Curb, Sidewalk On One Side (Improvements Include a New Signalized Intersection at SR264)				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$10,000.00	\$10,000
FILL CONSTRUCTION	CY	3,000	\$8.00	\$24,000
SUBGRADE PREPARATION	SY	25,440	\$2.00	\$50,880
PAVEMENT STRUCTURAL SECTION	SY	25,440	\$26.00	\$661,440
CONSTRUCT SIDEWALK AND RAMPS	SF	31,800	\$5.00	\$159,000
CONSTRUCT DRIVEWAY ENTRANCE	EA	25	\$3,000.00	\$75,000
REMOVE PAVEMENT	SY	13,924	\$3.00	\$41,771
PAVEMENT MARKING	LF	25,440	\$0.75	\$19,080
TRAFFIC SIGN ASSEMBLY	EA	15	\$200.00	\$3,000
SINGLE LANE ROUND-A-BOUT	LS	1	\$150,000.00	\$150,000
INTERSECTION TRAFFIC SIGNALS (SR 264)	LS	1	\$250,000.00	\$250,000
STREET LIGHTING IMPROVEMENTS/RELOCATION	LS	1	\$20,000.00	\$20,000
LANDSCAPING IMPROVEMENTS	LS	1	\$5,000.00	\$5,000
DRAINAGE IMPROVEMENTS	LS	1	\$15,000.00	\$15,000
UTILITY RELOCATION (OVERHEAD POWER)	LS	1	\$75,000.00	\$75,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$47,791.00	\$47,791
MOBILIZATION (7%)	LS	1	\$167,267.00	\$167,267
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$17,922.00	\$17,922
CONTINGENCY (25%)	LS	1	\$597,384.00	\$597,384
			TOTAL	\$2,389,535



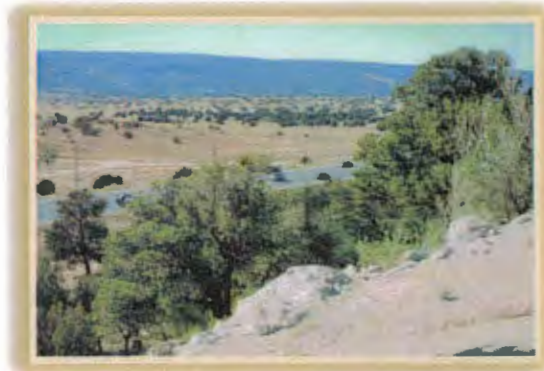
12.3 Alternative 7

Alternative 7 requires significant roadway excavation and haul at the high ridge near the west terminus. This roadway alignment was viewed favorably by the public for the following reasons: no impact to land holders in terms of grazing permits or home site leases and utilization of existing roadways. This option also satisfies the goal of providing a secondary emergency ingress/egress. It provides an intersection at N12 which also benefits residents at the Saint Michaels Housing area by providing an additional ingress/egress connection opportunity, which also addresses that same issue/problem at existing Shonto Boulevard located north of and in close proximity to the intersection of N12/N100. However, traffic analysis determined this option would not significantly improve existing and future traffic operation at along N12, N100 and at the intersections of N12 and N100, and SR 264 and N12. Negative aspects are the close proximity to existing homes, pedestrian safety concerns and multiple tie-ins with existing cross streets and driveways. Approximately two-thirds of the route utilizes existing roadways, which would be improved with a new asphalt pavement section and if necessary, street widening. However widening will be difficult due to the narrow available corridor. Utility relocations (overhead power) will be required with widening. Displacement of one residence will be required located west of the intersection of Morgan Boulevard and Chee Dodge Drive.

Since there is minimal traffic operation improvement, Alternative 7 is removed from further evaluation. See **Table 12-3** for the detailed conceptual cost estimate for the N100 west extension, totaling approximately \$2.6 million.



