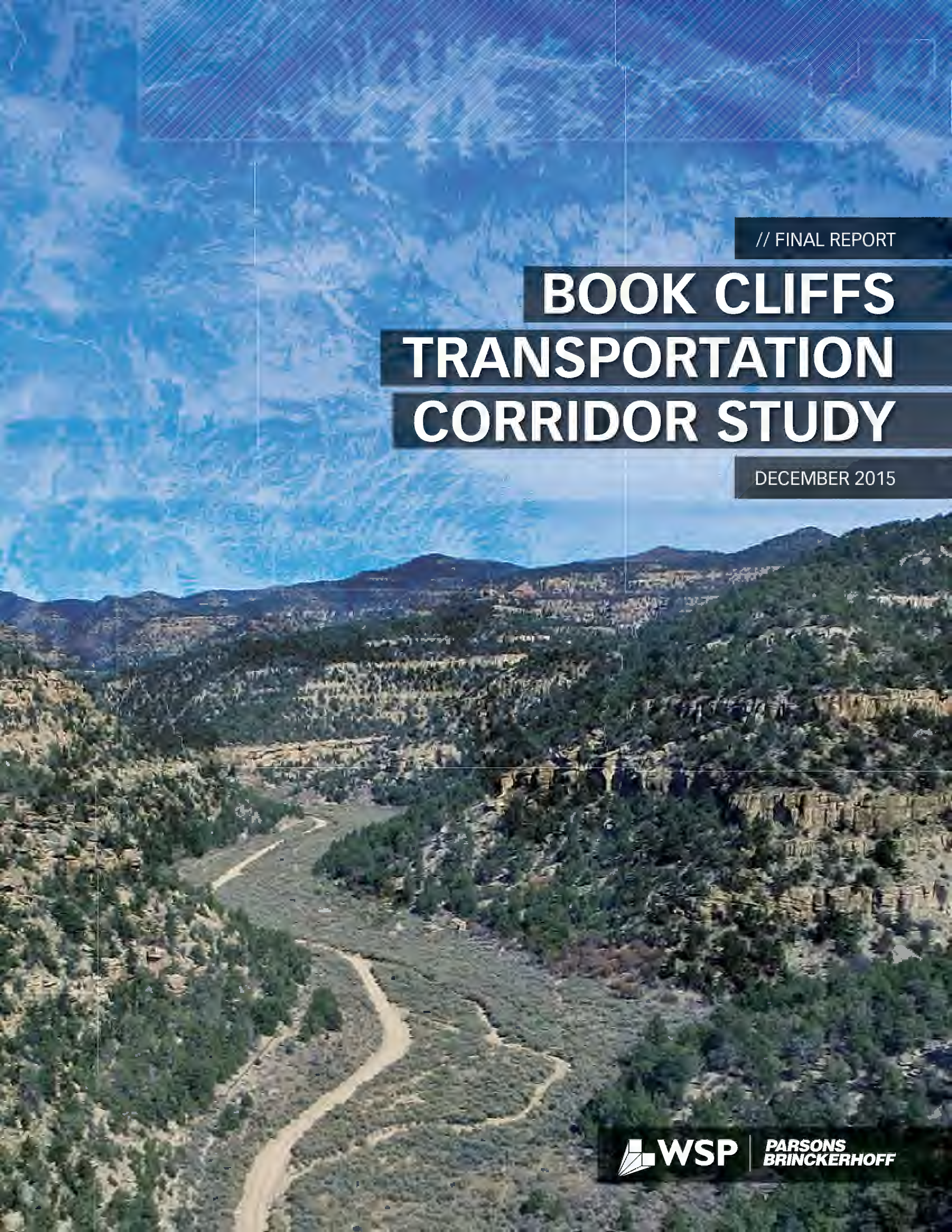

// FINAL REPORT

BOOK CLIFFS TRANSPORTATION CORRIDOR STUDY

DECEMBER 2015

WSP | PARSONS BRINCKERHOFF

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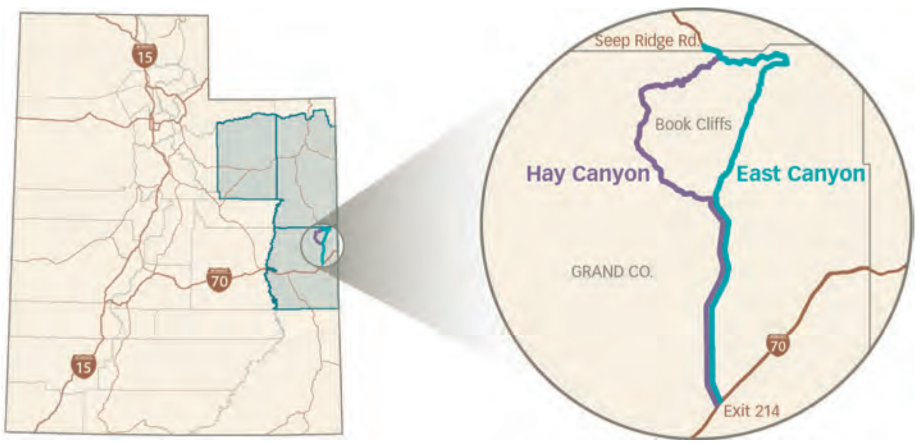
Table of Contents

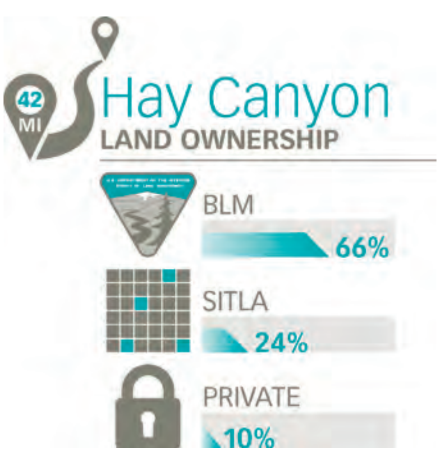
// EXECUTIVE SUMMARY

Background



Corridor Description

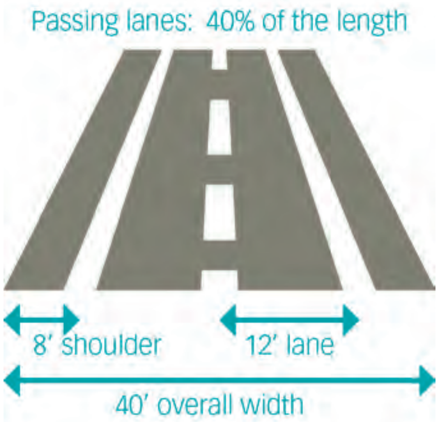
The study considered two separate route alternatives, Hay Canyon and East Canyon. These route alternatives follow a common path from I-70 to the Book Cliffs mountain range, and separate paths from there to Seep Ridge Road. Through the Book Cliffs mountain range, the separate paths generally follow the existing dirt (unpaved) roads through Hay Canyon and East Canyon, respectively. South of the Book Cliffs mountain range, the routes travel along the same path in a north/south direction and connect with I-70 at the existing Cisco/Danish Flat interchange (I-70 Exit 214). The Hay Canyon and East Canyon route alternatives are 42 and 41 miles long, respectively. Both route alternatives would travel through U.S. Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), and private property.



Study Purpose

The Book Cliffs Transportation Corridor Study (study) investigated the economic desirability and impacts of constructing a transportation corridor (study corridor) linking Seep Ridge Road in southern Uintah County, Utah to Interstate 70 (I-70) in Grand County, Utah. The study is part of a process to help ensure that future decisions regarding the study corridor consider the best interests of all stakeholders.

The study considered economic impacts to Grand, Duchesne, and Uintah counties, as well as general impacts to the state of Utah. The study evaluated corridor-related economic impacts to tourism and energy industries.



Roadway Description

The study corridor could accommodate multiple modes for moving people, goods, and utilities. In fact, the existing study corridor currently accommodates energy pipelines. However, this study focused on the economic impacts of constructing a paved roadway through the study corridor. Although alternate modes of transportation were considered, this study did not evaluate their economic impact.

The improved study corridor would accommodate vehicular traffic through a paved two-lane roadway with passing lanes for approximately 40 percent of the corridor length. The roadway would include roadside safety features consisting of paved shoulders, guardrail, cable barrier, concrete barrier, and crash attenuators.

Hay Canyon
EXISTING DIRT ROAD

East Canyon
EXISTING DIRT ROAD

Roadway Cost

This study evaluated construction and maintenance cost estimates for each study route alternative. The construction cost estimates were based on recent cost information for comparable projects and are cited in present day values. Construction bid tabulations for the Seep Ridge Road project were primarily used as the basis for the construction cost estimates. Seep Ridge Road was selected as a comparable project because it is located adjacent to the study corridor and its construction was completed in 2014.

Maintenance cost estimates for a 20 year period were based on a typical hot mix asphalt pavement maintenance cycle and recent cost information for comparable maintenance activities. The maintenance cycle includes annual striping, crack sealing, sign and delineator replacement, guardrail repair, drainage structure cleaning, snow removal, and pot hole patching. Additionally, a chip seal coat and emulsified asphalt would be required at 5-year intervals and resurfacing via milling and paving would be required after 20 years.

Possible construction of a paved roadway must be preceded by a National Environmental Policy Act (NEPA) study. A NEPA study could consider multiple modes of transportation for the study corridor, including roadways, pipelines, and utilities. The cost for such a study could reach an estimated $5 million, but could vary depending on project and NEPA process variables.

	Hay	East
NEPA STUDY	$5M	$5M
DESIGN ENGINEERING	$12M	$12M
CONSTRUCTION & ROW	$133M	$132M
CONSTRUCTION ENGINEERING	$13M	$13M
TOTAL CONSTRUCTION COST	$158M	$157M
MAINTENANCE (20 YEARS)	$28M	$27M

// EXECUTIVE SUMMARY

Access and Connectivity

Overview

Roadways facilitate the movement of people and goods. In eastern Utah, they connect people to each other, to industry, and to recreational destinations. The study corridor would increase access to Book Cliffs destinations, as well as improve connectivity to other destinations in eastern Utah. This improved connectivity would enhance mobility by allowing people and goods to travel more directly. The improved connectivity would also provide increased route choices for leisure and business travel.

Access: Book Cliffs

The existing routes through Hay Canyon and East Canyon provide dirt (unpaved) road access to the Book Cliffs mountain range. These dirt roads are unmaintained and mostly inaccessible during winter months. The dirt roads are also inaccessible to many vehicle types and to "out-of-town" recreational visitors who are unfamiliar with the roads. The improved study corridor would provide enhanced direct access to the Book Cliffs mountain range including access to outdoor recreational activities such as hiking, camping, hunting, horseback riding, and biking, just to name a few.

For motorists currently accessing the Book Cliffs from the south through the existing Hay Canyon or East Canyon dirt roads, the improved study corridor would reduce travel by approximately 40 minutes (10 miles). For similar motorists who do not or cannot use the current dirt roads to access the Book Cliffs, the improved study corridor would reduce travel by over 2 hours (120 miles).

Access: Safety

The existing Hay Canyon and East Canyon dirt roads present numerous safety hazards, including limited visibility from dust during dry seasons, slippery driving surfaces during wet seasons, poor sight distance because of substandard horizontal and vertical curves, and increased risk of vehicles leaving the roadway because of substandard horizontal curves and lack of roadside clear zone and barriers. The improved study corridor would reduce or eliminate these safety hazards through implementation of engineered roadway surface materials, shallower and longer curves, increased shoulder and clear zone widths, and roadside barriers.

Connectivity: Tourism

The improved connectivity of the study corridor would make destinations in eastern Utah better connected and more accessible. It would make regional travel quicker and more convenient. Many recreational destinations in eastern Utah rely on and benefit from through traffic traveling to major national parks north and south of the Book Cliffs. The study corridor would provide time and distance savings for travel between these destinations. The study considered the connectivity benefits to national and state parks in eastern Utah, including those shown on page v.

The study corridor provides a link that could facilitate a "Grand Corridor of Parks" similar to Utah's "Grand Circle of National Parks", but would focus on eastern Utah parks stretching between Lake Powell and Flaming Gorge or possibly extend from Grand Canyon National Park to Yellowstone National Park. The study corridor could also provide improved connectivity to additional outdoor recreational destinations in eastern Utah, such as mountain biking in Moab, Book Cliffs, and McCoy Flats near Vernal, and other outdoor activities in the Book Cliffs and Uinta mountains.

35-45 Minutes | 30-40 Miles
Time and distance saved traveling between Vernal and Moab, via the improved study corridor.

40 Minutes | 10 Miles
Time and distance saved traveling the improved corridor vs. the existing dirt road.

Connectivity: Energy

The study corridor would also provide shorter route alternatives between energy extraction activities in the Uinta Basin and destinations for energy products. Travel times and distances between oil extraction in the Book Cliffs and refineries would be shortened by providing more direct access to freeway, pipeline, or railway transportation infrastructure along I-70. Compared to Salt Lake City refineries, travel savings are more impactful for transport to out of state refineries that can be accessed through the I-70 corridor.

Overall travel impacts of the study corridor for Grand, Uintah, and Duchesne counties were estimated using the Utah Statewide Travel Demand Model (USTM). With the improved connectivity of the study corridor, the USTM estimated a 2040 reduction of 74,000 energy related heavy vehicle (truck) miles traveled per day.

120 Minutes | 110 Miles
Time and distance saved traveling between the Basin and a railroad, via the improved corridor.

Connectivity: Environment

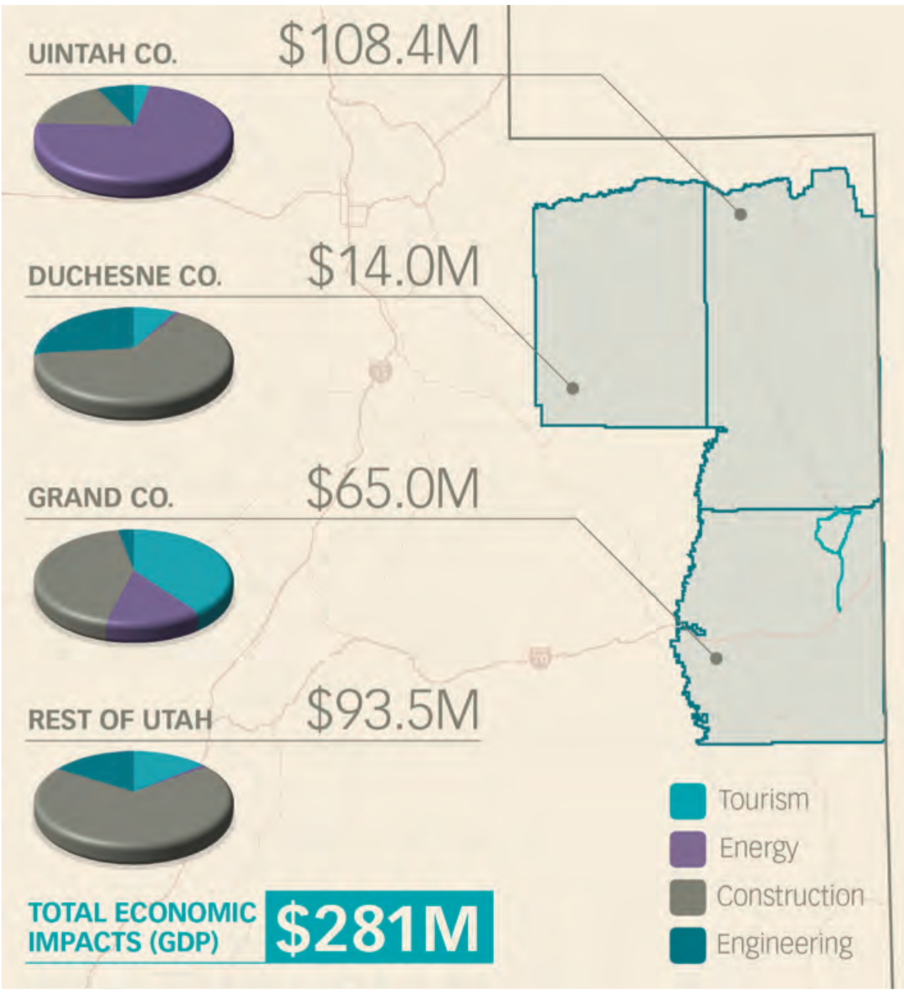
This study provided a high-level review of culturally sensitive sites and air quality for each corridor route alternative. However, this study did not provide an assessment of environmental impacts for the corridor. Possible implementation of an improved study corridor must be preceded by an environmental study that considers environmental impacts and follows the NEPA process.

Roadway improvements to the study corridor would result in a projected reduction of 118,000 daily vehicle miles traveled for the region and an average increase of 2,700 daily vehicle trips for the study corridor itself. Therefore, the study corridor is not expected to cause significant air quality impacts and would provide some dust particulate reduction as a result of roadway paving. Based on a review and analysis of previous cultural resource surveys, a small number of unrecorded archaeological sites are likely to be encountered within the study corridor route alternatives.

Hay 22 | East 20
Expected number of culturally sensitive sites.

Hay 2 | East 1
Expected number of unrecorded culturally sensitive sites.

// EXECUTIVE SUMMARY
Economic Impacts



Overview

Enhanced transportation infrastructure, including new and improved roadways, can foster increased economic activity. The travel savings of the improved study corridor would create opportunities for new, incremental economic activity. The incremental economic activity for tourism and recreation, energy production, and roadway construction industries is estimated to be $281 million in gross domestic product (GDP) and $557 million in total output through the year 2040. This potential incremental activity includes direct, indirect, and induced economic activity resulting from the construction of a paved roadway along the study corridor.

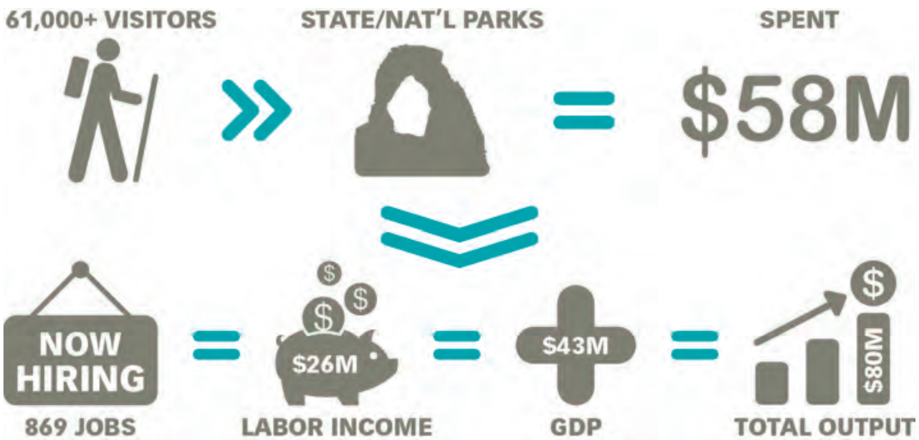
Spending for each industry occurs at different proportions among Grand, Duchesne, and Uintah counties. In turn, the economic impacts have varying degrees of effect in each county. The adjacent charts present the breakdown of the GDP impacts by county and industry.

Economic Impacts: Tourism

The travel and tourism sector is currently the main economic driver of the local economy in Grand County and is a growing component of the economy in Uintah and Duchesne counties. Tourism spending spans several categories of goods and services such as lodging, restaurants, travel costs, and admission fees. By improving access to the region, the study corridor would decrease the travel costs to national and state parks as well as other outdoor recreational destinations. The decreased costs would in turn increase the demand for tourism, increasing the spending associated with tourism industries.

It is estimated that by 2040, the travel time savings created from improving the study corridor would increase tourism visitations by over 61,000 annually. This translates into an estimated $58 million of incremental tourism spending through the year 2040. This incremental spending would spur economic impacts beyond those directly occurring in the tourism industry with an overall economic impact of $43 million in GDP.

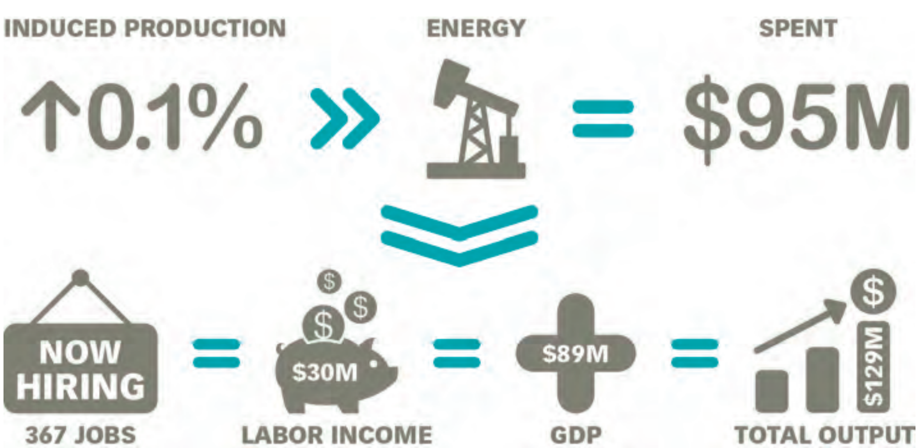
This study did not consider potential increased tourism economic impact derived from additional marketing or promotion of the region with easier travel and better connectivity.



Economic Impacts: Energy

By improving access to the Uinta Basin, the study corridor would reduce travel costs associated with the production of crude oil, natural gas, oil sands, and oil shale. These reduced travel costs would decrease the total cost of production and induce incremental production.

It is estimated that the improved study corridor would create $95 million of incremental oil and gas production spending through the year 2040. This incremental spending represents an increase of approximately one-tenth of one percent of the energy production in Uintah and Grand counties. This incremental spending would spur economic impacts beyond those directly occurring in the energy industry with an overall economic impact of $89 million in GDP.



Benefit/Cost Analysis

Whereas the economic impacts consider how the economy might change incrementally because of the improved study corridor, a benefit-cost analysis (BCA) considers the overall economic contribution of the corridor. Instead of considering the incremental activity resulting from travel time savings, the BCA considers the travel time saving itself as an economic benefit. The potential benefits considered by the BCA include:

- Fuel Savings
- Travel Time Savings
- Vehicle Operating Cost Savings
- Pavement Maintenance Savings
- Accident Cost Savings
- Emission (GHG) Cost Savings

These benefits were quantified based on results of the USTM, monetized using methods consistent with the latest guidance from the US Department of Transportation, and then evaluated against the initial (capital) and ongoing (operating and maintenance) costs. The net present value (NPV) of the benefits and costs of the improved study corridor were estimated to be $1.8 billion. The resulting benefit-cost ratio (BCR) for the improved study corridor is 14.8. These NPV and BCR results reflect a highly favorable overall contribution to the economic welfare of the region.

NPV: $1.8B

BCR: 14.8

// SECTION ONE

Introduction

1

1.1. Study Purpose

The Book Cliffs Transportation Corridor Study (study) investigated the economic desirability and impacts of constructing a transportation corridor (study corridor) linking Seep Ridge Road in southern Uintah County, Utah to Interstate 70 (I-70) in Grand County, Utah.

The study considered economic impacts to Grand, Duchesne, and Uintah counties, as well as general impacts to the State of Utah. The study was funded by a group of stakeholders that include Uintah County, Duchesne County, the School and Institutional Trust Lands Administration (SITLA), and transportation districts of Grand County, Duchesne County, and Uintah County.

The study followed a technical approach to gauge the economic impacts of constructing a paved roadway for the study corridor. This effort evaluated employment trends, growth impacts in communities, travel forecasts, energy production forecasts, tourism impacts, fiscal impacts, and a number of other metrics to inform how the improved study corridor would affect surrounding communities. The study analysis focused on evaluating corridor-related economic impacts to tourism and energy industries.

The study is part of a process to research and evaluate the study corridor to ensure that future decisions about the corridor consider the best interests of all stakeholders. The study is not intended to make or document decisions about the study corridor, but is rather intended to inform local, county, and state decision makers about the economic desirability and impacts of constructing the study corridor. If officials decide to move forward with the study corridor, the next step would be to conduct a National Environmental Policy Act (NEPA) guided process which would focus on and evaluate environmental impacts.

1.2. Recent Studies

Unlike previous studies, this study focused on the economic impacts of constructing a transportation corridor in the Book Cliffs area. This study builds on related research completed in recent years by the Utah Department of Transportation (UDOT). This study reviewed the methodologies and results of recent UDOT research including the following documents:

- *Uinta Basin Energy Transportation Study* (UBET Study) completed by UDOT in 2013.
- *Grand County to Uintah County Connection Feasibility Study* (UDOT Engineering Study) completed by UDOT in 2014.

Reviews of these UDOT documents included an assessment of the appropriateness and applicability of the methodologies applied by UDOT's UBET Study and Engineering Study. This study applied and, where necessary, modified those methodologies to evaluate the impacts of the improved study corridor. Following is a discussion of each of the UDOT documents referenced above and how they relate to this study.

The UBET Study investigated the prospective path of energy growth within the Uinta Basin and whether or not the current transportation capacity was limiting growth in that particular industry. The UBET Study findings showed that the current transportation infrastructure is limiting energy growth in the Uinta Basin. Although the current study applied some of the methodologies and findings of the UBET Study, it focused on specific corridors in the Book Cliffs area and considered a broader range of economic impacts, including tourism, regional mobility, and community services impacts.

The UDOT Engineering Study focused on the constructability and probable cost of building a road between Seep Ridge Road and I-70. It evaluated three alternative routes through the Book Cliffs including Sego, Hay, and East canyons. Based on the results of the UDOT Engineering Study and other considerations, officials decided to exclude the Sego Canyon route from further evaluation. Therefore, this study focused on the economic impacts for the remaining Hay Canyon and East Canyon route alternatives.

1.3. Study Methodology

As previously mentioned, the study followed a technical approach to gauge the economic impacts of constructing a paved roadway in the study corridor. Figure 1 summarizes the methodology followed to complete the study and summarizes the organization of the study report. The study focused on impacts to the tourism and energy industries. Because of its considerable anticipated impact on the economy, construction related impacts were also considered.

The economic impacts of the improved study corridor were estimated by first determining impacts to travel for each industry. Travel impacts were in turn monetized to understand the economic impacts to industry and the community.

First, the study reviewed and assessed the context for the study corridor (Section 1). These efforts included a review of historical and projected socioeconomic conditions for the study area and general conditions of tourism and energy development opportunities. In addition to framing the context for the study corridor, this information formed the basis for subsequent forecasting efforts.

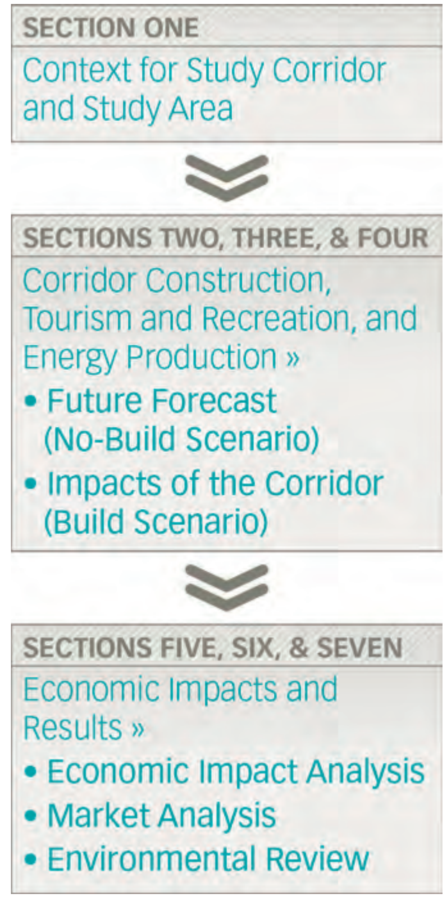
Next, the study considered the anticipated impacts for each industry. Construction impacts (Section 2) were primarily assessed in terms of the investment level (cost) required to implement study corridor improvements. Tourism visitation and energy production impacts (Sections 3 and 4, respectively) were assessed by forecasting future growth baseline no-build scenarios and comparing them to future growth forecasts of build scenarios. The baseline (no-build) scenarios forecasted growth assuming no improvements to the study corridor while the build scenarios forecasted growth assuming construction of the improved study corridor. The differences between these baseline and build scenarios were monetized to estimate incremental changes in tourism visitations and incremental changes in energy production.

Incremental changes in construction, tourism, and energy production activities were then analyzed to estimate their impact on the economy (Section 5), including contributions to employment and the gross domestic product (GDP). Economic impacts were also analyzed in terms of benefit-cost ratios and net present value (Section 5). The economic impacts were further quantified by analyzing impacts to the market and the community (Section 6). Finally, the impacts were assessed in terms of the environment (Section 7).

The economic impacts estimated by this study were based on forecasts through the year 2040. This future year horizon was selected based on available baseline projections and a 20-year project design, assuming construction of the study corridor can be completed in approximately five years. Although forecasts and impacts stretch through 2040, monetized estimates are reported in current day values. Unless otherwise stated, all currency and values presented in this study are in 2015 dollars.

The technical approach of the study required the engagement of a multi-disciplinary team. The study was completed by WSP | Parsons Brinckerhoff, who led the overall study efforts and provided services related to transportation infrastructure planning and design, economic modeling and analysis, environmental reviews, energy, and tourism. The project team also included subconsultants GSBS for socioeconomic and market analysis support, RSG for travel demand modeling support, Jones & DeMille for GIS and local context support, and CIVCO Engineering for roadway design and local context support. Additional support for energy resources and for presentations was provided by independent consultants.

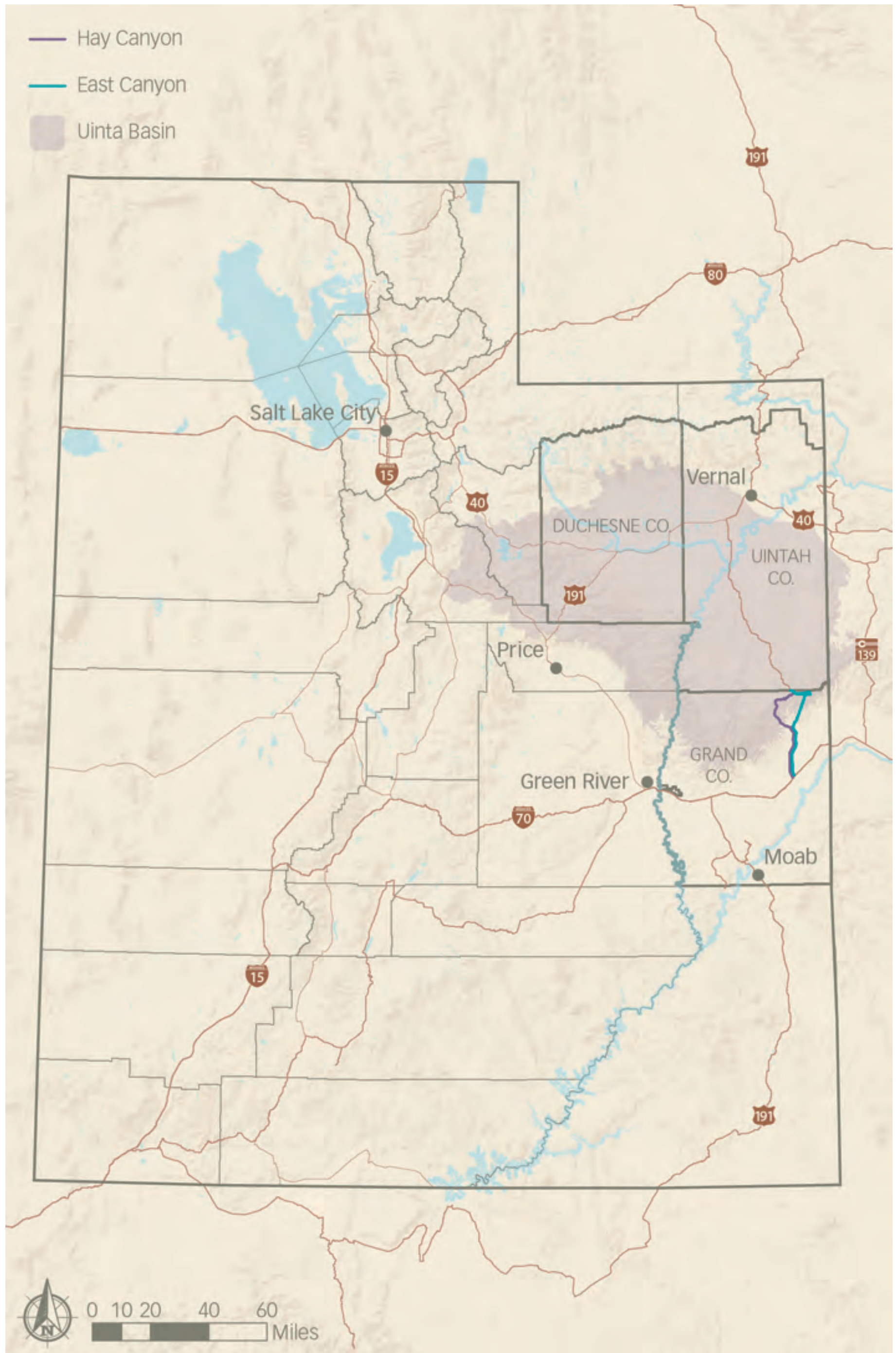
Figure 1: *Study Methodology*



1.4. Study Area

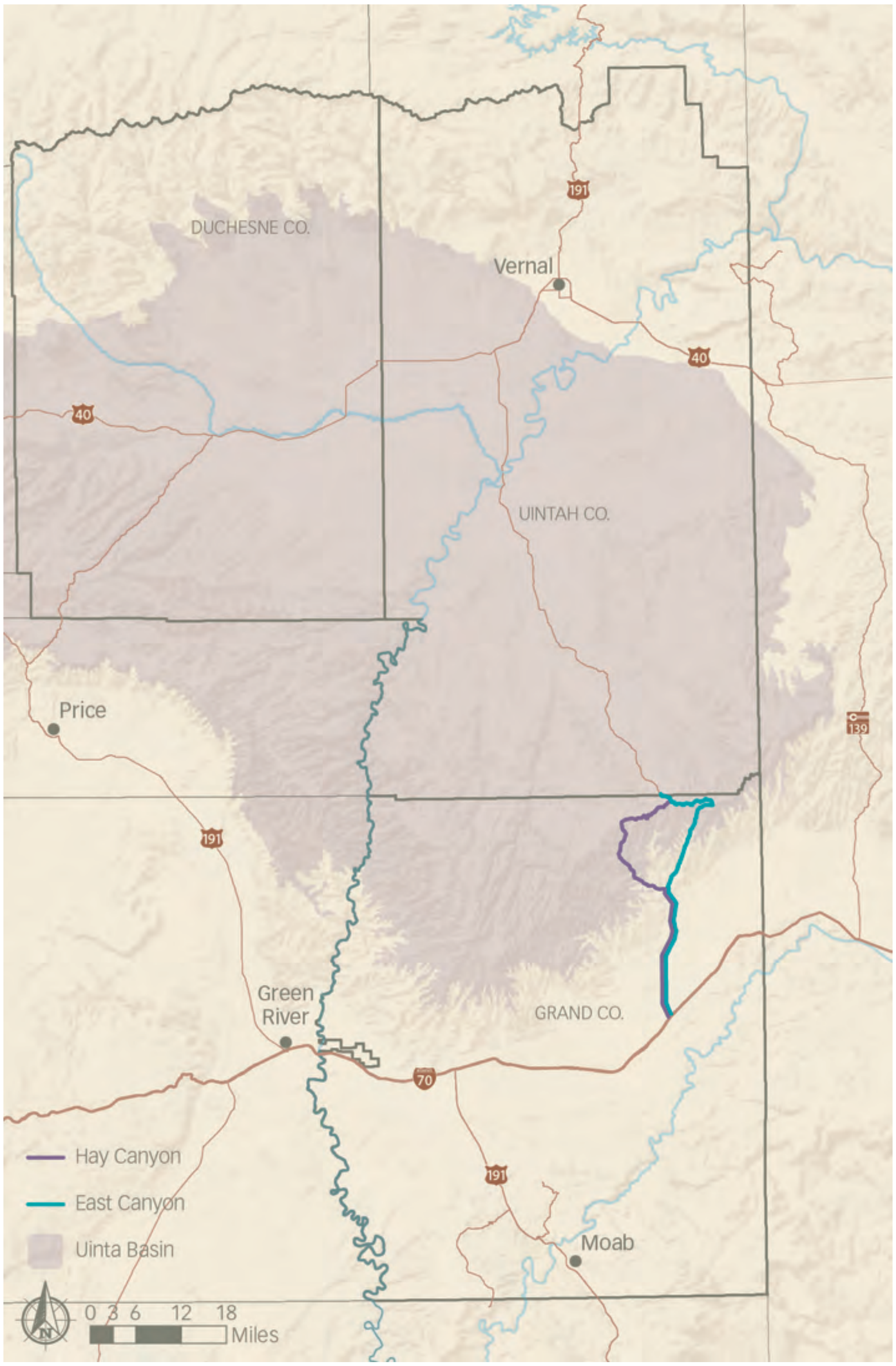
The study area consists of Grand, Duchesne, and Uintah counties. Figure 2 shows the study area in the context of the overall State of Utah. The statewide context is important because economic impacts were considered for each of the three study area counties and for the remaining areas of the state. Figure 3 shows the regional context of the three-county study area. Economic and

Figure 2: *Study Area – Statewide Context*



socioeconomic impacts of the study corridor were considered for the entire three-county study area. However, within Grand, Duchesne, and Uintah counties, consideration of energy characteristics focused within the limits of the Uinta Basin. The boundaries of the Uinta Basin and its relationship to the three-county study area are illustrated in Figure 3. Tourism characteristics accounted for national and state recreational attractions located within and near the three-county area.

Figure 3: *Study Area – Regional Context*



1.5. Socioeconomic Characteristics

To understand economic impacts, the socioeconomic characteristics of the study area must be understood. This study researched and summarized the county-level socioeconomic characteristics of the study area. Population and employment data and projections were gathered from the State of Utah Governor's Office of Management and Budget (GOMB) and the U.S. Bureau of Labor Statistics (BLS). Data from the GOMB included population estimates and projections and area employment projections. Data from the BLS included local area unemployment statistics and employment and wage data. Data for 2014 were used because this was the most recent and complete year of data available when the study was conducted. Data were coordinated with the other analyses and models in the study to maintain consistency. Socioeconomics data were compared to data from other sources used in study models and the data sets were consistent at the county level.

In 2014, the overall population of the State of Utah was estimated to be 2,942,902, an increase of 1.4 percent from 2013 according to the U.S. Census Bureau. In 2015, this population was estimated to reach 3,000,000. While the majority of Utah's population is concentrated across the Wasatch Front, in recent years, the Uinta Basin has had some of the highest rates of population growth. From 2012 to 2013, Duchesne County and Uintah County had the first and fifth highest population growth rates in the State of Utah, respectively. Grand County did not have significant growth in population over this same time.

Increased mining, oil, and gas productivity in the Uinta Basin has resulted in strong population and employment growth in the study area. This has also induced strong growth in the construction industry. Mining, oil, and gas wages have seen substantial increases, and are much higher than the respective county averages. Continued growth of tourism visits to the Grand County area is the source of its economic growth.

Overall, each of the counties' socioeconomic data reveals a dependence on a single sector of the economy. For Duchesne and Uintah counties, it is mining, oil, and gas production. For Grand County, it is tourism. Following is an overview of the socioeconomic characteristics and 2040 forecasts for Grand, Duchesne, and Uintah counties.

Grand County Overview

Its proximity to national parks and recreation areas has positioned Grand County as one of the top visitor destinations in the State of Utah. The area is popular for river running, off-road recreation vehicle adventures, and mountain biking. As a result, the Grand County economy is oriented around tourism. While the hotel, restaurant, and entertainment industries dominate the economy, recent growth in other sectors such as mining, transportation, and manufacturing suggest the local economy is diversifying.

Between 2000 and 2010, the Grand County population grew an average of 0.6 percent annually, lower than the state's average annual growth rate of 2.2 percent. The 2014 data available when this study was conducted show that the county population grew annually at 0.5 percent since 2010 which is also lower than the state's average annual growth rate of 1.6 percent. Between 2014 and 2040, the Grand County population is expected to grow about 1.0 percent annually which is lower than the state's expected average annual growth rate of 1.7 percent. Growth in the county has been through migration of retirees and the tourism labor force.

Labor force participation in Grand County is dominated by tourism-related industries. In recent years, labor force participation has grown by 1.0 percent annually. The unemployment rate peaked in 2010 at 10.5 percent as a result of the recession. The unemployment rate dropped to 6.2 percent by 2014.