**Existing Morgan Blvd., looking west
(Education Center is the large building to the left)**



**High Terrain Ridge at West Terminus of
Proposed Alt. 7 Alignment, looking northwest
(On ridge top with N12 below)**



Table 12-3 - Alternative 7 Conceptual Cost Estimate

Alternative 7 Conceptual Cost Estimate				
1 Lane In Each Direction, Striped Median, No Curb, Sidewalk (Improvements include a new signalized intersection at N12 and Connection to St. Michaels Housing)				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$10,000.00	\$10,000
ROADWAY EXCAVATION	CY	29,705	\$10.00	\$297,052
EARTHWORK EXPORT/HAUL OUT	CY	29,705	\$15.00	\$445,578
SUBGRADE PREPARATION	SY	14,480	\$2.00	\$28,960
PAVEMENT STRUCTURAL SECTION	SY	14,480	\$26.00	\$376,480
CONSTRUCT SIDEWALK AND RAMPS	SF	36,200	\$5.00	\$181,000
CONSTRUCT DRIVEWAY ENTRANCE	EA	26	\$5,000.00	\$130,000
REMOVE PAVEMENT	SY	8,566	\$3.00	\$25,699
PAVEMENT MARKING	LF	21,720	\$0.75	\$16,290
TRAFFIC SIGN ASSEMBLY	EA	10	\$200.00	\$2,000
INTERSECTION TRAFFIC SIGNALS (N12)	LS	1	\$150,000.00	\$150,000
STREET LIGHTING IMPROVEMENTS/RELOCATION	LS	1	\$20,000.00	\$20,000
LANDSCAPING IMPROVEMENTS	LS	1	\$5,000.00	\$5,000
DRAINAGE IMPROVEMENTS	LS	1	\$15,000.00	\$15,000
UTILITY IMPROVEMENTS/RELOCATION	LS	1	\$25,000.00	\$25,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$52,967.00	\$52,967
MOBILIZATION (7%)	LS	1	\$185,386.00	\$185,386
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$19,863.00	\$19,863
CONTINGENCY (25%)	LS	1	\$662,092.00	\$662,092
			TOTAL	\$2,648,367



13.0 Preferred Alternative – Alternative 3

The No Build and six Preliminary Alternatives were evaluated against the evaluation criteria described in Section 6.0. Based on public feedback and the traffic analysis they were screened and the following were carried forward for further evaluation:

- N100 West Extension
- Alternative 3
- Alternative 7

For these roadway alignments the drainage analysis, considerations and impacts were evaluated along with constructability. Conceptual cost estimates were also developed for these three roadway alignments.

Based on favorable public feedback, minimized environmental considerations and impacts, significant traffic operation improvements through year 2034, minimized drainage impacts, constructability, and lowest estimated construction cost, Alternative 3 is the preferred alternative.

See Table 13-1 for a summary of the evaluation of the N100 West Extension, No Build and six Preliminary Alternatives.



Key for Table 13-1	
	Unfavorable
	Favorable



Table 13-1 - Evaluation Criteria

	Public	Traffic	Drainage	Constructability	Cost
No Build			Removed from further evaluation. The No Build Alt. amplifies the existing failing traffic operations. There will be extensive queuing and delays in the future if improvements are not made to the existing roadway system		
N100 West Extension	 -Livestock grazing land -Requires land holder consent	 -Does not significantly improve existing and future traffic operation	 -flood plain area -second drainage crossing	 -earth fill, relocation of overhead power, reloc. of fence, and potential traffic signal install	\$3.2 Million
Alternative 2			Removed from further evaluation. Alt. 2 is based on future development plans adjacent to this alignment. There are no concepts or plans for immediate or future (20-yr) development.		
Alternative 3				 -two-thirds existing roadway	\$2.4 Million
Alternative 4	 -Home site leases -Existing grazing permits -Require land holder consent	 -Does not significantly improve existing and future traffic operation	Removed from further evaluation. Alt. 4 received negative public feedback and opposition from property owners with grazing permits and leases in the area. There are also no significant existing and future improvements to traffic operations.		
Alternative 5	 -Home site leases -Existing grazing permits -Requires land holder consent	 -Does not significantly improve existing and future traffic operation	Removed from further evaluation. Alt. 5 received negative public feedback and opposition to property owners with grazing permits and leases in the area. There are also no significant existing and future improvements to traffic operations.		
Alternative 6			Removed from further evaluation. Alt 6 will have significant construction costs due to the steep rock outcrop. This alignment is further east of Alt 2 and 3. In this area, Alt 3 is the most effective alignment.		
Alternative 7		 -Does not significantly improve existing and future traffic operation		 -significant excavation and haul, overhead utility relocations, and displacement of a residence	\$2.6 Million



14.0 N100 Reconstruction and N12/N100 Intersection Improvement

Addressing the improvement of traffic flow is a central goal of this study which is predicated on improving route N100. Another main component with a significant impact on traffic operation is the intersection of N12 and N100 (Window Rock Boulevard). The result of the traffic analysis indicates a roundabout intersection is recommended at this location.

Two-Lane Roundabout

A roundabout is a circular free-flow type of intersection with vehicles traveling without any stop conditions in a one way movement (counter clock-wise direction) around a central island. The capacity of roundabouts is based on the number of lanes, the more lanes the higher the capacity. A two-lane roundabout is proposed for the intersection of N12 and N100 (Window Rock Boulevard) to provide acceptable existing and future (2034) levels of service.

This intersection improvement will decrease vehicle queuing and delays. Roundabouts do not require entering vehicles to stop, unless yielding to other vehicles, unlike traffic signals where vehicles are required to stop and queue at a red light indication. The proposed two-lane roundabout provides acceptable traffic operations for the 20-year (2034) forecast with a secondary ingress/egress (Alternative 3).

Dedicated Right Turn Lanes

It is recommended that dedicated right turn lanes be incorporated into the roundabout design to remove these movements from the circular section. A dedicated right turn lane is a physical separation of a one lane split from the circular lanes by means of curbing and is recommended for the northbound N12 to eastbound N100 traffic and also for the westbound N100 to northbound N12 traffic. See **Figure 14-1** for examples of several types of roundabouts.

An existing roundabout is located at the junction of US 191 and N15 in Burnside, Arizona just a few miles (km) northwest of Ganado. The majority of the public feedback was favorable with respect to the installation of a roundabout, however, the public acknowledged that initially there would be a learning curve. See **Appendix A** for public comments.

Restrict Left Turn Movements

The Shonto Boulevard intersection with N12 present traffic operational issues due to its close proximity of approximately 420 feet (128 m) to the N12 and N100 (Window Rock Boulevard) intersection. During AM and PM peak hours, the eastbound left turn movement from Shonto Boulevard to N12, and the northbound left turn movement from N12 to Shonto Boulevard results in queuing and long delays. For these reasons it is recommended that the roundabout layout incorporate a raised median restricting the mentioned left turn movements, thus creating a right-in and right-out operation at Shonto Boulevard.

**Construct Secondary Access for the Saint Michaels Housing**

This in turn creates a need to provide a secondary access into and out of this area. It is proposed that the existing paved street, Jeddito Drive, located within the northern portion of the Saint Michaels Housing to be extended to create a stop-controlled 'T' intersection with N12. The left turn movements currently occurring at the intersection of N12 and Shonto Boulevard can be accommodated at this new intersection located approximately 2900 feet (884 m) from the N12 and N100 (Window Rock Boulevard) intersection.

Sunset Drive, located approximately 700 feet (213 m) north of Jeddito Drive is another alternative that can be considered providing a secondary access for the Saint Michaels Housing.

Constructing a secondary access as a result would alter traffic patterns within the Saint Michaels Housing area. Those traveling to and from Fort Defiance would route to through the north access rather than the south access. There will also be additional cost for new asphalt streets and possible reconstruction of the existing Jeddito Drive asphalt pavement which appears to be in poor condition.