Between 2011 and 2014, the number of jobs in Grand County grew at an average annual rate of change (AARC) of 3.6 percent. Employment data from BLS Quarterly Census of Employment and Wages are shown in Table 1. The accommodation and food service industries had the greatest share of employment at 32.1 percent of total employment in 2014. The retail industry had the second largest share at 16.6 percent. Between 2011 and 2014,

***Table 1:** Grand County Employment Data, 2011 - 2014*

	2011	2012	2013	2014	Change	AARC	% of 2014
Agriculture, Forestry, Fishing and Hunting	0	0	0	0	0	0.0%	0.0%
Mining, Quarrying, and Oil and Gas Extraction	104	128	106	117	13	4.0%	2.5%
Utilities	27	27	27	27	0	0.0%	0.6%
Construction	217	218	228	269	52	7.4%	5.7%
Manufacturing	25	30	34	37	12	14.0%	0.8%
Wholesale Trade	69	71	85	80	11	5.1%	1.7%
Retail Trade	738	767	778	790	52	2.3%	16.6%
Transportation and Warehousing	59	60	72	79	20	10.2%	1.7%
Information	31	33	0	30	-1	-1.1%	0.6%
Finance and Insurance	67	66	68	65	-2	-1.0%	1.4%
Real Estate and Rental and Leasing	84	91	94	102	18	6.7%	2.1%
Professional and Technical Services	129	121	110	119	-10	-2.7%	2.5%
Management of Companies and Enterprises	0	0	0	0	0	0.0%	0.0%
Administrative and Waste Services	0	0	0	0	0	0.0%	0.0%
Educational Services	272	266	277	292	20	2.4%	6.1%
Health Care and Social Assistance	329	364	359	382	53	5.1%	8.0%
Arts, Entertainment, and Recreation	358	461	453	460	102	8.7%	9.7%
Accommodation and Food Service	1,377	1,446	1,489	1,529	152	3.6%	32.1%
Other Services, Except Public Administration	87	80	74	76	-11	-4.4%	1.6%
Public Administration	312	317	315	304	-8	-0.9%	6.4%
Unclassified	0	0	0	0	0	0.0%	0.0%
Total	4,285	4,546	4,569	4,758	473	3.6%	

Source: BLS.

mining, oil, and gas employment had an annual increase of 4.0 percent, manufacturing had the strongest annual growth rate of 14.0 percent, and the transportation and warehousing industry increased by 10.2 percent annually.

Employment projections from the State of Utah GOMB through year 2040 by industry are presented in Table 2. Grand County projections suggest the addition of 1,284 new jobs between 2020 and 2040, growing annually by 0.8 percent. The biggest contributor to employment growth is expected to come from the accommodation and food service industry, which is projected to add 280 new jobs, growing annually by 0.8 percent. The professional and technical services industry is expected to be the second highest contributor to job growth with 213 new jobs added and growing annually at 2.2 percent. Other sectors such as arts and entertainment, healthcare, construction, administration, and government are also projecting strong growth. These State projections show the Grand County economy will be less dependent on accommodations and food services by 2040.

Duchesne County Overview

Historically, the Duchesne County economy was dominated by the agriculture and livestock industries. However, the relatively recent development of oil and gas production in the Uinta Basin has caused population and employment growth in the region and oil and gas extraction is now the dominant industry. As a result, other industries such as transportation and warehousing have emerged and are largely dependent on the success of the oil and gas industry. The Duchesne County economic productivity is heavily influenced by the volatility of global oil and gas prices.

Table 2: *Grand County Employment Projections, 2020 - 2040*

	2020	2030	2040	Change	AARC
Natural Resources	69	67	64	-5	-0.4%
Mining	183	180	171	-12	-0.3%
Utilities	26	21	19	-7	-1.6%
Construction	584	682	757	173	1.3%
Manufacturing	83	76	70	-13	-0.8%
Wholesale Trade	94	97	96	2	0.1%
Retail Trade	945	970	1,004	59	0.3%
Transportation and Warehousing	130	142	151	21	0.8%
Information	71	74	79	8	0.5%
Finance and Insurance	156	164	175	19	0.6%
Real Estate, Rental and Leasing	413	421	425	12	0.1%
Professional and Technical Services	383	480	596	213	2.2%
Management of Companies	47	47	45	-2	-0.2%
Administrative and Waste Services	265	320	365	100	1.6%
Educational Services	130	138	145	15	0.5%
Health and Social Services	416	467	512	96	1.0%
Arts, Entertainment and Recreation	441	503	581	140	1.4%
Accommodation and Food Services	1,640	1,771	1,920	280	0.8%
Other Services	305	324	346	41	0.6%
State and Local Government	779	864	939	160	0.9%
Federal Civilian	238	240	250	12	0.2%
Federal Military	38	35	33	-5	-0.7%
Farm	86	73	63	-23	-1.5%
Total	7,522	8,156	8,806	1,284	0.8%

Source: State of Utah GOMB.

Between 2000 and 2010, the Duchesne County population grew an average of 2.6 percent annually, higher than the state average annual growth rate of 2.2 percent. The 2014 data available when this study was conducted show that the county population grew annually by 2.3 percent since 2010 which is also higher than the state's average annual growth rate of 1.6 percent. Between 2014 and 2040, the Duchesne County population is expected to grow about 0.9 percent annually which is lower than the state's expected average annual growth rate of 1.7 percent. Growth in the county has been strongly influenced by the oil and gas industry and net migratory patterns.

Labor force participation in Duchesne County is heavily influenced by oil and gas production. In recent years, labor force participation has grown by 4.1 percent annually. The unemployment rate peaked in 2010 at 9.6 percent as a result of the recession. Historically, the county has followed the state's unemployment rates, and the unemployment rate since the recession dropped to 3.6 percent by 2014.

Between 2011 and 2014, the number of jobs in Duchesne County grew annually at 4.9 percent. Employment data from BLS Quarterly Census of Employment and Wages are shown in Table 3. The mining, oil, and gas sector had the greatest share of employment in the county at 28.2 percent of total employment in 2014. Retail trade and transportation each account for over 10 percent. Between 2011 and 2014, mining, oil, and gas employment had an annual increase of 12.9 percent, wholesale trade had the strongest annual growth rate of 28.2 percent, and the retail industry increased 8.2 percent annually. The agriculture industry saw a significant decline in employment, shrinking 18.4 percent annually. Other declining sectors

Table 3: *Duchesne County Employment Data, 2011 - 2014*

	2011	2012	2013	2014	Change	AARC	% of 2014
Agriculture, Forestry, Fishing and Hunting	35	34	11	19	-16	-18.4%	0.2%
Mining, Quarrying, and Oil and Gas Extraction	1766	2194	2269	2541	775	12.9%	28.2%
Utilities	52	55	53	46	-6	-4.0%	0.5%
Construction	693	898	805	802	109	5.0%	8.9%
Manufacturing	167	172	187	209	42	7.8%	2.3%
Wholesale Trade	184	265	322	388	204	28.2%	4.3%
Retail Trade	772	808	861	979	207	8.2%	10.9%
Transportation and Warehousing	912	1042	1016	973	61	2.2%	10.8%
Information	191	188	181	188	-3	-0.5%	2.1%
Finance and Insurance	120	125	125	128	8	2.2%	1.4%
Real Estate and Rental and Leasing	54	54	60	70	16	9.0%	0.8%
Professional and Technical Services	109	120	138	136	27	7.7%	1.5%
Management of Companies and Enterprises	0	0	0	0	0	0.0%	0.0%
Administrative and Waste Services	0	0	0	0	0	0.0%	0.0%
Educational Services	737	740	754	729	-8	-0.4%	8.1%
Health Care and Social Assistance	1,027	684	1,101	703	-324	-11.9%	7.8%
Arts, Entertainment, and Recreation	24	22	15	20	-4	-5.9%	0.2%
Accommodation and Food Service	361	419	434	423	62	5.4%	4.7%
Other Services, Except Public Administration	190	218	225	214	24	4.0%	2.4%
Public Administration	406	418	427	430	24	1.9%	4.8%
Unclassified	0	0	0	0	0	0.0%	0.0%
Total	7,800	8,456	8,984	8,998	1,198	4.9%	

Source: BLS.

include healthcare and social services, utilities, and arts and entertainment.

Employment projections from the State of Utah GOMB through year 2040 by industry are presented in Table 4. Duchesne County projections suggest the addition of 1,291 new jobs between 2020 and 2040, growing annually by 0.5 percent. Mining jobs are expected to shrink by 0.3 percent annually. The biggest contributor to employment growth is expected to come from the government sector, which is projected to add 413 new jobs, growing annually by 0.9 percent. The construction sector is expected to be the second highest contributor to job growth with 301 new jobs added and growing annually by 1.2 percent. Other sectors such as transportation and warehousing, healthcare, and professional services are also projecting strong growth. These State projections show Duchesne County will be less dependent on mining, oil, and gas whose share is expected to make up approximately 14 percent of total employment by 2040, much lower than in 2014.

Uintah County Overview

The relatively recent development of oil and gas production in the Uinta Basin is responsible for much of the population and employment growth in Uintah County. As a result, oil and gas extraction is now the dominant industry in the county. Economic productivity in Uintah County is heavily influenced by the volatility of global oil and gas prices.

Between 2000 and 2010, the Uintah County population grew an average of 2.6 percent annually; higher than the state's average annual growth rate. The 2014 data available when this study was conducted show that the county population grew annually by 3.1 percent since 2010 which is also higher than the state's average annual growth rate.

Table 4: *Duchesne County Employment Projections, 2020 - 2040*

	2020	2030	2040	Change	AARC
Natural Resources	100	95	92	-8	-0.4%
Mining	2,049	2,059	1,941	-108	-0.3%
Utilities	34	28	25	-9	-1.5%
Construction	1,084	1,253	1,385	301	1.2%
Manufacturing	254	239	218	-36	-0.8%
Wholesale Trade	189	193	192	3	0.1%
Retail Trade	1,125	1,155	1,194	69	0.3%
Transportation and Warehousing	1,104	1,223	1,294	190	0.8%
Information	235	248	264	29	0.6%
Finance and Insurance	285	296	317	32	0.5%
Real Estate, Rental and Leasing	453	465	469	16	0.2%
Professional and Technical Services	284	356	441	157	2.2%
Management of Companies	70	69	67	-3	-0.2%
Administrative and Waste Services	252	302	345	93	1.6%
Educational Services	64	67	70	6	0.4%
Health and Social Services	630	699	768	138	1.0%
Arts, Entertainment and Recreation	126	144	165	39	1.4%
Accommodation and Food Services	490	524	566	76	0.7%
Other Services	739	793	843	104	0.7%
State and Local Government	2,023	2,242	2,436	413	0.9%
Federal Civilian	90	92	97	7	0.4%
Federal Military	76	71	65	-11	-0.8%
Farm	772	651	565	-207	-1.5%
Total	12,528	13,264	13,819	1,291	0.5%

Source: State of Utah GOMB.

Between 2014 and 2040, the Uintah County population is expected to grow 0.6 percent annually which is lower than the state's expected average annual growth rate. Growth in the county has been strongly influenced by the oil and gas industry and net migratory patterns.

Labor force participation in Uintah County is heavily influenced by oil and gas production. In recent years, labor force participation has grown 1.2 percent annually. The unemployment rate peaked in 2010 at 8.5 percent as a result of the recession. Historically, the county has followed the state's unemployment rates, and the unemployment rate since the recession dropped to 3.5 percent by 2014.

Between 2011 and 2014, the number of jobs Uintah County grew annually at 2.2 percent. Employment data from BLS Quarterly Census of Employment and Wages are shown in Table 5. The mining, oil, and gas industry had the greatest share of employment at 23.8 percent of total employment in 2014. The retail industry had the second largest share at 12.4 percent. Other large employment industries include accommodation and food services and public administration. Between 2011 and 2014, the education services industry had the strongest annual growth rate at 25.3 percent. The other services and information industries both grew at over eight percent annually. The healthcare and social services, agriculture, manufacturing, professional services, and arts and entertainment industries all experienced declines.

Employment projections from the State of Utah GOMB through year 2040 by industry are presented in Table 6. Uintah County projections suggest the addition of 2,290 new jobs between 2020 and 2040, growing annually by 0.5 percent. The biggest contributor to employment growth is expected to come from the government sector, which is projected to add 566 new jobs, growing annually by 0.9

Table 5: *Uintah County Employment Data, 2011 - 2014*

	2011	2012	2013	2014	Change	AARC	% of 2014
Agriculture, Forestry, Fishing and Hunting	70	68	48	55	-15	-7.7%	0.4%
Mining, Quarrying, and Oil and Gas Extraction	3,089	3,190	3,056	3,209	120	1.3%	23.8%
Utilities	176	176	175	176	0	0.0%	1.3%
Construction	979	1,152	1,008	1,146	167	5.4%	8.5%
Manufacturing	190	194	192	179	-11	-2.0%	1.3%
Wholesale Trade	640	712	695	683	43	2.2%	5.1%
Retail Trade	1,524	1,597	1,616	1,672	148	3.1%	12.4%
Transportation and Warehousing	925	995	938	1005	80	2.8%	7.4%
Information	133	134	150	168	35	8.1%	1.2%
Finance and Insurance	189	219	201	186	-3	-0.5%	1.4%
Real Estate and Rental and Leasing	407	426	398	388	-19	-1.6%	2.9%
Professional and Technical Services	431	475	440	400	-31	-2.5%	3.0%
Management of Companies and Enterprises	0	0	0	0	0	0.0%	0.0%
Administrative and Waste Services	0	0	0	0	0	0.0%	0.0%
Educational Services	29	34	46	57	28	25.3%	0.4%
Health Care and Social Assistance	1,011	974	955	958	-53	-1.8%	7.1%
Arts, Entertainment, and Recreation	45	43	41	43	-2	-1.5%	0.3%
Accommodation and Food Service	1,030	1,159	1,174	1,179	149	4.6%	8.7%
Other Services, Except Public Administration	379	417	454	497	118	9.5%	3.7%
Public Administration	1,396	1,405	1,454	1,510	114	2.7%	11.2%
Unclassified	0	0	0	0	0	0.0%	0.0%
Total	12,643	13,370	13,041	13,511	868	2.2%	

Source: BLS.

***Table 6:** Uintah County Employment Projections, 2020 - 2040*

	2020	2030	2040	Change	AARC
Natural Resources	103	101	96	-7	-0.4%
Mining	3,595	3,522	3,334	-261	-0.4%
Utilities	126	109	95	-31	-1.4%
Construction	1,686	1,988	2,198	512	1.3%
Manufacturing	277	258	236	-41	-0.8%
Wholesale Trade	748	771	763	15	0.1%
Retail Trade	2,058	2,107	2,177	119	0.3%
Transportation and Warehousing	1,176	1,296	1,373	197	0.8%
Information	191	199	212	21	0.5%
Finance and Insurance	776	820	872	96	0.6%
Real Estate, Rental and Leasing	860	882	889	29	0.2%
Professional and Technical Services	713	897	1,111	398	2.2%
Management of Companies	125	120	118	-7	-0.3%
Administrative and Waste Services	494	586	672	178	1.6%
Educational Services	128	137	144	16	0.6%
Health and Social Services	1,324	1,499	1,638	314	1.1%
Arts, Entertainment and Recreation	137	153	179	42	1.3%
Accommodation and Food Services	1,151	1,243	1,345	194	0.8%
Other Services	1,195	1,280	1,361	166	0.7%
State and Local Government	2,769	3,069	3,335	566	0.9%
Federal Civilian	410	415	435	25	0.3%
Federal Military	133	124	113	-20	-0.8%
Farm	862	730	631	-231	-1.5%
Total	21,037	22,306	23,327	2290	0.5%

Source: State of Utah GOMB.

percent. The construction industry is expected to be the second highest contributor to job growth with 512 new jobs added and growing annually at 1.3 percent. Other sectors such as healthcare, professional services, and administration are also projecting strong growth. These State projections show the Uintah County economy will be less dependent on the mining, oil, and gas industry by 2040.

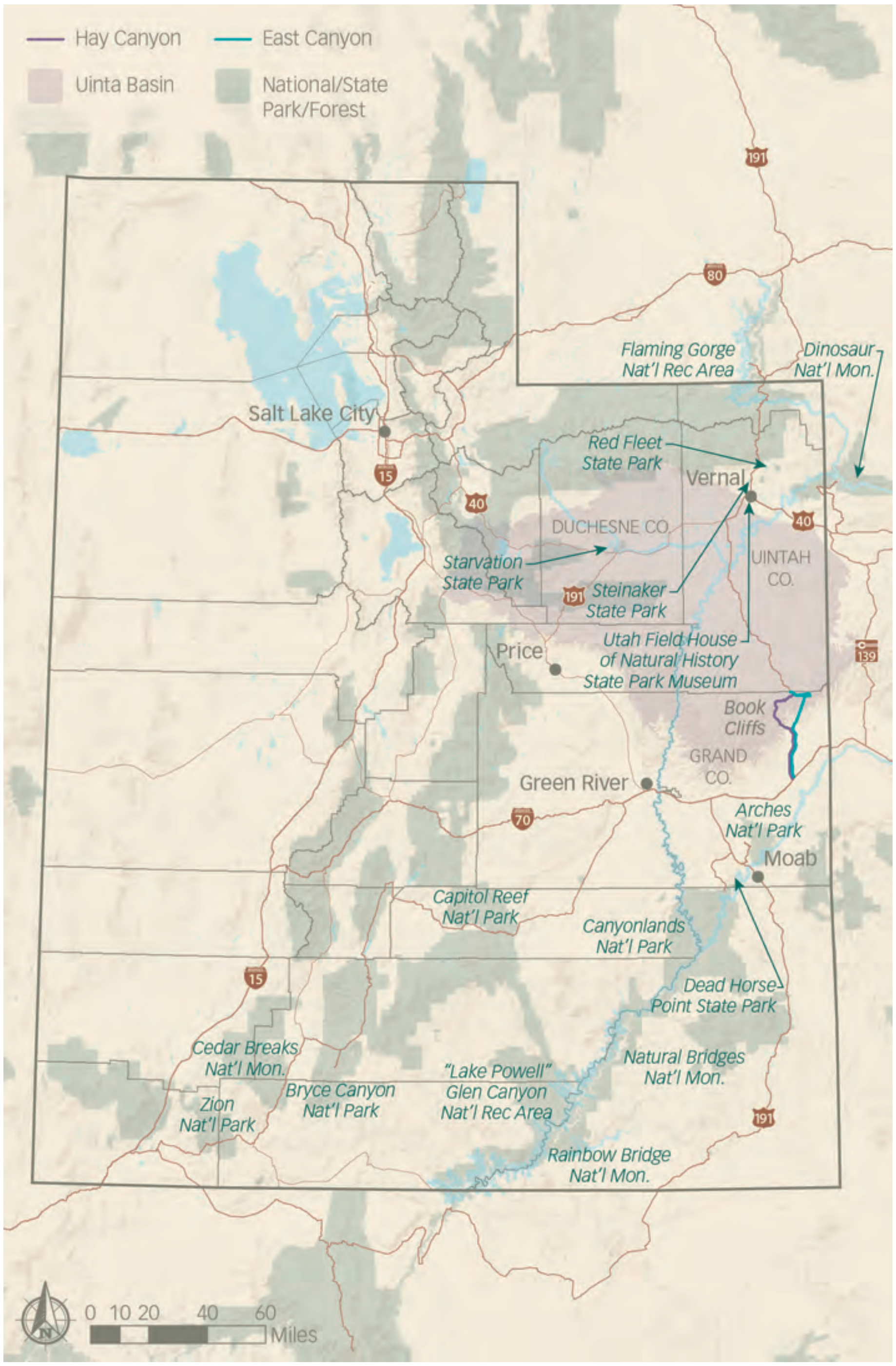
1.6. Tourism Characteristics

Utah is home to the "Mighty 5" national parks: Zion, Arches, Capitol Reef, Bryce Canyon, and Canyonlands. Utah has eleven national monuments and recreation areas and the North Rim of the Grand Canyon is accessible through Utah. Utah is also home to a large part of the "Grand Circle" itinerary, a regionally-promoted eleven-day itinerary used by visitors to the southwest United States for self-driving and bus tour vacations. The Utah Office of Tourism has also been working with regional and county-level tourism groups to identify additional recommended itineraries. One possible itinerary includes use of the proposed study corridor. It is an itinerary that links several parks and recreation areas running north/south including Glacier, Yellowstone, Flaming Gorge, Dinosaur National Monument, Arches and Lake Powell. This multi-day route represents an opportunity to link recreation attractions and boost visitation to areas in Utah.

The study area is home to two national parks, one national monument, five state parks, one hunting area and two recreation areas famous for world-class whitewater rafting, hiking, fishing and off-road bicycling and jeep trails. For the purpose of this study, the selection of these tourism and recreation attractions was based on potential access and connectivity benefits from the improved study corridor. The following tourism and recreation attractions, shown in Figure 4, were considered in this study:

- Four attractions south of the study corridor:
    - Arches National Park, Grand County
    - Canyonlands National Park, near Grand County
    - Dead Horse Point State Park, Grand County
    - Lake Powell in the Glen Canyon National Recreation Area, near Grand County

Figure 4: *Tourism and Recreation Context*



- Six attractions north of the study corridor:
  - Dinosaur National Monument, Uintah County
  - Utah Field House of Natural History State Park Museum, Uintah County
  - Steinaker State Park, Uintah County
  - Red Fleet State Park, Uintah County
  - Flaming Gorge National Recreation Area, near Uintah County
  - Starvation State Park, Duchesne County
- Hunting within the Book Cliffs area

South of the corridor, there are two national parks, a state park, and one recreation area. For visitors coming from I-70, the parks are accessible via US-191.

North of the corridor, there is one national monument, four state parks, and one recreation area. All six attractions are accessible via US-191 and US-40.

Apart from these 10 tourism attractions, the study corridor is expected to improve access to the Book Cliffs mountain range which is currently accessible via the existing dirt (unpaved) Hay Canyon and East Canyon routes. Additional tourism characteristics for the study area are presented in Section 3 of this study.

1.7. Energy Characteristics

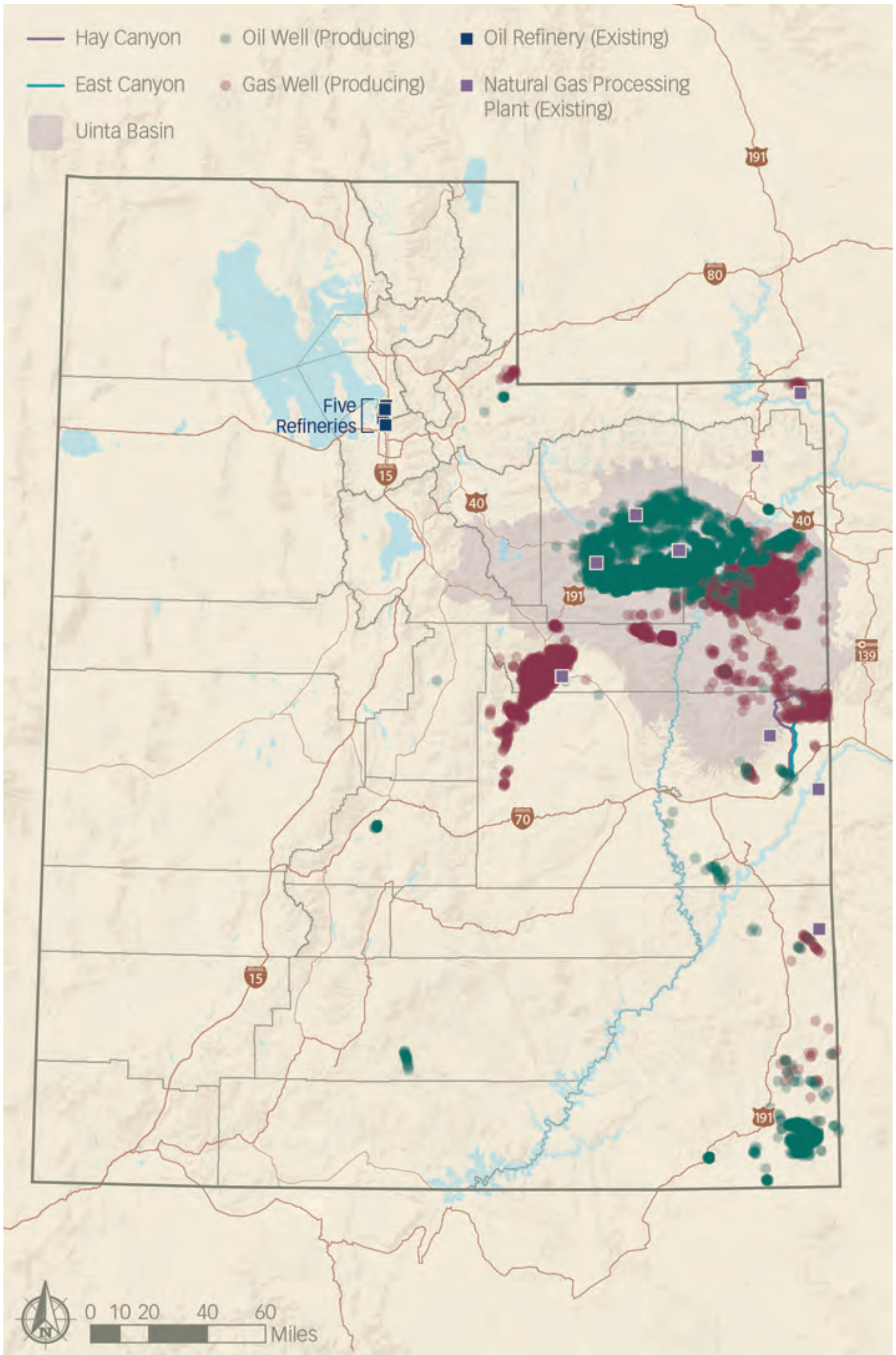
Energy Resources

Energy production considerations of this study focused on the key energy commodities currently being extracted in the Uinta Basin and those which show potential for future extraction. Figure 5 illustrates the crude oil and natural gas production wells for the State of Utah. It illustrates Uinta Basin's role as the largest source of crude oil and natural gas energy production in Utah. The Uinta Basin also shows potential for the development of oil shale and oil sands. In terms of the potential for oil shale and oil sands, the Utah Geological Survey (UGS) places the Uinta Basin as the location for the most prospective unconventional fossil fuel resources.[1]

The energy characteristics and resources of the Uinta Basin are explored at length in the UDOT's UBET Study. The UBET Study estimates energy reserves of 200 million to 700 million barrels of crude oil, 77,000 million to 226,000 million equivalent oil barrels of oil shale, 11,000 million to 12,000 million equivalent oil barrels of oil sands, and 4,000 billion to 50,000 billion cubic feet of natural gas. The UBET Study also presents studies that exceed these estimates for the Uinta Basin, particularly for oil shale and oil sands. As previously mentioned, this study built on work completed by other recent studies, including UDOT's UBET Study. This study revisited and, when appropriate, adjusted resource estimates to reflect additional information as well as the context of the study corridor. Additional energy characteristics are presented in Section 4 of this study.

1 Utah's Energy Landscape, by Michael D. Vanden Berg, Circular 113, Utah Geological Survey, 2011.

Figure 5: Energy Characteristics



Utah Oil Refineries

The State of Utah is home to five oil refineries. These refineries are:

- North Salt Lake Refinery (Big West Oil)
- Salt Lake City Refinery (Chevron)
- Salt Lake City Refinery (Tesoro)
- Woods Cross Refinery (Holly Frontier)
- Woods Cross Refinery (Silver Eagle Refining)

The U.S. Energy Information Administration (EIA) notes that all five refineries in Utah had a total Crude Oil capacity of 178,050 barrels per calendar day in 2015 (186,100 barrels per stream day).[2] Following are descriptions of each refinery. Note that the barrels per day values below were derived from the individual refinery web sites or the EIA and may not add up to the total barrels per day noted from the EIA in 2015.

Big West Oil Refinery

The Big West Oil facility is located in North Salt Lake City, Utah and is operated by Big West Oil LLC. The facility has a total capacity of 35,000 barrels per day and refines crude oils from Utah, Wyoming, and Canada into motor fuels and other specialty chemicals.[3]

Tesoro Refinery

The Tesoro facility is located in Salt Lake City, Utah and is operated by Tesoro. This is the largest refinery in Utah with a total crude oil capacity of 58,000 barrels per day.[4] Crude oils are processed from Utah, Colorado, Wyoming, and Canada to produce gasoline, diesel fuel, jet fuel, heavy fuel oils, and liquefied petroleum gas.

Chevron Refinery

The Chevron facility is operated by Chevron and also located in Salt Lake City, Utah. This refinery can turn up to 50,000 barrels of crude oil a day into gasoline, jet fuel, and diesel fuel.[5]

Holly Frontier Refinery

The Holly Frontier facility is operated by Holly Frontier and is located in Woods Cross, Utah. This refinery has a crude oil capacity of 31,000 barrels per day.[6] Holly Frontier is undergoing a modernization project which would increase refining capacity. Phase 1 is expected to increase capacity to 45,000 barrels per day and phase 2 is expected to see total capacity increase to 60,000 barrels per day.

Silver Eagle Refining

The Silver Eagle Refining facility is located in Woods Cross, Utah and is operated by Silver Eagle Refining. This refinery has a capacity of 10,000 barrels per day.[7]

2 http://www.eia.gov/dnav/pet/pet_pnp_cap1_dcu_sut_a.htm.
3 http://www.bigwestoil.com/wordpress/north-salt-lake-refinery.
4 http://tsocorp.com/refining/salt-lake-city-utah/.
5 https://www.eia.gov/petroleum/refinerycapacity/table5.pdf
6 http://www.hollyfrontier.com/operations/refineries/woods-cross/default.aspx.
7 http://www.bighornoilandgas.com/u-s-a-oil-and-gas-refineries-and-capasity/.

// SECTION TWO

Corridor Construction Impacts 2

This study reviewed and, where necessary, modified the methodologies and assumptions of the UDOT Engineering Study to understand construction-related impacts of the improved study corridor. Following is a description of the existing regional transportation network, the study corridor route alternatives, cost estimates for each route alternative, and summaries of the potential access and safety impacts of the improved study corridor.

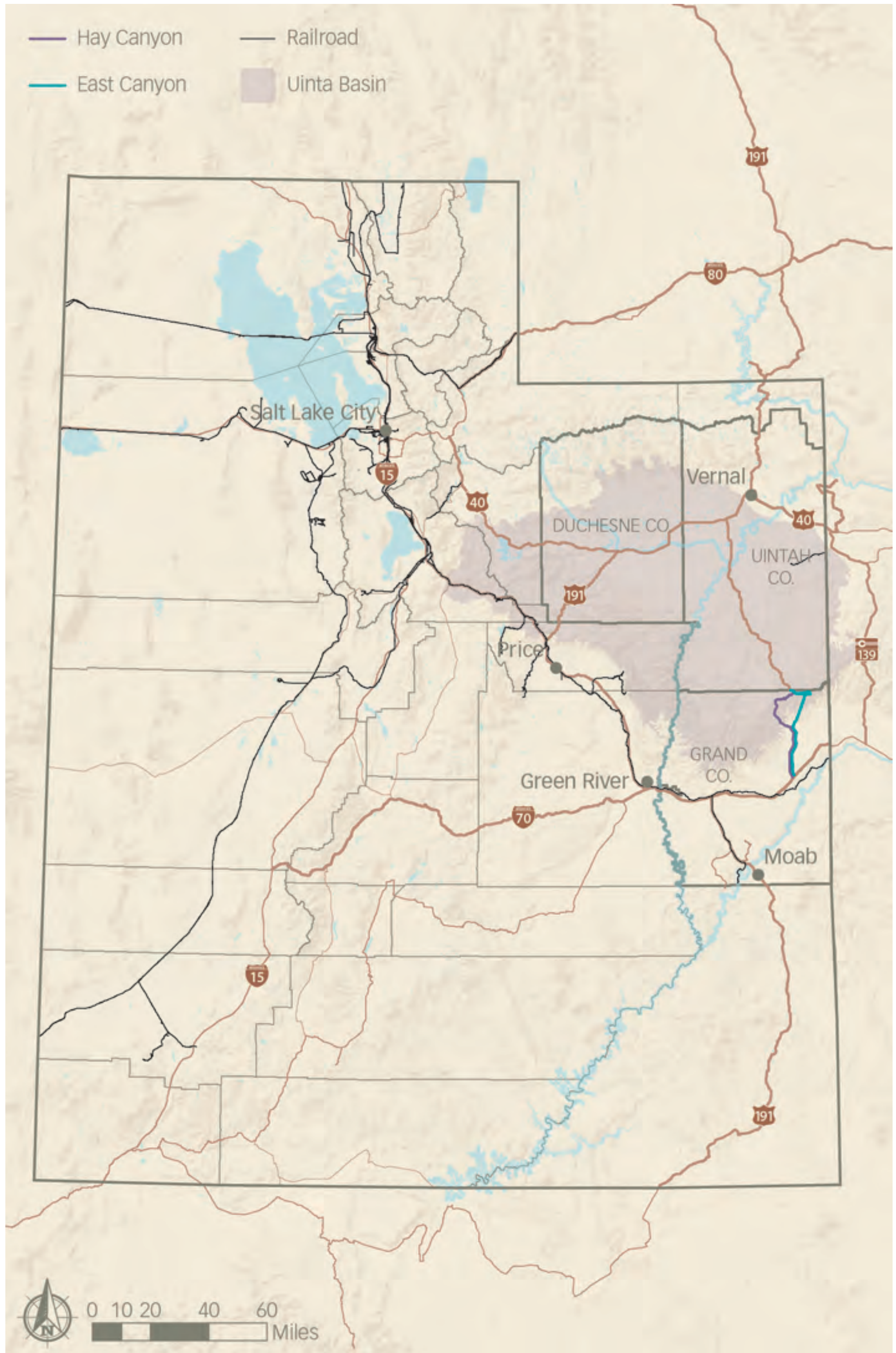
2.1. Transportation Network

Figure 6 shows the existing regional transportation network that serves the study area. Highway US-40 runs east and west along the northern edge of the study area and is paralleled by interstate 80 (I-80) to the north. I-70 runs east and west along the southern part of the study area and immediately south of the study corridor. Highway US-191 runs primarily north and south along the western edge of the study area where it connects I-70 and US-40. Along the northeastern portion of the study area, US-191 also connects US-40 to Daggett County and I-80. Colorado Highway 139 (SR-139) runs north and south adjacent to (east of) the study area and also connects I-70 to US-40.

The most significant transportation facility centrally located in the study area is Seep Ridge Road, which runs south from US-40 near Vernal to the Uintah County and Grand County border. The northern portion of Seep Ridge Road is designated as Utah State Road SR-88. The improved portion of Seep Ridge Road ends at the county border and currently extends south as an unpaved road that connects with other unpaved roads in the Book Cliffs area. The improved study corridor would link Seep Ridge Road to I-70 in Grand County.

The improved study corridor would also connect to other modes of transportation along the I-70 corridor, including existing railroad lines. Existing railroad infrastructure follows I-70 from the east to Green River and then follows US-191 towards Salt Lake City.

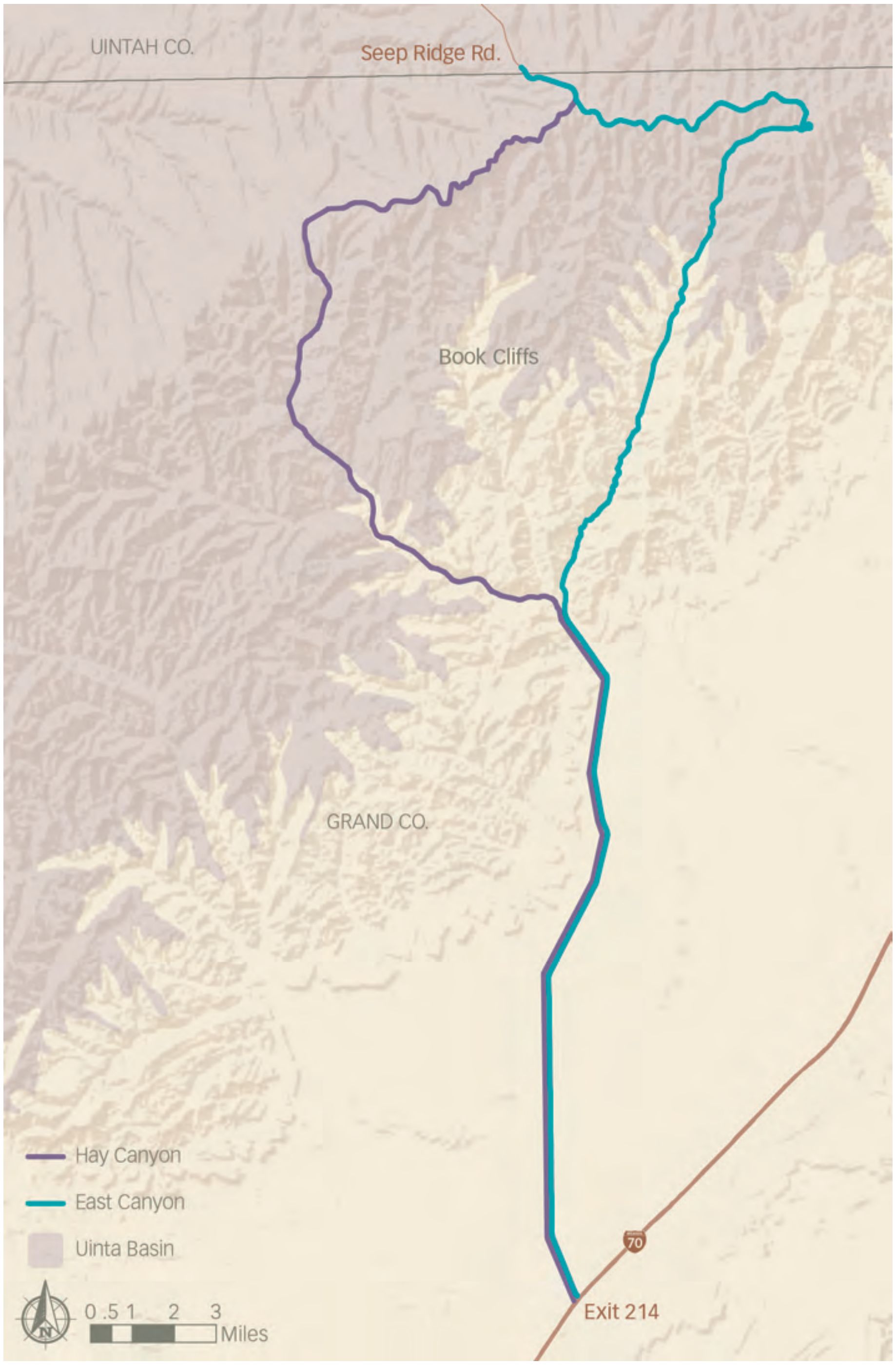
Figure 6: *Transportation Network*



2.2. Corridor Routes

The study considered two separate route alternatives, Hay Canyon and East Canyon. As shown in Figure 7, these route alternatives follow a common path from I-70 to the Book Cliffs mountain range, and separate paths from there to Seep Ridge Road. Through the Book Cliffs mountain range, the separate paths generally follow existing dirt (unpaved) roads through Hay Canyon and East Canyon, respectively. South of the Book Cliffs mountain range, the routes travel along the same path in a north/south direction and connect with I-70 at the

Figure 7: Study Corridor Route Alternatives



existing Cisco/Danish Flat interchange (I-70 Exit 214). Figure 8 and Figure 9 show existing dirt roads for the Hay Canyon and East Canyon route alternatives, respectively. Figure 10 shows existing dirt roads and the existing I-70 Cisco/Danish Flat interchange for the common southern segment (shared path) of the two route alternatives.

The Hay Canyon route is approximately 42 miles in length. Extending to the north from the existing I-70 Cisco/Danish Flat interchange, the route follows the same path as the East Canyon route for approximately 18 miles to the existing

Figure 8: Hay Canyon Route

Figure 9: *East Canyon Route*

Figure 10: *Shared Hay Canyon/East Canyon Path*

intersection of Hay Canyon and East Canyon roads near the southern end of Westwater Creek. Continuing to the northwest, the Hay Canyon route generally follows the existing Hay Canyon Road for approximately 15 miles to the existing intersection of Hay Canyon Road and Bureau of Land Management Road 209. Turning to the northeast, the last section of the route generally follows the existing Book Cliffs Ridge Road for approximately nine miles to the southern end of Seep Ridge Road.

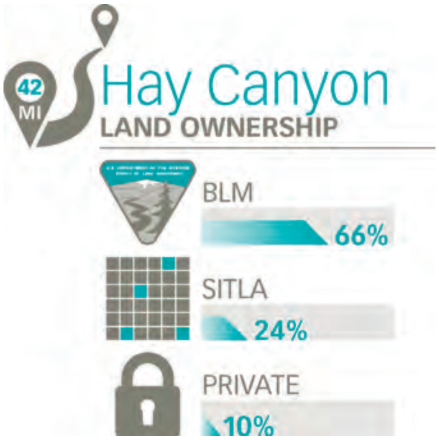
The East Canyon route is approximately 41 miles in length. The southern 18 miles of the route follow the same path as the Hay Canyon route. Near the existing intersection of Hay Canyon and East Canyon roads near the southern end of Westwater Creek, the route turns to the northeast and generally follows the existing East Canyon Road for approximately 15 miles to the existing intersection of East Canyon and Book Cliffs Ridge roads. Turning to the west, the final eight miles of the route generally follow the existing Book Cliffs Ridge Road to the southern end of Seep Ridge Road. This route may be shortened by approximately four miles by turning northwest south of the existing East Canyon and Book Cliffs Ridge roads intersection and following the approximate route of existing Brusher Canyon Road where it would intersect the existing Book Cliffs Ridge Road farther to the west and follow this existing road to the southern end of Seep Ridge Road. According to the UDOT Engineering Study, the East Canyon route may be the most feasible from a roadway design perspective.