The construction cost estimates provided in **Table 14-1** and **Table 14-2** do not include the construction of a secondary access for the Saint Michaels Housing



Types of Vehicles at the N12/N100 Intersection
(Proposed roundabout must accommodate various turning movements)

The traffic analysis confirms that the existing N100 lane configuration/typical roadway section and horizontal alignment (a slight skew may be necessary for the approach leg to the roundabout) will provide acceptable levels of service for the 20-year (2034) traffic volumes. Roadway widening is not necessary. The existing N100 was constructed in the early 1980s and is in poor pavement condition. The reconstruction of the asphalt pavement, curbs, sidewalk, signing and pavement marking, and drainage improvements are necessary. See **Table 14-1** for estimated construction costs of reconstructing N100 and **Table 14-2** for construction of a new roundabout intersection at N12 and N100 (Window Rock Boulevard).



Additional N12 and N100 Intersection Improvements

Roadway and/or pedestrian lighting for increased visibility and pedestrian safety, bike lanes, landscaping (low maintenance decomposed granite and native trees/shrubs without irrigation), wider sidewalks at least a minimum of 6 feet (1.8 m) wide, decorative hardscape at identified entry nodes/center of roundabout, and an entry monument to the N100 corridor in order to create a sense of arrival and importance to the Nation's capital are recommended amenities.

Table 14-1 - N100 Reconstruction Conceptual Cost Estimate

N100 (Window Rock Blvd.) Reconstruct Conceptual Cost Estimate				
2 Lanes Each Direction, Striped Median, Curbs, & Sidewalk on One Side (Does Not Include Roundabout at N12)				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$10,000.00	\$10,000
SUBGRADE PREPARATION	SY	26,367	\$2.00	\$52,733
PAVEMENT STRUCTURAL SECTION	SY	26,367	\$26.00	\$685,533
CONCRETE CURB AND GUTTER	LF	6,780	\$18.00	\$122,040
CONSTRUCT SIDEWALK AND RAMPS	SF	16,950	\$5.00	\$84,750
CONSTRUCT DRIVEWAY ENTRANCE	EA	9	\$5,000.00	\$45,000
REMOVE PAVEMENT	SY	25,289	\$3.00	\$75,867
REMOVE CURB	LF	3,048	\$5.00	\$15,240
REMOVE CONCRETE (SIDEWALK, SW RAMPS, DRIVEWAYS)	SF	12,984	\$4.00	\$51,936
PAVEMENT MARKING	LF	13,560	\$0.75	\$10,170
TRAFFIC SIGN ASSEMBLY	EA	14	\$200.00	\$2,800
SINGLE LANE ROUND-A-BOUT	LS	1	\$150,000.00	\$150,000
STREET LIGHTING IMPROVEMENTS/RELOCATION	LS	1	\$30,000.00	\$30,000
LANDSCAPING IMPROVEMENTS	LS	1	\$10,000.00	\$10,000
DRAINAGE IMPROVEMENTS	LS	1	\$25,000.00	\$25,000
UTILITY IMPROVEMENTS/RELOCATION	LS	1	\$40,000.00	\$40,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$43,251.00	\$43,251
MOBILIZATION (7%)	LS	1	\$151,379.00	\$151,379
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$16,219.00	\$16,219
CONTINGENCY (25%)	LS	1	\$540,640.00	\$540,640
			TOTAL	\$2,162,558