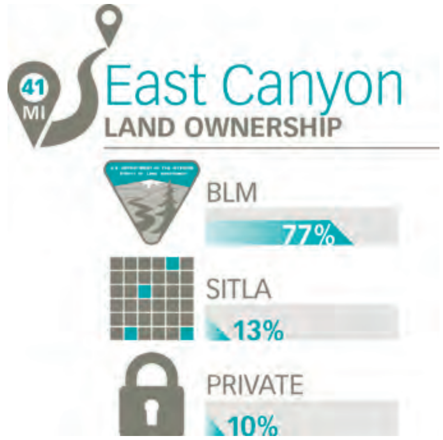
Land ownership for the Hay Canyon and East Canyon route alternatives was considered and presented in the UDOT Engineering Study. Both of the corridor route alternatives would travel through U.S. Bureau of Land Management (BLM), SITLA, and private property. Figure 11 summarizes land ownership for both study corridor route alternatives.

2.3. Roadway Improvements

The study corridor could accommodate multiple modes for moving people, goods, and utilities. In addition to dirt roads, the existing study corridor currently accommodates energy pipelines. However, this study focused on the economic impacts of constructing a paved roadway through the study corridor. As used in this study, corridor improvements refer to the construction of a

Figure 11: *Study Corridor Land Ownership*





paved roadway for the Hay Canyon or East Canyon route alternatives. Although alternate modes of transportation were considered, this study did not evaluate their economic impact.

Roadway improvements for the Hay Canyon and East Canyon route alternatives were considered at length in the UDOT Engineering Study. Final design of the route improvements depends on further environmental studies and more detailed design analysis; however, either route alternative likely includes right-of-way acquisition, right-of-way fencing, significant earthwork, some blasting, drainage pipe, drainage channels, retaining walls, a paved roadway surface, roadside safety features such as guardrail and crash cushions, and landscaping. Design of the roadway should meet the UDOT's design standards. A typical roadway section would likely include one 12-foot travel lane in each direction, 8-foot outside shoulders, and passing lanes for approximately 40 percent of the corridor length. The final roadway section and inclusion of passing, turn, acceleration, or deceleration lanes would be determined by future permitting and design efforts.

2.4. Roadway Cost Estimate

This study evaluated each route alternative and prepared construction cost estimates for each. Because of the remote location of the routes, there was limited available project cost history with comparable scope of work. The estimates were based on bid tabulations from southern segments of the Seep Ridge Road project in Uintah County because this project was the most comparable to the proposed study corridor in regards to scope of work, geology, and location and construction was completed in 2014. The estimates are cited in 2015 values.

The bid tabulations from the Seep Ridge Road project were used to calculate unit costs per mile of roadway for expected items of work. The roadway improvement cost estimates for Hay Canyon and East Canyon route alternatives are presented in Table 7 and Table 8, respectively. Mobilization, traffic control, survey, geotechnical exploration, and engineering costs were estimated using percentage of construction cost values typically used by UDOT in their cost estimates. The percentage values for these work items are shown in Table 7 and Table 8. Right-of-way acquisition costs are based on land value estimates

***Table 7:** Hay Canyon Initial Build Cost Estimate*

Item of Work Description	Quantity	Unit	Unit Cost	Amount
Mobilization (7%)	1	Lump	$8,147,924.00	$8,147,924.00
Traffic Control (5%)	1	Lump	$5,819,946.00	$5,819,946.00
Dust Control and Watering	42	Mile	$50,000.00	$2,085,000.00
Miscellaneous	42	Mile	$16,100.00	$671,370.00
Erosion Control	42	Mile	$25,000.00	$1,042,500.00
Survey (1.5%)	1	Lump	$1,745,984.00	$1,745,984.00
Clearing and Grubbing	42	Mile	$5,000.00	$208,500.00
Roadway Excavation	42	Mile	$250,000.00	$10,425,000.00
Roadway Excavation - Blasting	4	Mile	$250,000.00	$1,000,000.00
Paving	42	Mile	$1,512,500.00	$63,071,250.00
Geotechnical Exploration/Remediation (0.25%)	1	Lump	$290,997.00	$290,997.00
Drainage Conveyance	42	Mile	$65,000.00	$2,710,500.00
Channel Crossing (6' Typical)	32	Each	$80,000.00	$2,560,000.00
Channel Crossing (12' Typical)	5	Each	$100,000.00	$500,000.00
Channel Crossing (20' Typical)	21	Each	$200,000.00	$4,200,000.00
Channelization	4.5	Mile	$1,300,000.00	$5,850,000.00
Right of Way Fencing	42	Mile	$10,500.00	$437,850.00
Concrete Barrier	5.5	Mile	$316,800.00	$1,742,400.00
MSE Retaining Wall	220,200	Sq Ft	$65.00	$14,313,000.00
Sign/Striping	42	Mile	$14,250.00	$594,225.00
Landscaping	42	Mile	$19,600.00	$817,320.00
Utility Relocation	42	Mile	$100,000.00	$4,170,000.00
Subtotal Construction Cost				$132,403,766
Right of Way - SITLA	97	Acre	$3,000.00	$291,000.00
Right of Way - Private	77	Acre	$1,000.00	$77,000.00
Subtotal Right of Way				$368,000
Design Engineering (9%)	1	Lump	$11,949,459.00	$11,949,459.00
Construction Engineering (10%)	1	Lump	$13,277,177.00	$13,277,177.00
Subtotal Engineering				$25,226,636
Total Estimated Initial Build Cost				$157,998,402
Lower Range	-10%			$142,198,562
Upper Range	+20%			$189,598,082

Table 8: *East Canyon Initial Build Cost Estimate*

Item of Work Description	Quantity	Unit	Unit Cost	Amount
Mobilization (7%)	1	Lump	$8,062,800.00	$8,062,800.00
Traffic Control (5%)	1	Lump	$5,759,143.00	$5,759,143.00
Dust Control and Watering	41	Mile	$50,000.00	$2,050,000.00
Miscellaneous	41	Mile	$16,100.00	$660,100.00
Erosion Control	41	Mile	$25,000.00	$1,025,000.00
Survey (1.5%)	1	Lump	$1,727,743.00	$1,727,743.00
Clearing and Grubbing	41	Mile	$5,000.00	$205,000.00
Roadway Excavation	41	Mile	$250,000.00	$10,250,000.00
Roadway Excavation - Blasting	2	Mile	$250,000.00	$500,000.00
Paving	41	Mile	$1,512,500.00	$62,012,500.00
Geotechnical Exploration/Remediation (0.25%)	1	Lump	$287,957.00	$287,957.00
Drainage Conveyance	41	Mile	$65,000.00	$2,665,000.00
Channel Crossing (6' Typical)	41	Each	$80,000.00	$3,280,000.00
Channel Crossing (12' Typical)	4	Each	$100,000.00	$400,000.00
Channel Crossing (20' Typical)	29	Each	$200,000.00	$5,800,000.00
Channelization	4	Mile	$1,300,000.00	$5,200,000.00
Right of Way Fencing	41	Mile	$10,500.00	$430,500.00
Concrete Barrier	5.5	Mile	$316,800.00	$1,742,400.00
MSE Retaining Wall	207,300	Sq Ft	$65.00	$13,474,500.00
Sign/Striping	41	Mile	$14,250.00	$584,250.00
Landscaping	41	Mile	$19,600.00	$803,600.00
Utility Relocation	41	Mile	$100,000.00	$4,100,000.00
Subtotal Construction Cost				$131,020,493
Right of Way - SITLA	178	Acre	$3,000.00	$534,000.00
Right of Way - Private	78	Acre	$1,000.00	$78,000.00
Subtotal Right of Way				$612,000
Design Engineering (9%)	1	Lump	$11,846,925.00	$11,846,925.00
Construction Engineering (10%)	1	Lump	$13,163,250.00	$13,163,250.00
Subtotal Engineering				$25,010,175
Total Estimated Initial Build Cost				$156,642,668
Lower Range	-10%			$140,978,401
Upper Range	+20%			$187,971,202

provided by SITLA and county personnel. The total estimated cost is $158 million for the Hay Canyon route alternative and $157 million for the East Canyon route alternative. At this early stage of planning and design, there are still unknowns in the costs; therefore, the actual costs can be expected to fall within a range of minus 10 percent and plus 20 percent from these estimates.

This study also evaluated and estimated the maintenance costs for each route alternative. The estimated maintenance costs for the 20 years following construction are presented in Table 9 and Table 10 for Hay Canyon and East Canyon route alternatives, respectively. In addition to the same assumptions used for initial construction costs, the maintenance cost estimates applied the following assumptions:

- Striping, crack sealing, sign and delineator replacement, guardrail repair, drainage structure cleaning, snow removal, and pot hole patching would be required annually.
- Chip seal coat and emulsified asphalt would be required in five year increments.
- A 2-inch rotomill and new hot mix asphalt pavement would be required after 20 years.

The total estimated maintenance cost for the 20 years following construction, given in present day values without inflation, is $28 million for the Hay Canyon route alternative and $27 million for the East Canyon route alternative. As with the construction cost estimates, these maintenance costs can be expected to fall within a range of minus 10 percent and plus 20 percent from these estimates.

Changes to the route paths considered in this study would result in changes to the corresponding construction and maintenance cost estimates. For example, following a shorter path through Brusher Canyon may result in lower construction and maintenance costs for the East Canyon route alternative.

Possible construction of a paved roadway along the study corridor must be preceded by a NEPA study. Although this study focused on the impacts of constructing a paved road, a NEPA study could consider multiple modes of transportation for the study corridor, including roadways, pipelines, and utilities. The cost for such a study could reach an estimated $5 million, but could vary depending on project and NEPA process variables. Figure 12 summarizes the overall cost estimate for each route alternative, including a NEPA study, roadway design and construction, and roadway maintenance for 20 years after construction is complete.

Figure 12: *Summary of Roadway Costs*

	Hay	East
NEPA STUDY	$5M	$5M
CONSTRUCTION	$158M	$157M
MAINTENANCE (20 YEARS)	$28M	$27M

Table 9: *Hay Canyon Maintenance Cost Estimate*

Item of Work Description	Quantity	Unit	Unit Cost	Amount	Frequency	20-Year Cost
Chip Seal Coat	1,125,344	Sq Yd	$0.85	$956,542.40	5 Years	$2,869,627.20
Emulsified Asphalt LMCRS-2	2,110	Ton	$500.00	$1,055,010.00	5 Years	$3,165,030.00
Highway Traffic Paint	7,480	Gallon	$21.00	$157,080.00	Annually	$3,377,220.00
Crack Seal	5	Ton	$2,500.00	$11,250.00	Annually but not year 20	$213,750.00
Rotomill (2")	1,125,344	Sq Yd	$1.25	$1,406,680.00	20 Years	$1,406,680.00
HMA (3")	188,636	Ton	$75.00	$14,147,684.10	20 Years	$14,147,684.10
Sign Replacement (5% annually)	20	Each	$250.00	$5,000.00	Annually	$100,000.00
Delineator Replacement (5% annually)	72	Each	$50.00	$3,600.00	Annually	$72,000.00
Guardrail (5% annually)	300	Feet	$25.00	$7,500.00	Annually	$150,000.00
Drainage (clean or repair)	1	Lump	$10,000.00	$10,000.00	Annually	$200,000.00
Snow Removal (13 events/year)	13	Event	$6,440.00	$83,720.00	Annually	$1,674,400.00
Pot Hole Patching (2 events/year)	2	Event	$4,600.00	$9,200.00	Annually	$184,000.00
Total 20-Year Maintenance Cost						$27,560,391

Table 10: *East Canyon Maintenance Cost Estimate*

Item of Work Description	Quantity	Unit	Unit Cost	Amount	Frequency	20-Year Cost
Chip Seal Coat	1,106,453	Sq Yd	$0.85	$940,485.33	5 Years	$2,821,456.00
Emulsified Asphalt LMCRS-2	2,075	Ton	$500.00	$1,037,300.00	5 Years	$3,111,900.00
Highway Traffic Paint	7,216	Gallon	$21.00	$151,536.00	Annually	$3,258,024.00
Crack Seal	4	Ton	$2,500.00	$10,000.00	Annually but not year 20	$190,000.00
Rotomill (2")	1,106,453	Sq Yd	$1.25	$1,383,066.67	20 Years	$1,383,066.67
HMA (3")	185,469	Ton	$75.00	$13,910,193.00	20 Years	$13,910,193.00
Sign Replacement (5% annually)	20	Each	$250.00	$5,000.00	Annually	$100,000.00
Delineator Replacement (5% annually)	74	Each	$50.00	$3,700.00	Annually	$74,000.00
Guardrail (5% annually)	300	Feet	$25.00	$7,500.00	Annually	$150,000.00
Drainage (clean or repair)	1	Lump	$10,000.00	$10,000.00	Annually	$200,000.00
Snow Removal (13 events/year)	13	Event	$6,440.00	$83,720.00	Annually	$1,674,400.00
Pot Hole Patching (2 events/year)	2	Event	$4,600.00	$9,200.00	Annually	$184,000.00
Total 20-Year Maintenance Cost						$27,057,040

Figure 13: *Tourism Connectivity Impacts*

2.5. Access and Connectivity Impacts

Roadways facilitate the movement of people and goods. In eastern Utah, they connect people to each other, to industry, and to recreational destinations. The study corridor would increase access to Book Cliffs destinations, as well as improve connectivity to other destinations in eastern Utah. This improved connectivity would enhance mobility by allowing people and goods to travel more directly. The improved connectivity would also provide increased route choices for leisure and business travel.

The existing routes through Hay Canyon and East Canyon provide dirt (unpaved) road access to the Book Cliffs mountain range. These dirt roads are unmaintained and mostly inaccessible during winter months. The dirt roads are also inaccessible to many vehicle types and to "out-of-town" recreational visitors who are unfamiliar with the roads. The improved study corridor would provide enhanced direct access to the Book Cliffs mountain range including access to outdoor recreational activities such as hiking, camping, hunting, horseback riding, and biking, just to name a few.

The improved connectivity of the study corridor would make destinations in eastern Utah better connected and more accessible. It would make regional travel quicker and more convenient. Many recreational destinations in eastern Utah rely on and benefit from through traffic traveling to major national parks north and south of the Book Cliffs. The improved study corridor would provide time and distance savings for travel between these destinations. This study considered the connectivity benefits to national and state parks in eastern Utah, including those shown in Figure 13.

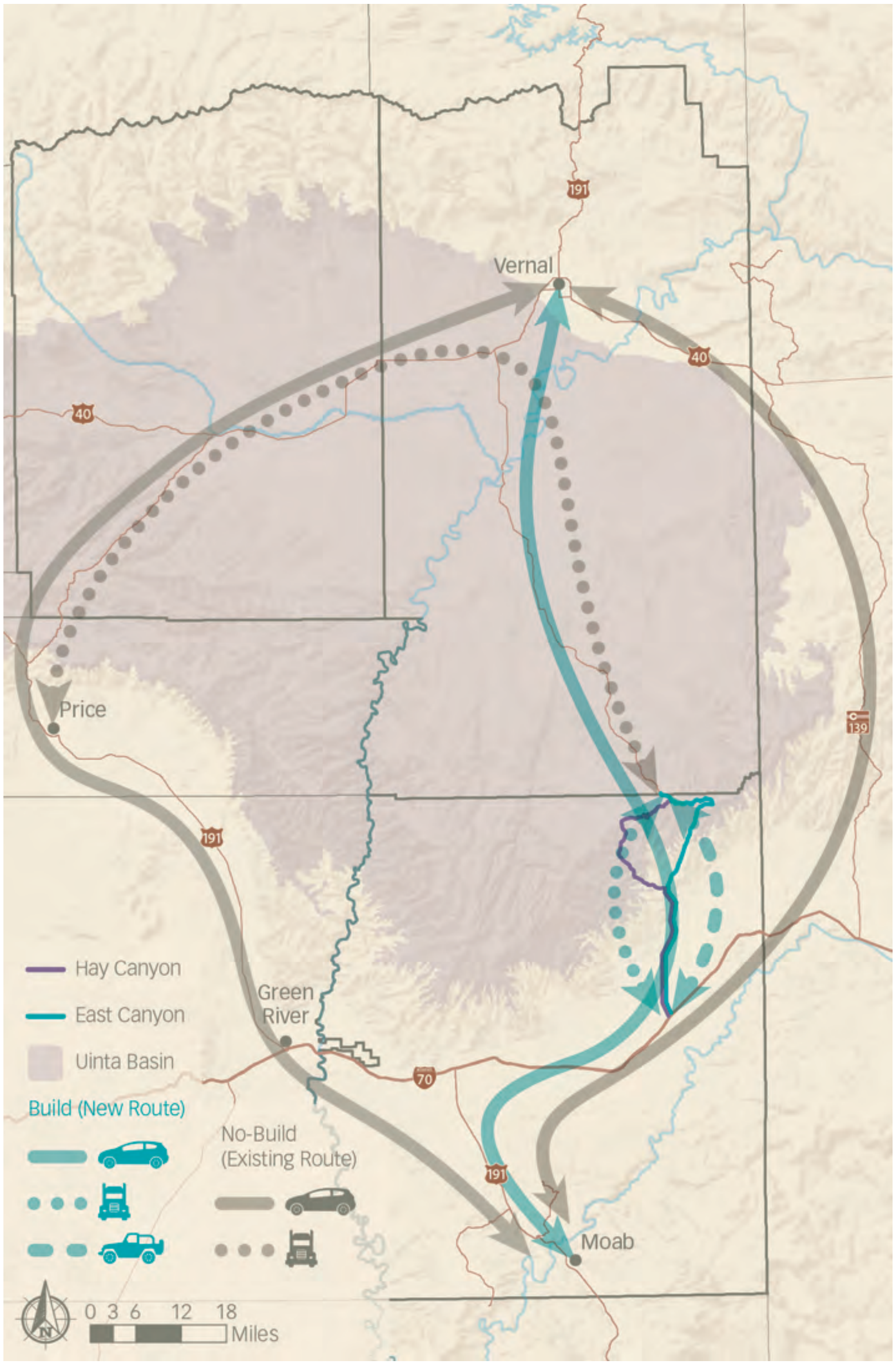
The study corridor would provide a link that could facilitate a "Grand Corridor of Parks" similar to Utah's "Grand Circle of National Parks", but would focus on eastern Utah parks stretching between Lake Powell and Flaming Gorge or possibly extend from Grand Canyon National Park to Yellowstone National Park. The tourism connectivity benefits of the improved study corridor are illustrated in Figure 13. Additionally, the improved study corridor could also connect additional outdoor recreational destinations and activities in eastern Utah, such as mountain biking in Moab, Book Cliffs, and McCoy Flats near Vernal, and other outdoor activities in the Book Cliffs and Uinta mountains.

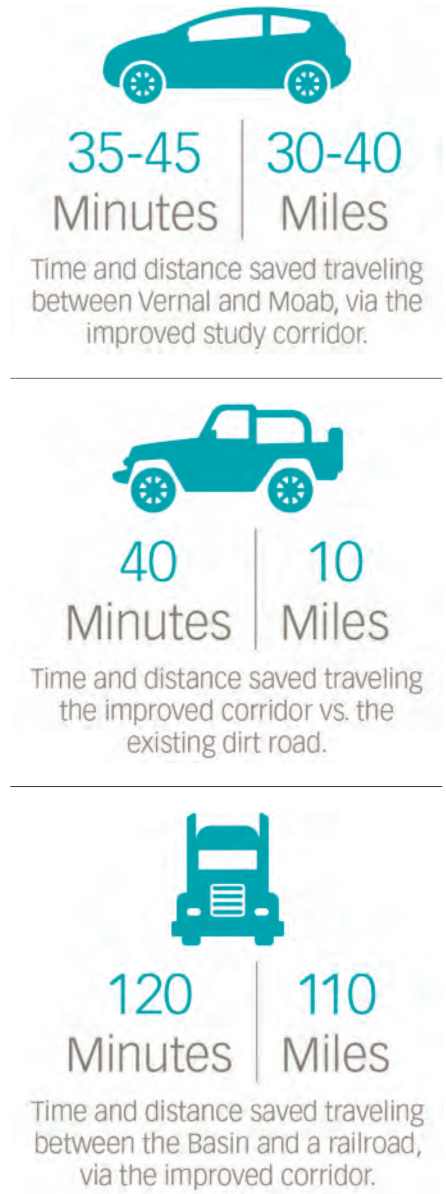
The improved study corridor would provide a shorter route alternative for travel between Moab and Vernal. Potential travel time benefits of the improved study corridor are illustrated in Figure 14 and described below.

The study corridor would provide an alternative to Utah's US-191 (Indian Canyon) west of the Book Cliffs and Colorado's SR-139 (Douglas Pass) east of the Book Cliffs. Traveling through an improved study corridor would save motorists approximately 40 minutes (30 to 40 miles). These travel time and distance savings would also apply to travel between state and national parks in southeastern and northeastern Utah.

For motorists currently accessing the Book Cliffs from the south through the existing Hay Canyon or East Canyon dirt roads, the improved study corridor

Figure 14: *Travel Savings*





would reduce travel by approximately 40 minutes (10 miles). For similar motorists who do not or cannot use the current dirt roads to access the Book Cliffs and must travel around the study area and access the Book Cliffs from the north, the improved study corridor would reduce travel by over 2 hours (120 miles).

The study corridor would also provide shorter route alternatives between energy extraction activities in the Uinta Basin and destinations for energy products. Travel times and distances between oil extraction and refineries would be

Figure 15: *Current Unpaved Roadway*

Figure 16: *Sample Roadway Safety Improvements*

shortened by providing more direct access to freeway, pipeline, or railway transportation infrastructure along I-70. Compared to Salt Lake City refineries, travel savings are more impactful for transport to out of state refineries that can be accessed through the I-70 corridor.

For trucks and maintenance crews currently accessing the Book Cliffs from the south through the existing Hay Canyon or East Canyon dirt roads, the improved study corridor would reduce travel by approximately 40 minutes (10 miles). Compared to existing travel to railheads in Price which are currently accessed through Indian Canyon, oil trucks traveling from the Uintah/Grand County boundary would save over 2 hours (110 miles) of travel by accessing rail near Cisco, Utah.

2.6. Safety Impacts

The study corridor would provide enhanced safety for the traveling public. The existing Hay Canyon and East Canyon dirt surface roads provide narrow or no shoulders and steep drop offs adjacent to the roadway similar to that shown in Figure 15. They present numerous safety hazards including limited visibility from dust during dry seasons; slippery driving surfaces during wet seasons because of mud formation and snow; poor sight distance because of substandard horizontal and vertical curves even at low speeds; increased risk of vehicles leaving the roadway because of substandard horizontal curves and lack of roadside clear zone and barriers; and increased risk of severe injury if a vehicle leaves the roadway at steep and long vertical drop offs adjacent to the roadway.

Either of the study corridor route alternatives would reduce or eliminate these safety hazards through implementation of engineered roadway surface materials, shallower and longer curves, increased shoulder and clear zone widths, and roadside barriers. Figure 16 shows an example of these safety improvements installed in a similar setting. The improved roadway alternatives would enhance safety for travel from I-70 to Seep Ridge Road.

// SECTION THREE

Tourism and Recreation Impacts

3

According to the Economic Value of Public Lands in Grand County, Utah report published in March 2015,[8] the travel and tourism sector is the main economic driver of the local economy. A key component of this study was to understand the impact of tourism on the local and state economy. This study researched historical tourism visitation and spending data and applied it to forecast future visitation trends and estimate corridor impacts to tourism visitation and spending. These forecasts were used to estimate travel savings and tourism activity induced by the improved study corridor. The following sections summarize historical data trends, establish baseline forecasts, describe how incremental impacts were estimated, and detail those impacts.

3.1. Tourism Trends and Forecasts

This section presents historical tourism visitation and spending trends and visitation forecasts and describes how they were developed.

The study area includes 11 tourism and recreation attractions: Arches and Canyonlands National Parks; Dinosaur National Monument; Dead Horse Point, Utah Field House, Red Fleet, Steinaker, and Starvation state parks; Lake Powell and Flaming Gorge Recreation Areas; and hunting in the Book Cliffs. For the purpose of this study, the selection of these tourism attractions was based on potential access and connectivity benefits from the improved study corridor.

Tourism Visitation Trends

The study used visitation data through 2015 whenever possible to capture the most current trends. Data for the two national parks and one national monument were obtained from the National Park Service Visitor Use Statistics (NPS Stats),[9] while data for the five state parks were obtained from the Utah Department of Natural Resources, Division of Utah State Parks and Recreation.[10] The national parks and monument have complete visitation data available from 2003 to 2014; because of when this study was conducted, only partial data were available for 2015. The study therefore used available 2015 cumulative visitation data through October 2015 and added five percent to account for November and December.

8 Headwater Economics (2015). The Economic Value of Public Lands in Grand County, Utah. http://headwaterseconomics.org/economic-development/local-studies/economic-grand-county.

9 Data are retrieved from https://irma.nps.gov/Stats/.

10 Data are retrieved from http://stateparks.utah.gov/resources/economic-benefits-of-state-parks/.

The state parks track visitation on a fiscal year basis which ends in June. Complete state park data were available through fiscal year 2015, which ended in June 2015. To make national and state park data consistent, the state park visitation data for fiscal year 2015 were increased by five percent to approximate 2015 calendar year visitations. The five percent increase was intended to account for higher visitation anticipated for the second half of the 2015 calendar year compared to the second half of the 2014 calendar year which was included in the 2015 fiscal year. The five percent increase applied to the national and state tourism attractions represents a conservative approach that was expected to generally underestimate visitations for the 2015 calendar year.

Lake Powell is part of Glen Canyon National Recreation Area and the NPS Stats reports visitation counts at various locations in Glen Canyon National Recreation Area. The number of Lake Powell visitors was assumed to be the sum of the visitation counts observed at Bullfrog Marina and Halls Crossing Marina. Available visitation data from 2003 to 2014 were analyzed as part of this study.

Flaming Gorge National Recreation Area is part of Ashley National Forest and historically has not collected annual visitation data. The park's visitation estimates for 2015 were obtained from the Daggett County Economic Development Office. These visitation estimates represent the best available information based on recent market studies completed in Daggett County for the Flaming Gorge area.

Finally, the number of hunters in the Book Cliffs area was obtained from the Utah Big Game Annual Report[11] which has data for 2004 through 2013.

Tourism Visitation Forecasts

The historical visitation trends were used to forecast future visitation. For attractions with relatively low volatility (notably Arches, Canyonlands, Dead Horse Point, Book Cliffs hunting, Dinosaur, Utah Field House, and Starvation), the study calculated the average historical growth rate and applied it to the last observed data point to get the incremental change value. This constant value was then added to each year data point, thus making the projected curve linear and upward sloped.

The same method was applied for projecting Flaming Gorge's visitation data. Because historical visitation data for the recreation area was not available, the study relied on tourism-related tax revenue growth of Daggett County reported by the Bureau of Economic and Business Research (BEBR) to calculate the rate of future visitation growth.

For parks with relatively high volatility (Red Fleet, Steinaker, and Lake Powell), the study flattened the projected future visitations as the average of historical visitations. For this reason, the projected curves for these parks were assumed to remain flat at historical average values.

Figure 17 through Figure 27 present historical visitation data and future forecasts for the 11 study tourism and recreation attractions. Historical data are represented by the solid teal lines and growth forecasts are represented by the dotted red lines.

11 Bernales H.H., K.R. Hersey and J. Shannon (2013). Utah Big Game Annual Report. Publication Number 14-22 Annual Performance Report for Federal Aid Project W-65-M, segments 61 and 62. State of Utah Department of Natural Resources, Division of Wildlife Resources. Link: http://wildlife.utah.gov/hunting/biggame/pdf/annual_reports/13_bg_report.pdf.

Figure 17: *Arches National Park Visitation Trends and Projections*

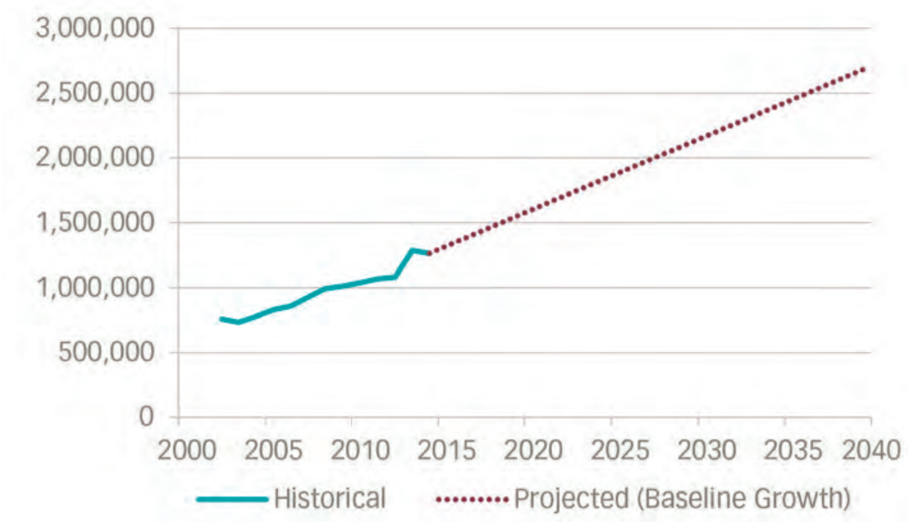


Figure 18: *Canyonlands National Park Visitation Trends and Projections*

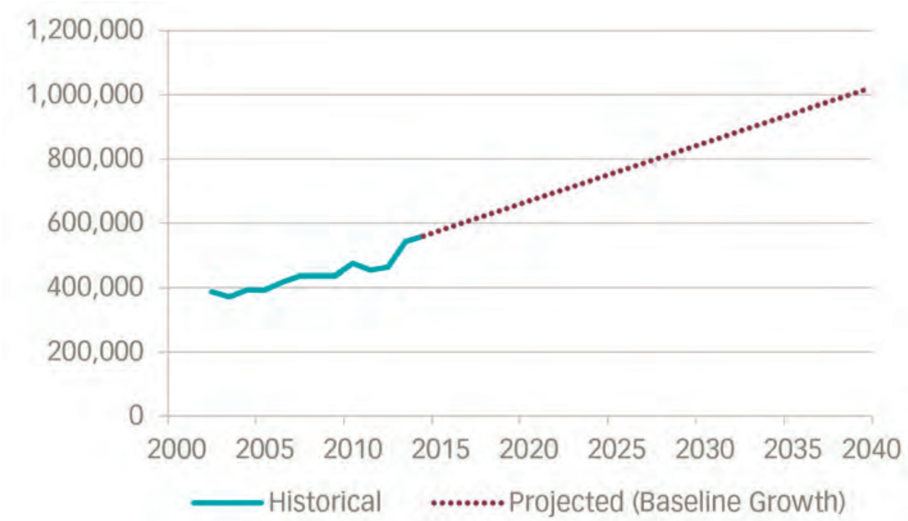


Figure 19: *Dinosaur National Monument Visitation Trends and Projections*

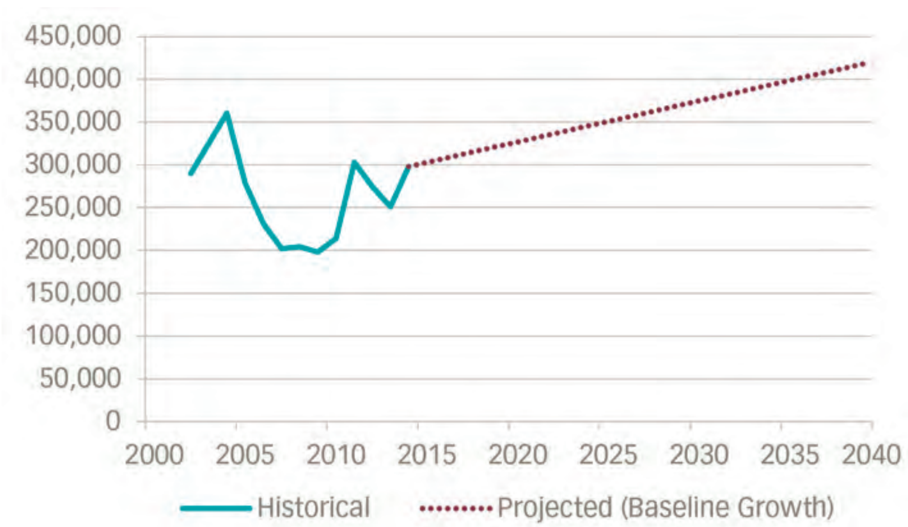


Figure 20: *Dead Horse Point State Park Visitation Trends and Projections*

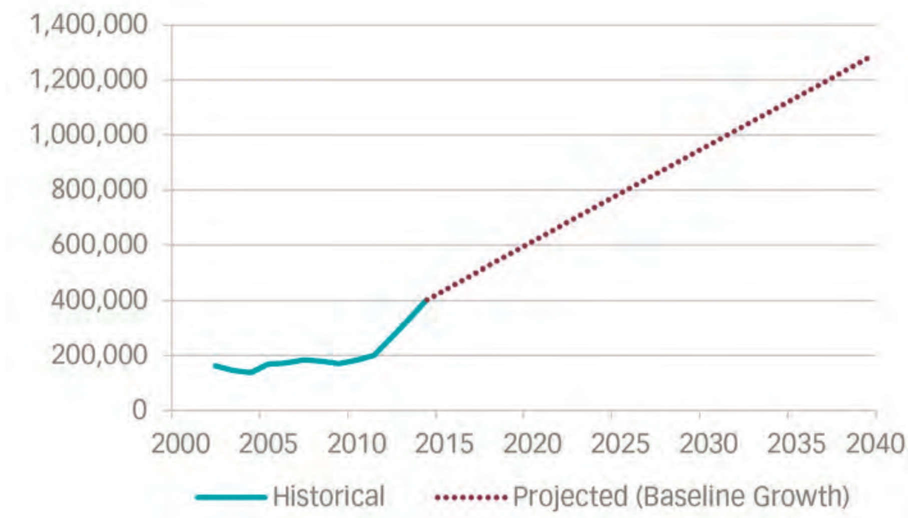


Figure 21: *Red Fleet State Park Visitation Trends and Projections*

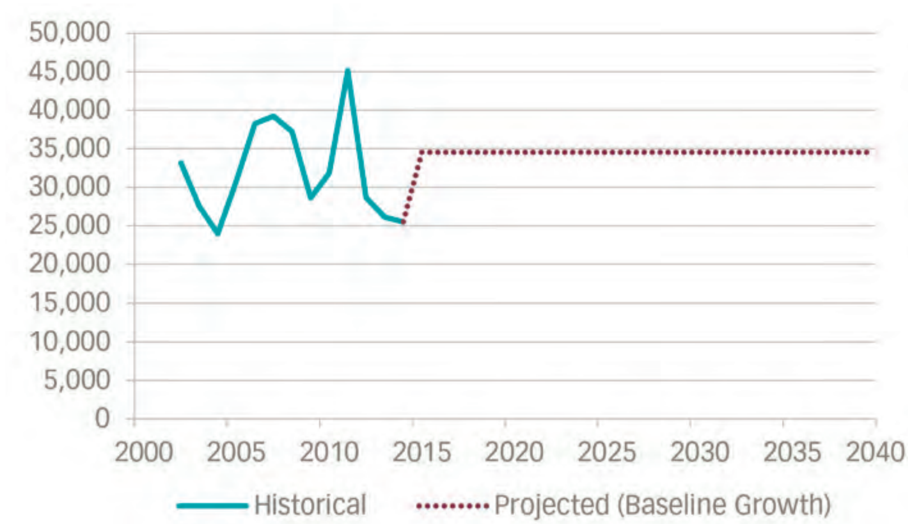


Figure 22: *Starvation State Park Visitation Trends and Projections*

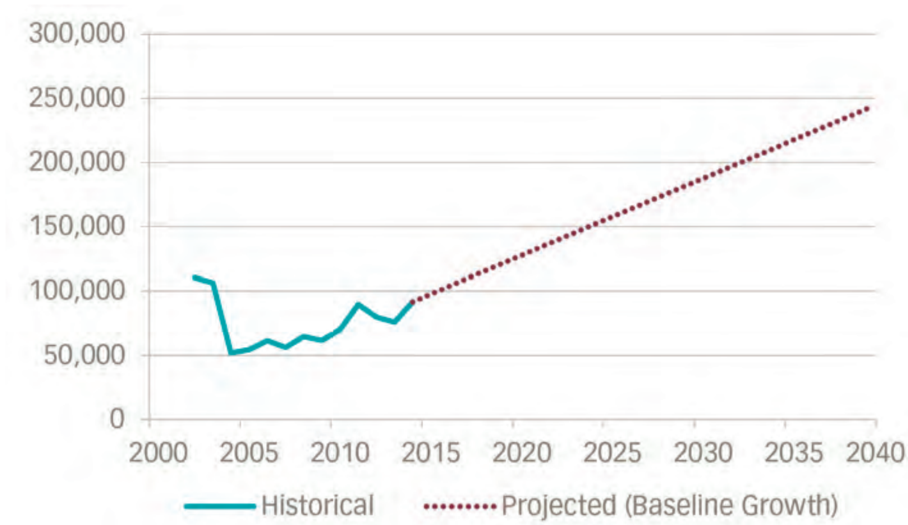


Figure 23: *Steinaker State Park Visitation Trends and Projections*

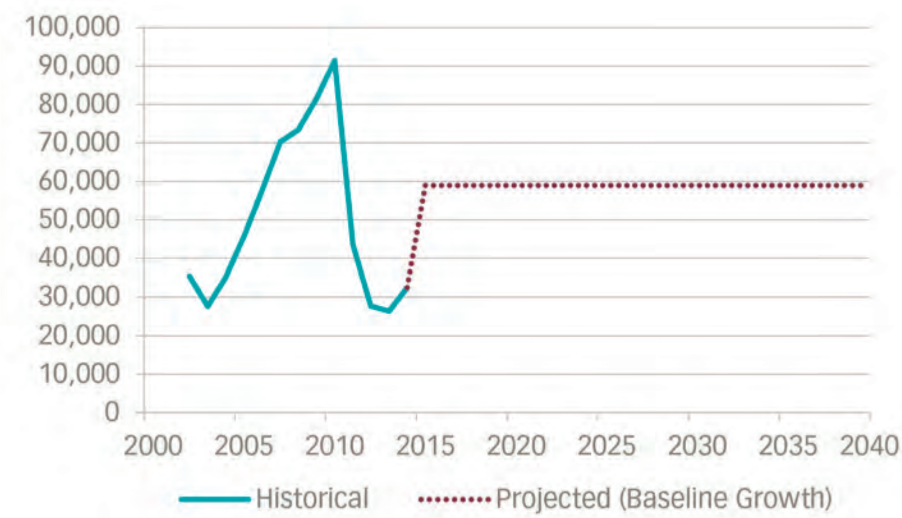


Figure 24: *Utah Field House State Park Visitation Trends and Projections*

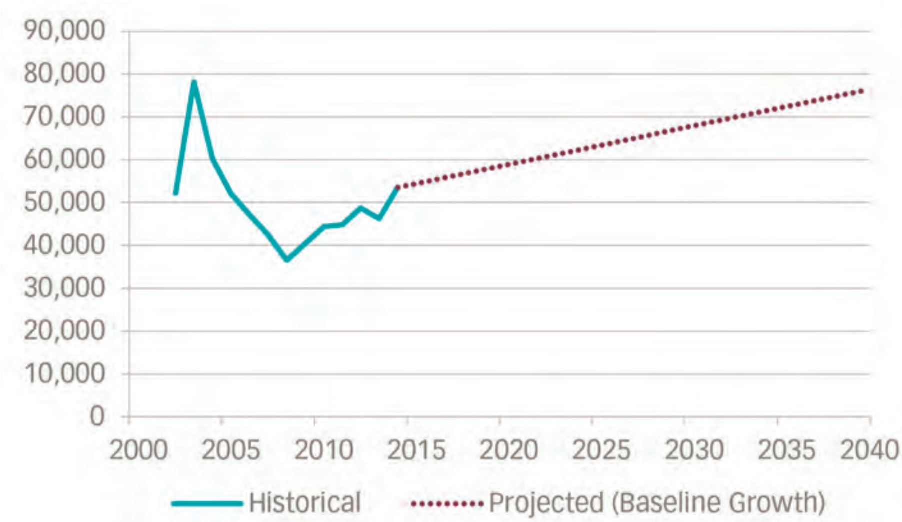


Figure 25: *Lake Powell Recreation Area Visitation Trends and Projections*

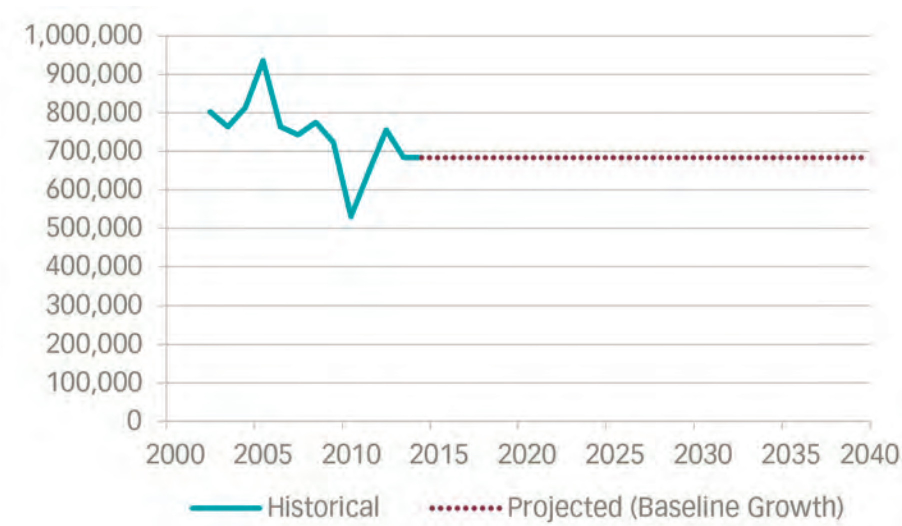


Figure 26: Flaming Gorge Recreation Area Visitation Trends and Projections

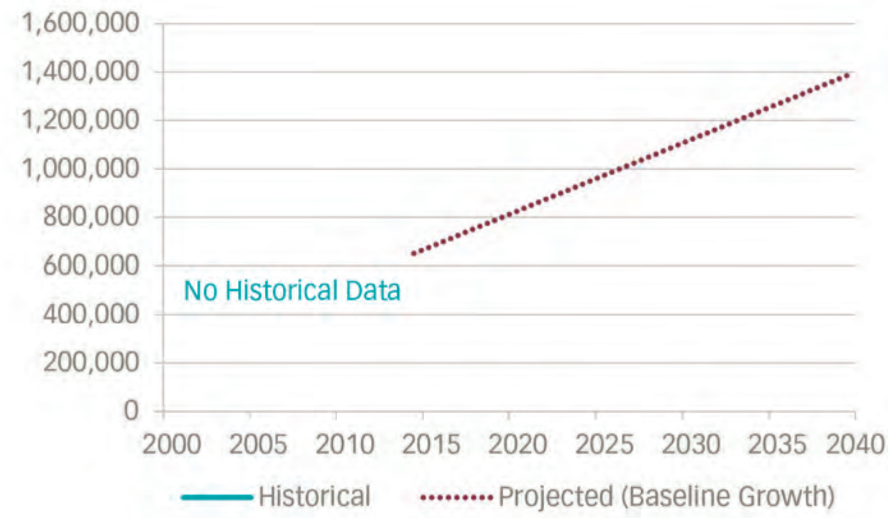
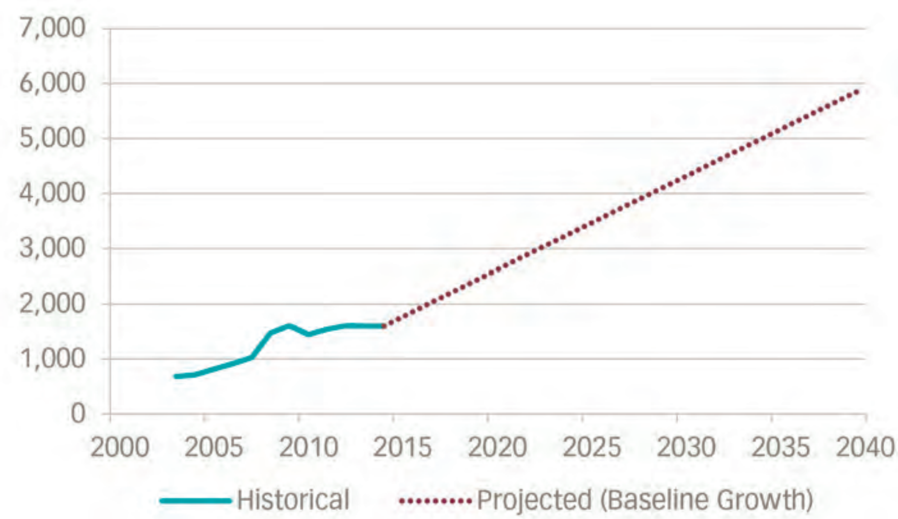


Figure 27: Book Cliffs Hunting Visitation Trends and Projections



3.2. Tourism Spending

This section summarizes recent tourism spending for the study area, establishes a spending profile using available industry data, and uses these data sets to establish a spending baseline. Because of when the study was conducted, 2014 spending distribution data was applied to 2015 visitation estimates and total spending data to develop a 2015 spending distribution.

Tourism Spending Trends

Spending is an important measure of tourism activity. Spending trends were analyzed by reviewing historical tourism-related sales and tax revenues. Tourism-related sales include leisure and hospitality sales (arts and entertainment, accommodation, and food services and drinking places), and general retail sales. According to representatives of the BEBR, 90 percent of accommodation sales in Grand County are most likely generated by tourists. The percentage is much lower for Duchesne and Uintah counties because a large portion of purchases related to hotel sales are made by oil and gas workers staying in town during the week. These same trends and assumptions can be applied to sales in other sectors such as arts and entertainment, recreation, food service, and retail. Sales and tax amounts were collected from the State of Utah Tax Commission.

Since 2009, Grand County has seen 9.8 and 5.6 percent growth in leisure and hospitality sales and retail sales, respectively. It has seen positive growth in tourism-related tax revenues since 2012. Since 2009, Duchesne County has seen 7.3 and 24.0 percent growth in leisure and hospitality sales and retail sales, respectively. It has seen positive growth in tourism-related tax revenues since 2012. Since 2009, Uintah County has seen 7.4 and 4.1 percent growth in leisure and hospitality sales and retail sales, respectively. Tourism-related tax revenues in Uintah County have remained constant since 2012.

Visitation Spending Estimates

Table 11 presents the spending estimates for the 11 tourism and recreation destinations considered in this study. In total, these destinations received 4 million visitors in 2015. These tourists spent an estimated total of $291.8 million.

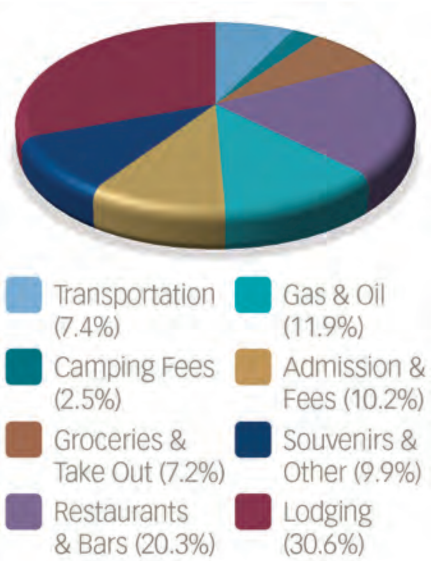
***Table 11:** 2015 Tourism and Recreation Visitation and Spending*

Destination	Number of Visitors	Average Spending per Visitor	Total Spending ($ Thousands)
Park in/near Grand County			
Arches	1,263,700	$115[a]	$145,139
Canyonlands	558,800	$58[a]	$32,553
Dead Horse Point	402,500	$52[b]	$20,847
Hunting - Book Cliffs[f]	1,600	$93[c]	$149
Park in/near Uintah County			
Dinosaur	297,900	$58[a]	$17,167
Red Fleet	25,500	$45[b]	$1,136
Steinaker	32,500	$32[b]	$1,044
Utah Field House	53,500	$62[b]	$3,291
Park in/near Duchesne County			
Starvation	91,600	$35[b]	$3,243
Rest of Utah			
Lake Powell[e]	683,300	$65[a]	$44,222
Flaming Gorge	650,000	$35[d]	$23,011
All Destinations Total	4,060,900		$291,802

Notes: a = data obtained from Cullinane, Huber and Koontz[12]; b = data obtained from Utah Department of Natural Resources and based on authors' calculations; c = spending per hunter based on data obtained from U.S. Fish and Wildlife Service and U.S. Census Bureau; d = value assumed to be the per visitor spending at Starvation due to the fact that both parks have a limited number of facilities close to them; e = Lake Powell data were only available through 2014, refer to section 3.1; and f = Hunting – Book Cliffs data were only available through 2013, refer to section 3.1.

12 Cullinane Thomas, C., C. Huber, and L. Koontz. 2015. 2014 National Park visitor spending effects: Economic contributions to local communities, states, and the Nation. Natural Resource Report NPS/NRSS/EQD/NRR—2015/947. National Park Service, Fort Collins, Colorado.

***Figure 28:** Distribution of U.S. National Park Visitor Spending, 2014*



Source: Cullinane, Huber and Koontz[12]

As shown in Table 11, the most visited park within the study area was Arches National Park, with more than 1.2 million estimated visitors in 2015. Arches' average spending per visitor was also the highest at $115 per visitor. The average expenditure per visitor in the Book Cliffs area was estimated at $93. This value reflects the amount spent on a hunting trip, excluding hunting equipment and taking into account the average number of annual visits per hunter.[13]

Visitation Spending Profile

Figure 28 presents the distribution of visitor spending at national parks across eight categories of goods and services.

In 2014, national parks visitors spent about 30.6 percent on lodging, the highest part of their budget, followed by restaurants and bars which accounted for 20.3 percent. When travel transportation (7.4 percent) and gas and oil (11.9 percent) are merged together to represent all travel costs, they account for 19.3 percent of total spending and thus represent the third largest component of visitors' budget.

Because of the lack of spending breakdown data for state park visitors and hunters, the study applied the spending profile of Figure 28 to all 11 study tourism and recreation attractions to approximate spending patterns. The resulting spending breakdown for 2015 is presented in Table 12. Note that the

***Table 12:** Baseline (No-Build) Tourism Spending by Category (2015 $ millions)*

Destination	Camping Fees	Groceries & Take Out	Souvenirs & Other Expenses	Admission & Fees	Travel (Transportation + Gas & Oil)	Restaurants & Bars	Hotels, Motels and B&Bs	Total by Destination
Park in/near Grand County								
Arches	$3.63	$10.45	$14.37	$14.8	$28.01	$29.46	$44.41	$145.14
Canyonlands	$.81	$2.34	$3.22	$3.32	$6.28	$6.61	$9.96	$32.55
Dead Horse Point	$.52	$1.5	$2.06	$2.13	$4.02	$4.23	$6.38	$20.85
Hunting - Book Cliffs	$.01	$.01	$.02	$.02	$.03	$.03	$.05	$0.15
Park in/near Uintah County								
Dinosaur	$.43	$1.24	$1.7	$1.75	$3.31	$3.48	$5.25	$17.17
Red Fleet	$.03	$.08	$.11	$.12	$.22	$.23	$.35	$1.14
Steinaker	$.03	$.08	$.1	$.11	$.2	$.21	$.32	$1.04
Utah Field House	$.08	$.24	$.33	$.34	$.64	$.67	$1.01	$3.29
Park in/near Duchesne County								
Starvation	$.08	$.23	$.32	$.33	$.63	$.66	$.99	$3.24
Rest of Utah								
Lake Powell	$1.11	$3.18	$4.38	$4.51	$8.53	$8.98	$13.53	$44.22
Flaming Gorge	$.58	$1.66	$2.28	$2.35	$4.44	$4.67	$7.04	$23.01
Total	$7.30	$21.01	$28.89	$29.77	$56.32	$59.23	$89.30	$291.80

13 U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

spending estimate for the travel category is the sum of transportation and gas and oil categories.

In 2015, visitors spent an estimated total of $56.3 million for travel. Of this amount, $28.0 million was spent for traveling to Arches National Park, $8.5 million to Lake Powell, $6.3 million to Canyonlands National Park, $4.4 million to Flaming Gorge National Recreation Area, and $9.0 million to the other seven study tourism destinations. These spending amounts served as the baseline used to estimate the impact of travel cost reduction of the improved study corridor on the number of recreation visits.

3.3. Incremental Tourism Model

This section describes the method utilized to estimate the impact of the improved study corridor on tourism and recreation visitations for the 11 destinations considered in this study. As previously discussed, the improved study corridor would enhance access to the region and increase connectivity between eastern Utah attractions. This is, in turn, expected to decrease the travel costs to and between the 11 study tourism and recreation destinations of the study.

Economic Theory Overview

As the prices of goods and services decrease, the demand for these goods and services increase. In the case of the study corridor, if "price" is the travel cost and "demand" for goods and services is the volume of visitations, then reducing the travel cost will increase the volume of visitations. As such, the anticipated change in travel costs can be used to estimate the change in tourism visitations. The theory applied to estimate incremental tourism visitation growth caused by the improved study corridor is illustrated by the downward-sloping demand curve of Figure 29.

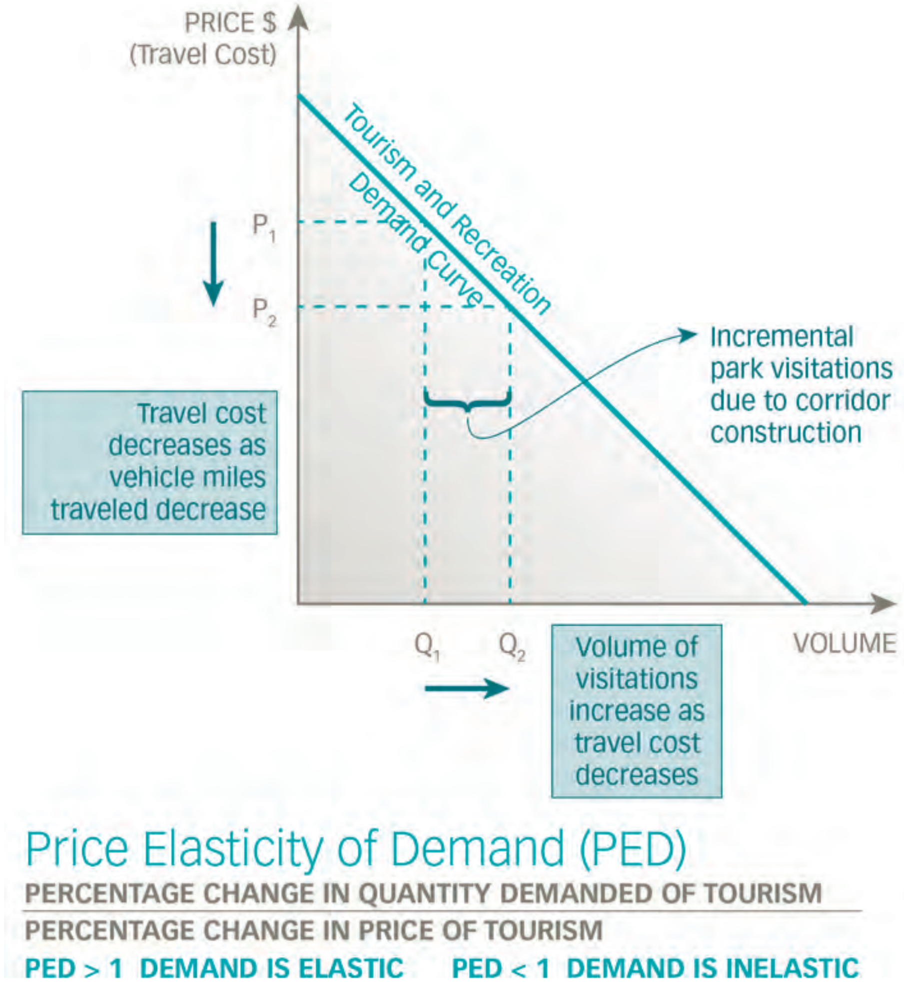
The volume Q_1 in Figure 29 represents the baseline number of tourism and recreation visitors who, without the benefit of the improved study corridor, take the existing routes to travel to and between the study tourism and recreation destinations. These visitors pay the current (baseline) price P_1 for their trip. If the improved study corridor is constructed, the travel cost would decrease from P_1 to P_2 as a result of the decrease in vehicle miles traveled.

Because traveling the improved study corridor would cost less than the existing travel alternatives, an increased portion of visitors would travel to and between the tourism and recreation destinations of the study area. This trend is illustrated in Figure 29 as the increase of volume from Q_1 to Q_2 and is called the incremental visitations. The incremental visitations ($Q_2 - Q_1$) are estimated by assessing the travel cost elasticity of demand for tourism and recreation which is detailed below.

Travel Cost Elasticity of Demand

The price (travel cost) elasticity of demand for tourism and recreation defines the relationship between changes to the price (travel cost) and changes to the volume of visitations. Price elasticity predicts the percentage by which volume of visitations will increase for every one percent decrease in travel cost. In other

***Figure 29:** Tourism and Recreation Impact of Change in Travel Costs*



words, the percentage change in the volume demanded resulting from a one percent decrease in travel cost is called the sensitivity of tourism and recreation to changes in travel costs. Elasticity is defined by Equation 1.

***Equation 1:** Price Elasticity*

$$\text{Elasticity}_{Q/P} = \frac{Q_2 - Q_1}{P_2 - P_1} \times \frac{P_1}{Q_1}$$

The elasticity is a unit-free measure. The sign of the price elasticity is expected to be negative as improving access and connectivity would increase the volume of visitations. Visitation estimates are measured by the number of individuals who enter the park each day (i.e., parks count visits).

There are three potential values of elasticity:

- If elasticity (in absolute value) > 1.0, visitation is elastic (more sensitive) to changes in travel costs. In other words, a one percent reduction in the travel costs would result in a more than one percent increase in the number of visits.
- If elasticity < 1.0, visitation is inelastic (less sensitive) to changes in travel costs.

- If elasticity = 1.0, any decrease in travel costs would lead to an equi-proportional increase in the number of visits.

Because existing studies estimate only the sensitivity of tourists' spending budget to changes in travel costs (commonly expressed as the price elasticity of demand for tourism), the elasticity can be further broken into two components defined by Equation 2.

Equation 2: *Components of Price Elasticity of Demand*

$$\textbf{Elasticity}_{Q/P} = \textbf{Elasticity}_{Q/SB} \times \textbf{Elasticity}_{SB/P}$$

Where SB stands for spending budget for travel.

The second component in the right hand side of the equation can be obtained from a number of empirical studies for U.S. tourism, while the first can be estimated from visitation data provided by Cullinane, Huber and Koontz.[12]

Because studies of U.S. tourism focus mostly on the international level (i.e., U.S. as a destination in comparison to other countries), the domestic U.S. tourism study by Pyo, Uysal and McLellan[14] is especially well suited to assess the impact on increased visitations. According to the authors, the elasticity of spending budget for travel with respect to travel costs (by keeping preference of visitors unchanged) is defined by Equation 3.

Equation 3: *Second Component of Elasticity*

$$\textbf{Elasticity}_{SB/P} = \textbf{-0.562}$$

This means that a one percent increase in the travel cost would lead to a 0.562 percent decrease in spending budget allocated to travel consumption.

For the right hand side of the elasticity equation, Cullinane, Huber and Koontz[12] detail the total number of visits and total visitor spending for 370 national parks. Applying a simple econometric regression (Ordinary Least Square) allows results in Equation 4.

Equation 4: *First Component of Elasticity*

$$\textbf{Elasticity}_{Q/SB} = \textbf{1.007}$$

As opposed to the sensitivity of spending budget for travel to travel costs which is called "price elasticity", the above positive elasticity is called "expenditure elasticity." It is interpreted to mean that a one percent increase in tourism and recreation budget for travel is associated with a 1.007 percent increase in the volume of visitations.

The price elasticity was calculated by multiplying these two components as shown in Equation 5. As shown, the price elasticity of demand for tourism and recreation to changes in travel costs was estimated to be -0.566.

Equation 5: *Price Elasticity of Demand for Tourism Visitations*

$$\textbf{Elasticity}_{Q/P} = \textbf{1.007} \times \textbf{-0.562} = \textbf{-0.566}$$

14 Pyo, S.S., M. Uysal, and R.W. McLellan. 1991. "A linear expenditure model for tourism demand." Annals of Tourism Research Vol. 18, pp. 443-454.

This elasticity can be interpreted to mean that for a one percent decrease in travel costs, the expected number of tourism and recreation visits increases by 0.566 percent.

Incremental Tourism Visitation Model

The travel cost elasticity of demand for tourism and recreation can be applied to incremental changes in travel costs to estimate the corresponding change in tourism visitations. As mentioned above, the change in travel cost results from a decrease in vehicle miles traveled induced by changes to the transportation network.

Corridor studies routinely apply sophisticated regional travel demand models to estimate changes in vehicle miles traveled. Where possible, this study applied the UDOT Utah Statewide Travel Demand Model (USTM) to analyze the transportation impacts of the improved study corridor (more about the USTM is presented later). However, the recreational attractions defined in the current USTM are rudimentary and cannot reliably predict recreation-related changes to vehicle miles traveled based on changes to the transportation network. As such, a customized model was defined and applied to estimate the impact of the improved study corridor on the volume of visitations. The steps of this customized model are summarized in Table 13. These steps estimate the four main variables defined in Figure 29, namely Q_1, Q_2, P_1, and P_2.

Because of the lack of visitor origin-destination data available for the study, the volume of visitors who currently take existing routes to travel within the study area from north to south and vice-versa is based on the Dinosaur National

Table 13: *Incremental Tourism Visitation Model*

Variable	Equation
(1) Number of Beneficiaries (Q_1)	(1) = (Percentage of Beneficiaries) x (Visitors)
(2) Travel Costs (P_1)	(2) = (1) x (Percentage Assigned to Travel Costs)
(3) Unit Driving Cost	See Table 4
(4) Total VMT	(4) = (2)/(3)
(5) Vehicle Occupancy Rate	(5) = 2.6 Passengers per Vehicle
(6) Number of Vehicles	(6) = (1)/(5)
(7) Average Trip Length per Vehicle	(7) = (4)/(6)
(8) New (Reduced) Average Trip Length per Vehicle	(8) = (7) – (Miles Reduced by Improved Corridor)
(9) New (Reduced) Total VMT	(9) = (8) x (6)
(10) New (Reduced) Travel Cost (P_2)	(10) = (9) x (3)
(11) Travel Cost Reduction ($) ($P_1 – P_2$)	(11) = (2) – (10)
(12) Travel Cost Reduction (%) ($(P_1 – P_2)/P_1$)	(12) = (11)/(2)
(13) Incremental Visitation (%)	(13) = (12) x (Travel Cost Elasticity)
(14) Incremental Visitation (Persons) (Q_2 - Q_1)	(14) = (13) x (1)

Monument visitor survey conducted by Manni and Le in 2014.[15] According to the authors, 18 percent of the national park visitors are from the five counties located in southern adjacent states; and 35 percent of them are from the eight counties located in northern Utah and adjacent states. This information indicates that upwards of 18 percent of visitors could benefit from the improved study corridor. Consideration of inter-park trips (trips to multiple study destinations) would increase the portion of visitors that would benefit from the improved study corridor.

Based on the visitor travel patterns noted above, this study assumed that approximately 30 percent of visitors travel between northern and southern park destinations and would therefore benefit from the improved study corridor. Because travel patterns are largely unknown, a sensitivity analysis was conducted to test the robustness of this travel assumption. Results of the sensitivity analysis are summarized in Section 5.8. The 30 percent proportion was applied to all study tourism and recreation destinations, except for the Book Cliffs hunting area. Because of direct access to the Book Cliffs mountain range, the improved study corridor was assumed to potentially benefit all Book Cliffs area hunters. These assumptions coupled with total visitors yield the number of beneficiaries, defined as (1) in Table 13.

Multiplying (1) by the 19.3 percent of the spending profile attributed to travel costs (Figure 28) results in the baseline (no-build) travel costs for the visitors who would benefit from the corridor, defined as (2) in Table 13.

Table 14 reports two projected indexes used to calculate fuel consumption and three indexes used to calculate vehicle operating costs through the year 2040. All costs are expressed in real terms (i.e., in 2015 dollars). Fuel consumption is largely influenced by technology development in the automobile industry as newer cars generally use less fuel. The overall real fuel cost is expected to increase slightly from current values ($0.091 per mile in 2015) to $0.097 per mile in 2021 and decrease slightly to $0.094 per mile in 2040.

Unlike fuel consumption, the real costs of operating a car including maintenance and repair, tires, and depreciation are assumed to remain unchanged for the entire study time horizon. As a result, the costs of driving a car (the sum of fuel and operating costs) are expected to be about $0.40 per mile through the year 2040.

The resulting unit driving cost reported in row (H) of Table 14 and shown as row (3) of Table 13 allows calculation of the total vehicle miles traveled as shown in row (4) of Table 13.

The study assumed an average occupancy rate of 2.6 passengers per vehicle, which is equivalent to 38 vehicles in use per 100 visitors. This rate has been widely employed in the Michigan Tourism and Economic Model developed by Michigan State University Professor Daniel Stynes. This rate is also consistent with rates used by the USTM and appears consistent with expected visitor travel patterns for study tourism and recreation destinations. Based on this

15 Manni, M. F. and Y. Le. 2014. Dinosaur National Monument visitor study: Summer 2013. Natural Resource Report NPS/NRSS/EQD/NRR—2014/786. National Park Service, Fort Collins, Colorado.

Table 14: *Projection of Driving Costs (2015 $)*

Variable	2021	2025	2030	2035	2040
(A) Fuel Efficiency (mpg)	$25.6	$28.5	$32.3	$35.1	$37.0
(B) Utah Gasoline Price ($/gal)	$2.48	$2.62	$2.85	$3.14	$3.47
(C) Fuel Consumption ($/VMT) = (B) / (A)	$0.097	$0.092	$0.088	$0.089	$0.094
(D) Maintenance & Repair ($/VMT)	$0.051	$0.051	$0.051	$0.051	$0.051
(E) Tires ($/VMT)	$0.010	$0.010	$0.010	$0.010	$0.010
(F) Depreciation ($/VMT)	$0.244	$0.244	$0.244	$0.244	$0.244
(G) Vehicle Operating Costs ($/VMT) = (D) + (E) + (F)	$0.306	$0.306	$0.306	$0.306	$0.306
(H) Transportation Costs ($/VMT) = (C) + (G)	$0.403	$0.398	$0.394	$0.395	$0.400

Sources: U.S. Energy Information Administration (EIA), AAA Exchange, and authors' calculations.

assumption, the calculation of the average trip length per car follows the formulas stated for (6) and (7) in Table 13.

As can be seen from Figure 14, visitors traveling between northern and southern study tourism and recreation destinations currently take either US-191 in Utah (west of the study corridor) or SR-139 in Colorado (east of the study corridor). Because the study corridor will create a more direct route, it is expected that tourists who travel between study tourism and recreation destinations will save an average of 36 miles of trip length, except for those who travel to or from Lake Powell, who are expected to continue to mostly use US-191. Lake Powell trips were therefore assumed to achieve an average trip length reduction of 10 miles. The reduced trip length per car caused by the improved study corridor are reported as (8) in Table 13. The resulting new (reduced) vehicle miles traveled are calculated as shown for (9) in Table 13.

The reduced travel cost (P_2) is in turn computed by multiplying the reduced VMT by the unit driving cost as shown for (10) in Table 13. The travel cost reduction in monetary value and in percentage terms are then calculated as shown for (11) and (12) in Table 13. Multiplying the travel cost elasticity of tourism (-0.566) by the percentage of travel cost reduction yields the percentage of incremental visitations as shown for (13) in Table 13. Finally, the incremental visitations measured in persons are calculated as shown for (14) in Table 13 by multiplying the percentage of incremental visitations by the number of beneficiaries.

3.4. Incremental Tourism Impacts

This section reports and comments on the application of the incremental tourism model to forecast tourism and recreation visitation impacts through the year 2040.

Travel Cost Reduction

Table 15 shows the travel costs saved by each of the study tourism and recreation destinations. Assuming construction completion by 2021, the improved corridor would reduce travel costs by $7.5 million. This amount would be nearly doubled

Table 15: *Projected Travel Cost Savings (2015 $)*

Destination	2021	2025	2030	2035	2040
Park in/near Grand County					
Arches	$2,680,651	$3,024,733	$3,458,349	$3,935,174	$4,448,881
Canyonlands	$1,116,450	$1,223,970	$1,360,635	$1,514,526	$1,682,185
Dead Horse Point	$1,023,691	$1,243,301	$1,517,179	$1,809,455	$2,119,740
Hunting - Book Cliffs	$14,596	$18,175	$22,628	$27,354	$32,356
Park in/near Uintah County					
Dinosaur	$546,024	$571,505	$605,072	$646,480	$693,416
Red Fleet	$57,745	$57,085	$56,517	$56,705	$57,329
Steinaker	$98,483	$97,357	$96,388	$96,709	$97,774
Utah Field House	$98,442	$103,264	$109,597	$117,348	$126,106
Park in/near Duchesne County					
Starvation	$213,262	$250,478	$297,056	$347,284	$400,884
Rest of Utah					
Lake Powell	$317,228	$313,602	$310,479	$311,514	$314,942
Flaming Gorge	$1,381,189	$1,559,703	$1,784,627	$2,031,841	$2,298,113
All Destinations Total	$7,547,763	$8,463,173	$9,618,527	$10,894,390	$12,271,726

by 2040. In absolute real value, travel costs related to Arches National Park are expected to experience the largest savings ($2.7 million dollars saved in 2021, $3.5 million saved in 2030 and $4.4 million saved in 2040), followed by Flaming Gorge National Recreation Area, Canyonlands National Park, and Dead Horse Point State Park. The travel cost savings for Dead Horse Point State Park and for hunting in the Book Cliffs area are expected to increase at a higher rate than the other study tourism and recreation destinations.

Incremental Visitations

Table 16 shows that by 2040, the corridor would bring nearly one million incremental visitors to the 11 study tourism and recreation destinations. This value is the cumulative number of annual incremental visitations from 37,480 visitors in 2021 to 61,117 visitors in 2040. Because of its relatively significant travel cost reduction (see Table 15), Flaming Gorge National Recreation Area is projected to receive the largest incremental visitations over the projection period, 301,781 visitors in total. The expected additional visits to the National Recreation Area would increase from about 11,442 in 2021 to 19,037 in 2040. Through the study forecast period, the Book Cliffs area is projected to receive a relatively lower total of incremental visits; 1,463 additional hunters over the 2021-2040 period.

Incremental Tourism Spending

Multiplying the per capita spending presented in Table 11 by the expected additional visits given in Table 16 yields the increase in tourism and recreation spending generated from the build scenario. The result for each destination is shown in Table 17. It is estimated that through 2040, the increase of nearly one million visitors translates to a total incremental spending of $57.5 million.

Table 16: *Projected Incremental Visitations, 2021 - 2040*

Destination	2021	2025	2030	2035	2040	Total 2021-2040 Period
Park in/near Grand County						
Arches	6,845	7,723	8,831	10,048	11,360	180,250
Canyonlands	5,620	6,162	6,850	7,624	8,468	139,486
Dead Horse Point	5,796	7,040	8,590	10,245	12,002	176,264
Hunting - Book Cliffs	46	57	71	86	102	1,463
Park in/near Uintah County						
Dinosaur	2,779	2,908	3,079	3,290	3,529	62,435
Red Fleet	380	376	372	373	377	7,497
Steinaker	899	889	880	883	893	17,732
Utah Field House	469	492	523	559	601	10,597
Park in/near Duchesne County						
Starvation	1,767	2,075	2,461	2,877	3,321	50,379
Rest of Utah						
Lake Powell	1,437	1,421	1,407	1,412	1,427	28,349
Flaming Gorge	11,442	12,920	14,784	16,831	19,037	301,781
All Destination Total	37,480	42,063	47,848	54,228	61,117	976,233

Table 17: *Projected Tourism and Recreation Spending Increase (2015 $)*

Destination	2021	2025	2030	2035	2040	Total 2021-2040 Period
Park in/near Grand County						
Arches	$786,139	$887,046	$1,014,210	$1,154,046	$1,304,698	$20,702,104
Canyonlands	$327,415	$358,947	$399,026	$444,156	$493,325	$8,125,654
Dead Horse Point	$300,212	$364,616	$444,934	$530,648	$621,644	$9,129,532
Hunting - Book Cliffs	$4,281	$5,330	$6,636	$8,022	$9,489	$136,373
Park in/near Uintah County						
Dinosaur	$160,129	$167,602	$177,446	$189,589	$203,354	$3,598,009
Red Fleet	$16,935	$16,741	$16,574	$16,630	$16,813	$333,968
Steinaker	$28,882	$28,551	$28,267	$28,361	$28,673	$569,574
Utah Field House	$28,869	$30,284	$32,141	$34,414	$36,982	$651,851
Park in/near Duchesne County						
Starvation	$62,542	$73,456	$87,116	$101,846	$117,565	$1,783,516
Rest of Utah						
Lake Powell	$93,032	$92,802	$91,052	$91,356	$92,361	$1,834,677
Flaming Gorge	$405,053	$457,405	$523,367	$595,866	$673,954	$10,683,659
All Destination Total	$2,213,489	$2,482,780	$2,820,770	$3,194,935	$3,598,858	$57,548,919

Increased Demand for Regional Services

Given the spending distribution presented in Figure 28 and Table 12, Figure 30 shows the total incremental spending through 2040. Amongst others, the spending amount allocated to travel (which includes transportation, and gas and oil) would increase by $11.1 million, behind lodging which would increase by $17.6 million and restaurants and bars which would increase by $11.7 million.

As shown, Grand County's tourism industry would benefit the most from the improved study corridor, followed by Uintah County. The "Rest of Utah" and particularly Daggett County (Flaming Gorge) would also see significant benefits. The improved study corridor would result in an additional $38.1 million for Grand County over the 20 year period, $10.7 million for Daggett County, and $5.2 million for Uintah County.

Figure 30: *Incremental Tourism and Recreation Breakdown, 2021-2040 (2015 $ millions)*

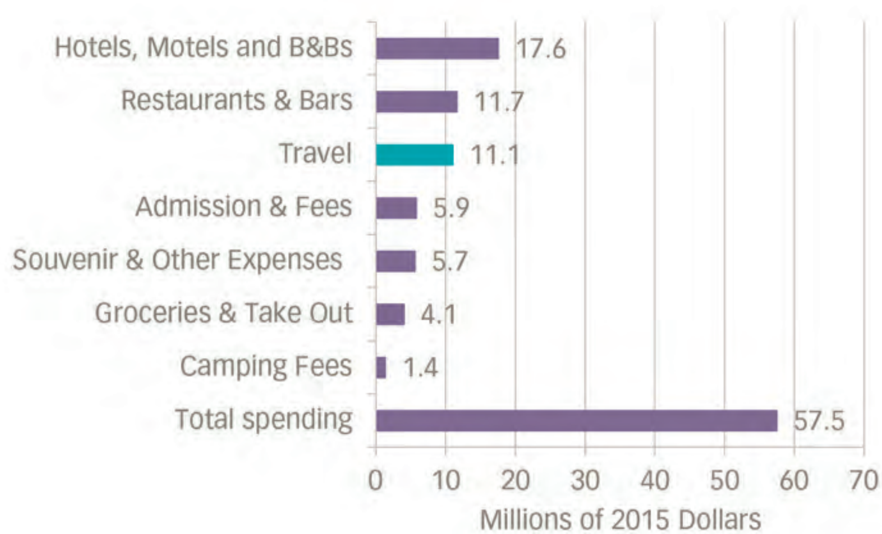


Table 18 further breaks down spending through 2040 by categories for each of the counties considered in the study.

Table 18: *Regional Tourism Spending Increase by Category, 20-Year Impact (2015 $)*

Destination	Transpor-tation	Camping Fees	Groceries & Take Out	Restaur-ants & Bars	Gas & Oil	Admis-sion & Fees	Souvenirs & Other Expenses	Hotels, Motels and B&Bs	Total Spending
Park in/near Grand County									
Arches	$1,531,956	$517,553	$1,490,551	$4,202,527	$2,463,550	$2,111,615	$2,049,508	$6,334,844	$20,702,104
Canyonlands	$601,298	$203,141	$585,047	$1,649,508	$966,953	$828,817	$804,440	$2,486,450	$8,125,654
Dead Horse Point	$675,585	$228,238	$657,326	$1,853,295	$1,086,414	$931,212	$903,824	$2,793,637	$9,129,532
Hunting - Book Cliffs	$10,092	$3,409	$9,819	$27,684	$16,228	$13,910	$13,501	$41,730	$136,373
Grand County Total	$2,818,931	$952,342	$2,742,744	$7,733,014	$4,533,146	$3,885,554	$3,771,273	$11,656,661	$38,093,663
Park in/near Uintah County									
Dinosaur	$266,253	$89,950	$259,057	$730,396	$428,163	$366,997	$356,203	$1,100,991	$3,598,009
Red Fleet	$24,714	$8,349	$24,046	$67,796	$39,742	$34,065	$33,063	$102,194	$333,968
Steinaker	$42,148	$14,239	$41,009	$115,624	$67,779	$58,097	$56,388	$174,290	$569,574
Utah Field House	$48,237	$16,296	$46,933	$132,326	$77,570	$66,489	$64,533	$199,466	$651,851
Uintah County Total	$381,352	$128,835	$371,045	$1,046,141	$613,255	$525,647	$510,187	$1,576,941	$5,153,403
Park in/near Duchesne County									
Starvation	$131,980	$44,588	$128,413	$362,054	$212,238	$181,919	$176,568	$545,756	$1,783,516
Rest of Utah									
Lake Powell	$135,766	$45,867	$132,097	$372,439	$218,327	$187,137	$181,633	$561,411	$1,834,677
Flaming Gorge	$790,591	$267,091	$769,223	$2,168,783	$1,271,355	$1,089,733	$1,057,682	$3,269,200	$10,683,659
All Region Total	$4,258,620	$1,438,723	$4,143,522	$11,682,431	$6,848,321	$5,869,990	$5,697,343	$17,609,969	$57,548,919

// SECTION FOUR

Energy Production Impacts 4

The study corridor would provide improved access to and connectivity within the Uinta Basin where there are significant energy resources and production. The study evaluated the impacts of corridor improvements on energy production. The following sections define the energy resources considered in the study, provide high-level background information on extraction methods, describe forecasting methods and results, and present estimated impacts to energy production.

4.1. Energy Production Forecast

Forecasting energy production for the study area was necessary to evaluate impacts of the improved study corridor. This section provides energy resources background information and key assumptions applied to develop baseline energy production forecasts.

Definition of Energy Resources

The energy production forecast focused on the key energy commodities currently being extracted in the Uinta Basin, as well as those which show potential for future extraction. The forecast examined the following resources:

- Crude oil
- Crude natural gas
- Oil sands
- Oil shale

Note that crude oil was assumed to include waxy crude as well as natural gas liquids and lease condensate which are typically reported as oil because of their liquid form. Other resources such as uranium exist in the Uinta Basin. However, these other resources were not examined in the forecast because their correlation with the study corridor is negligible.

The crude oil and crude natural gas resources refer to all oil and gas resources extracted from wells using various techniques, including vertical wells, directional wells, and horizontal wells. Directional wells largely consist of multiple wells drilled from a single pad, deviated away from vertical towards a target, and then returned to near vertical to penetrate a thick formation with multiple targets. Horizontal wells use techniques such as hydraulic fracturing to extract resources. Crude oil is extracted using vertical wells and, to a lesser extent, horizontal wells; while crude natural gas is extracted using directional wells and, to a lesser extent, vertical wells. Historically, vertical and directional wells have been considered conventional techniques while horizontal wells have been considered unconventional. However, as trends have increasingly moved towards horizontal drilling, it is increasingly considered a conventional method for extracting oil and gas. In the Uinta Basin, “unconventional oil” is increasingly used to refer to oil sands and oil shale extraction instead of horizontal well drilling methods.

The Uinta Basin contains oil sand deposits similar, in concept, to the Athabasca Oil Sands in Canada and the Orinoco Oil Sands in Venezuela. Although the Uinta Basin deposits are smaller in quantity, there is interest in further development because the resource itself is compatible with innovative oil sands extraction processes developed by companies including U.S. Oil Sands Inc. and MCW Energy Group Ltd. These processes are expected to allow for more cost effective oil sands production. As mentioned above, oil sands are considered an unconventional method of oil extraction. Synthetic crude oil is the end product extracted from oil sands.

The Uinta Basin is also home to what may be the world’s largest oil shale deposits, largely contained in the Green River Formation. Although oil shale extraction efforts have been initiated in the Uinta Basin by Red Leaf Resources Inc. and Enefit American Oil, there is no current large scale oil shale production. Oil shale extraction efforts in the Uinta Basin have been somewhat stifled recently because of the international price drop of oil. However, long run interest remains strong. As mentioned above, oil shale production is considered an unconventional method of oil extraction. It is typically produced using mining techniques to extract the shale, followed by the application of heat to release the synthetic crude oil from the shale.

For purposes of this study, total oil production was forecasted as the sum of crude oil, oil sands, and oil shale forecasts. Natural gas production forecasts were considered separately.

Energy Data Sources

Principal data sources used to complete energy production forecasts included the EIA, the Utah Division of Oil, Gas, and Mining (DOGM), the Annual Energy Outlook, the BLM, and the UBET Study. These sources were used to understand possible and feasible levels of production given the current environment and current estimates of recoverable reserves.

Other sources and industry knowledge of study contributors were also used for more specialized purposes. For example, the West Texas Intermediate and Henry Hub prices indices were used for estimating the future prices of oil and gas, respectively. Materials published by producers were also considered in the production estimates, particularly in the case of oil sands and oil shale where production forecasts are less clear.

Because of the uncertainty involved in forecasting, three energy production forecasts were considered: low, mid-range, and high scenarios. The mid-range scenario refers to production estimates that are most likely to occur given current knowledge and conditions, while the low and high scenarios represent low end and high end estimates, respectively.

Well Quantity Forecasts

The first step to forecasting oil and gas production was to determine oil and gas well quantities. To do so, the mid-range scenario used the BLM's August 2011 estimate of the total number of foreseeable wells in the Uinta Basin in the next 15-20 years. The UBET Study estimate of the total number of foreseeable wells in the next 20 years was used in the low scenario. The UBET Study estimates were used for the low scenario because it was lower in magnitude than the BLM estimate. In addition, the UBET Study estimate was based on data dating back to 2006 and was therefore considered to be more out-of-date than the BLM estimate. With the absence of other Uinta Basin well estimates, the high scenario used a 20 percent increase over the mid-range scenario well estimate.