Table 14-2 - N12 and N100 Intersection Improvements Conceptual Cost Estimate

N12 and N100 Roundabout Conceptual Cost Estimate				
Duel Ring (2 Lanes And Dedicated Right Only Lanes) Includes Drainage Box Culvert & Baffle Drop Structure				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$5,000.00	\$5,000
FILL CONSTRUCTION	CY	1,000	\$10.00	\$10,000
SUBGRADE PREPARATION	SY	11,544	\$2.00	\$23,089
PAVEMENT STRUCTURAL SECTION	SY	11,544	\$26.00	\$300,156
CONCRETE CURB AND GUTTER	LF	2,950	\$18.00	\$53,100
CONSTRUCT SIDEWALK AND RAMPS	SF	10,000	\$5.00	\$50,000
CONSTRUCT DRIVEWAY ENTRANCE (SHONTO BLVD.)	EA	1	\$7,500.00	\$7,500
REMOVE PAVEMENT	SY	13,536	\$3.00	\$40,608
REMOVE CURB	LF	2,749	\$5.00	\$13,745
REMOVE CONCRETE (SIDEWALK, SW RAMPS, DRIVEWAYS)	SF	2,300	\$4.00	\$9,200
REMOVE TRAFFIC SIGNALS AND EQUIPMENT	LS	1	\$10,000.00	\$10,000
PAVEMENT MARKING	LF	5,105	\$0.75	\$3,829
TRAFFIC SIGN ASSEMBLY	EA	16	\$200.00	\$3,200
STREET LIGHTING IMPROVEMENTS	LS	1	\$15,000.00	\$15,000
LANDSCAPING IMPROVEMENTS (ROUND-A-BOUT MONUMENT)	LS	1	\$10,000.00	\$10,000
DRAINAGE IMPVMTS (BOX CULVERT & BAFFLE DROP STRUCTURE)	LS	1	\$250,000.00	\$250,000
INTERSECTION STOP CONDITION (N12/JEDDITO DRIVE)	LS	1	\$60,000.00	\$60,000
UTILITY IMPROVEMENTS/RELOCATION	LS	1	\$40,000.00	\$40,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$27,722.00	\$27,722
MOBILIZATION (7%)	LS	1	\$97,027.00	\$97,027
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$10,396.00	\$10,396
CONTINGENCY (25%)	LS	1	\$346,523.00	\$346,523
			TOTAL	\$1,386,094



SAMPLE ROUNDABOUT



WINDOW ROCK PROPSED ROUNDABOUT



SAMPLE ROUNDABOUT



SAMPLE ROUNDABOUT



EXAMPLES OF ROUND-A-BOUTS

FIG 14-1



15.0 SR 264 and N12 Intersection Improvements

This intersection will require improvements including restriping the southbound through lane to a shared through-right turn lane and changing the corresponding signing to reflect this change. Additionally, the westbound leg will require dual right-turn lanes, therefore an additional right turn lane will need to be constructed. See Table 15-1 for the conceptual cost estimate for these improvements.

Table 15-1 - SR 264 and N12 Intersection Improvements Conceptual Cost Estimate

SR264 and N12 Intersection Improvements Conceptual Cost Estimate				
Restripe North Leg, Add 2 Right Turn Lanes On East Leg				
ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
EROSION CONTROL (SWPPP BY CONTRACTOR)	LS	1	\$5,000.00	\$5,000
FILL CONSTRUCTION	CY	900	\$8.00	\$7,200
SUBGRADE PREPARATION	SY	1,600	\$2.00	\$3,200
PAVEMENT STRUCTURAL SECTION	SY	1,600	\$26.00	\$41,600
CONCRETE CURB AND GUTTER	LF	700	\$18.00	\$12,600
CONSTRUCT SIDEWALK AND RAMPS	SF	3,500	\$5.00	\$17,500
CONSTRUCT DRIVEWAY ENTRANCE	EA	4	\$5,000.00	\$20,000
REMOVE PAVEMENT	SY	311	\$3.00	\$933
REMOVE CURB	LF	700	\$5.00	\$3,500
REMOVE CONCRETE (SIDEWALK, SW RAMPS, DRIVEWAYS)	SF	2,800	\$4.00	\$11,200
RELOCATE TRAFFIC SIGNAL (NORTHEAST CORNER)	EA	1	\$50,000.00	\$50,000
PAVEMENT MARKING	LF	700	\$0.75	\$525
TRAFFIC SIGN ASSEMBLY	EA	4	\$200.00	\$800
RELOCATE STREET LIGHT	EA	2	\$5,000.00	\$10,000
LANDSCAPING IMPROVEMENTS	LS	1	\$5,000.00	\$5,000
DRAINAGE IMPROVEMENTS (REGRADE EXISTING BASIN)	LS	1	\$3,000.00	\$3,000
MAINTENANCE & PROTECTION OF TRAFFIC (2%)	LS	1	\$5,887.00	\$5,887
MOBILIZATION (7%)	LS	1	\$20,604.00	\$20,604
CONSTRUCTION SURVEYING & LAYOUT (3%)	LS	1	\$2,208.00	\$2,208
CONTINGENCY (25%)	LS	1	\$73,586.00	\$73,586
			TOTAL	\$294,343