These well estimates were extrapolated to a 26-year horizon (2015 through 2040) and were split into oil wells, gas wells, and service wells based on current and historic trends and general knowledge of future Uinta Basin oil and gas operations. The well estimates were then allocated to each year based on the West Texas Intermediate (WTI) and Henry Hub price forecasts (in real terms) under the premise that higher prices mean larger profits which in turn means a greater appetite for well construction. The WTI and Henry Hub price forecasts are shown in Table 19.

The annual estimates of oil and gas wells were then broken down into vertical, directional, and horizontal wells. In the mid-range scenario, it was assumed that the forecasted trend of vertical, directional, and horizontal well construction would be similar to the trend seen from 2011 to 2015. The high and low scenarios had more optimistic and pessimistic views, respectively, of the amount of horizontal wells to be constructed. The well quantity forecasts categorized by resource and well type and are presented in Table 20 and Table 21, respectively.

Well Production Forecasts

The forecast of well quantities was used to drive the oil and gas production forecasts. This was achieved by applying an assumed average production per well. In practice, oil and gas production is dependent on the age of the well in that the quantity of resource extraction per unit time is larger for younger wells and smaller for older wells. This relationship follows a "production decline curve." The University of Utah developed an equation that models this decline curve, which is shown in Equation 6. The equation's parameters are shown in Table 22 and a sample graph is shown in Figure 31.

Table 19: *WTI and Henry Hub Price Forecasts (2015 $)*

Item	Units	2015	2020	2025	2030	2035	2040
WTI (Oil)	$/bbl	$49.53	$58.10	$67.70	$79.21	$92.56	$108.03
Henry Hub (Natural Gas)	$/million BTU	$2.34	$3.09	$3.46	$3.61	$4.18	$4.97

Source: Annual Energy Outlook, 2015.

Table 20: *Uinta Basin Well Quantity Forecasts by Resource (Year End)*

Item	2015	2020	2025	2030	2035	2040
Low Scenario						
Oil Wells	5,036	6,851	9,130	11,836	15,069	18,976
Gas Wells	6,757	8,339	10,092	11,887	13,750	15,725
Service Wells	1,809	2,330	2,949	3,639	4,421	5,323
Mid-range Scenario						
Oil Wells	5,036	7,620	10,895	14,807	19,503	25,202
Gas Wells	6,757	9,275	12,043	14,871	17,796	20,885
Service Wells	1,809	2,592	3,519	4,553	5,722	7,070
High Scenario						
Oil Wells	5,036	8,091	11,978	16,630	22,223	29,022
Gas Wells	6,757	9,849	13,241	16,701	20,278	24,050
Service Wells	1,809	2,752	3,869	5,113	6,520	8,141

Table 21: *Uinta Basin Well Quantity Forecasts by Well Type (Year End)*

Item	2015	2020	2025	2030	2035	2040
Low Scenario						
Vertical Wells	9,805	11,272	12,559	13,995	15,622	17,499
Directional Wells	3,493	5,705	8,787	12,226	16,121	20,616
Horizontal Wells	304	542	825	1,140	1,497	1,909
Mid-range Scenario						
Vertical Wells	9,805	12,009	13,808	15,752	17,949	20,483
Directional Wells	3,493	6,699	11,127	15,909	21,085	26,814
Horizontal Wells	304	778	1,522	2,570	3,986	5,860
High Scenario						
Vertical Wells	9,805	11,586	13,565	15,770	18,263	21,136
Directional Wells	3,493	7,760	12,497	17,778	23,747	30,627
Horizontal Wells	304	1,346	3,025	4,897	7,012	9,450

Equation 6: *Extraction Rate for Gas and Oil from Vertical Wells (Per Vertical Well)*

$$Q = \alpha\,(1 + \Theta \cdot \delta \cdot t)^{-\frac{1}{\Theta}}$$

Where,

Q = barrels extracted per month (oil) and thousands of cubic feet equivalent extracted per month (gas)

t = age of well in months

Equation 6 was used with the described parameters to estimate the oil and gas production provided by vertical wells. For horizontal well production, the UBET Study methodology was adopted whereby a multiplier of 2.5 was applied to the results from Equation 6 to adjust the production estimate for horizontal wells. Similarly, a multiplier of 1.75 was selected to adjust the production estimate for directional wells. This multiplier represents the midpoint between the vertical and horizontal well production. This is a reasonable assumption given that directional drilling is intended to access additional reserves and has characteristics of both vertical and horizontal wells.

To simplify the forecast of production quantities, forecasts were conducted separately for existing wells and new wells, which were summed together. The process of forecasting the production from new wells was straightforward in that the production for each new well can be expected to follow the production curve from the beginning, at 't' equals to zero months. In the case of existing wells, however, production could not be modeled from the beginning of the production curve. For modeling purposes, it was therefore necessary to estimate the average well age and then assume the production from all existing wells follow the production curve at 't' (average well age in months).

Because of limited data availability, it was necessary to make two key assumptions before estimating the average age of existing Uinta Basin wells. First, because well quantities are reported at the state level by DOGM, it was assumed that the average well age in Utah is equivalent to the average well age in the Uinta Basin. As production in the Uinta Basin has been growing as a percentage of total production in Utah, it might be inferred that Uinta Basin wells are, on average, younger than Utah wells as a whole. If this is the case in actuality, then the energy production results may be slightly conservative. Second, because the most recent dataset of production totals and well counts available for the study was from 2014, it was assumed that the average well age in 2014 is equivalent to the average well age in 2015.

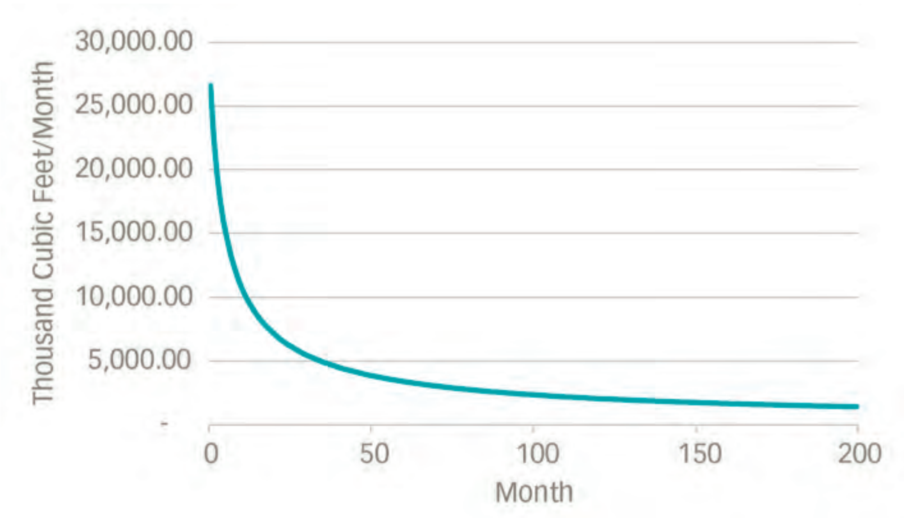
The premise of estimating the average age of existing wells was to provide Equation 6 with different 't' values, multiply by existing well counts, and compare the resulting production totals to what was reported by DOGM. The 't' values that resulted in the smallest variance between calculated production and actual production reported by DOGM were assumed to be indicative of the average age of existing wells. This exercise resulted in an estimated average oil well age of 21 months and an estimated average gas well age of 65 months.

***Table 22:** Parameters for Hyperbolic Decline Curve for Extraction Rates*

Categories	α	δ	Θ
Gas Production from Gas Wells	32,760	1.33	0.24
Oil Production from Gas Wells	370	1.12	0.31
Gas Production from Oil Wells	2,986	1.39	0.054
Oil Production from Oil Wells	3,807	1.76	1.10

Source: Estimates of the Marginal Cost of Oil and Gas Production in the Uinta Basin, Michael Hogue, November 16, 2012.

***Figure 31:** Gas Production Curve from Gas Wells*



Source: Estimates of the Marginal Cost of Oil and Gas Production in the Uinta Basin, Michael Hogue, November 16, 2012.

Oil Sands Production Forecasts

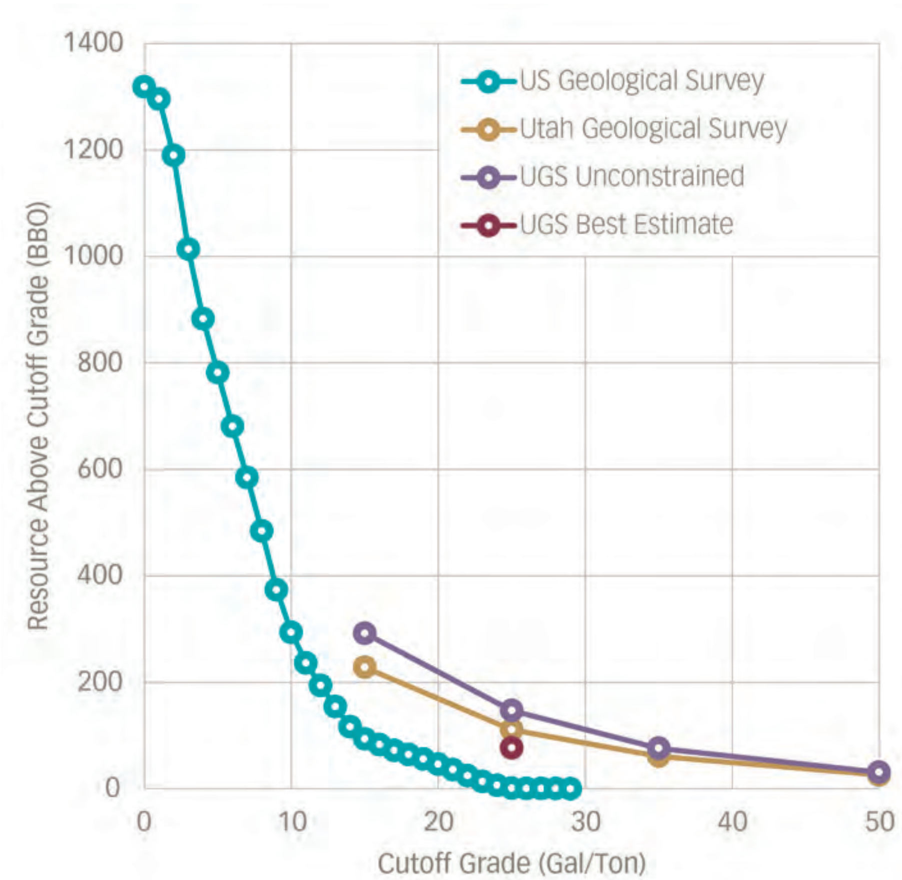
The two main companies with oil sands operations within the study area are MCW Energy Group and US Oil Sands Inc. The information communicated by these companies on current and expected production levels was largely used to drive the oil sands production forecast. It is stated that MCW Energy Group is currently producing 250 barrels of oil per day as a pilot project of sorts, and that it plans to ramp up to 5,000 barrels of oil per day. Similarly, US Oil Sands Inc. is looking to pilot production at 2,000 barrels of oil per day before ramping up to 10,000 or 20,000 barrels of oil per day.

This industry information was combined with insights provided by team members specializing in unconventional oil extraction and obtained by reviewing historical growth of Athabasca and Orinoco Oil Sands in Canada and Venezuela to forecast annual oil sands production. In doing so, it was assumed that MCW Energy Group and US Oil Sands Inc. would ramp up their production slowly over time with the exact quantities held as the variable between the low, mid-range, and high scenarios. MCW Energy Inc. production in 2040 was assumed to range from 2,500 barrels of oil per day in the low scenario to 20,000 barrels of oil per day in the high scenario, while US Oil Sands Inc. production in 2040 was assumed to range from 2,000 barrels of oil per day in the low scenario to 22,000 barrels of oil per day in the high scenario. Additionally, the high scenario forecasted the entry of Amerisands into the Uinta Basin beginning in 2021. Currently, Amerisands is interested in the Carbon County reserves, which are outside of the study area, but it is foreseeable that they may consider reserves in neighboring Grand, Duchesne, and Uintah counties.

Oil Shale Production Forecasts

There has been a good deal of discussion about the amount of oil potentially recoverable from oil shale of the Green River Formation in the Uinta Basin. The U. S. Geological Survey (USGS) has estimated the total oil recoverable from the Green River Formation in the basin as 1,319 billion barrels of oil (BBO). Their assessment was based on subdividing the Green River Formation into 18 alternating rich and lean zones, calculating the potential yield from those zones (based upon a very large database of measurements using the traditional Fischer Assay method) in wells that penetrate the Green River Formation, and integrating the total producible oil by interpolation of those well data across the Uinta Basin. The USGS has also estimated the portion of that very large resource that consists of rock above a specified richness (above a grade cutoff). Figure 32 shows the plot of the USGS data for all grades for the Uinta Basin oil shale. Figure 32 also shows the Utah Geological Survey (UGS) oil shale resource estimates for the Uinta Basin.

Figure 32: *USGS and UGS Estimates of Oil Shale Resources in the Uinta Basin*



The USGS estimates make it clear that relatively small amounts of the oil shale resource are in high yielding intervals (yields greater than 20 gal/ton) that are reasonably likely to be economically recoverable. The largest share of the resource is in very low yielding intervals (yields less than 10 gal/ton) that are almost certainly too lean to be readily recovered economically. The USGS estimate of recoverable oil shale may be most applicable to in situ methods of production that heat significantly thick zones of oil shale, but it has been applied to all the Green River Formation basins to provide a consistent estimate of the available resources. Averaging over a full stratigraphic unit may result in relatively low values for some sections of rock in which a portion of the stratigraphic unit could be richer than the average value for the unit. These intervals could potentially be mined and retorted using more traditional surface processing methods for oil shale. Because of the generally shallow depth of the Green River Formation in Utah, and the fact that the bulk of the richest resource is confined to one or two of the major rich zones, all active efforts to produce oil from oil shale in Utah plan to use surface-based retorting methods.

For this reason, the UGS has approached resource estimation differently. Their method measured the thickness of the total section that averaged above a given cutoff grade, starting from the Mahogany zone, generally the richest zone in the formation. As shown in Figure 32, this UGS method gives higher resources for cutoff grades at 50, 35, 25, and 15 gallons per ton than the USGS method. As also shown, UGS provided an unconstrained estimate, a constrained estimate (adding constraints based, for example, on a maximum likely mineable depth of 3,000 feet, and eliminating lands not available for leasing), and a best estimate of 77 billion barrels of oil (at a yield of 25 gallons per ton). These UGS estimates probably represent appropriate values for the Uinta Basin recoverable resources. The USGS estimates represent an increasing fraction of the UGS estimates as grade decreases. It is therefore reasonable to infer from Figure 32 that the two different methods would likely converge at lower cutoff values. It is also evident that much of the 1,319 billion barrels of oil shale resource in Utah is contained in rocks that are unlikely to be economic any time in the foreseeable future. The UGS estimates, with an appropriate range based on the potential for cutoff grades lower than 25 gallons per ton, are the best estimates for the likely future of oil shale development in the Uinta Basin. It is also important to note that current developers' estimates of the resources they expect to develop over the next 30 years are substantially less than the best estimate of the available resource from the UGS.

Based on a review of available oil shale resources for the Uinta Basin, this study assumed that the information on oil shale provided in the UBET Study remains the most up-to-date information. Whereas the UBET Study estimated aggregate Uinta Basin oil shale production at 131,000 barrels of oil per day, this estimate was scaled back to 26,000, 53,500, and 92,000 barrels of oil per day for 2040 low, mid-range, and high scenarios, respectively. The reason for the scale back was to adjust the UBET Study numbers for the decline in oil shale appetite. Oil shale production was forecasted from four producers which include Red Leaf Resources, Enefit American Oil, TomCo, all of which have expressed interest in developing Uinta Basin oil shale, and "Company 4" which accounts for the possibility in the mid-range and high scenarios that other competitors could enter the marketplace.

Energy Forecast Results

This section presents the results of the baseline energy production forecasts. These results were cross-checked with energy reserve estimates from the USGS and UGS to ensure they are realistic, noting that future technological developments, as well as unconventional extraction techniques, may facilitate the ability to increase estimates of recoverable reserves.

Figure 33 illustrates the low, mid-range, and high oil production forecasts for the Uinta Basin. As illustrated in Figure 33, oil production in the Uinta Basin is forecasted to continue its historical growth trend in the short term. Current production for the Uinta Basin is approximately 40 million barrels of oil (MMBO) per year, but this is expected to grow to approximately 150 million barrels of oil per year in the 2040 mid-range scenario. This trend is a result of the low oil prices and a corresponding moderate lag period before growth picks back up. Limited oil well construction in the short term will continue to impact production even after prices recover because time will be required to "catch up" for the shortfall in oil well construction. In the long term, growth rates in oil production are forecasted to increase to match trends realized in the Uinta Basin over the last ten years.

The oil production forecasts of Figure 33 include combined forecasts for oil wells, oil sands, and oil shale resource materials. Figure 34 illustrates the breakdown of oil production in terms of these oil resource materials. Because of the current early stages of oil shale and oil sands production in the Uinta Basin, approximately 99.5 percent of current oil production in the Uinta Basin is estimated to come from oil wells. Oil sands production is estimated to make up 0.5 percent of current oil production in the Uinta Basin. Relative to other resources, oil sands production is forecasted to peak in 2021 at 10.8 percent of oil production before tapering to 5.4 percent in 2040. While oil sands production in absolute terms never declines, its percentage of overall oil production decreases because oil sands production is forecasted to grow slower than oil well and oil shale production. Oil shale production is forecasted to start in 2017 and peak

Figure 33: *Uinta Basin Oil Production (MMBO/yr)*

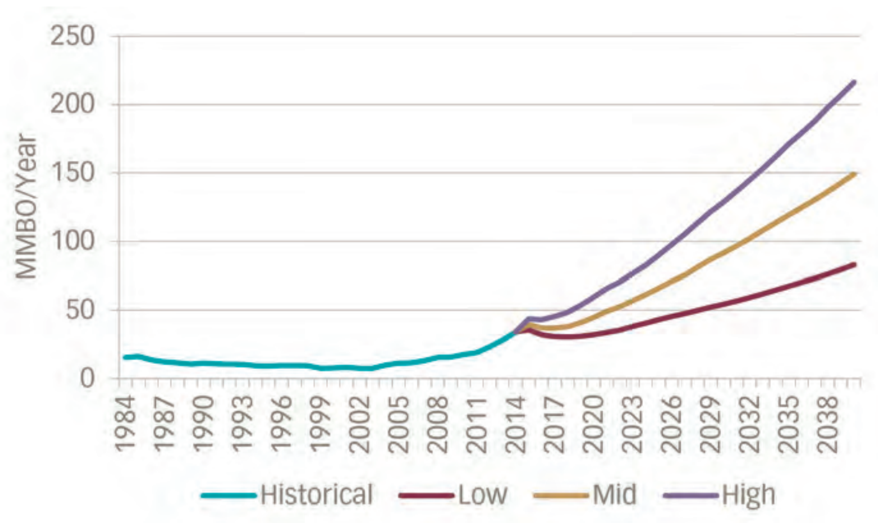
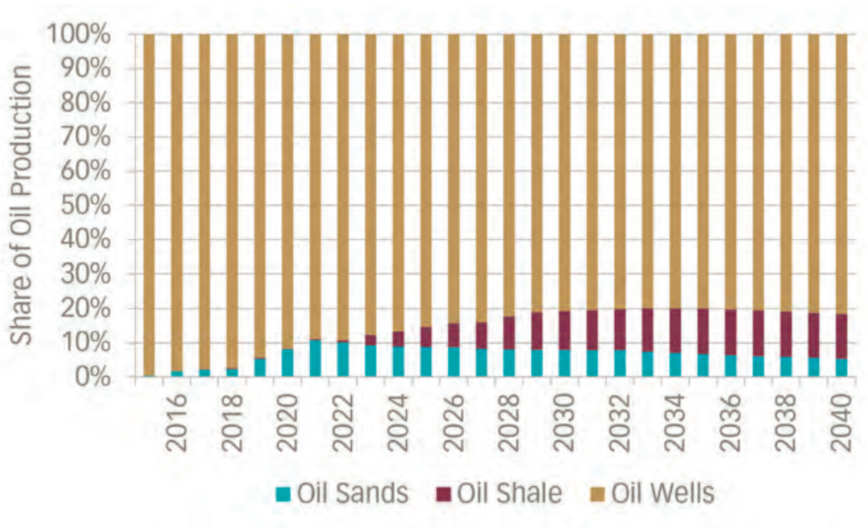


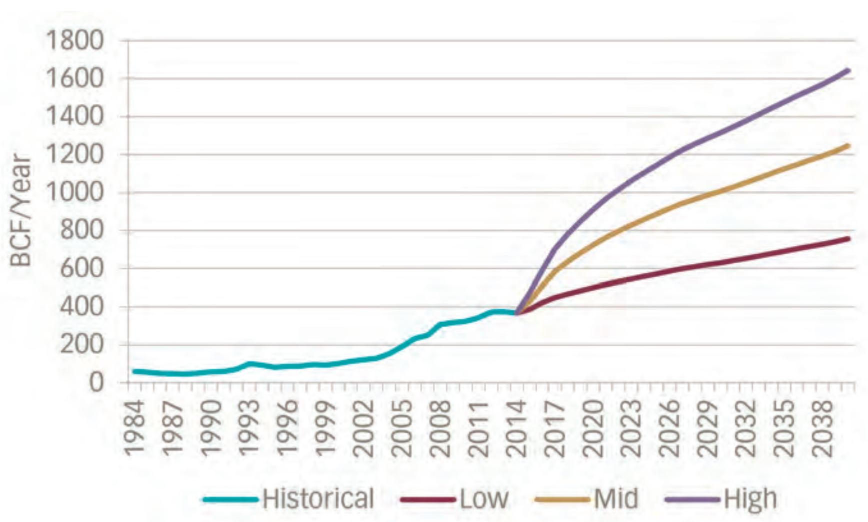
Figure 34: *Oil Resource as a % of Total Oil Production, Mid-range Scenario*



at 13.3 percent of oil production in 2035. Oil shale production is forecasted to surpass oil sands production in 2028.

Figure 35 illustrates the low, mid-range, and high gas production forecasts for the Uinta Basin. Gas production is reported in billion cubic feet (BCF) of gas per year. Figure 35 illustrates that gas production in the Uinta Basin is forecasted to ramp up quickly in the short term before tapering to more moderate growth in the long term. Current production in the Uinta Basin is approximately 430 BCF of natural gas per year, but this is expected to grow to approximately 1,250 BCF of natural gas in the 2040 mid-range scenario. Short term growth rates are steeper as natural gas is being exploited in lieu of oil because of the low oil prices. Although natural gas prices are also presently lower than they were in 2014, the drop-off was not nearly as sudden or extreme as it was for oil. Current prices for natural gas are also more in line with those of 2013. Consequently, the growth rate in natural gas production slows down in the long term because the

Figure 35: *Uinta Basin Gas Production (BCF/yr)*



long term increases of natural gas prices are more moderate than those of oil. Even through 2040, it is expected that the annual natural gas well construction will be greater than the annual closures and lost production of existing wells. This is why natural gas production is not forecasted to stagnate through 2040.

4.2. Travel Demand Model

The study used the UDOT Utah Statewide Travel Demand Model (USTM) to analyze the transportation impacts of the low, mid-range, and high energy production scenarios forecasted for the Uinta Basin. The USTM is a behaviorally based model that estimates changes in travel demands and patterns based on changes in the transportation network (e.g., improvements to the study corridor), socioeconomic data, transportation supply, and other inputs. The transportation impacts estimated by the USTM were subsequently used to estimate incremental impacts on energy production. The study used USTM version 1.3, which was used in the development of the 2015-2040 UDOT Long Range Transportation Plan. Several modifications were made to USTM version 1.3 to understand the impacts of the improved study corridor at the level of detail required for this study. This section summarizes the modifications made to key components of the travel demand model and presents the resulting travel impacts of improving the study corridor.

Energy Freight Components

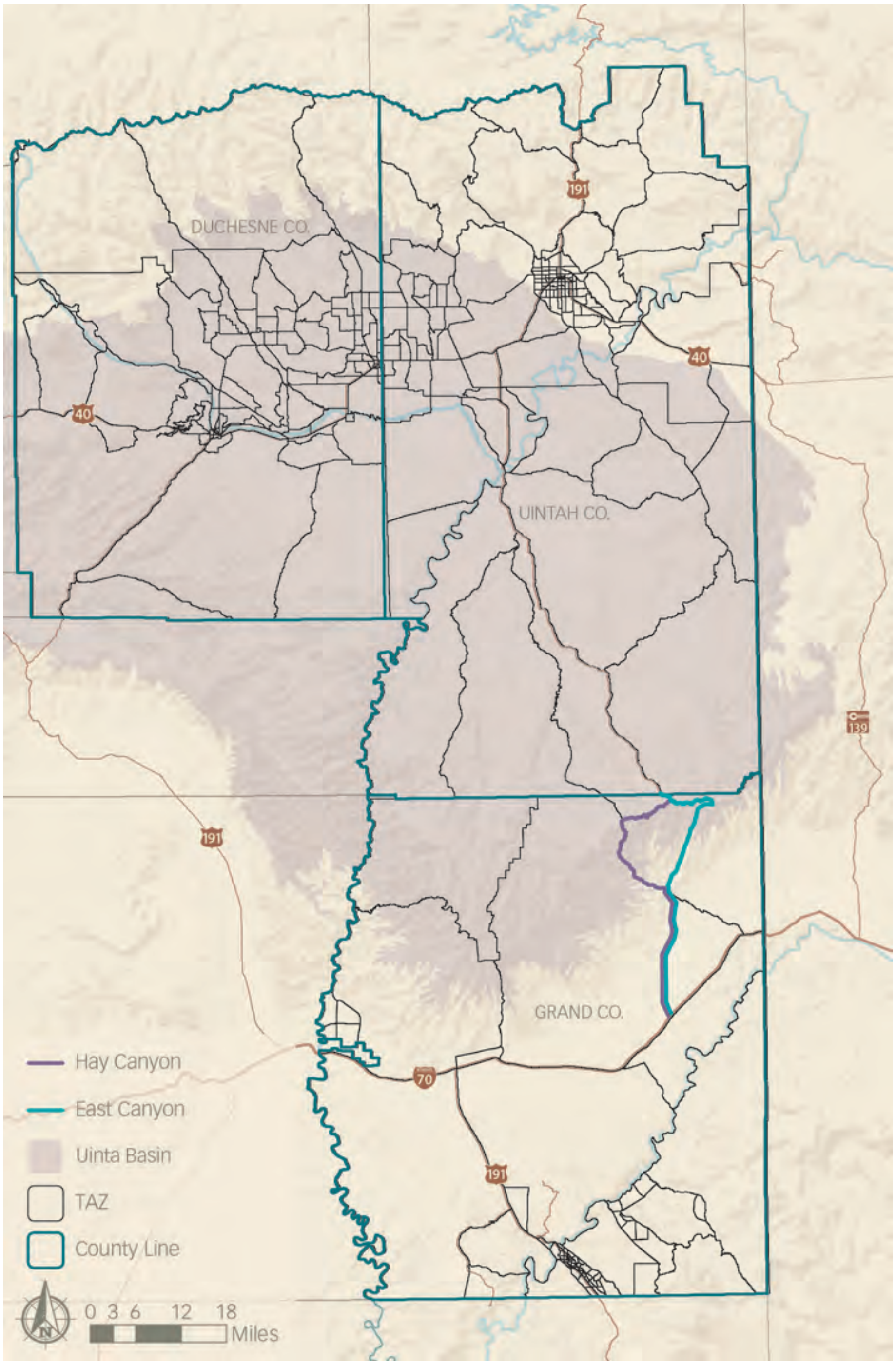
Embedded in the USTM is a commodity freight model component that forecasts the movement of goods, such as crude oil, both internally and externally to Utah. The commodity freight model components were modified to reflect the energy production forecasts summarized above and to incorporate well support activities.

Although the USTM considers the movement of energy-related goods, the model's oil and gas production and attraction input files were modified to better account for county and sub-county production totals. The oil and gas production zone input files were also updated to reflect county-level production forecasts. This effort included refreshing the Traffic Analysis Zone (TAZ) energy production levels based on forecasts developed for the study.

TAZs are geographic areas defined within the travel demand model. TAZs define activities for trip generation and destination that allow the model to predict travel-related impacts of changing these activities and/or the transportation network. Figure 36 shows the TAZ boundaries of the travel demand model used for the study. As shown, these TAZs define sub-county spatial boundaries for Grand, Duchesne, and Uintah counties. Modifications to the USTM included updates to the TAZ energy production levels based on estimated extraction locations within Grand, Duchesne, and Uintah counties.

The trips mentioned above account for transporting energy-related goods, but do not account for support truck and person trips required to construct and maintain wells. The USTM freight model was therefore also modified to account for the truck movements needed to transport materials that support well drilling and maintenance operations.

Figure 36: *USTM Traffic Analysis Zones (TAZs) for Study Area*



Well support trips pivot on the number of new and existing wells. Because the USTM does not differentiate between oil wells, oil sands, and oil shale resource materials, the first step in estimating the support service trips is to estimate the number of total wells for all oil source materials. The number of active wells was estimated by applying rates of production per well to the total forecasted production. As a simplified and conservative estimate for USTM, the number of new wells was calculated as the difference between the number of active wells for the model year and the number of active wells for the prior year.

***Table 23:** New Well Construction (Support) Heavy Truck Trips*

	Trips per Well
On- or Near-site	962
Outside Local Area	47
	1,009
"Estimate of On-site Movement to/from Outside Local Area"	48
Outside Local Area	47
	95
Annualization Factor	260
Daily Truck Trips / Well	0.366

***Table 24:** Well Construction and Maintenance (Support) Person Trips*

	Work	Non-Work
Construction Person Trips per 100 New Wells		
Oil and Natural Gas Well	11.5	2.31
Maintenance Person Trips per Active 100 Wells		
Oil Well	2.0	0.67
Natural Gas Well	1.0	0.35

Crude oil is produced by both oil and gas wells. Based on existing oil and gas well production data, one barrel (bbl) of oil is produced by a gas well for every 11.4 bbl of oil produced at crude oil wells. This means eight percent of total oil production in the Uinta Basin is coming from gas wells. Based on this existing trend, the freight model was updated so that eight percent of crude oil production comes from gas wells and the remaining 92 percent comes from oil source materials, including oil wells, oil sands, and oil shale.

The model was updated to account for support truck trips needed to develop new wells. Based on the UBET Study and its supporting research, an estimated 1,009 trips are needed to support development activities for new wells. As shown in Table 23, these truck trips were categorized as on-site or near-site material supply trips and those located outside the local area. The study assumed that on-site material movement would be internal to the TAZ and would not travel on the broader transportation network. Trucks originating from outside the local area were assumed to travel on the broader transportation network.

The study also assumed that a fraction of the on-site truck trips would travel to the site from outside the local area. This fraction of on-site truck trips represents initial movement of vehicles to/from the site, movement of vehicles between non-local sites, and replacement of vehicles. For this study, five percent of the on-site trips were assumed to come from outside the local area. Annual trips were converted to daily trips by dividing by the freight model's annualization factor of 260. This annualization factor represents five working days per week, excluding holidays. The resultant average daily well-support truck trip rate was then applied to the number of new crude oil and natural gas wells.

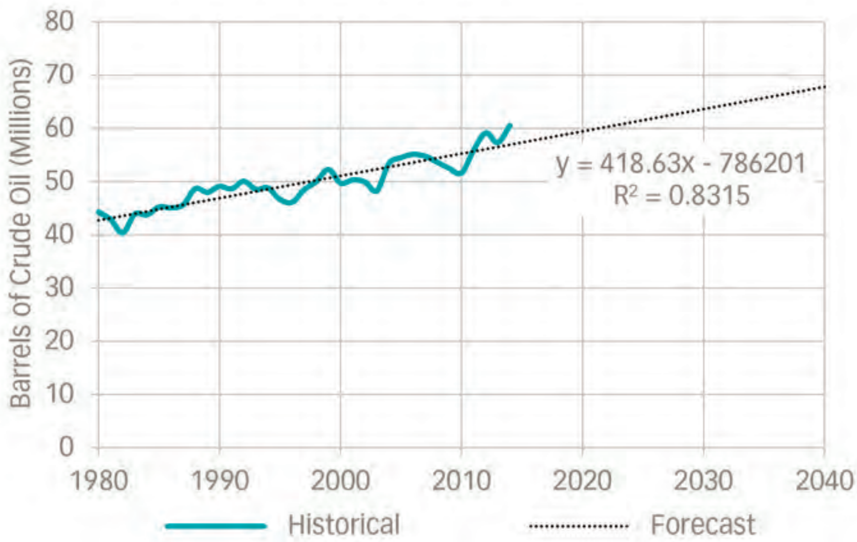
In addition to support truck trips needed to construct wells, additional person trips are needed to support the construction and maintenance of wells. The USTM was therefore also modified to account for these person support trips. Table 24 presents the estimate of work and non-work related person trips needed to support well construction and maintenance. Construction trips were based on the number of new wells. Maintenance trips were estimated based on the number of total active wells. The model estimated the number of support trips based on the person trip rates defined in Table 24.

Oil Refining (Destination) Components

As mentioned earlier, the USTM includes a model component that forecasts the movement of goods internally and externally to Utah. This model component required estimates of the proportion of energy products transported to oil refineries internal and external to Utah. To estimate how much of the forecasted crude oil production might remain in the state, the study considered historical receipts of crude oil by Utah refineries. A review of historical crude oil receipts by Utah refineries indicated a near linear increase from 1980 to 2014. Figure 37 shows this historical trend and extrapolates it to estimate the potential future capacity of Utah refineries.

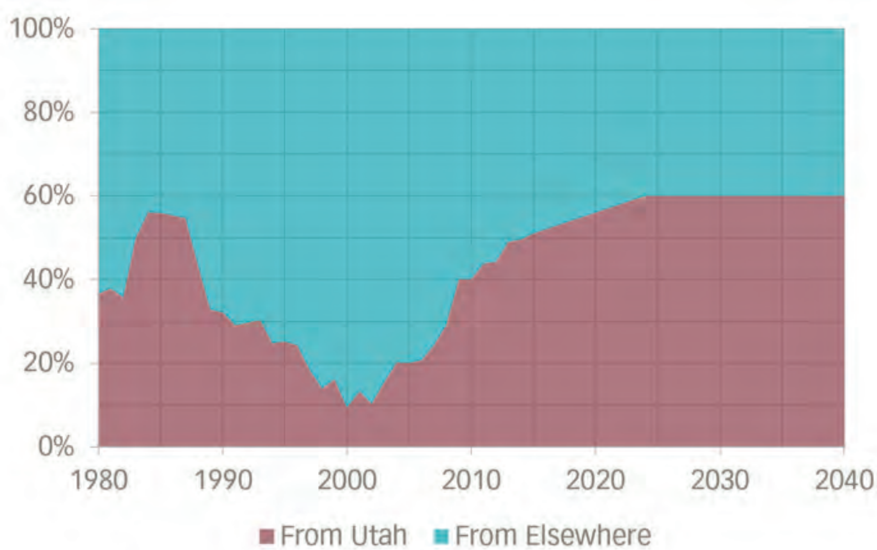
The historical data showed that about half of the Utah refinery crude oil receipts came from Utah oil wells. As shown in Figure 38, the historical share of Utah produced oil varied significantly from 1980 to 2014 with as little as nine percent and as much as 56 percent of crude oil receipts by Utah refineries. The data suggest that contributions from Utah wells will increase when Utah wells

Figure 37: *Receipts of Crude Oil for Utah Refineries*



Source: Utah Geological Survey.

Figure 38: *Source-Share of Utah Oil Refinery Receipts*

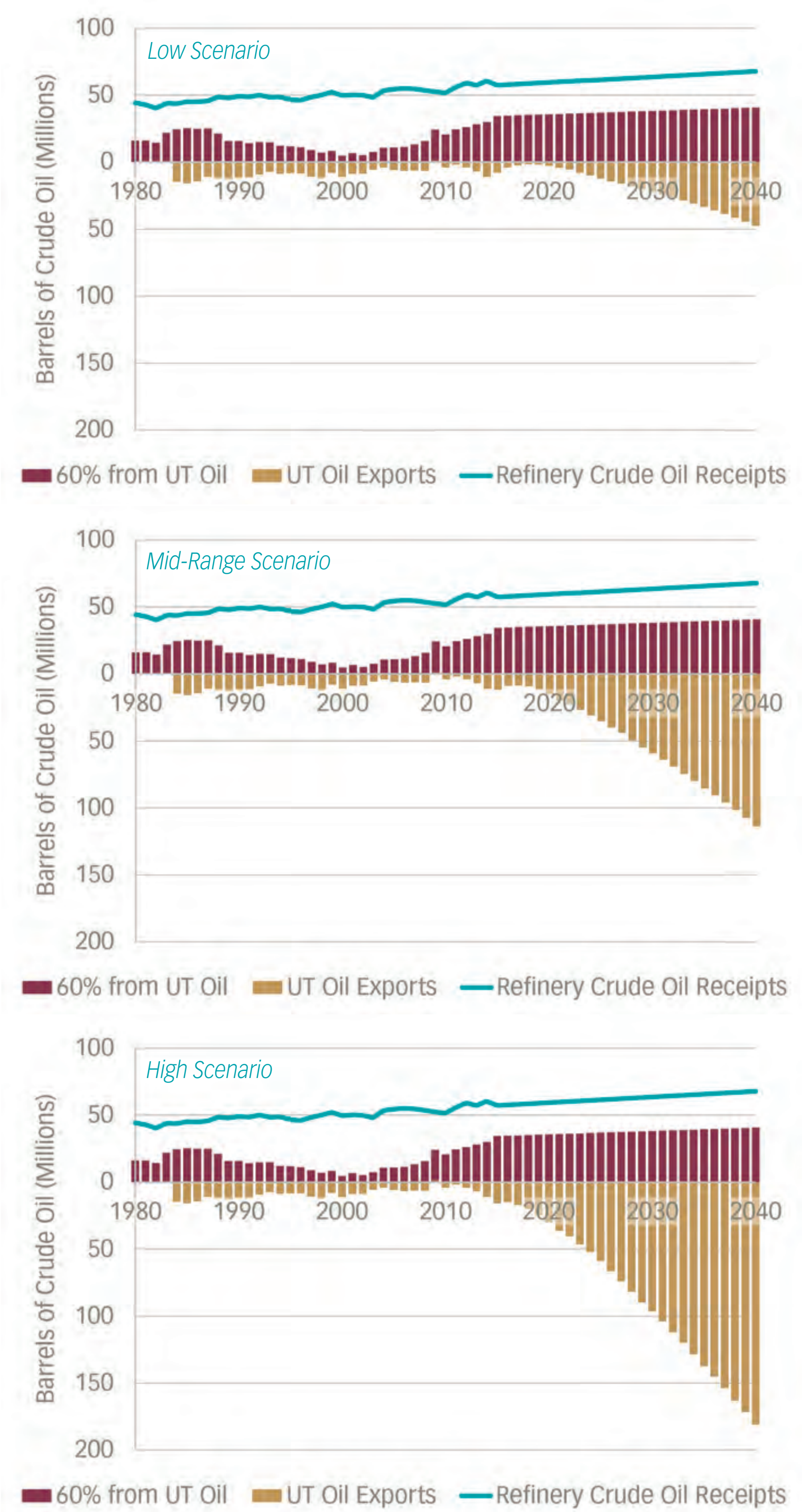


Source: Utah Geological Survey.

produce more and decline when Utah wells produce less. However, the data also suggest that a significant share of future crude oil receipts might be produced outside of Utah. This study therefore assumed that as production by Utah wells increases, Utah refineries would receive up to 60 percent of their oil from Utah wells. The remaining receipts would be produced outside of Utah.

In addition to historical data, Figure 38 presents the forecasted share of Utah produced oil receipts through 2040. Any excess crude oil produced in Utah and not processed by Utah refineries was assumed to be shipped outside of Utah as an export. Figure 39 illustrates the amount of oil from Utah wells forecasted to be transported to Utah refineries (red bars) and exported outside of Utah (orange bars) under the low, mid-range, and high production scenarios. Figure

Figure 39: *Forecasted Distribution of Utah Produced Oil*



39 incorporates the forecasted refining capacity and source assumptions presented in Figure 37 and Figure 38.

Although the oil receipts for the five existing refineries in the Salt Lake City area have steadily grown for the past three decades, there are several constraints to continued growth. For example, urbanization trends and air quality concerns for the region surrounding these refineries make significant capacity growth unlikely. Because new refineries have not been permitted and constructed in the U.S. for well over three decades, adding capacity through new refineries is also unlikely.

A refinery is currently being considered near Green River, Utah. This refinery would process approximately 15,000 barrels of oil per day, representing a modest six percent increase in statewide refining capacity. The Green River refinery is not expected to process Uinta Basin waxy oil, but rather import oil products from outside the state. Because of its potential development, the Green River refinery was added to the USTM. However, because of the uncertainty of its development and its product source, the refinery was added to the USTM in a way that would reflect either transporting these 15,000 barrels of oil per day to a Green River refinery (for a six percent increase in statewide refining capacity) or exporting this oil outside of the state along the I-70 corridor.

The forecasts for refining capacity and the source-share assumptions presented above were cross-checked with constraints for expanding refining capacity in Utah and found to be consistent. Although the overall refining capacity forecasted might not follow past trends, the Utah-based products assigned to Utah refineries fall well below overall refining capacity levels for Utah refineries. If refining capacity for Utah refineries remains stagnant or declines, it could accommodate forecasts by increasing the share of Utah-produced oil to more than 60 percent.

Network and Mode Components

To estimate the travel impacts of the improved study corridor, the study compared USTM results for the baseline (no build) and build scenarios. The baseline scenarios assumed the existing transportation network, while the build scenarios assumed an improved study corridor. For the baseline scenarios, the USTM transportation network was updated to include the improved Seep Ridge Road connection to the Uintah and Grand county line. For the build scenarios, the transportation network was updated to include the improved study corridor connection from Seep Ridge Road to I-70. TAZ centroid connectors were also added to connect zones to the improved study corridor. Because the travel demand model results for Hay Canyon and East Canyon route alternatives were shown to be in effect equal, the results of the analysis are reported for the East Canyon route.

The USTM mode choices were estimated ‘off-model’ and added as static inputs. Mode choices were based on existing transportation trends for oil and gas. Oil transported from Utah oil wells to Utah refineries was assumed to move by truck. Imports of oil from outside of Utah to Utah refineries were assumed to move by pipeline. In terms of the USTM, this means imported oil would not directly impact or be directly impacted by the improved study corridor. Crude oil exports from Utah oil wells to refineries outside of Utah were assumed to move by truck to a transloading facility and via railway (or other modes) from there. Transloading facilities were assumed to be located in the Ogden, Salt Lake City, Helper and Cisco areas. Natural gas was assumed to move by pipeline.

Incremental Travel Impacts

Baseline (no-build) and build scenarios were modeled primarily for existing year conditions and future year 2040 forecasts. However, interim model runs for future years 2024 and 2034 were also completed to better understand patterns between current and 2040 conditions. Model results show that the improved study corridor affects a decrease in both vehicle miles traveled (VMT) and vehicle hours traveled (VHT) for the state as a whole. By 2040 most of the reduction in VMT and VHT comes from transportation related crude oil production.

Figure 40 presents the statewide (model wide) reductions in VMT and VHT resulting from improvements to the study corridor. The reduction in both VMT and VHT demonstrate that on a statewide level, the improved study corridor improves transportation efficiency. Although a similar or slightly higher number of trips are made for build scenario, they represent average durations and distances that are shorter than trips for the no-build scenario.

The results for Duchesne and Grand counties show that VMT and VHT decreases or remains about the same, while the results for Uintah county show that VMT and VHT stay the same or increase slightly. Figure 41 graphically illustrates the regional VMT impacts of the improved study corridor. As shown, travel on the study corridor is expected to increase, while travel on alternate routes (Indian Canyon and Douglass Pass) is expected to decrease. By 2040, the improved study corridor would attract about 2,700 daily trips. This traffic represents trips that have switched from other routes to take advantage of the increased efficiencies provided by the new corridor. The USTM results do not show increased energy related traffic for the Moab area.

Figure 40: *Statewide Daily VMT and VHT Reductions, 2040 Mid-Range Scenario*

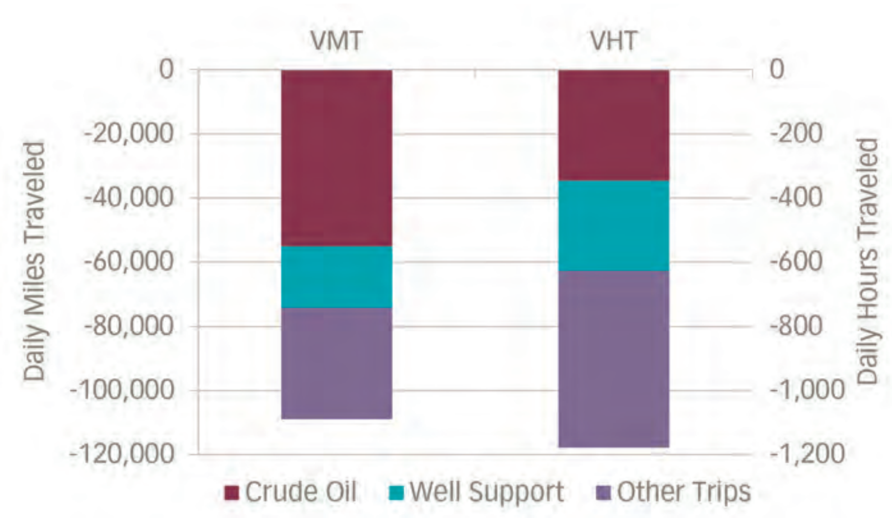


Figure 41: *Changes in Traffic Volume, 2040 Mid-Range Scenario*

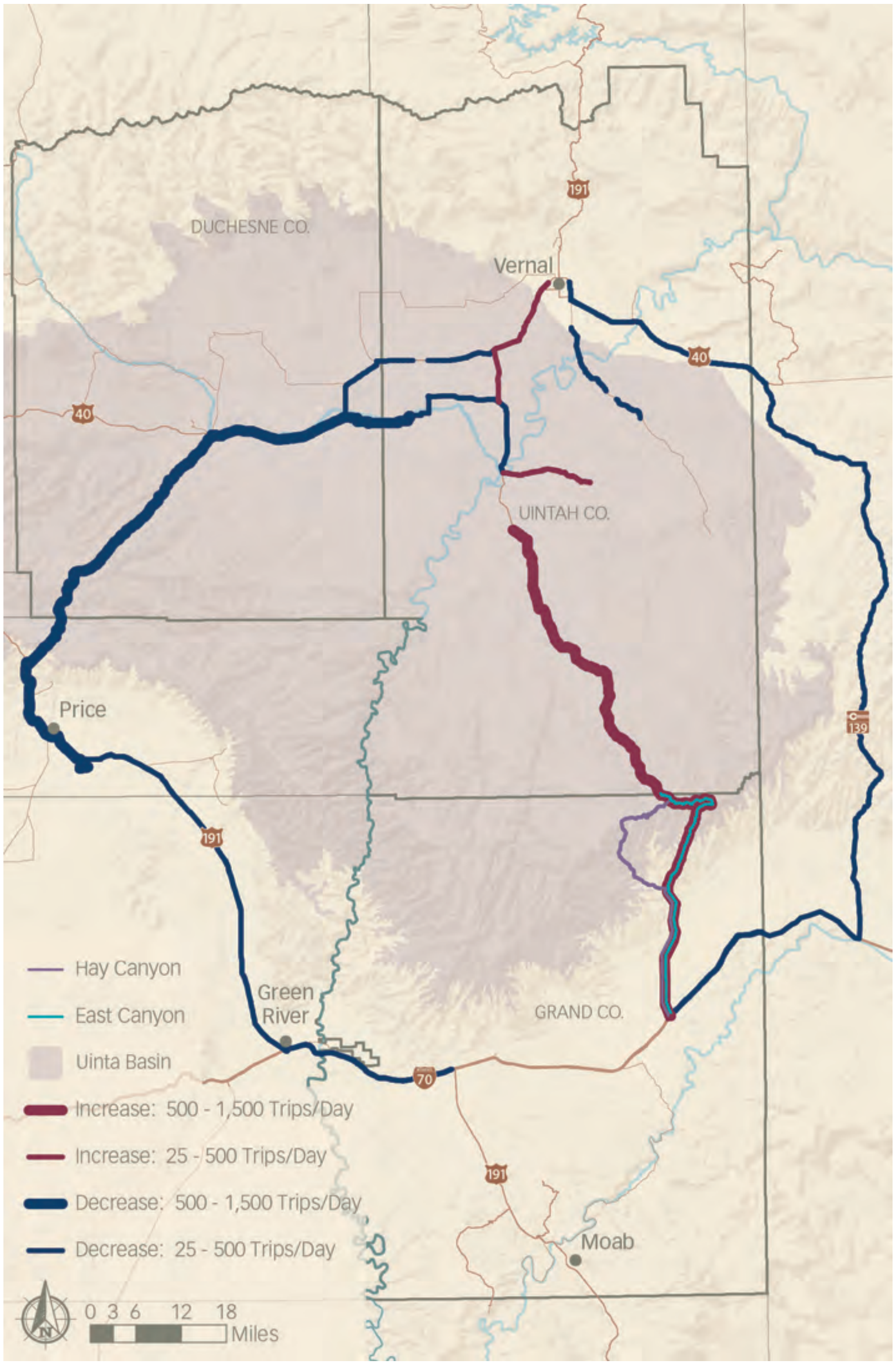
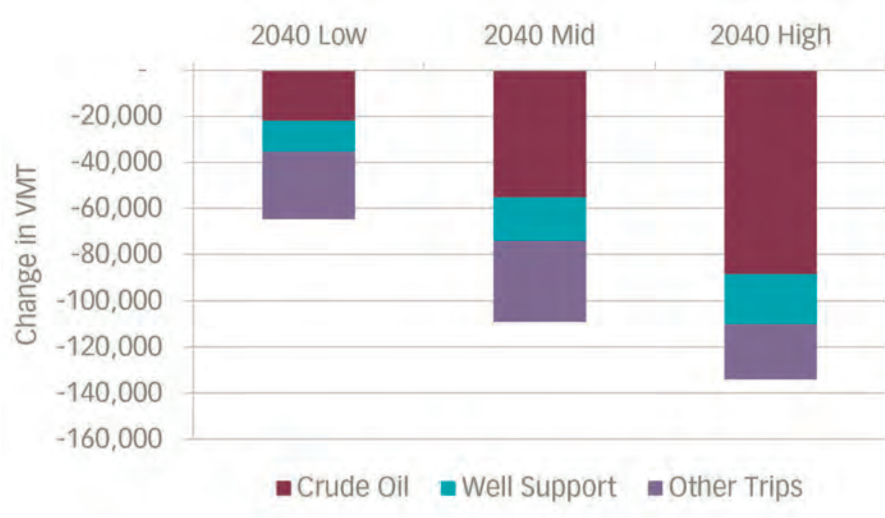


Figure 42 illustrates the relative impacts of the low, mid-range, and high energy production scenarios. As shown, the mid-range scenario predicts a statewide decrease in VMT of about 109,000 vehicle miles per day for 2040. The low scenario predicts a decrease of about 60,000 vehicle miles per day, while the high scenario predicts a decrease of about 140,000 vehicle miles per day. All three scenarios show an improvement in transportation system efficiency.

Figure 42: *Comparison of 2040 Daily Statewide VMT Reductions*



4.3. Incremental Energy Impacts

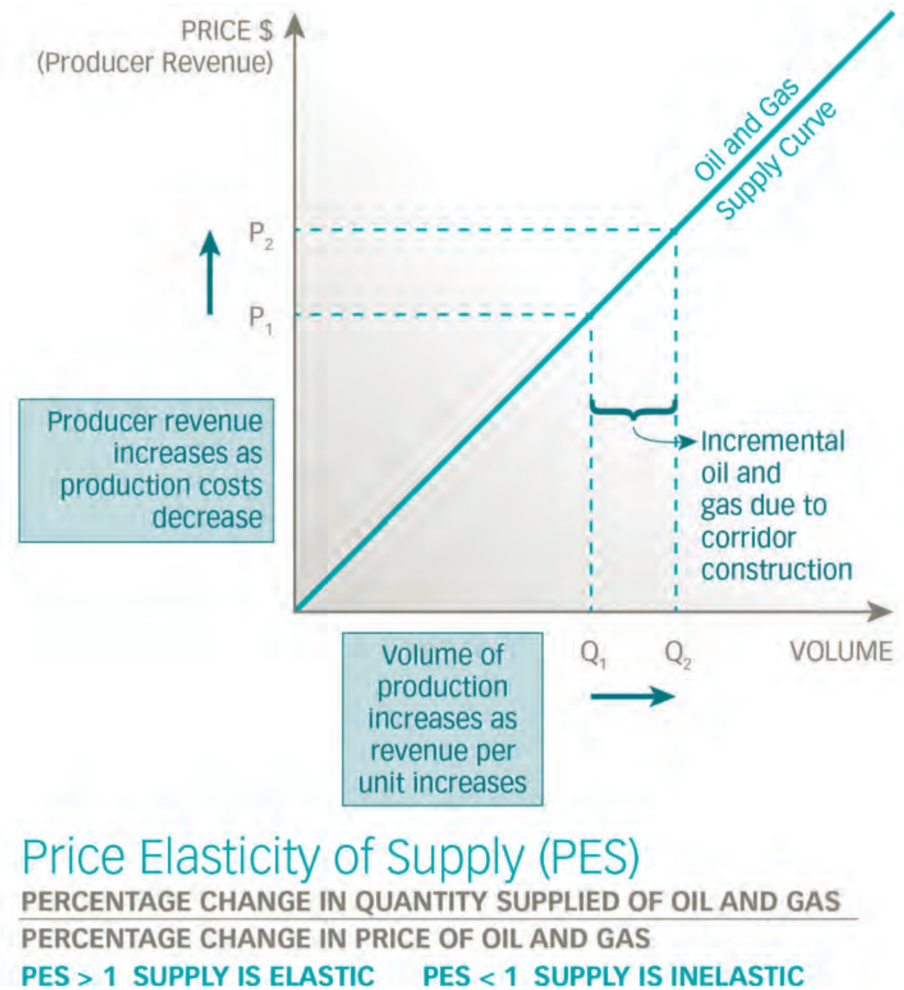
This section describes the method applied to estimate the impact of the improved study corridor on energy production in the Uinta Basin. The improved study corridor would improve accessibility for shipping materials to develop and maintain energy production. The improved study corridor would also improve accessibility for shipping crude oil to the five Salt Lake refineries and to rail connections to markets outside Utah. The improved accessibility, which includes reduced travel time and reduced travel distance, would reduce the overall crude oil production cost which would in turn incentivize oil companies operating in the region to produce more.

Economic Theory Overview

As the revenues generated from the sale of goods increase and other variables hold constant, the supply for these goods increase. In the case of the study corridor, revenues increase because less is being spent on shipping costs to transport energy materials to market. Because of the increased revenue, the supply or production of crude energy materials would increase. As such, the forecasted changes in transportation costs can be used to estimate the change in energy production. The theory applied to estimate incremental energy production growth caused by the improved study corridor is illustrated by the upward-sloping supply curve of. An underlying assumption is that any incremental energy production from the Uinta Basin would be able to be absorbed by the market. In other words, market demand in the U.S. is large enough to accept the additional production from the Uinta Basin.

The volume Q_1 in Figure 43 represents the current volume of production in the Uinta Basin. The producer revenue P_1 represents the revenue generated from every unit of energy (barrel of oil) produced. The producer revenue P_2 represents the increase in revenue because of a reduction in transportation costs to ship the product to market. The reduction in transportation cost is caused by a reduction in VMT for trucks shipping materials to the Uinta Basin and shipping crude oil to market. The shift in producer revenue from P_1 to P_2 will lead to an

Figure 43: *Oil Production Impact of Change in Producer Revenue*



increase in the volume of production from Q_1 to Q_2. An increase in volume from Q_1 to Q_2 is called the incremental production and is estimated by assessing the transportation cost elasticity of supply from oil and gas production which is detailed below.

Production Cost Elasticity of Supply

The price (producer revenue) elasticity of supply for oil production defines the relationship between the changes to the price and changes to the volume of oil production. In other words, the percentage change in the volume supplied resulting from a one percent increase in the revenue remitted to producers. Elasticity is defined by Equation 1 (repeated here for convenience).

Equation 1: *Price Elasticity*

$$\text{Elasticity}_{Q/P} = \frac{Q_2 - Q_1}{P_2 - P_1} \times \frac{P_1}{Q_1}$$

The elasticity is a unit-free measure. The sign of the price elasticity is expected to be positive as improving access and connectivity would increase the volume of production. The elasticity value was taken from research developed by the

International Monetary Fund.[16] According to the authors, the elasticity of supply for oil production caused by changes in transportation costs is 0.23 as shown in Equation 7.

Equation 7: *Price Elasticity of Supply for Oil and Gas Production*

$$\textbf{Elasticity}_{Q/P} = \textbf{0.23}$$

This elasticity can be interpreted to mean that for a one percent increase in revenue to producers, the expected volume of oil production increases by 0.23 percent.

Incremental Energy Production

Energy production forecasts were presented in Section 4.1. The study assumed that the development of new oil wells, which is a component of the total oil forecast, would benefit from a reduction in shipping materials for well development. The study also assumed that because of the reduced transportation costs, the volume of oil production would also benefit from the study corridor improvements. As a result, the total production volume Q_1 was assessed to generate incremental energy production. Because natural gas was assumed to be transported by pipeline, the highway network improvements for the study corridor provide limited benefits to natural gas. As such, incremental energy production impacts focus on induced production for crude oil.

The increase in production revenue was assumed to be equal to the reduction in production cost caused by reductions in VMT. The changes in VMT between the baseline (no-build) and build scenarios were presented in Section 4.2. The 2040 VMT reductions previously illustrated in Figure 42 are presented in tabular format in Table 25. This table categorizes forecasted VMT changes by reductions in crude oil truck trips, well support, and other trips. For the purpose of the elasticity model, this study assumed that well support trips are generated by development of new wells, while the crude oil trips are generated by shipments of oil to refineries.

As previously mentioned, the daily VMT reduction factors were annualized using a factor of 260. The change in production price caused by the reduction in VMT was monetized using a shipping rate of $1.72 per mile. This shipping rate was developed by the American Transportation Research Institute (ATRI) and updated to real 2015 dollars.[17]

Table 25: *Daily VMT Reductions, 2040*

Scenario	Crude Oil Trips	Well Support Trips	Other Trips	Total Volume Change
2040 Low	-21,993	-13,355	-29,259	-64,608
2040 Mid	-55,147	-18,911	-34,874	-108,933
2040 High	-88,266	-21,661	-24,011	-133,938

16 IMF Working Paper. A Simultaneous Equation Model for World Crude Oil and Natural Gas Markets. February 2005.

17 ATRI. An Analysis of the Operational Costs of Trucking: A 2014 Update.

Decrease in production costs were estimated to be relative to oil price. The study assumed that new incremental production would be produced by the marginal producer. In other words, the cost to produce would decline enough to incentivize producers who are currently not producing because their costs exceed the market rate they would receive. As a result, the change in production price (P_2 – P_1) was assumed to be relative to the market price for oil price at West Texas Intermediate (WTI) prices.

The decrease in production cost for new barrels of oil produced was calculated to vary between 1.20 percent in 2021 to 2.16 percent in 2040. The decrease in production cost for transporting oil was calculated to vary between 1.38 percent in 2021 to 0.55 percent in 2040. Total incremental oil production caused by the decrease in production cost (increase in producer revenue) is shown in Table 26 for the low, mid-range and high production scenarios.

As previously stated, the study assumed that incremental oil production will be produced by the marginal producer whose total production cost is equivalent to the market rate of oil. This is a simplifying assumption applied because of the lack of production cost information available for the Uinta Basin. Therefore, total incremental spending on oil production has been calculated to be the WTI market rate multiplied by the total incremental oil production value. Total incremental spending on oil production is shown in Table 27. This incremental spending on oil production by year is an input to the economic impact analysis model as described in the section that follows.

Table 26: *Incremental Oil Production, 2021-2040*

Scenario	Incremental Oil Production (MMBO)
Low	0.56
Mid	1.12
High	1.61

Table 27: *Incremental Oil Production Spending, 2021-2040 (2015 $ millions)*

Scenario	Incremental Spending
Low	$47.6
Mid	$95.1
High	$137.8

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// SECTION FIVE

Economic Impact

5

The construction of a paved roadway along the study corridor would enable travel savings and create opportunities for new, incremental economic activity. In addition to economic impacts generated from the roadway construction, the study evaluated corridor-related economic impacts to tourism and energy industries. These industries represent predominant industry activities currently occurring in the study area. The travel savings of the improved study corridor would create opportunities for new, incremental economic activity. In addition to the incremental spending that would occur in these industries, wider economic impacts would be generated in eastern Utah and the rest of the state.

The incremental spending would in turn impact other industry sectors through economic multiplier effects. The study considered economics impacts to Grand, Duchesne, and Uintah counties, as well as general impacts to the rest of the State of Utah. The economic multiplier effects are expressed as direct, indirect, and induced effects. Direct impacts refer to the initial economic activity resulting from direct expenditures of that industry, indirect impacts gauge business spending that is generated throughout the supply chain of the industry, and induced impacts are associated with increased labor income that accrue either directly or indirectly from the industry spending. Full descriptions of direct impacts and multiplier effects are summarized in Table 28.

Table 28: *Description of Impact Multipliers*

Direct Effects	Direct effects are the economic impacts which result from immediate activities directly associated with incremental spending within each identified industry (defined in Table 31).
Indirect Effects	Indirect effects are the impact of local industries buying goods and services from other local industries. The cycle of spending works its way backward through the supply chain until all money leaks from the local economy, either through imports or by payments to GDP.
Induced Effects	Induced effects are the response by an economy to an initial change (direct effect) that occurs through re-spending of income received by a component of value added. Labor income (employee compensation and proprietor income components of value added) is not a leakage to the regional economy. This money is recirculated through the household spending patterns causing further local economic activity.

In describing the economic impact, the aggregate of direct, indirect, and induced impacts provide a total measure for economic impact estimates. The economic impacts assessed in this study caused by the incremental industry spending are estimated in terms of jobs, labor income, output, and gross domestic product (GDP). A description of each economic impact is summarized in Table 29.

Table 29: *Description of Economic Impacts*

Jobs	Jobs represent the total employment impact created as a result of industry incremental spending. Jobs are defined as the annual average of monthly jobs in that industry. Therefore one job lasting 12 months is equivalent to two jobs lasting 6 months each. A job can be either full-time or part-time.
Labor Income	Labor income represents all forms of employment income, including Employee Compensation (wages and benefits) and Proprietor Income.
GDP	GDP refers to the difference between an industry's total output and the cost of its intermediate inputs. It equals gross output (sales or receipts and other operating income, plus inventory change) minus intermediate inputs (consumption of goods and services purchased from other industries or imported). GDP consists of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.
Output	Output represents the value of industry production. IMPLAN uses annual production estimates for the year of the data set and are in producer prices.

5.1. Economic Impact Analysis Methodology

Input-output modeling was completed to estimate the wider economic impacts from industry spending resulting from the study corridor improvement. An input-output model can be used to explain how one sector or industry can affect others in the same region, state, or nation. Input-output models provide multipliers which can be used to estimate the economy-wide effects sector and industry activity will have on a regional economy. These models are generally used to simulate the economic impact of an expenditure on a given basket of goods and services or the output of one of several industries. Input-output analysis is based on information about the flow of goods and services among various sectors of the economy. It allows for the calculation of relationships between various aspects of a given economy, including production, consumption, and all inter-industry relationships associated with the factors of production (labor and capital) and consumption (wages and income).

IMPLAN input-output (I-O) modeling software[18] was used to estimate the total economic and fiscal impacts expected from the study corridor improvements. IMPLAN generates industry multiplier effects based on industry profiles of the study area at the county and state level for 536 sectors. These multipliers represent the inter-industry relationship within the study area and capture the

18 IMPLAN Version 3 by IMPLAN Group LLC.

relationship between industry output and calculated effects on output, labor income, jobs, and value-added (i.e., GDP).

The IMPLAN system provides the ability to run a multi-regional input-output analysis (MRIO). A MRIO model shows the effect of an event in one area and examines how the impact affects other regions as well. MRIO analysis allows a larger study area to be defined to capture "leaked" impacts, while maintaining the specificity and individual identities of local economic relationships of a smaller area where the direct impacts occurs. For example, MRIO accounts for labor income that occurs from the change (e.g., study corridor improvement) paid to employees that live outside of the study area but commute into the study area for work. Single region I-O models are not able to capture leaked impacts, which minimize the indirect and induced effects. A MRIO analysis shows a more complete understanding of total economic impacts because it is able to account for leaked impacts. A MRIO analysis provides the most inclusive, comprehensive and complete economic picture by capturing feedback effects that occur for a region.

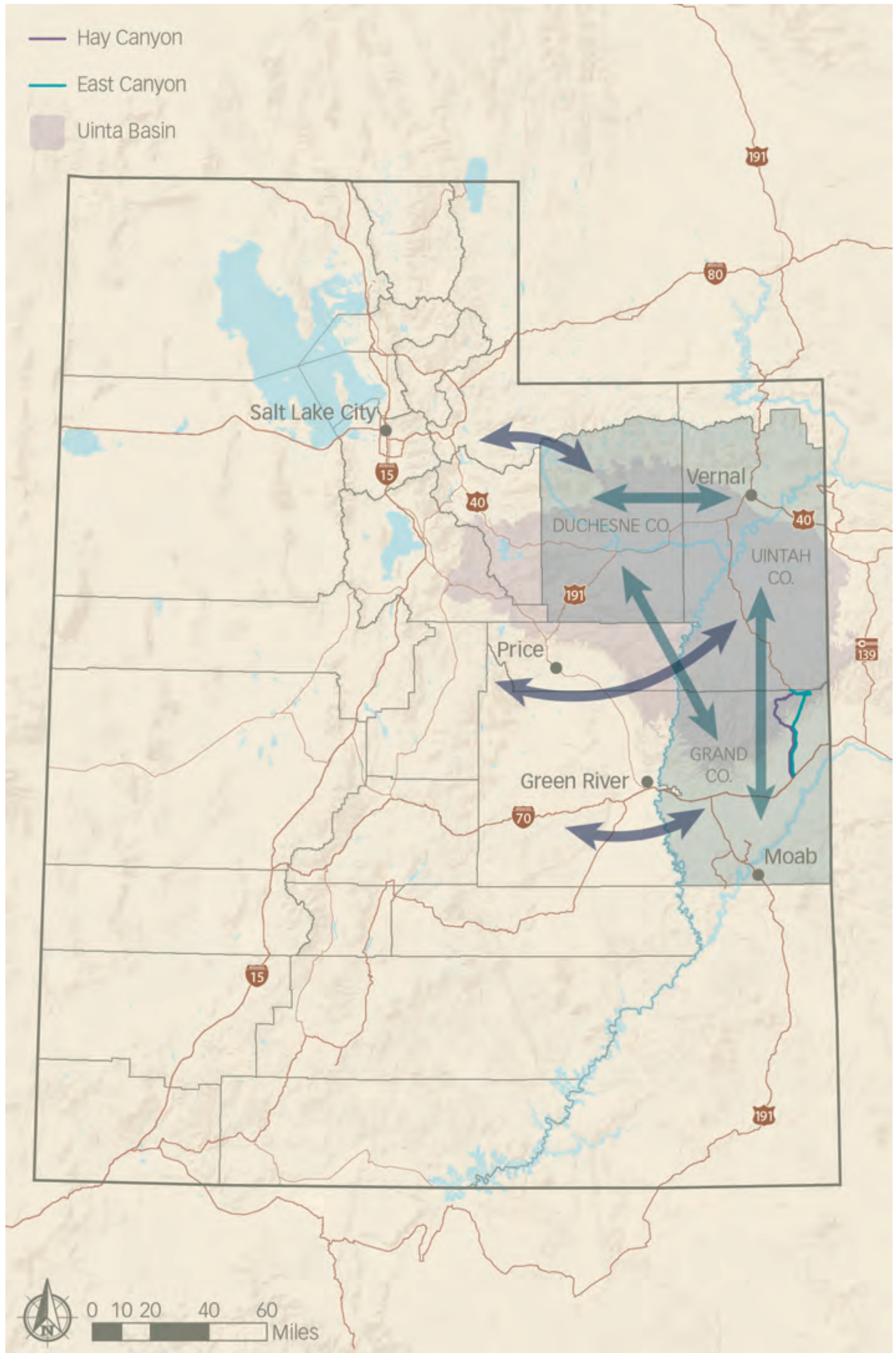
For the purposes of setting up the MRIO model, the State of Utah was divided into four separate regions based on the geographic specificities of each industry (see Figure 44). Various MRIO analyses were completed based on the incremental spending experienced in each region caused by the corridor improvement. Table 30 summarizes the regional grouping of counties and the industries for which incremental spending was estimated. County data for these industries were obtained from IMPLAN for 2013, the most recent year available for this study.

IMPLAN's MRIO analysis was then used to estimate the impacts caused by increased spending in the four regions according to the industries affected. IMPLAN's industry sectors largely equate to industries defined by the North American Industry Classification System (NAICS). Table 31 lists the IMPLAN sectors used in the MRIO model for each of the industries and the NAICS equivalent. All input prices, costs, and impacts shown in the economic impact analysis are in 2015 dollars.

Table 30: *Study Area's Defined Regions and Industries*

Region	Industries
Grand County	Tourism Oil and Gas Production Highway Engineering and Design Construction (Capital and Operating)
Duchesne County	Tourism Oil and Gas Production Highway Engineering and Design Construction (Capital)
Uintah County	Tourism Oil and Gas Production Highway Engineering and Design Construction (Capital)
Rest of Utah (all other Utah counties except for those above)	Tourism Highway Engineering and Design Construction (Capital)

Figure 44: *Economic Relationships Captured by the MRIO Models*



The economic impact outcomes presented in the following sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty. The results presented in this document focus on mid-range forecast assumptions. A sensitivity analysis was conducted to test the robustness of the estimated economic impact against different variations of the model inputs. The sensitivity analysis for low and high range variable scenarios are summarized in Section 5.8.

Table 31: *Sector Descriptions*

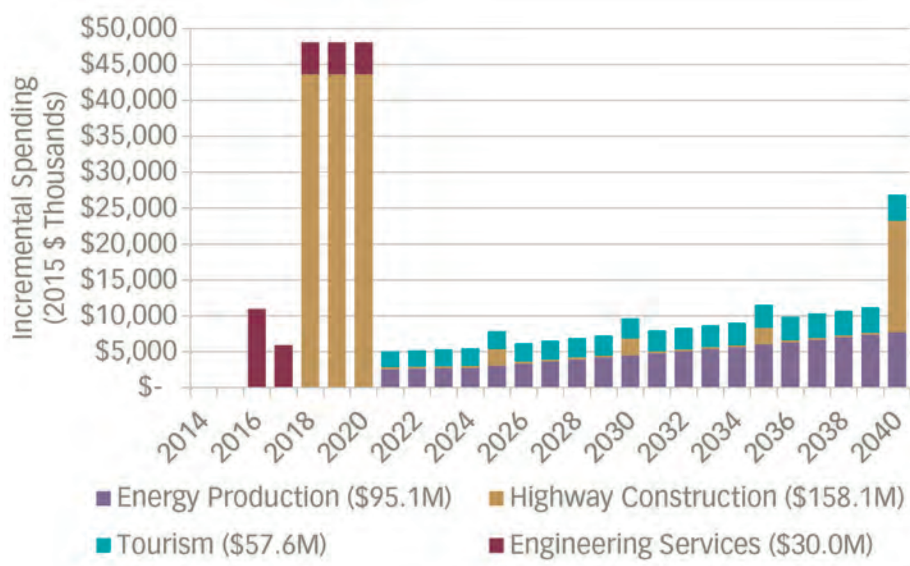
IMPLAN Sector	Description	Equivalent NAICS Code
Tourism		
402	Retail - Gasoline Stores	447
406	Retail - Miscellaneous Store Retailers	453
412	Transit and Ground Passenger Transportation	485
496	Other Amusement and Recreation Industries	71391-3, 71399
499	Hotels and Motels, Including Casino Hotels	72111-2
500	Other Accommodations	72119, 7212-3
501	Full-service Restaurants	722511
502	Limited-service Restaurants	722513
Oil and Gas Production		
20	Extraction of Natural Gas and Crude Petroleum	211111
Highway Engineering and Design		
449	Architectural, Engineering, and Related Services	5413
Construction (Capital Expenditure)		
56	Construction of New Highways and Streets	23
Construction (Operating Expenditure)		
64	Maintenance and Repair Construction of Highways, Streets, Bridges, and Tunnels	23

5.2. Economic Impact Analysis Inputs

Enhanced transportation infrastructure, including new and improved roadways, can foster increased economic activity. The roadway construction and travel savings of the improved study corridor would create opportunities for new, incremental economic activity. The increased industry spending for highway construction, tourism, and energy production are derived from calculations described in Sections 5.4, 5.5, and 5.6, respectively.

Figure 45 provides the cash flow of incremental industry spending. This incremental spending provided the inputs into the MRIO models to estimate the total economic impact of the study corridor. The spike in spending in 2040 is due to the anticipated roadway maintenance activities at the end of its 20-year life.

Figure 45: *Cash Flow of Incremental Industry Spending (2015 $ thousands)*



5.3. Economic Impact Analysis Results

The cumulative economic impacts derived from the incremental economic activity for tourism and recreation, energy production, and roadway construction industries is estimated to be $280.8 million in GDP and $557.3 million in total output through the year 2040 (see Table 32). This potential incremental activity includes direct, indirect, and induced economic activity resulting from the construction of a paved roadway along the study corridor. The impacts for each industry occur at different proportions among Grand, Duchesne, and Uintah counties.

Figure 46 summarizes the GDP impact breakdown by county and industry. Approximately 39 percent ($108.4 million) of the impacts occur in Uintah County, 23 percent ($65.0 million) in Grand County, 5 percent ($14.0 million) in Duchesne County, and 33 percent ($93.5 million) in the rest of Utah. Figure 47 presents the breakdown of GDP impacts by industry and Figure 48 further breaks down the impacts by year.

Table 32: *Cumulative Impacts of Total Industry Spending (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	1,759	$98,475	$163,436	$331,569
Indirect Effect	713	$36,118	$67,308	$136,007
Induced Effect	661	$24,970	$50,052	$89,683
Total Effect	3,133	$159,563	$280,795	$557,259

Note: All dollar amounts expressed in 2015 dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up due to rounding.

***Figure 46:** Breakdown of Economic Impacts by Region and Industry (GDP)*

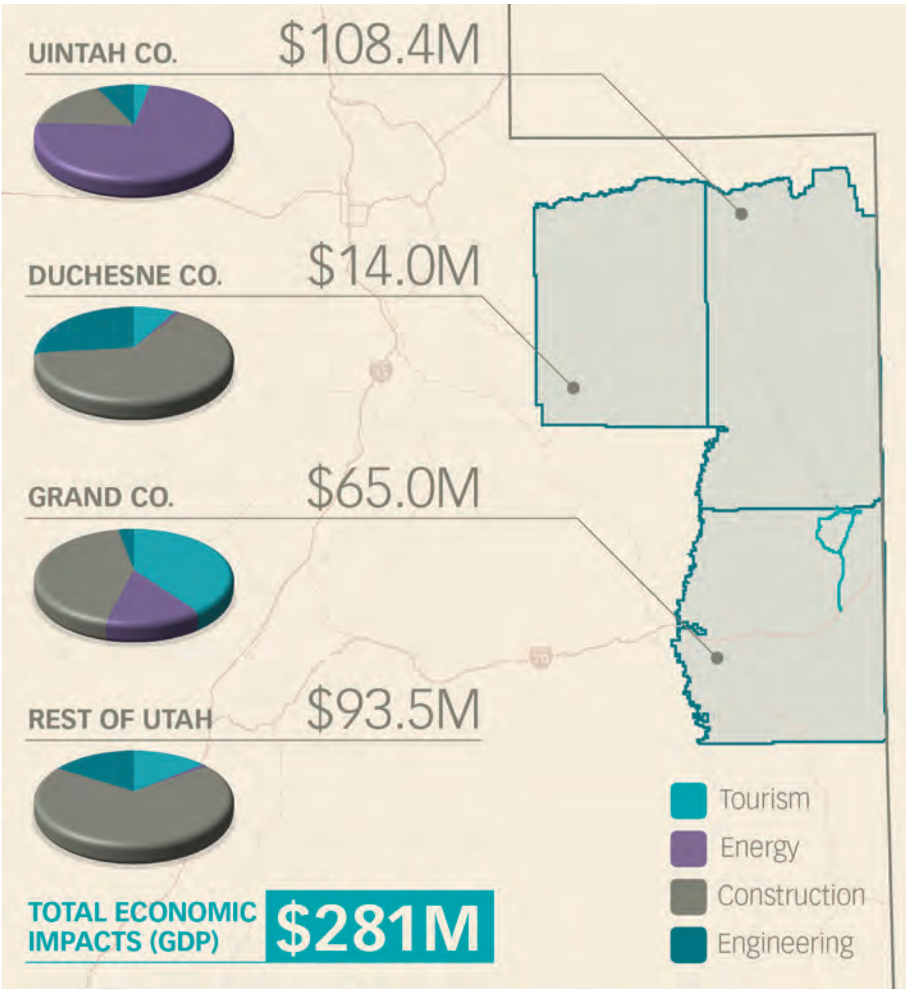


***Figure 47:** Industry Breakdown of Total Economic Impacts*

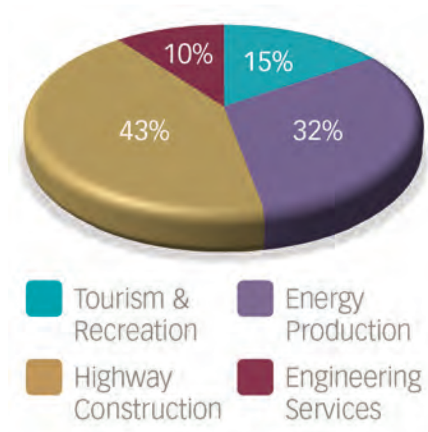
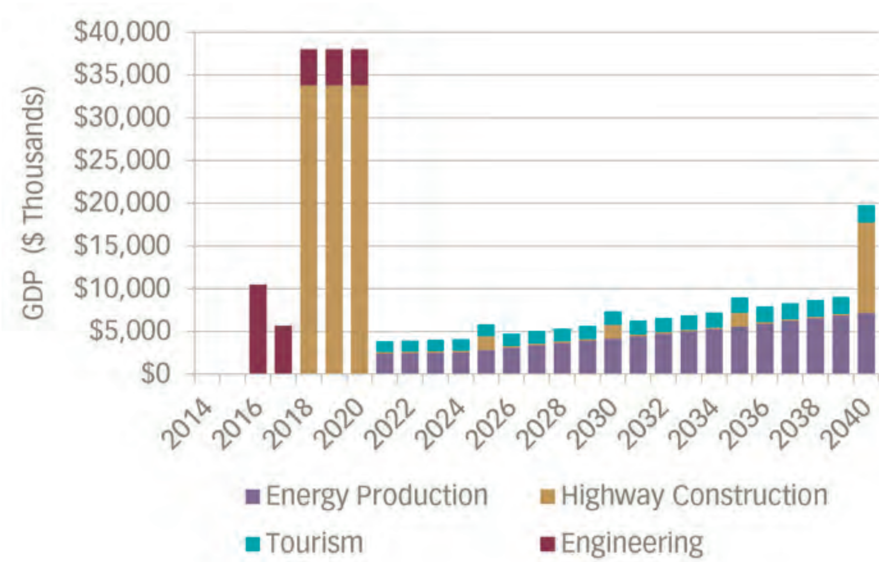


***Figure 48:** Annual Industry Breakdown of Total Economic Impacts (2015 $ thousands)*



The economic impacts estimate industry activity through 2040, which assumes completion of the study corridor improvements by the end of 2020 followed by 20 years of highway operation from 2021 to 2040.

The economic impact analysis results are further broken down for highway construction and operations, tourism, and energy industries in Sections 5.4, 5.5, and 5.6, respectively.

5.4. Highway Construction and Operations Impacts

The construction and operations/maintenance activities required for the improved study corridor would spur economic impacts to the State of Utah through the duration of construction and highway operations and maintenance. Table 33 summarizes the cost comparison for the study corridor route alternatives. The Hay Canyon and East Canyon alternatives are similar in both construction and operations costs. Because of the similar cost estimates of the two corridors, economic impacts were estimated for only one route alternative. The economic impacts for highway construction and operations are based on the study route alternative for East Canyon. The East Canyon route alternative was selected to provide a more conservative (i.e., slightly lower) economic impact. However, the impacts of the Hay Canyon route alternative are expected to be very similar to those of East Canyon. Furthermore, the construction and maintenance costs for Hay Canyon fit well within the sensitivity parameters analyzed in Section 5.8.

Construction and maintenance activities would create incremental spending in the industries associated with the construction of the corridor. The cumulative impacts for the total engineering, construction, and operations spending are summarized in Table 34.