16.0 Design Considerations

16.1 Design Controls and Guidelines

Roadway design shall be based upon average daily traffic volumes, traffic study, geotechnical report, and drainage analysis. The design will be in accordance with the following reference materials, with the American Association of State Highway and Transportation Officials (AASHTO) as the controlling design criteria:

- "Policy of Geometric Design of Highways and Streets" (AASHTO, latest edition)
- "Standard Specification for the Construction of Roads and Bridges on Federal Highway Projects, FP-2003" Federal Highway Administration (FHWA 7, 2003)
- "Standard Specifications for Highway Bridges" (AASHTO, latest edition)
- "Manual on Foundation Investigations" (AASHTO, latest edition)
- "AASHTO Guide for Design of Pavement Structures" (AASHTO, latest edition)
- "Soil Mechanics, NAVFAC DM-7.1" (Department of the Navy)
- "Highway Drainage Guidelines" (AASHTO)
- "Navajo Region Road Construction Certification Acceptance Program" (BIA – Navajo Region Department of Transportation, NRDOT)
- "Soils and Foundation Workshop Manual" (FHWA)
- "Standard Specifications for Transportation of Material and Methods of Sampling and Testing" (Parts I and III, 15th Edition by AASHTO)
- "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals" (AASHTO)
- "Manual on Design and Construction of Driven Pile Foundations" (FHWA)
- "Drilled Shafts: Construction Procedures and Design Methods, Pub. No. FHWA-HI-88-042" (FHWA)
- "Manual of Uniform Traffic Control Devices" (FHWA)
- "Roundabouts An Informational Guide" (FHWA)
- "Roadside Design Guidelines" (AASHTO)
- "Americans with Disabilities Act Standards for Accessible Design" (Department of Justice)
- All Arizona Department of Transportation (ADOT) Design Manuals

16.2 Seasonal/Design Considerations

Large events within/near the study area include the Navajo Nation Fair typically held during the first and second weeks in September and the 4th of July Celebration, both events are held at the fairgrounds located south of SR 264. Other locations of interest with tourism traffic include the Navajo Nation Zoological and Botanical Park located near the state line and SR 264, the Navajo Nation Museum, Library, and Visitor Center located west of the Zoo, the Veteran's Memorial, Council Chambers and President's Office are all located in the Tribal government complex area directly below the geologic formation named Window Rock.



The open areas not designated with a color boundary shape on **Figure 2-1** can be considered open livestock (horses, cattle and sheep) grazing areas. A majority of N12 and SR 264 right of way does practice access control (fencing), it would be prudent for driver safety to take this into consideration during the design phase to limit access to major roadways.

The average elevations in the study area range from 6700 feet to 6900 feet in elevation (2040 m to 2100 m). This high terrain tends to have cold winters with sub-zero temperatures. This should be considered during construction scheduling for the placement of asphaltic concrete and any Portland cement concrete pavement.

16.3 Geotechnical Overview

A geotechnical report is required during the engineering design phase. The pavement structural-sections for reconstruction of existing roadways and construction of new roadways are determined based on testing results. Foundation recommendations are also required. Testing shall be composed of but not limited to soil borings, penetration sampling, rock coring and laboratory testing. A geotechnical investigation and foundation recommendation (GIFR) report will be required.



17.0 Conclusions and Recommendations

The N100 West Extension, No Build and six Preliminary Build Alternatives were evaluated based on the evaluation criteria as outlined in **Section 6.0**. Taking into consideration public feedback; environmental considerations and impacts; traffic analysis, including traffic operations and crash analysis; drainage analysis, considerations and impacts; constructability, including utility impacts and right of way impacts; and, constructions costs, **the preferred alternative is Alternative 3**. See Table 13-1 for a summary of the evaluation.