Table 33: *Construction and Maintenance Cost Estimates (2015 $ thousands)*

	Hay Canyon	East Canyon
Design Engineering	$16,948	$16,847
Construction and ROW	$132,772	$131,632
Construction Engineering	$13,277	$13,163
Total Construction Cost	$162,998	$161,643
Maintenance (20 years)	$27,560	$27,057

Table 34: *Cumulative Impacts of Total Highway Spending (2015 $ thousands)*

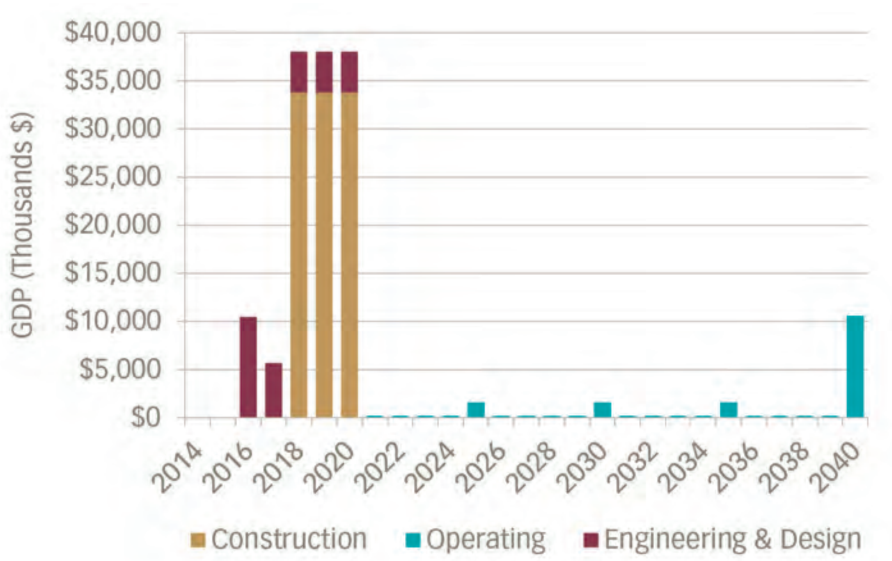
Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	932	$60,296	$67,921	$188,088
Indirect Effect	514	$25,313	$46,837	$98,954
Induced Effect	451	$17,317	$33,878	$60,977
Total Effect	1,897	$102,926	$148,636	$348,019

Note: All dollar amounts expressed in 2015 dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

Economic impacts fluctuate throughout the study period. Figure 49 provides the cumulative year over year GDP impact of all highway construction and operations/maintenance spending through the year 2040. Highway engineering and design impacts would only occur from project initiation through construction of the highway. The construction period and capital expenditures were assumed to last for three years from 2018 to 2020. Highway operations expenditures for the improved study corridor were assumed to start after initial construction concludes in 2020, and were forecasted for 20 years to the end of the study period. Minor rehabilitation is estimated for every five years with major rehabilitation expected after 20 years when the highway reaches the end of its service life (see Section 2.4 for more details).

In addition to the industries for construction, operations, and engineering services, other sectors of the state's economy would be impacted through multiplier effects. The impacts from the incremental spending would have impacts on a range of industries. The top 10 industries affected by the increased spending in highway construction and engineering are summarized in Table 35. The top 10 industries affected by the increased spending in highway operations are summarized in Table 36. The industries are ranked in terms of employment impacts.

Figure 49: *Forecasted Annual GDP Impacts for Highway Construction and Operations (2015 $ thousands)*



Engineering and Design Services

Design and construction engineering services are required for the construction of the study corridor improvement. It is estimated that engineering and design fees will total $30.0 million, with $13.2 million in construction engineering fees and $16.8 million in design engineering fees (including NEPA studies). The majority of these fees are expected to occur in the "rest of Utah" region and Uintah County (40 percent and 30 percent, respectively). However, the combined remaining spending would occur in Grand and Duchesne counties. The incremental spending would spur economic impacts beyond those directly occurring in the engineering services industry, with an overall economic impact

***Table 35:** Top 10 Industries Affected by Highway Construction and Design (2015 $ thousands)*

Rank	Industry	Employment	Total Value Added (GDP)
1	Construction of New Highways and Streets	553	$43,869
2	Architectural, Engineering, and Related Services	296	$15,647
3	Wholesale Trade	56	$7,261
4	Real Estate	52	$5,122
5	Limited-service Restaurants	32	$975
6	Full-service Restaurants	29	$657
7	Truck Transportation	29	$1,721
8	Employment Services	22	$835
9	Retail - Non-store Retailers	19	$1,256
10	Hospitals	15	$1,068

***Table 36:** Top 10 Industries Affected by Highway Operations (2015 $ thousands)*

Rank	Industry	Employment	Total Value Added (GDP)
1	Maintenance and Repair Construction of Highways, Streets, Bridges, and Tunnels	151	$10,055
2	Retail - Miscellaneous Store Retailers	10	$230
3	Real Estate	8	$758
4	Retail - Building Material and Garden Equipment and Supplies Stores	8	$395
5	Retail - Gasoline Stores	5	$166
6	Retail - Non-store Retailers	5	$311
7	Wholesale Trade	4	$440
8	Architectural, Engineering, and Related Services	4	$95
9	Full-service Restaurants	4	$95
10	Limited-service Restaurants	4	$107

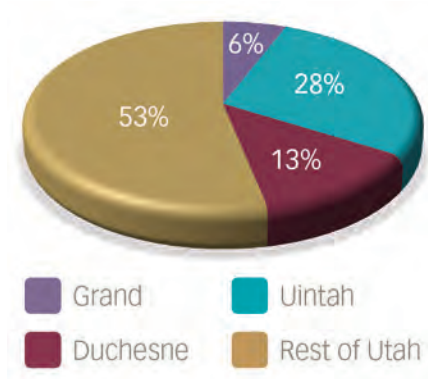
of $28.8 million in GDP (see Table 37). Figure 50 summarizes the regional distribution of the economic impacts (GDP) from the engineering services spending for the improved study corridor. The "rest of Utah" region would experience the majority of economic impacts with an estimated $15.3 million in GDP (53 percent).

***Table 37:** Cumulative Impacts of Engineering Services Spending (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	255	$16,176	$13,997	$30,010
Indirect Effect	90	$4,361	$6,837	$12,579
Induced Effect	103	$4,055	$7,942	$14,217
Total Effect	457	$24,592	$28,777	$56,806

Note: All dollar amounts expressed in 2015 thousand dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

***Figure 50:** Regional Distribution of Engineering Services Economic Impacts*



Highway Construction

Construction costs were estimated to be $131.6 million. The majority of this spending would occur in Grand County, the location of the study corridor. However, although the construction is located in Grand County, the construction process entails specialized industries that will largely be located outside of the county. The incremental spending would spur economic impacts beyond those directly occurring in the construction industry, with an overall economic impact of $101.5 million in GDP (see Table 38). Figure 51 summarizes the regional distribution of the economic impacts (GDP) from the construction spending for the improved study corridor. The majority of economic impacts will occur outside of Grand, Uintah, and Duchesne counties with $62.2 million (61 percent) in GDP occurring in the "rest of Utah" region.

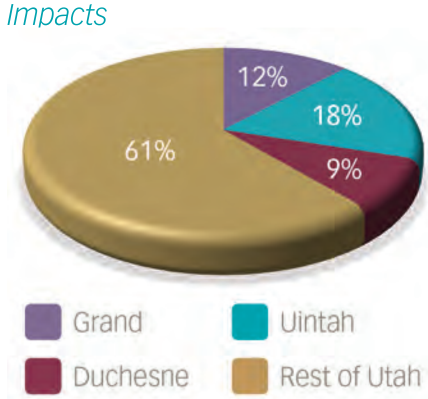
The total highway construction cost is estimated to total $131.6 million. This includes a projected $0.6 million for right-of-way acquisition. Economic impacts for right-of-way acquisition activities were not evaluated because this activity is largely a fiscal exchange and has limited impacts to industry job creation and output.

***Table 38:** Cumulative Impacts of Highway Capital Spending (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	531	$35,817	$43,869	$131,020
Indirect Effect	352	$18,618	$35,099	$74,875
Induced Effect	297	$11,697	$22,492	$40,507
Total Effect	1,180	$66,132	$101,460	$246,403

Note: All dollar amounts expressed in 2015 thousand dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

***Figure 51:** Regional Distribution of Construction Economic Impacts*



Operations and Maintenance

The operations and maintenance costs are forecasted to be $27.1 million. Because the study corridor is located wholly within Grand County, the study assumed that the industry activities for maintenance of the improved study corridor would occur exclusively in Grand County. The incremental spending would spur economic impacts beyond those directly in highway operations and maintenance, with an overall economic impact of $18.4 million in GDP (Table 39). The direct spending occurring in Grand County would generate leaked economic impacts outside of the county. It is estimated that $2.4 million (13 percent) of economic impacts would occur outside of Grand County (Figure 52).

***Figure 52:** Regional Distribution of Highway Operating Economic Impacts*

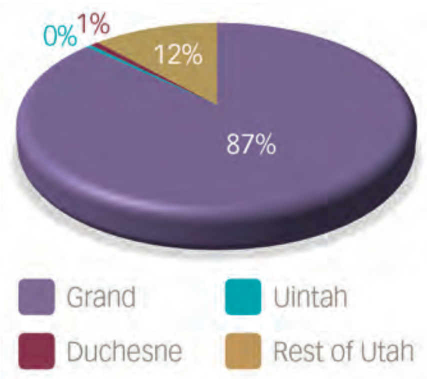


***Table 39:** Cumulative Impacts of Highway Operating Spending (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	145	$8,304	$10,055	$27,057
Indirect Effect	64	$2,335	$4,901	$11,501
Induced Effect	51	$1,564	$3,444	$6,253
Total Effect	260	$12,202	$18,400	$44,811

Note: All dollar amounts expressed in 2015 thousand dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

5.5. Tourism and Recreation Impacts

The travel and tourism sector is currently the main economic driver of the local economy in Grand County and is a growing component of the economy in Uintah and Duchesne counties. Tourism spending spans several categories of goods and services such as lodging, restaurants, travel costs, and admission fees. By improving access to the region, the study corridor would decrease the travel costs to national and state parks as well as other outdoor recreational destinations in eastern Utah. The decreased costs would in turn increase the demand for tourism, increasing the spending associated with tourism industries.

It is estimated that with the improvement of the study corridor, $57.6 million of incremental tourism spending would occur through the year 2040. This incremental spending would spur economic impacts beyond those directly occurring in the tourism industry with an overall economic impact of $43.4 million in GDP. The breakdowns of impacts are summarized in Table 40. The majority of impacts occur in Grand County with an estimated $26.1 million (60

***Table 40:** Cumulative Impacts of Incremental Tourism Spending (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	663	$18,245	$27,104	$48,380
Indirect Effect	105	$3,996	$8,219	$17,384
Induced Effect	101	$3,905	$8,035	$14,540
Total Effect	869	$26,146	$43,358	$80,304

Note: All dollar amounts expressed in 2015 thousand dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

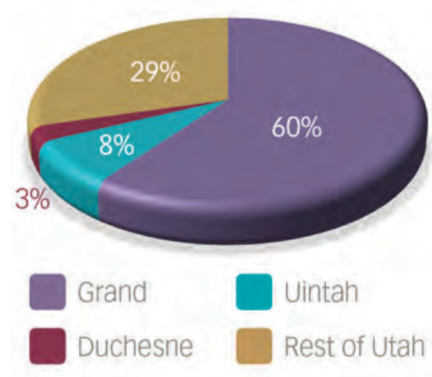
percent) of GDP being generated in the county (see Figure 53). The distribution of economic impacts follows the distribution of incremental visitation increases.

The top 10 industries affected by the increased spending in tourism are summarized in Table 41.

Table 41: *Top 10 Industries affected by increased Tourism Spending (2015 $ thousands)*

Rank	Industry	Employment	Total Value Added (GDP)
1	Full-service Restaurants	250	$6,015
2	Hotels and Motels, Including Casino Hotels	204	$10,021
3	Other Amusement and Recreation Industries	91	$3,386
4	Limited-service Restaurants	90	$2,667
5	Retail - Miscellaneous Store Retailers	76	$1,657
6	Transit and Ground Passenger Transportation	52	$2,753
7	Real Estate	28	$2,687
8	Other Accommodations	22	$857
9	Retail - Gasoline Stores	14	$500
10	Management of Companies and Enterprises	11	$258

Figure 53: *Regional Distribution of Tourism Economic Impacts*



5.6. Energy Production Impacts

By improving access to the Uinta Basin, the study corridor would reduce travel costs associated with the production of crude oil, natural gas, oil sands, and oil shale. These reduced travel costs would decrease the total cost of production and induce incremental production.

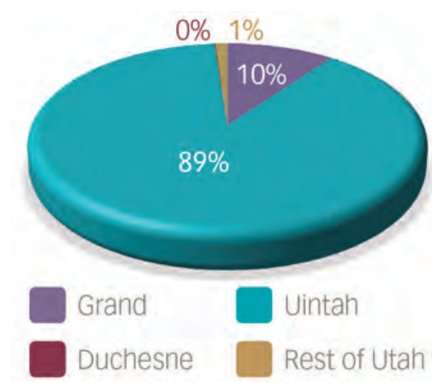
It is estimated that the improved study corridor would create $95.1 million of incremental oil and gas production spending through the year 2040. This incremental spending would spur economic impacts beyond those directly occurring in the energy industry with an overall economic impact of $88.8 million in GDP (see Table 42). These impacts reflect incremental energy production in Grand and Uintah counties, with 89 percent of impacts ($78.8 million in GDP) occurring in Uintah County (see Figure 54). Based on the

Table 42: *Cumulative Impacts of Incremental Energy Production (2015 $ thousands)*

Impact Type	Employment (Jobs)	Labor Income	Total Value Added (GDP)	Output
Direct Effect	164	$19,933	$68,411	$95,101
Indirect Effect	94	$6,809	$12,253	$19,669
Induced Effect	109	$3,748	$8,139	$14,166
Total Effect	367	$30,490	$88,802	$128,936

Note: All dollar amounts expressed in 2015 thousand dollars rounded to the nearest thousands; GDP is a component of output and should not be added; employment impacts are presented as FTEs; totals might not add up because of rounding.

Figure 54: *Regional Distribution of Energy Production Economic Impacts*



existing transportation network considered in this study, Duchesne County and the rest of Utah are not expected to have incremental energy production resulting from the improved study corridor. As such, the economic impacts for energy production occurring in Duchesne County and the rest of Utah are limited to leaked impacts.

The top 10 industries affected by the increased spending in energy production are summarized in Table 43.

Table 43: *Top 10 Industries affected by increased Energy Production (2015 $ thousands)*

Rank	Industry	Employment	Total Value Added (GDP)
1	Extraction of Natural Gas and Crude Petroleum	171	$20,469
2	Support Activities for Oil and Gas Operations	50	$4,277
3	Limited-service Restaurants	11	$172
4	Management of Companies and Enterprises	11	$93
5	Maintenance and Repair Construction of Non-residential Structures	7	$511
6	Real Estate	7	$71
7	Wholesale Trade	6	$483
8	Full-service Restaurants	6	$110
9	Hospitals	5	$269
10	Retail - General Merchandise Stores	4	$141

5.7. Benefit Cost Analysis

A benefit-cost analysis (BCA) was conducted for the improved study corridor. The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. Department of Transportation (U.S. DOT) in the TIGER BCA Guidance and conducted for a 20-year analysis period starting after the assumed completion of construction at the end of 2020 and ending in 2040. The benefit categories assessed as part of this analysis were mapped to the long-term outcomes as described by the U.S. DOT in the TIGER BCA Guidance. The key long-term outcomes assessed in this BCA are: economic competitiveness, safety, state of good repair, and environmental sustainability. These long-term outcomes, benefits, and discounted values at seven percent are provided in Table 44.

BCA converts potential gains (benefits) and losses (costs) from the improved study corridor into monetary units and compares them. Table 44 presents benefit-cost evaluation results using two common BCA evaluation metrics, namely Net Present Value (NPV) and Benefit Cost (B/C) ratio. NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms. The

Table 44: *Improved Study Corridor Benefits and Costs (2015 $ millions)*

Long-Term Outcome	Benefit Category	Discounted at 7 %	Un-discounted
Economic Competitiveness	Travel Time Savings from Reduced Vehicle Hours Traveled	$117.8	$362.1
	Fuel Cost Savings from Reduced Vehicle Miles Traveled	$1,772.8	$5,458.5
	Vehicle Operating and Maintenance Cost Savings (Excluding Fuel) from Reduced Vehicle Miles Traveled	$64.8	$189.7
Safety	Accident Cost Savings from Reduced Vehicle Miles Traveled	$3.7	$11.0
State of Good Repair	Pavement Maintenance Savings from Reduced Vehicle Miles Traveled	$2.4	$7.1
Environmental Sustainability	Emission Cost Savings from Reduced Vehicle Miles Traveled	$18.3	$54.8
Costs	Capital (Design, ROW, and Construction)	$126.1	$161.6
	Operating and Maintenance	$7.3	$27.1
Evaluation Metrics	Net Present Value (NPV)	$1,846.4	$5,894.5
	Benefit Cost Ratio (BCR)	14.8	32.2

Numbers may not add up exactly because of rounding.

B/C ratio divides the present value of incremental benefits by the present value of incremental costs. The B/C ratio expresses the relationship of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs.

The overall improved study corridor impacts can be seen in Table 45, which shows the magnitude of change and direction of the various impact categories. As shown in Table 45, travel time (VHT), vehicle-miles traveled (VMT), accidents, and emissions decrease as a result of the study corridor improvements.

Following is a description of the assumptions applied to complete the BCA. They include analytical assumptions and additional details for the long-term benefits and costs introduced in Table 44.

Analytical Assumptions

Key analytical assumptions of the BCA include the discount rate applied to investments and benefits and the period of analysis. Additional assumptions for the travel demand model used as the basis for the BCA were presented in Section 4.2.

Discount Rate Assumptions

For study corridor investments, dollar figures in the BCA are expressed in constant 2015 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values in other (historical) years, the U.S. Bureau of Labor Statistics' Consumer Price Index for Urban Consumers (CPI-U)

NPV: $1.8B

BCR: 14.8

Table 45: *Project Impacts for the Improved Study Corridor, Cumulative 2021-2040*

Category	Quantity
Vehicle-hours traveled (VHT)	▼ 11.1 million
Vehicle-miles traveled (VMT)	▼ 362.9 million
Fatalities (number)	▼ 1
Injury accidents (number)	▼ 28.7
Emissions – CO_2 (tons)	▼ 565,425
Emissions – NO_x (tons)	▼ 638.8
Emissions – SO_x (tons)	▼ 5.9
Emissions – PM (tons)	▼ 31.0
Emissions – VOC (tons)	▼ 64.8

was used to adjust them.[19] The real discount rate used for this analysis was 7.0 percent, consistent with U.S. DOT guidance for TIGER VII grants[20] and OMB Circular A-4.[21]

Evaluation Period Assumptions

For the improved study corridor, the evaluation period includes the relevant (post-design) construction period during which capital expenditures are undertaken, plus 20 years of operations beyond the project completion within which to accrue benefits.

For purposes of this study, capital expenditures for the study corridor were assumed to occur between 2016 and 2020. NEPA documentation and design engineering were assumed to occur between 2016 and 2017. The construction and construction engineering period would proceed from 2018 through 2020, and operations would begin in 2021. The analysis period, therefore, begins with the first expenditures in 2016 and continues through 20-years of operations, or through 2040.

All benefits and costs were assumed to occur at the end of each year, and benefits to begin in the calendar year immediately following the final construction year.

Annualizing Factor Assumptions

Travel demand models produce outputs on a daily basis. An annualization factor was therefore applied to convert the travel demand outputs into yearly values. The travel demand model results presented in Section 4.2 applied an annualizing factor of 260.

Economic Competitiveness

Economic competitiveness benefits consider travel time savings, fuel cost savings, and vehicle operating cost savings.

Travel Time Savings

Travel time savings include in-vehicle travel time savings for truck drivers as these are the primary group impacted by the improved study corridor. Travel time is considered a cost to users and its value depends on the disutility that travelers attribute to time spent traveling. A reduction in travel time translates into more time available for other productive purposes. As presented in Section 4.2, the improved study corridor creates travel time savings through a reduction of vehicular hours traveled.

Travel time savings must be converted from hours to dollars so benefits can be aggregated and compared against costs. This is performed by assuming that travel time is valued as a percentage of the average wage rate, with different percentages assigned to different trip purposes. Consistent with U.S. DOT guidance, 100 percent of per-hour earnings are monetized for truck operators. The U.S. DOT recommends a value of time of $26.51 per person-hour for truck

19 U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. West, Series CUUR0400SA0. 1982-1984=100.

20 TIGER 2015 NOFA: Benefit-Cost Analysis Guidance, Updated March 27, 2015.

21 White House Office of Management and Budget, Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (October 29, 1992).

drivers.[22] Additionally, U.S. DOT guidance accepts the use of a real growth rate of 1.2 percent a year for the value of time.[23]

Fuel Cost Savings

Fuel efficiency values were derived from the EIA, which provides estimates of fuel efficiency through 2040. The values used to calculate fuel efficiency can be found in the table published by EIA titled "Transportation Sector Key Indicators and Delivered Energy Consumption."[24] Fuel efficiency (miles per gallon) values for freight trucks were used for this analysis as shown in Table 46.

The EIA provides estimates for fuel prices through 2040. Because fuel taxes are considered a pecuniary benefit, or transfer payment, they cannot be accurately included in benefit calculations of a BCA. Thus, the federal and Utah taxes estimated by the EIA are subtracted out of the end user fuel prices. All dollars were reported in real 2013 dollars by the EIA. These dollar amounts were subsequently converted to real 2015 dollars using the U.S. Bureau of Labor Statistics Consumer Price Index (CPI) adjustment for "motor fuel" between 2013 and 2015.[25] Table 47 provides the fuel prices, in real 2015 dollars.

Table 46: *Fuel Efficiency (miles per gallon) EIA reference Case*

Fuel Type	2015	2020	2030	2040
Trucks (Freight Truck)	6.80	7.20	7.70	7.80

Source: U.S. Energy Information Administration, 2015.

Table 47: *Fuel Prices (2015 $ / gallon)*

Fuel Type	2015	2020	2030	2040
Diesel Likely	$2.75	$2.73	$2.73	$2.73

Source: U.S. Energy Information Administration, 2015.

Vehicle Operating Cost Savings

Vehicles have operating costs beyond the fuel costs addressed above. These costs include maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. The per VMT factors of these costs were estimated by the American Automobile Association[26] and the American Transportation Research Institute,[27] and used in this analysis as shown in Table 48. Because the original studies estimated the likely range for these values in 2013 dollars, the values for this analysis have been updated to 2015 dollars using a CPI adjustment.[28]

Table 48: *Non-Fuel Vehicle O&M Costs Commercial Truck*

Cost Category	Commercial Truck (2015 $ / VMT)
Maintenance/ Repair	$0.152
Tires	$0.042
Depreciation	$0.329
Total	**$0.523**

Source: ATRI, 2014; AAA Exchange, 2013.

22 Office of the Secretary of Transportation. (2014). Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis, p. 11-12.

23 Office of the Secretary of Transportation. (2014). Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis (Revision 2), p. 14.

24 Energy Information Administration. (2015). Annual Energy Outlook 2015. Components of Selected Petroleum Product Prices, United States, Reference case.

25 U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. City Average, Motor Fuel. Series CUUR0000SETB. 1982-1984=100, 2010=240.724; 2011=301.448.

26 AAA Exchange. (2013). Your Driving Costs, p.7-8.

27 American Transportation Research Institute. (2014). An Analysis of the Operational Costs of Trucking, p.15.

28 U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. West, Series CUUR0400SA0. 1982-1984=100.

***Table 49:** Truck Fatality and Injury Rate per VMT*

5-Year Avg.	Unit
2.21E-09	Fatalities/VMT
7.90E-08	Injuries/VMT

Source: Bureau of Transportation Statistics.

***Table 50:** U.S. AIS Categories as Proportion of All Non-fatal Injuries*

Injury Type	Proportion
AIS 5	0.18%
AIS 4	0.69%
AIS 3	2.39%
AIS 2	8.28%
AIS 1	88.46%
All Injuries	100%

Source: NHTSA.

***Table 51:** Monetized Accident Values*

Accident Type	Unit Value (2015 $)
Fatality	$9,552,486
AIS 5	$5,664,624
AIS 4	$2,540,961
AIS 3	$1,003,011
AIS 2	$448,967
AIS 1	$28,657

Source: U.S. DOT.

***Table 52:** State of Good Repair Value*

	Pavement Damage Cost (2015 $/VMT)
Truck	$0.0209

Source: FHWA

Safety

Safety benefits consider accident cost savings. The BCA assumes constant accident rates for the no build (baseline) and build scenarios. As a result, any changes considered in the number of accidents will be a result of changes in VMT, not of structural changes to the safety conditions on the roadway network. Although additional safety benefits identified in Section 2.6 may provide further benefits, those benefits were not monetized as part of the BCA.

The cost savings that arise from a reduction in the number of accidents include direct savings (e.g., reduced personal medical expenses, lost wages, and lower individual insurance premiums), as well as significant avoided costs to society (e.g., second party medical and litigation fees, emergency response costs, incident congestion costs, and litigation costs). The value of all such benefits (i.e., both direct and societal) could also be approximated by the cost of service disruptions to other travelers, emergency response costs to the region, medical costs, litigation costs, vehicle damages, and economic productivity loss caused by workers' inactivity.

Accident rates for this analysis were obtained from Bureau of Transportation Statistics data which reports truck related fatalities and injuries on a VMT basis. A five year average of fatalities and injuries for 2009 to 2013 was utilized, the most current years of data available (see Table 49). These rates were utilized to calculate a total reduction in fatalities and injuries over the study period caused by the reduction in VMT.

To convert these accident rates into the appropriate Accident Injury Severity (AIS) scale for monetizing benefits, national statistics from the National Highway Traffic and Safety Administration (NHTSA) were used.[29] Using the national statistics allowed the distribution of total injuries to be derived into their respective AIS categories. AIS categories were derived as indicated in Table 50, which lists each AIS category as a proportion of all possible injuries.

Monetized values for fatalities and accidents categorized on the AIS scale are reported in the U.S. DOT's guidance for "Treatment of the Economic value of a Statistical Life."[30] Table 51 lists the values used for each accident type.

State of Good Repair

State of good repair benefits consider pavement maintenance savings. Reductions in VMT lead to societal benefits in the form of reduced costs of pavement damage. Fewer vehicle-miles lead to a lower need of maintenance on roads. The per-mile costs of these values were estimated based on the Federal Highway Administration (FHWA) cost allocation value presented in Table 52.[31] The calculation of truck impacts on pavement maintenance assumed 60 kip four-axle single unit trucks.

29 National Highway Traffic Safety Administration (2002), The Economic Impact of Motor Vehicle Crashes, 2000, p. 9, Table 3 "Incidence Summary – 2000 Total Reported and Unreported Injuries."

30 Office of the Secretary of Transportation, Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2013 update).

31 Federal Highway Administration, Addendum to the 1007 Federal Highway Cost Allocation Study, Table 13.

Environmental Sustainability

The improved study corridor would create environmental and sustainability impacts relating to air pollution associated with commercial truck travel. It is important to note that a high level environmental review was completed for the study corridor as described in Section 7, including a review of air quality for the study corridor. However, the environmental sustainability considerations of the BCA were based only on outputs of the travel demand model. Five forms of emissions were identified and monetized, including nitrous oxide, particulate matter, sulfur dioxide, volatile organic compounds, and carbon dioxide.

Per-mile emissions rates were derived from the California Environmental Protection Agency's Air Resources Board EMFAC2011 Emissions Database.[32] This tool provides emissions rates projected out to 2035. After 2035, emissions rates were assumed to "flat-line." The flat-line represents both a leveling out of emissions rates and consider the uncertainty in estimating rates that far into the future.

Per mile emissions factors differ depending on vehicle, fuel efficiency, average speed, and driving conditions. The BCA completed for this study used emissions factors for trucks at aggregated speeds and model years. It is important to note that a unique set of emissions factors exists at each speed. Thus, the emissions data set consists of emissions factors for each emissions type by year and by speed. Table 53 shows per-mile emission rates for different vehicle classes in the EMFAC2011 Emissions Database.

Total emission reduction benefits were monetized based on the values shown in Table 53. The resulting benefits are presented in Table 54. The values of PM_{10} emissions were derived from a report published by the National Cooperative Highway Research Program.[33] The values for NO_x, SO_x, and VOC were derived from a NHTSA's CAFE standards for MY2017-MY2025.[34] These are consistent with U.S. DOT guidelines.

Table 53: *Truck Emissions Rates (grams per vehicle-mile traveled)*

Emissions Type	2015	2020	2030	2040
NO_x	6.04	3.11	1.71	1.69
PM_{10}	0.12	0.09	0.08	0.08
SO_x	0.02	0.02	0.02	0.02
VOC	0.73	0.56	0.21	0.04
CO_2	1,581	1,568	1,558	1,558

Source: California Air Resources Board EMFAC, 2011; CAL B/C, 2010.

Table 54: *Non-CO_2 Emissions Costs (2015 $ / metric ton)*

Emissions Type	Emissions Costs
NO_x	$8,094
PM_{10}	$370,321
SO_x	$47,845
VOC	$2,054

Source: NHTSA, 2012, NCHRP, 2007.

32 California Environmental Protection Agency Air Resources Board. (2011). EMFAC2011 Emissions Database. (http://www.arb.ca.gov/emfac/).

33 NCHRP Project 08-36, Task 61: Monetary Valuation per Dollar of Investment in Different Performance Measures (2007).

34 National Highway Traffic and Safety Administration (August 2012), Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks, page 922, Table VIII-16, "Economic Values Used for Benefits Computations (2010 Dollars)."

The per-ton costs of carbon emissions were derived from the Interagency Working Group on the Social Cost of Carbon[35] as well as the analysis conducted by the U.S. DOT in the TIGER Benefit Cost Analysis Resource Guide.[36] The values used for this analysis were discounted at a three percent rate as recommended by the U.S. DOT. Next the social cost of carbon was converted from 2013 dollars to 2015 dollars using a CPI adjustment. Table 55 shows the social costs of carbon for selected years as used for the analysis.

Table 55: *Social Cost of Carbon at 3 percent Discounting (2015 $)*

	2015	2020	2030	2040
Social Cost of CO_2	$44.24	$53.43	$64.74	$76.04

Source: U.S. EPA, 2013.

Economic Costs Included

In the BCA, the term “cost” refers to the additional resource costs or expenditures required to implement and maintain the investments associated with the improvements to the study corridor. The BCA uses annualized forecasted capital and operations and maintenance costs for the improved study corridor. Initial investment costs include NEPA, design engineering, purchase of right-of-way, construction, and construction engineering. These costs were assumed to begin in 2016 and end in 2020. The improved study corridor was assumed to be operational in 2021. Total project cost is $161.6 million, in undiscounted 2015 dollars.

The annual costs of operating and maintaining the improved study corridor were also included in the analysis. Operations and maintenance costs were assumed to begin in 2021. The total estimated operations and maintenance cost for 20 years of maintenance was estimated to be $27.1 million in undiscounted 2015 dollars.

5.8. Sensitivity Analysis

The economic impact outcomes presented in the study rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty. Sensitivity analyses were conducted to test the robustness of the estimated economic impact against different variations of model inputs. Sensitivity analysis is used to help identify which variables have the greatest impact on the economic impact results. This analysis can be used to estimate how reasonable changes to individual variables from their preferred or most likely value affect the final results. This allows for the assessment of the robustness of the economic impact, including whether the conclusions reached using the preferred set of input variables are significantly altered by reasonable departures from those values.

35 U.S. Environmental Protection Agency, Interagency Working Group on Social Cost of Carbon (2013), Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, p.18., Table A1.

36 U.S. Department of Transportation (2015), Tiger Benefit-Cost Analysis (BCA) Resource Guide, p.7.

The sensitivity analyses tested the mid-range scenario economic impacts against low and high spending scenarios for tourism visitations, tourism corridor use, construction cost, and energy production.

Tourism Sensitivities

Sensitivity analyses were completed on two different tourism variables: tourism visitations and tourism corridor use. The tourism visitations sensitivity analysis used a no growth scenario and a high growth scenario of 'plus' 20 percent of the mid-range scenario visitations for the parks assessed in this study. Tourism corridor use scenarios tested high and low ranges for share of total tourists traveling on the improved study corridor from parks south of the corridor to parks north of the corridor and vice versa. The corridor demand dictates how much tourism incremental spending can be attributed to the corridor. The corridor use scenarios tested a 'plus' and 'minus' 10 percent range to the mid-range scenario corridor use assumption.

Construction Sensitivity

Sensitivity analysis was completed for the East Canyon study route alternative. This analysis used a range of 'minus' 10 percent and 'plus' 20 percent from the mid-range scenario construction cost assumptions.

Energy Production Sensitivity

Sensitivity analysis was completed for various assumptions in the energy production forecast. Well quantity forecasting sensitivity tested the high and low scenarios defined in Section 4.1. The high scenario considered 'plus' 20 percent of the mid-range scenario. The low scenario used the UBET Study estimate of the total number of forecasted oil wells for the next 20 years. Energy production forecasting relied on various sources to determine high and low scenarios such as MCW Energy Inc., US Oil Sands Inc., and the UBET Study. Several high and low scenarios were developed for each type of well and each type of oil and gas production.

Sensitivity Analysis Results

The economic impacts resulting from the sensitivity analyses scenarios are summarized in Table 56 and Figure 55. Although the sensitivity analyses did not consider all study variable assumptions, it considered all study sectors, including tourism, construction, and energy related variables. The sensitivity impacts for each of these sectors provide insights to the potential sensitivity impacts of other variable assumptions of that sector.

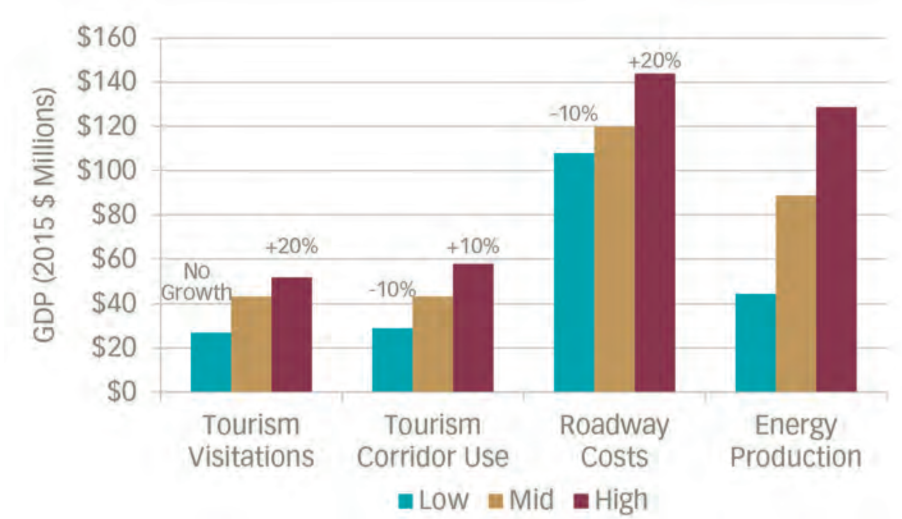
The sensitivity analyses results show that reducing improved study corridor use from 30 percent to 20 percent (a one-third variable reduction) would result in a $14 million (or five percent) reduction in the $281 million GDP impacts estimated for the mid-range scenario. The results also show that the low scenario assumptions for energy production would result in a $44 million (or 16 percent) reduction in the $281 million GDP impacts estimated for the mid-range scenario.

The combined sensitivity analysis results show positive economic impacts for all combinations of considered tourism, construction, and energy variables. The combined low-case variables result in GDP impacts approximately 30 percent lower than those presented for the mid-range scenario. The combined high-case variables result in GDP impacts approximately 30 percent higher than those presented for the mid-range scenario.

Table 56: *Economic Impact Sensitivity Scenarios (2015 $ thousands)*

Sector	Variable	Total Value Added (GDP)		
		Low	Mid	High
Tourism	Tourism Visitations	$26,936	$43,358	$52,029
Tourism	Tourism Corridor Use	$28,938	$43,358	$57,778
Construction	Cost Estimate Variance (East Canyon)	$107,873	$119,859	$143,831
Oil and Gas	Production	$44,494	$88,802	$128,688

Figure 55: *Economic Impact Sensitivity Analyses (2015 $ millions)*



// SECTION SIX

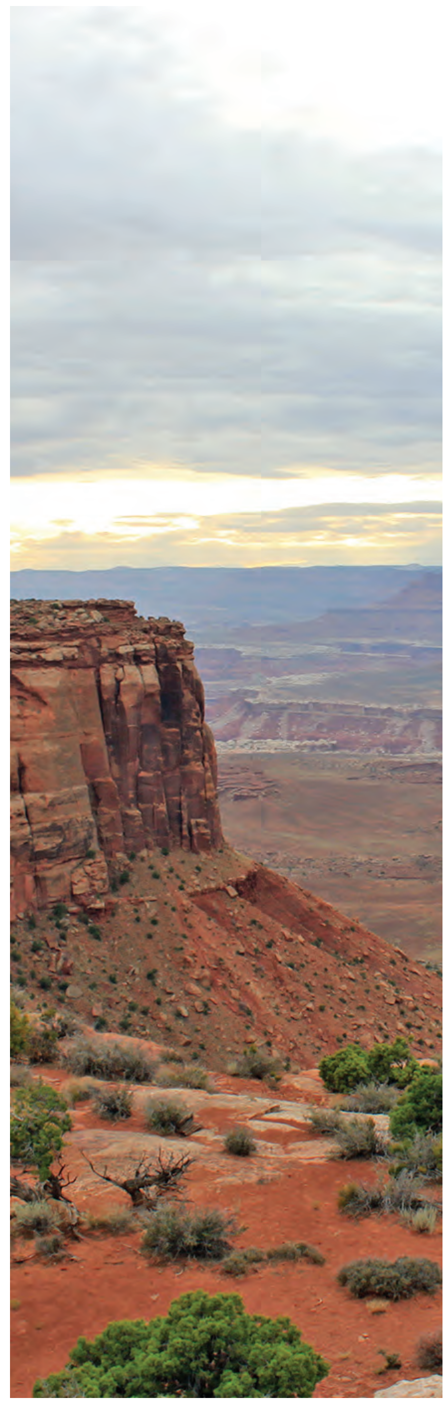
Market Analysis

6

This section presents an interpretation of the economic impact analysis results presented in Section 5. The study corridor improvements are estimated to result in an increase in employment and overall economic activity for roadway construction, tourism, and energy production industries. At its most basic level, this economic impact means new jobs and families in the area. The impact of the new jobs and population growth in the area can be understood within the context of the existing socioeconomic characteristics of Duchesne, Grand, and Uintah counties. The focus of the impacts on the various economic sectors depends on the source of the new activity. For instance, the number of new energy jobs would be small relative to the jobs created from increased tourism. However, although there would be more jobs created from increased tourism, government revenues in the form of excise and other taxes are much greater from increased oil and gas production than from tourism. There is a net positive benefit for all three counties from construction of the study corridor improvements, but the focus of that benefit differs based on whether or not the area is expected to experience growth from tourism, oil and gas production, or both.

As detailed in Section 1.5, the study area has experienced significant growth in both population and jobs over the last 10 years. Both Duchesne and Uintah counties have experienced average annual population growth rates significantly higher than the Utah State average. Employment growth has also been significant in Duchesne, Grand, and Uintah counties from 2010 through 2014. Employment growth in Grand County has focused in the manufacturing and transportation and warehousing sectors signaling diversification of the area's traditional tourism-based economy. Employment growth in Duchesne County was focused in the mining, quarrying, and oil and gas extraction and wholesale trade sectors indicating continued growth in Duchesne County's traditionally strong natural resources sector. In Uintah County the greatest gains have occurred in the education sector, reflecting the location and expansion of the Utah State University Vernal campus. The GOMB projects that employment and population growth rates in the study area will level off during the next 25 years. Construction of the study corridor may open up new opportunities in the study area that could create additional opportunities for growth and new investment.

Following is a discussion of economic impacts in terms of market conditions and growth implications for the study area. The subsequent sections quantify the growth induced by the improved study corridor and then present expected impacts to regional services, the regional economy, the employment pool, and tax revenues for Duchesne, Grand, and Uintah counties.



6.1. Quantification of Growth

The baseline projections of population growth without construction of the study corridor are summarized in Table 57.

The baseline projections of employment growth without construction of the study corridor are summarized in Table 58. Because projected employment growth data and actual employment data were only available from different sources, Table 58 displays employment growth from 2020 instead of 2014.

Baseline projections assume that economic structure and household formation will remain relatively constant. As previously stated, the study corridor improvements linking areas and transportation networks that have not previously been directly connected has the potential to impact the economic performance and growth projections of the newly connected areas. This improved connectivity has the potential to affect population, employment, and overall economic performance growth in the study area as a result of the following:

- Reduced travel time between major tourist destinations north of the study corridor with major tourist destinations south of the study corridor.
- New access to previously remote recreation areas such as hiking trails and game hunting areas.
- Connection of existing and planned natural resource extraction areas in Grand and Uintah counties with the I-70 highway and rail corridor.

Employment Growth

The improved study corridor is estimated to increase tourism and recreation activity by nearly one million new visitors through the year 2040. The tourism and recreation visitation impacts and corresponding impacts on employment are presented in Sections 3.4 and 5.5, respectively. More than half of the new visits are projected to occur in Grand County. This is a result of the improved access and reduced travel times to national and state parks.

Table 59 provides the estimated number of new tourism sector jobs associated with construction and operation of the corridor. Table 59 includes direct, indirect, and induced job creation. The improved study corridor would cause a 51 percent increase over GOMB's baseline projections.

The projections assume that economic structure and visitor spending habits will be comparable to current patterns. To the extent that additional opportunities for visitor spending are created, the study area may enjoy increases in per visitor spending that would increase the overall economic impact of increased visitation.