The traffic analysis of the existing AM and PM peak hours shows that the intersections of SR 264 and N12, and N12 and N100 (Window Rock Boulevard) are currently failing. This means that there are more vehicles arriving than can be processed through the intersection resulting in delays and queuing at the intersections. This condition will worsen with growth and development.

Therefore specific improvements to the existing roadways and intersections must occur immediately to provide acceptable traffic operations. Other improvements become necessary with the build out of future developments. Below are the recommended improvements and timeline:

Design

N12 and N100 Intersection

- **Immediately** begin the design for the intersection of N12 and N100 for a two-lane roundabout.

N100 Roadway

- **Immediately** begin the design for the reconstruction of N100

TTIP

Alternative 3

- Add a project to the TTIP for the design of the Alternative 3 roadway alignment including a roundabout at the intersection of Window Rock Loop Road and Main Street, and N100 (Window Rock Boulevard) and Navajo Hill Drive (**Design 2016 thru 2017; Construction 2018 thru 2020**)

N12 and Shonto Boulevard

- Add a project to the TTIP for the design of an eastbound dedicated left turn lane at the intersection of N12 and Shonto Boulevard (**Design 2028; Construction 2030**)

N100 (Window Rock Boulevard) and Morgan Boulevard

- Add a project to the TTIP for the design of an eastbound dedicated left turn lane and southbound dedicated right turn lane at the intersection of N100 (Window Rock Boulevard) and Morgan Boulevard (**Design 2028; Construction 2030**)



N100 West Extension

- Add a project to the TTIP for the design of the N100 West Extension depending upon future development to the west (**Design 2034; Construction 2036**)

Alternative 7

- Add a project to the TTIP for the design of Alternative 7 depending upon future development in the area (**Design 2034; Construction 2036**)

ADOT

SR 264 and N12 Intersection

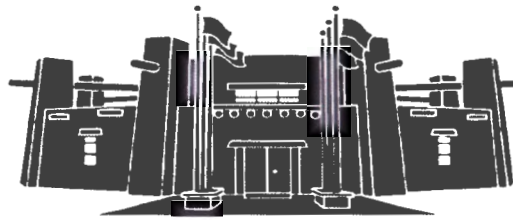
- **Immediately** begin coordination efforts with ADOT for intersection improvements at SR 264 and N12 which includes converting the southbound through lanes to a shared through-right turn lanes and constructing westbound dual right-turn lanes.

SR 264 and Window Rock Loop Road

- Begin coordination efforts with ADOT for the installation of a traffic signal at the intersection of SR 264 and Window Rock Loop Road. This improvement must coincide with the construction of the Alternative 3 roadway alignment (**Design 2016 thru 2017; Construction 2018 thru 2020**)

SR 264 and Main Street/Beacon Road

- Begin coordination efforts with ADOT for the construction of a southbound left turn lane at the intersection of SR 264 and Main Street/Beacon Road. (**Design 2028; Construction 2030**)



MEMORANDUM

TO: Honorable Leonard Pete
23rd Navajo Nation Council Delegate, Chinle Chapter

FROM: Mariana Kahn
Mariana Kahn, Attorney
Office of Legislative Counsel

DATE: September 24, 2015

SUBJECT: PROPOSED STANDING COMMITTEE RESOLUTION; AN ACTION RELATING TO RESOURCES AND DEVELOPMENT; AMENDING THE NAVAJO DIVISION OF TRANSPORTATION 2016 TRIBAL TRANSPORTATION IMPROVEMENT PLAN, RDCS-70-15, TO INCLUDE FUNDING FOR DESIGN WORK FOR THE INTERSECTION OF N12 AND N100 WITHIN WINDOW ROCK, NAVAJO NATION

As requested, I prepared the above-reference proposed resolution and associated legislative summary sheet. Based on existing law, the resolution drafted is legally sufficient. However, as with all legislation, the proposed resolution is subject to review by the courts in the event of a challenge. You are encouraged to review the proposed resolution to ensure this is drafted to your satisfaction.