The study corridor improvements are also expected to result in increased oil production. Oil production is projected to increase by more than 1.1 million barrels in the 2021 to 2040 period. This increased oil production would result in additional employment in the study area. Table 60 identifies projected direct, indirect, and induced employment impacts associated with oil production.

Table 57: *Baseline Projected Population Growth, 2014 - 2040*

Location	2014	2020	2030	2040	Total Increase	AARG
Duchesne County	20,380	22,797	24,836	25,721	5,341	0.9%
Grand County	9,429	10,300	11,300	12,147	2,718	1.0%
Uintah County	36,867	38,982	41,099	42,690	5,823	0.6%
State of Utah	2,942,902	3,309,234	3,914,984	4,570,433	1,627,531	1.7%

Source: State of Utah Governor's Office of Management and Budget.

Table 58: *Baseline Projected Employment Growth, 2020 - 2040*

Location	2020	2030	2040	Total Increase	AARG
Duchesne County	12,528	13,264	13,819	1,291	0.5%
Grand County	7,522	8,156	8,806	1,284	0.8%
Uintah County	21,037	22,306	23,327	2,290	0.5%
State of Utah	1,995,556	2,313,752	2,627,326	631,770	1.4%

Source: State of Utah Governor's Office of Management and Budget.

***Table 59:** Tourism-Related Job Growth Induced by Study Corridor, 2021 - 2040*

Location	GOMB Baseline	Additional from Project	Total	% Increase from Corridor
Duchesne County	218	28	246	13%
Grand County	666	548	1,214	82%
Uintah County	404	78	482	19%
Total Study Area	1,288	654	1,942	51%

Source: See Section 1.5 for baseline details. See Section 5.5 for new tourism employment details.

***Table 60:** Energy-Related Job Growth Induced by Study Corridor, 2021 - 2040*

Location	GOMB Baseline	Additional from Project	Total	% Increase from Project
Duchesne County	217	0	217	0%
Grand County	1	36	37	N/A
Uintah County	410	319	729	78%
Total Study Area	627	355	982	57%

Source: See Section 1.5 for baseline details. See Section 5.6 for new energy employment details.

Population and Household Growth

Increased employment in the study area is expected to result in increased population and new households. According to the U.S. Census Bureau's OnTheMap Application and LEHD Origin-Destination Employment Statistics, from 2006 to 2013, approximately 30 percent of Uinta Basin oil and gas employees commute to the area from outside the county of employment. Employees in the tourism industry are more likely to live in the area where they work. Other industries have different percentages of employees commuting. Using data from the U.S. Census Bureau, a model of employees commuting was created. Section 5 presented the number of additional jobs that could be expected if the study corridor improvements are constructed. Using the commuting model, the number of additional jobs expected, and average household size information from the U.S. Census Bureau SF1, the additional households and population were estimated for the period between 2016 and 2040. Figure 56 illustrates the average annual population and household growth forecasted for Duchesne, Grand, and Uintah counties. Grand County is expected to see the largest increase in population and households, adding 60 additional residents and 26 additional households annually. Uintah County is expected to see the second largest increase, adding 51 residents and 19 households annually. Duchesne County is expected to experience the lowest increase, adding 15 residents and five households.

Table 61 summarizes the cumulative employment, population, and household growth forecasted to be induced by the improved study corridor. The results of Table 61 mean that, for each new job created in Grand County, an estimated additional 1.4 people would move into the county. In Uintah and Duchesne

Figure 56: *Average Annual Population and Household Impact, 2016 – 2040*

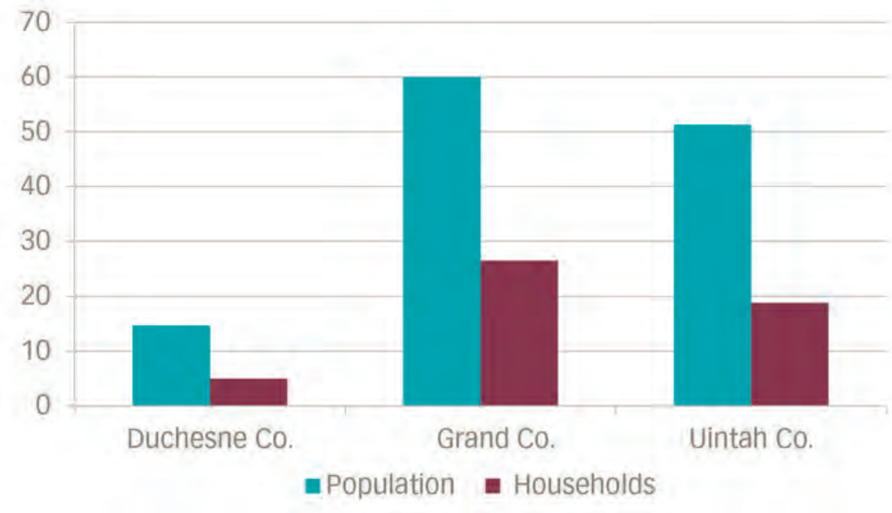


Table 61: *Jobs, Population, and Household Creation, 2016 - 2040*

Location	Jobs	Population	Household
Duchesne County	201	367	123
Grand County	1,070	1,498	661
Uintah County	692	1,282	470
Total Study Area	1,961	3,146	1,254

counties, for every new job an estimated 1.85 and 1.83 people would move in, respectively.

The additional people represent members of the new employee's household, including partners, spouses, and children. This additional population will attend local area schools, seek service at local hospitals and clinics, and become members of the community.

The estimated influx of new population is relatively minor within the study area's current population. However, the estimated increases in population and household formation are additive to current GOMB projections.

Table 62 provides the GOMB population and employment projections with the improved study corridor impacts included. The data in the table represent the summation of baseline and study corridor related population and employment increases from Table 57, Table 58 and Table 61.

Each jurisdiction uses GOMB projections to plan for growth in population and households in their area. The additional population and household growth caused by the improved study corridor should therefore be accounted for in jurisdictional planning efforts.

Table 62: *Baseline Plus Improved Study Corridor Population and Employment Growth, 2016 - 2040*

Location	Total Population	% from Project	Total Employment	% from Project
Duchesne County	7,445	5%	3,057	7%
Grand County	4,420	34%	3,254	33%
Uintah County	11,384	11%	5,694	12%

6.2. Regional Services Impacts

The impacts to public health and safety services are presented in Table 63. Estimated new police officers, firefighters, and hospital beds needed are based on total projected (baseline + improved study corridor) population growth and current ratios of officers, firefighters, and beds per 1,000 population. The number attributable to growth resulting from the improved study corridor is also identified in Table 63. Data for law enforcement were collected from 2011 FBI police employee data to establish service levels across each county. Fire service data were collected from local fire departments via website or phone interview. Health care providers include only major hospitals and medical centers in the area and the data were collected from the American Hospital Directory.

Increased tourism activity would result in increased demand for hotel beds and related services. Table 64 presents the estimated increase in new room nights by county based on the projected new visits to the area. This is in addition to current baseline projected increases in visitation. In Duchesne County an additional 274 room nights, or one room, are need. Additional tourism visits to Grand County are expected to require 2,759 new room nights, or eight new rooms, and visitors to Uintah County are expected to require 729 room nights, or two additional hotel rooms. This study did not consider potential increased tourism economic impact derived from additional marketing or promotion of the region with easier travel and better connectivity.

Table 63: *Additional Service Needs, 2020 - 2040*

Location	# of New Police Officers		# of New Firefighters		# of New Hospital Beds	
	Total	# from Project	Total	# from Project	Total	# from Project
Duchesne County	12	1	38	2	56	3
Grand County	15	5	28	9	8	3
Uintah County	17	2	34	4	13	1

Table 64: *Impacts from Increase in Tourism Visits on Hotels, 2021 - 2040*

	Room Nights	New Rooms
Duchesne County	274	1
Grand County	2,759	8
Uintah County	729	2

Table 65: *Construction and Maintenance-Related Taxable Sales Estimates, 2018 - 2040 (2015 $)*

Location	Amount
Total	**$188,087,707**
Duchesne Co.	$19,104,084
Grand Co.	$56,262,155
Uintah Co.	$35,207,151
Rest of Utah	$77,514,317

6.3. Regional Economy Impacts

Sales related to the construction and maintenance of the study corridor improvements are presented in Table 65 and are estimated to be $188.1 million or $8.2 annually. Additional details were presented in Section 5.4. Sales in this sector are the largest from any source primarily because of the high costs of materials to construct the road and provide maintenance. Approximately 86 percent of the impact is expected to be collected between 2018 and 2020, during the assumed construction period. The remaining 14 percent is expected between 2021 and 2040 for road maintenance impacts.

Tourism-related taxable sales are presented in Table 66. Between 2021 and 2040 estimated total sales from increased tourism spending is $57.6 million. The largest impact is expected in Grand County. Over the total period Uintah County is estimated to see an increase of $5.2 million in tourism-related sales while Duchesne County is estimated to see an increase of $1.8 million.

Energy production activities induced by the improved study corridor are presented in. Additional details were presented in Section 5.6. Estimates show that between 2021 and 2040, 1.1 million barrels of oil would be extracted as a result of the improved study corridor and produce $95.1 million in sales. Approximately 89 percent of the productivity would occur in Uintah County and the remaining 11 percent in Grand County. The induced Grand County energy activity would likely occur in the SITLA property located in the northern portion of Grand County.

Table 66: *Tourism-Related Taxable Sales Estimates, 2021 - 2040 (2015 $)*

Location	2012-2014 Historical Average Annual	Project Estimate Average Annual	Total	% Increase from Project
Duchesne County	$9,634,230	$103,043	$9,737,272	1%
Grand County	$102,483,165	$2,323,434	$104,806,599	2%
Uintah County	$47,006,871	$313,388	$47,320,258	1%
Total Study Area	$159,124,266	$2,739,865	$161,864,129	2%

Source: Utah State Tax Commission.

Table 67: *Energy-Related Production and Taxable Sales Estimates, 2021 - 2040 (2015 $)*

	Total Barrels	Total Sales
Total	**1,128,133**	**$95,100,715**
Grand County*	118,886	$10,021,980
Uintah County	1,009,247	$85,078,735

**Assumes additional activity occurs on SITLA land.*

6.4. Employment Pool Impacts

Investment and spending for study corridor improvements were estimated to support a total of 1,961 employees between 2016 and 2040 in the study area and 1,170 employees in the rest of Utah. The employment impacts to Uintah, Grand, and Duchesne counties are presented in Figure 57. Employment impacts are greatest in Grand County and are estimated to produce 1,070 jobs. The impact in Uintah County is estimated to add 692 jobs, and Duchesne County is estimated to add 200 jobs.

Employment impacts by occupation type to Uintah County are shown in Figure 58. The oil and gas industry is expected to account for 46 percent of the additional employment followed by roadway construction at 28 percent. Engineering and tourism are estimated to account for the remaining 15 and 11 percent, respectively.

Employment impacts by occupation type in Grand County are shown in Figure 59. The tourism sector is expected to account for 51 percent of the additional employment followed by the construction sector related to the maintenance of roads which is estimated to account for 23 percent of the additional employment. Construction related to roadway capital expenses is expected to account for 18 percent of the additional employment while engineering and oil and gas are estimated to account for 8 percent of the additional employment.

Employment impacts by occupation type for Duchesne County are shown in Figure 60. Construction employment related to capital expense is estimated to account for 46 percent of the additional employment, while engineering and design is expected to account for 40 percent of the additional employment. Tourism is estimated to account for 14 percent of the additional employment. There is no direct employment impact to the oil and gas industry in Duchesne County.

Figure 57: *Total Employment Impacts, 2016 - 2040*

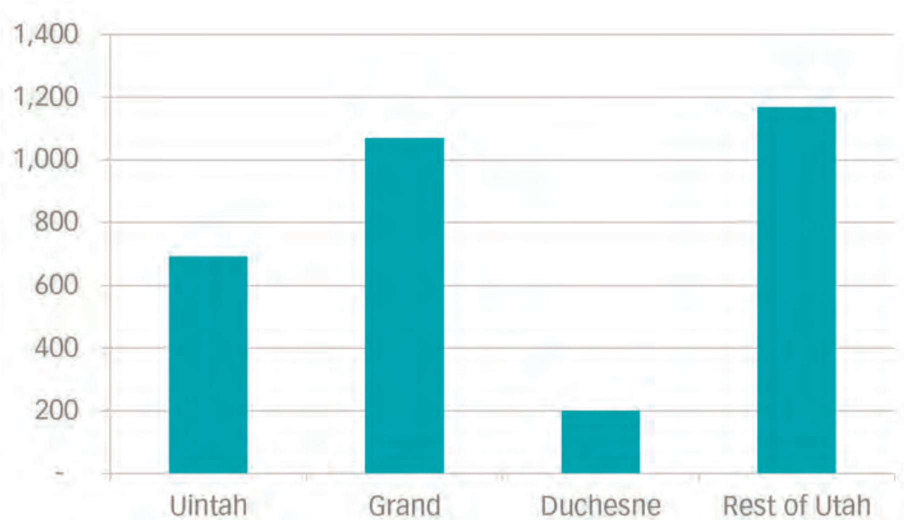


Figure 58: *Uintah County Employment Impacts by Type, 2016 - 2040*

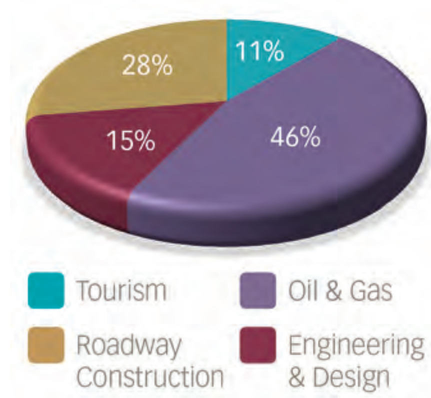


Figure 59: *Grand County Employment Impacts by Type, 2016 - 2040*

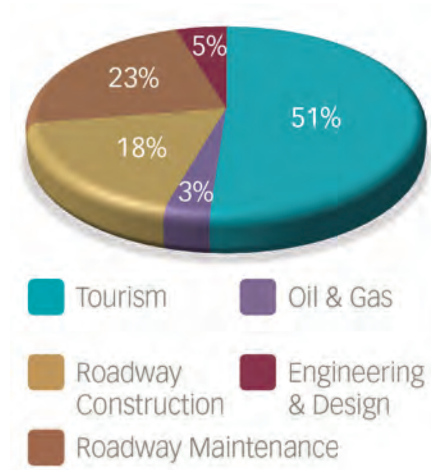


Figure 60: *Duchesne County Employment Impacts by Type, 2016 - 2040*

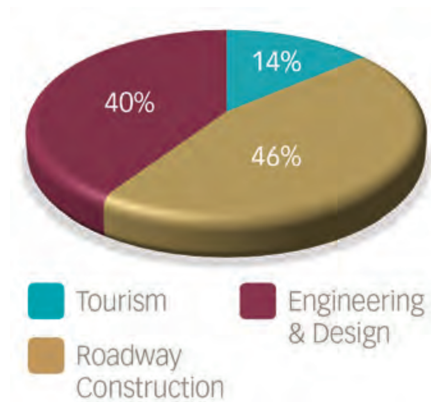


Table 68: *Construction and Maintenance-Related Tax Estimates, 2018 - 2040 (2015 $)*

Location	Amount
Total	$11,226,426
Duchesne Co.	$1,136,693
Grand Co.	$3,347,598
Uintah Co.	$2,130,033
Rest of Utah	$4,612,102

Table 69: *Tourism-Related Tax Estimates, 2021 - 2040 (2015 $)*

Location	Amount
Total	$4,127,370
Duchesne Co.	$122,621
Grand Co.	$2,764,886
Uintah Co.	$379,199
Rest of Utah	$860,664

Table 70: *Energy Production-Related Tax Estimates, 2021 - 2040 (2015 $)*

Location	Amount
Total	$5,695,269
Grand Co.*	$1,703,737
Uintah Co.	$3,991,533

**Assumes additional activity occurs on SITLA land.*

6.5. Fiscal Impacts

Tax impacts related to the construction and maintenance of the corridor are presented in Table 68. Collections are expected to be just over $11.2 million and are the largest from any source primarily because of the high cost of material to construct the roadway improvements and provide annual maintenance. Approximately 86 percent of the impact is expected to be collected between 2018 and 2020 during the assumed construction period. The remaining 14 percent is distributed between 2021 and 2040 and would account for roadway maintenance impacts.

Tourism-related tax revenues are presented in Table 69. The taxes collected include local sales tax and transient room tax. The estimated total tax collections from increased tourism spending between 2021 and 2040 would be $4.1 million or approximately $200 thousand annually. The largest impact is expected in Grand County followed by the rest of Utah. Both Duchesne and Uintah County impacts are estimated to increase tourism-related tax revenues by approximately one percent annually.

Energy production tax collections are presented in Table 70 and are estimated to total approximately $5.7 million between 2021 and 2040. Tax collections from Uintah County are estimated to be just under $4.0 million while collections from Grand County are estimated to be $1.7 million.

// SECTION SEVEN

Environmental Review

7

This study provided a high-level review of air quality impacts and cultural sensitive sites for each route alternative. Possible implementation of the study corridor must be preceded by an environmental study that considers environmental impacts and follows the NEPA process. Following is a description of the air quality and cultural resources review completed for this study. This section also provides a brief overview of additional environmental-related considerations presented in recent study corridor work completed by UDOT.

7.1. Air Quality

A qualitative review of potential air quality impacts to criteria pollutants, greenhouse gas emissions (GHG), and mobile source air toxics (MSAT) caused by the improved study corridor was completed by analyzing traffic model data presented in Section 4.2. The review follows the guidance provided by the FHWA *Interim Guidance on Air Toxic Analysis in NEPA Documents* for analyzing MSAT impacts.[37] [38] Preliminary air quality data for the project area was sourced from the Environmental Protection Agency (EPA) *Green Book Nonattainment Areas for Criteria Pollutants* database.[39]

Air Quality Review Criteria

As mentioned above, this study considered the potential air quality impacts of the improved study corridor in terms of criteria pollutants, greenhouse gas emissions, and mobile source air toxics. Following is a description of the air quality review criteria.

Criteria Pollutants

Under the Clean Air Act, the EPA regulates common air pollutants, known as criteria pollutants. For these pollutants, the EPA has established the National Ambient Air Quality Standards (NAAQS), which are considered permissible levels of human and/or environmental exposure. The EPA evaluates the concentrations of the pollutants across the country and designates areas as either in attainment or non-attainment of the established NAAQS. The EPA's *Green Book Nonattainment Areas for Criteria Pollutants* database was referenced

37 FHWA, Office of Planning, Environment, and Realty, 2012. Memorandum: Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA (dated December 6, 2012).

38 FHWA, Office of Planning, Environment, and Realty, 2012. Appendix B: Prototype Language for Qualitative Project Level MSAT Analysis.

39 EPA, 2015. Green Book Nonattainment Areas for Criteria Pollutants database (updated January 20, 2015). http://www.epa.gov/airquality/greenbook/.

for the designation of non-attainment areas potentially located within the vicinity of the study corridor.

Greenhouse Gas Pollutants

Greenhouse gases are those emissions that trap heat in the atmosphere. Greenhouse gases of concern include carbon dioxide (CO_2), methane (CH_4), Nitrous oxide (N_2O), and fluorinated gases. Both CO_2 and N_2O are emitted during the burning or combustion of fossil fuels, used in the transportation of people and goods. A total of 31 percent of CO_2 emissions and 26 percent of all greenhouse gas emissions in the U.S. were a result of transportation sources in 2013.[40] However, transportation only accounts for 5 percent of total N_2O emissions and the projected increases for this pollutant are primarily related to agricultural activities and not transportation.[41] As such, this qualitative review focused on the potential increase in CO_2 emissions as a result of increased VMT.

Mobile Source Air Toxics

Amendments to the Clean Air Act in 1990 addressed the need to control toxic emissions from transportation activities including MSATs. Mobile source air toxics are compounds emitted from roadway vehicles and are either known or suspected to cause serious health and/or environmental effects.[42] Following the amendments, the EPA issued the Mobile Source Air Toxics Rule, which identified 21 MSAT compounds to be regulated and the Control of Hazardous Air Pollutants from Mobile Sources Rule, which identified 93 toxic compounds. Seven of the MSATs were identified by the EPA as having the most adverse impact to human health: acrolein, benzene, 1,3-butidiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter.[43] Mobile sources emit these toxic pollutants as well as precursor emissions which react to form secondary pollutants.[44] Unlike the criteria pollutants, the MSAT compounds do not have NAAQS so an evaluation of their impacts is more qualitative and subjective.

In 2012, the FHWA developed the *Interim Guidance on Air Toxic Analysis in NEPA Documents* to provide an approach for analyzing MSAT impacts to address stakeholder concerns during project development and alternatives analysis. The guidance identifies three levels of analysis as follows:

- No analysis for projects with no potential for meaningful MSAT effects;
- Qualitative analysis for projects with low potential MSAT effects;
- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.

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40 EPA, 2015. Overview of Greenhouse Gases. http://www.epa.gov/climatechange/ghgemissions/gases.html.

41 EPA, 2014. Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2013. http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

42 EPA, 2014. Mobile Source Air Toxics, Basic Information. http://www.epa.gov/otaq/toxics.htm.

43 FHWA, Office of Planning, Environment, and Realty, 2012. Memorandum: Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA (dated December 6, 2012). http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/aqintguidmem.cfm.

44 EPA, 2014. Mobile Source Air Toxics, Basic Information. http://www.epa.gov/otaq/toxics.htm.

Projects requiring a quantitative analysis are those that have the potential for significant differences among the project alternatives. These projects must:

- Create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel particulate matter in a single location; or
- Create new or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the annual average daily traffic (AADT) volumes are projected to be in the range of 140,000 to 150,000, or greater, by the design year; and also
- Be proposed to be located in proximity to populated areas or in rural areas, in proximity to concentrations of vulnerable populations (i.e., schools, nursing homes, hospitals).

The 2040 year traffic for the improved study corridor was forecasted to be approximately 2,700 AADT. In addition, the study corridor is not located in proximity to any populated areas or vulnerable populations. Therefore, the improved study corridor would likely not require a quantitative analysis for the subsequent NEPA process.

The FHWA's *Interim Guidance on Air Toxic Analysis in NEPA Documents* was used to direct the air quality review completed for this study. However, the study is not intended to meet NEPA requirements. Additional air quality analysis would be required in future phases of the Book Cliffs Transportation Corridor project if the project is advanced through the NEPA process.

Qualitative Review of Air Quality

Travel demand model data was prepared for this study (see Section 4.2) and forms the basis for the air quality review. Table 71 summarizes the travel demand model results used in this review. This review considered traffic data for existing model conditions and 2040 forecasts for baseline (no build) and build scenarios. Because the Hay Canyon and East Canyon route alternatives are so similar, traffic data for the East Canyon alternative was modeled and used as the proxy for both build scenarios in assessing potential GHG and MSAT emissions. East Canyon was selected for consistency with other components of the study corridor analysis. Data considered included non-local VMT and AADT volumes by trip type for selected study corridor locations.

That data show an increase of approximately 2,700 daily trips within the study corridor from the baseline (no build) to the build scenario and a decrease of approximately 118,000 non-local daily VMT within the three-county study area for the build scenario. This value varies from the 109,000 VMT statewide

Table 71: *Comparison of VMT, AADT, and Average Travel Speeds*

Scenario	Non-local VMT (Adjusted)	AADT*	Average Travel Speeds
Existing	2,477,471	N/A	46.6
No Build 2040	4,595,492	N/A	44.0
Build 2040	4,477,509	+2,700	44.5

**USTM AADT values not available for the dirt road of the no-build scenarios.*

reductions presented in Section 4.2 because it accounts only for changes in the three-county study area rather than the entire state. In other words, the relative localized impacts are larger than the statewide impacts. Travel speeds do not vary significantly among the scenarios. The data indicate the proportion of heavy truck VMT would increase from 49 percent to 57 percent when comparing the 2040 no build scenario to the 2040 build scenario, respectively. However, as mentioned above, this higher proportion represents an overall reduction in VMT for the 2040 build scenario compared to the 2040 no build scenario.

The 2040 no build scenario indicates a 59 percent increase in passenger VMT from the existing conditions scenario and a 124 percent increase in heavy truck VMT. Comparatively, the 2040 build scenario indicates a 31 percent increase in passenger VMT from the existing conditions scenario and a 154 percent increase in heavy truck VMT.

Criteria Pollutants

According to the EPA's *Green Book Nonattainment Areas for Criteria Pollutants* database, all areas in the project vicinity are in attainment of the NAAQS. However, activities within the study corridor may increase concerns with ozone concentrations and particulate matter.

Ozone - The Uinta Basin has ozone concentrations in excess of current NAAQS during winter inversion periods.[45] Increased oil and gas production resulting from the improved study corridor could increase ozone concentrations within the study area. Although not directly applicable to the study corridor, it is likely that the EPA will soon designate portions of the Uinta Basin as non-attainment areas. The impact of this designation on oil and gas production is not clear and has not been quantitatively considered in this study. However, it is likely this possible designation could cause a reduction in oil and gas production. These cumulative and indirect impacts are beyond the scope of this study and would need to be addressed should the project advance through the NEPA process.

Particulate Matter - This review considered particulate matter (PM) impacts during construction and post-construction of the roadway improvements. While all areas within the study corridor vicinity appear in attainment of the PM NAAQS, work activities during construction can expose soils and increase the quantity of dust generation and transport in the short-term. Dust pollution during construction should be mitigated by implementing dust control measures on site. Best management practices could include:

- Sprinkling/irrigation;
- Vegetative cover;
- Mulch;
- Wind breaks;
- Tillage;
- Stone cover; and
- Spray-on chemical soil treatments.

45 Utah Department of Transportation, 2015. 2015 – 2040 Long Range Transportation Plan: Transportation in Utah's Rural Areas. http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:207.

However, construction impacts would be temporary and post-construction conditions should also be considered. Over the long-term, the EPA notes that roadway paving reduces air pollution caused by dust particulates generated from vehicle travel over an unpaved roadway, specifically a significant reduction in PM_{10} emissions.[46] Given the potential increase in heavy truck traffic for both route alternatives over the baseline (no build) scenario, the build scenario would provide some air quality benefit as a result of roadway paving. This benefit has been anecdotally observed on the recently constructed Seep Ridge Road project. Before the paving of the roadway, plants within about 150 feet of the roadway were covered with dust and had unhealthy appearances. During the 2015 growing season, the vegetation along the roadway appeared to have improved and be healthier than when the roadway was unpaved. Additional air quality analysis would be required as the project advances through the NEPA process to better understand the potential cumulative, direct, and indirect air quality impacts as a result of the project.

Greenhouse Gas Pollutants

Increased VMT was used as the qualitative indicator of increased CO_2 emissions for the improved study corridor. The traffic model data indicate an 85 percent increase in VMT for the 2040 no build scenario over the existing conditions scenario and an 81 percent increase for the 2040 build scenario. This represents considerable reduction in VMT for the 2040 build scenario compared to the 2040 no build scenario. Given that the existing conditions VMT for the study corridor represents approximately 0.3 percent of the existing conditions total annual VMT for the region, the VMT increase for the build scenario would not be considered significant.[47]

While the GHG emissions increase caused by transportation would be minimal, the proposed improvements could encourage additional energy production and the potential increase from such activity is unknown. The potential increase in GHG pollutants from energy production activities that may result from the improved study corridor was not evaluated here. Such potential impacts may need to be considered in future air quality analysis if the project advances through the NEPA process.

Mobile Source Air Toxics

For each scenario considered in this review, the amount of MSAT emitted would be proportional to the VMT, assuming other variables such as fleet mix are the same for each alternative. However, as shown in Table 72 the fleet mix for the build scenario reflects a higher percentage of heavy truck trips than the baseline (no build) scenario. While the heavy vehicle VMT estimated for the build scenario is higher than the baseline (no build) scenario, there is an overall decrease in estimated total VMT because of the decrease in passenger VMT (see Table 71). This shift in fleet mix could impact MSAT emissions for the study corridor. This would need to be considered if the project advances through the NEPA process.

46 FHWA, Office of Planning, Environment, and Realty, 2011. Multi-Pollutant Emissions Benefits of Transportation Strategies-FHWA: Road Dust Reductions Strategies (last Updated July 6, 2011). http://www.fhwa.dot.gov/environment/air_quality/conformity/research/mpe_benefits/mpe07.cfm.

47 Utah Department of Transportation, 2011. 2011 Vehicle Miles of Travel (VMT) by County by Ownership. http://www.udot.utah.gov/main/uconowner.gf?n=11301508583688012.

Table 72: *VMT by Vehicle Type*

Scenario	Passenger VMT	Heavy Truck VMT
Existing	1,469,890	1,007,581
No Build 2040	2,335,751	2,259,741
Build 2040	1,918,601	2,558,908

According to the EPA's emissions MOVES2010b model, emissions of all of the priority MSAT pollutants decrease as speed increases.[48] The travel demand model did not indicate a significant difference in average speeds between the 2040 baseline (no build) and build scenarios. The estimated VMT increases 85 percent for the 2040 no build scenario over the existing conditions scenario compared to an 81 percent increase for the 2040 build scenario over the existing conditions scenario. Therefore, there may be no appreciable increase in overall MSAT emissions between the 2040 baseline (no build) and 2040 build scenarios.

Air Quality Review Results

The improved study corridor would result in approximately a three percent decrease in VMT over the no build scenario and therefore regional criteria pollutants and GHG emissions are not expected to be impacted significantly. The projected shift in vehicle mix, an eight percent proportional increase in heavy truck VMT in the study corridor relative to the no build scenario, could be considered in future air quality analyses.

The total AADT projected for the build scenario is well below the FHWA guidance threshold of 140,000 – 150,000 AADT for quantitative analysis and the route alternatives are not in proximity to populated areas or vulnerable populations; therefore, a quantitative analysis for MSATs may not be required. Significant contributions to MSAT emissions would not be anticipated as a result of the improving the study corridor.

Cumulative, direct, and indirect impacts as a result of energy production and other related economic development activities were not considered as part of the air quality review. These and other air quality impacts that may result from the proposed roadway improvements may be considered in future air quality analysis if the project advances through the NEPA process.

7.2. Cultural Resources

A high-level review of cultural sensitive sites for each route alternative was conducted to identify potential future cultural resource considerations.

Cultural Resources Survey

A search area extending 200 feet on either side of each route alternative centerline was generated to identify previously recorded archaeological sites and previously conducted surveys. Using the Utah Division of State History's Preservation Pro application, lists of all the sites and surveys that intersect each alternative were compiled. In addition, consultation with the BLM Moab office

48 FHWA, Office of Planning, Environment, and Realty, 2012. Appendix B: Prototype Language for Qualitative Project Level MSAT Analysis. http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/aqintguidapb.cfm.

was conducted to find general overviews of the area (Class I inventories). The BLM Moab office indicated that Class I inventories are not completed on a large scale basis but are conducted for individual project areas. Because much of this information is also documented in the Preservation Pro application, the BLM files were not reviewed for this study. However, a review of BLM files would be needed for further investigations if the project advances through the NEPA process.

A total of 31 sites were identified within the search areas of both route alternatives. Cultural affiliations associated with the sites include Archaic (1 site), Fremont (2 sites), Late Prehistoric (1 site), Unknown Aboriginal (10 sites), European/American (7 sites), multi-component (7 sites), and unknown (3 sites). See Table 73 for details.

Table 73: *Archaeological Sites*

Alternative	Site Number	Cultural Affiliation	Comments
Hay Canyon	42GR699	Unknown Aboriginal	
Hay Canyon	42GR990	Multi-component	Includes Archaic, Late Prehistoric, and European/American
Hay Canyon	42GR991	Multi-component	Includes Archaic, Late Prehistoric, and European/American
Hay Canyon	42GR1016	Multi-component	Includes Unknown Aboriginal and European/American
Hay Canyon	42GR1033	Multi-component	Includes Fremont and European/American
Hay Canyon	42GR1729	Unknown Aboriginal	
Hay Canyon	42GR1730	Late Prehistoric	
Hay Canyon	42GR1957	Fremont	
Hay Canyon	42GR2301	Unknown Aboriginal	
Hay Canyon	42GR2302	Multi-component	Includes Early Archaic, Protohistoric/Contact, and European/American
Hay Canyon	42GR3329	Unknown Aboriginal	
Hay Canyon	42GR4242	Unknown	
East Canyon	42GR768	Unknown Aboriginal	
East Canyon	42GR1018	Unknown	
East Canyon	42GR2283	Fremont	
East Canyon	42GR2293	Unknown Aboriginal	
East Canyon	42GR2294	Archaic	
East Canyon	42GR2295	Multi-component	Includes Archaic and Fremont
East Canyon	42GR2296	Unknown Aboriginal	
East Canyon	42GR2297	Unknown Aboriginal	
East Canyon	42GR2298	Unknown	
East Canyon	42GR2299	Unknown Aboriginal	
East Canyon	42GR3224	European/American	
Both	42GR331	Multi-component	Includes Archaic, Protohistoric/Contact, and European/American
Both	42GR935	European/American	
Both	42GR2303	European/American	
Both	42GR2304	European/American	
Both	42GR2305	European/American	
Both	42GR2651	European/American	
Both	42GR3592	Unknown Aboriginal	
Both	42GR3965	European/American	

A total of 20 sites were identified within the Hay Canyon route alternative and 19 sites within the East Canyon route alternative. Eight of the sites fall within the search areas of both route alternatives, with most being located near the southern intersection of the separate paths for the two route alternatives.

The majority of the sites are concentrated at canyon confluences, and primarily at the confluence of the Hay, Middle, and East canyons. A lower density was noted within the narrower portions of Hay and East canyons (see). Grand Valley and the Danish Flat at the southern end of the study corridor featured a very sparse density of previously recorded sites within the search area. However, large clusters of sites were located outside the search area in the floodplains of various washes. Undocumented sites may be present in similar settings along the study corridor.

Previous Cultural Resources Surveys

Both route alternatives have had portions surveyed in the past. With the exception of one minor survey area, all of the investigations within the search areas were conducted more than ten years ago, with most occurring in the 1980s and 1990s.

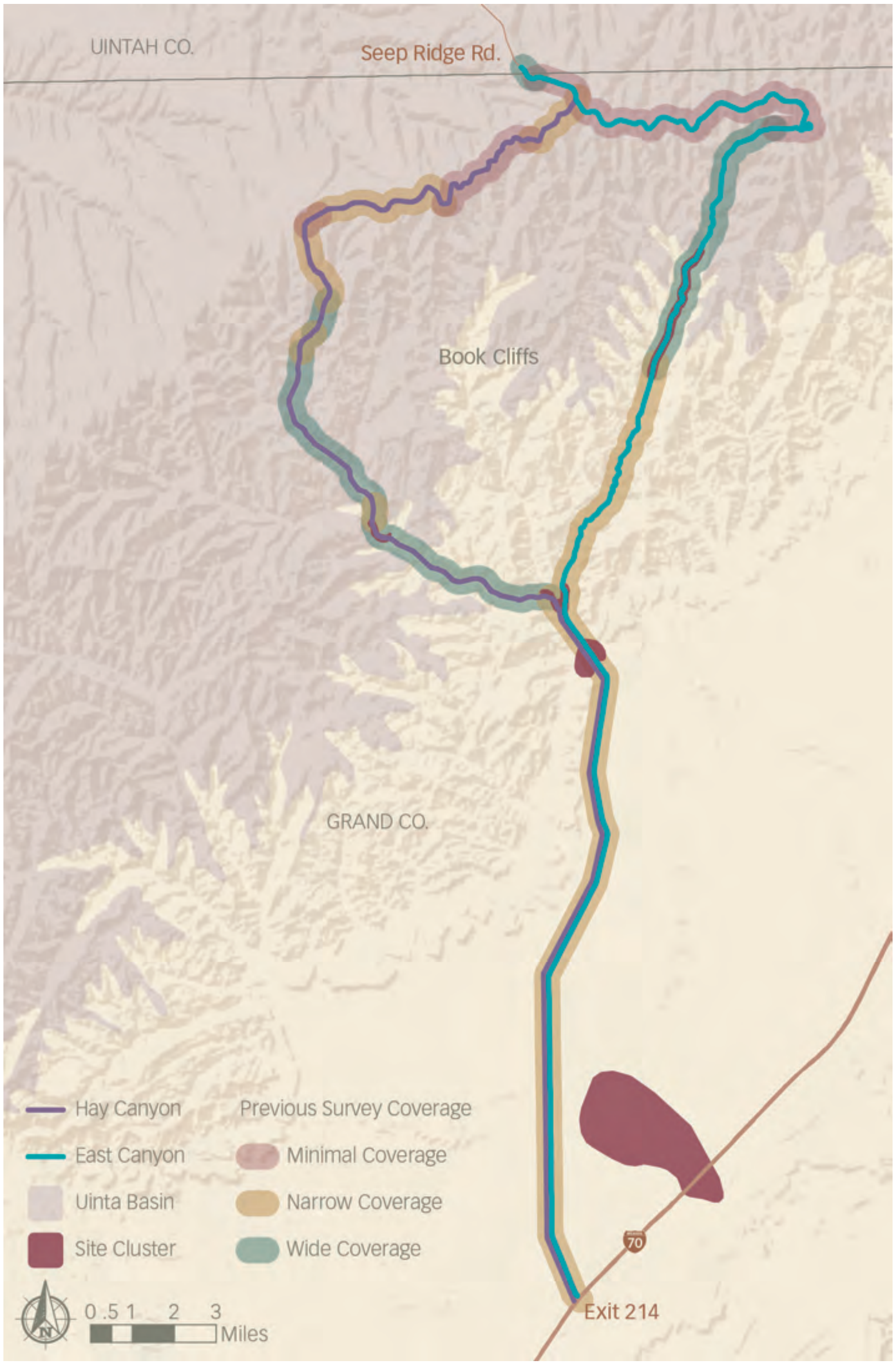
Many of the investigations conducted featured very narrow survey corridors that might not have covered the entire area of the study corridor. Wider surveys, which likely did cover the entire area of the study corridor, were also conducted in portions of both route alternatives. Minimal survey coverage was noted in multiple areas in the northern portion of the corridor. In these areas, either no investigations have been conducted in the past or the surveys that have taken place were generally perpendicular to the study corridor route alternatives. Previously surveyed areas along the study corridor are indicated on Figure 61.

Previous surveys along the Hay Canyon route alternative total 33,842 acres with 360 identified archaeological sites for a density of 0.0106 sites per acre, or one site every 94 acres. Previous surveys along the East Canyon route alternative total 24,987 acres with 258 sites for a density of 0.0103 sites per acre, or one site every 97 acres.

Cultural Resources Review Results

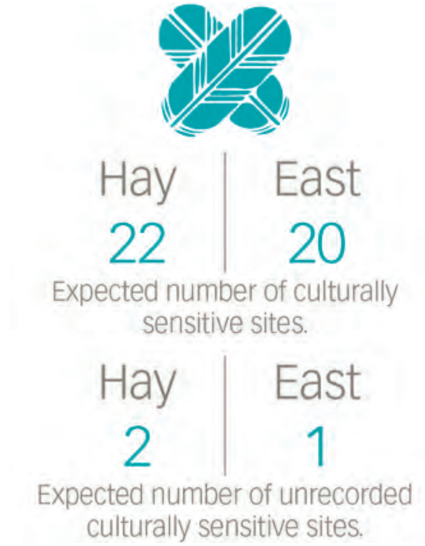
Based on the acreage of the 200-foot search radius for each route alternative, 22 archaeological sites are likely along Hay Canyon and 20 sites are likely along East Canyon. These estimates suggest that only a small number of unrecorded sites are likely to be encountered within the route alternatives in addition to the previously recorded sites that have been documented (20 previously recorded sites within the Hay Canyon alternative and 19 within the East Canyon alternative). The anticipated cultural resource impacts are summarized in Figure 62. For both route alternatives, sites would likely be clustered at canyon confluences.

Figure 61: *Cultural Resources and Surveys*



There are very few discernable differences between the two route alternatives regarding previous surveys and expected site counts. Because of the lack of recent surveys and inconsistent coverage of previous investigations, future surveys would likely be needed for either route alternative if the project advances through the NEPA process. Coordination with the Utah State Historic Preservation Office and other land managing agencies will also be necessary.

Figure 62: *Anticipated Cultural Resource Impacts*



7.3. Other Environmental Considerations

The 2014 UDOT Engineering Study referenced in Section 1.2 conducted high-level reviews of potential impacts to streams, water quality, wetlands, protected species, big game habitat, hazardous waste, and paleontological sensitivity. It concluded the East Canyon route alternative would encounter more stream intersection area, but because of the nature of the crossings, it would most likely include less water quality issues than the Hay Canyon route alternative. The UDOT Engineering Study also estimated the East Canyon route alternative would impact less wetland area. It also concluded that both route alternatives could impact protected species, both include pronghorn antelope, mule deer, and elk habitat that must be addressed in future environmental processes. The UDOT Engineering Study also concluded that neither route alternative appears to have hazardous waste sites present and both route alternatives have a high paleontological sensitivity (fossil-yielding potential). Overall, the UDOT Engineering Study expected the Hay Canyon route alternative to have moderate risk of environmental impacts and expected the East Canyon route alternative to impact the environment the least. As with other environmental impact considerations, additional reviews and analysis will need to be considered in the future if the project advances through the NEPA process.

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