The Office of Legislative Council confirms the appropriate standing committee(s) reviews based on the standing committees powers outlined in 2 N.N.C. §§ 301, 401, 501, 601 and 701. Nevertheless, “the Speaker of the Navajo Nation Council shall introduce [the proposed resolution] into the legislative process by assigning it to the respective oversight committee(s) of the Navajo Nation Council having authority over the matters for proper consideration.” 2 N.N.C. § 164(A)(5).

If you are satisfied with the proposed resolution, please sign as “Primary Sponsor” and submit to the Office of Legislative Services where the proposed resolution will be given a tracking number and sent to the Office of the Speaker for assignment. If the proposed legislation is unacceptable to you, please contact me at the Office of Legislative Counsel and advise me of the changes you would like to make.

THE NAVAJO NATION
LEGISLATIVE BRANCH
INTERNET PUBLIC REVIEW PUBLICATION



LEGISLATION NO: _0341-15__

SPONSOR: Leonard H. Pete

TITLE: An Action Relating To Resources And Development; Amending The Navajo Nation Division Of Transportation 2016 Tribal Transportation Improvement Plan, RDCS-70-15, To Include Funding For Design Work For The Intersection Of N12 And N100 Within Window Rock, Navajo Nation

Date posted: September 28, 2015 at 3:06PM

Digital comments may be e-mailed to_comments@navajo-nsn.gov

Written comments may be mailed to:

Executive Director
Office of Legislative Services
P.O. Box 3390
Window Rock, AZ 86515
(928) 871-7586

Comments may be made in the form of chapter resolutions, letters, position papers, etc. Please include your name, position title, address for written comments; a valid e-mail address is required. Anonymous comments will not be included in the Legislation packet.

Please note: This digital copy is being provided for the benefit of the Navajo Nation chapters and public use. Any political use is prohibited. All written comments received become the property of the Navajo Nation and will be forwarded to the assigned Navajo Nation Council standing committee(s) and/or the Navajo Nation Council for review. Any tampering with public records are punishable by Navajo Nation law pursuant to 17 N.N.C. §374 *et. seq.*

THE NAVAJO NATION
LEGISLATIVE BRANCH
INTERNET PUBLIC REVIEW SUMMARY

LEGISLATION NO.: 0341-15

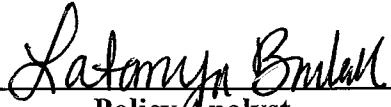
SPONSOR: Honorable Leonard H. Pete

TITLE An Action Relating To Resources And Development; Amending The Navajo Nation Division Of Transportation 2016 Tribal Transportation Improvement Plan, RDCS-70-15, To Include Funding For Design Work For The Intersection Of N12 And N100 Within Window Rock, Navajo Nation.

Posted: September 28, 2015 at 3:06PM

5 DAY Comment Period Ended: October 3, 2015

Digital Comments received: *No comments received.*



Policy Analyst
Office of Legislative Services

10/5/15 9:29am

Date/Time

RESOURCES AND DEVELOPMENT COMMITTEE
23rd NAVAJO NATION COUNCIL

FIRST YEAR 2015

COMMITTEE REPORT

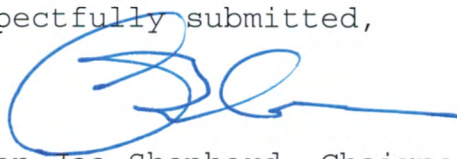
Mr. Speaker,

The **RESOURCES AND DEVELOPMENT COMMITTEE** to whom has been assigned:

Legislation # 0341-15: An Action Relating to Resources and Development; Amending the Navajo Division of Transportation 2016 Tribal Transportation Improvement Plan, RDCS-70-15, to Include Funding for Design Work For the intersection of N12 and N100 within Window Rock, Navajo Nation *Sponsor: Honorable Leonard H. Pete*

Has had it under consideration and report the same that the matter was **RULED OUT OF ORDER** by Chairman Shepherd due to the appropriate TTIP documents are not attached for amendment.

Respectfully submitted,



Alton Joe Shepherd, Chairperson
Resources and Development Committee
of the 23rd Navajo Nation Council

Date: October 13, 2015

MAIN MOTION: Davis Filfred
Second: Walter Phelps