Board of County Commissioners

Boulder County has in place a set of Policies to ensure that people of all opinions are comfortable attending public meetings and hearings, and are able to express their opinions without fear.

As public hearings and meetings are official civil proceedings, it is the policy of the Board of County Commissioners that the following Rules of Conduct be observed for all hearings in order to facilitate an orderly, respectful and fair discussion where all points of view may be heard and the Board may conduct county business:

C. Rules of conduct

1. It is inappropriate to cheer, boo, hiss, talk, cry out or applaud. Members of the public are not expected to agree on all issues but must make an effort to respect the process so that all viewpoints are heard.
…
4. The waving or posting of signs, banners or other materials in the hearing room is not allowed.

5. So that everyone can hear the proceedings, side conversations must be taken outside of the hearing room.

6. The use of profanity, threatening or abusive language is not allowed.
…
8. The placement of electronic recording devices and cameras, including but not limited to audio recorders, video cameras, still cameras, motion picture cameras or microphones, may be regulated by the Chair so as to avoid interference with the orderly conduct of the hearing.

In accordance with Boulder County Polices and Colorado State Law, disruption of a public hearing or meeting by audience members will not be tolerated. At the discretion of the Chair, the hearing or meeting may be suspended. In addition, individuals who violate the provisions of this policy may be subject to removal by law enforcement from the public hearing and/or the County Courthouse and, depending on the seriousness of the violation, may be prosecuted under state law.

Cindy Domenico *County Commissioner* **Deb Gardner** *County Commissioner* **Elise Jones** *County Commissioner*

Boulder County Courthouse • 1325 Pearl Street • Boulder, Colorado 80302 • Tel: 303.441.3500 • Fax: 303.441.4525
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Procedures for Boulder County Commissioners' 1/24/12 Public Meeting on Extension of the Current Moratorium on Acceptance of Oil and Gas Development Permits and the Proposed Transportation Impact Fee.

Boulder County has a long and storied tradition of protecting First Amendment rights and taking extensive public input on policy and legislative matters. However, we must balance the continued public input with our ability to conduct the business of the county.

There will be public testimony taken at this hearing. Speakers will have three minutes to give the Commissioners their thoughts on both the extension of the moratorium and the proposed transportation impact fees. Individual speakers may pool their time for a total of 10 minutes.

Individuals and/or groups who attempt to disrupt this meeting or who attempt to thwart the ability of specific speakers to address the Board will be asked to stop their disruption. If further disruption continues, those individuals will be removed from the Hearing Room and the Courthouse. If the disruption makes it impossible for the Board to conduct its business, the Hearing Room will be cleared and the meeting continued.

Disruption of this meeting is defined as significantly obstructing or interfering with the meeting by physical action, verbal utterance, or other means. This definition includes yelling, singing, chanting, mic check activities, shouting at the Board or other attendees, or other activities which make it impossible for the BOCC to continue the business on their agenda.

If a disruption occurs, the Chair will give notice that the disruption needs to stop. If it continues, the individual or group will be asked to leave the room. We ask that the disrupting party leave the room without incident; failure to do so will result in legal action.

Please also note that under our policies the interior of the Courthouse is expressly reserved for the functioning of county operations. The Courthouse Plaza, on the Pearl Street side of the Courthouse, has been designated as the public forum for protest activities. Any protests should occur outside the Courthouse.

Boulder County

Land Use

Courthouse Annex • 2045 13th Street • Boulder, Colorado 80302 • Tel: 303.441.3930 • Fax: 303.441.4856
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BOULDER COUNTY
BOARD OF COUNTY COMMISSIONERS

January 24, 2013, 4:00 P.M.

Commissioners' Hearing Room, Third Floor
Boulder County Courthouse
Boulder, Colorado

Public hearing to review results of final Oil & Gas Roadway Impact Study, to include consideration of setting appropriate transportation fees for oil and gas activities in the unincorporated county;

and

Continued public hearing on Docket DC-12-0003: Amendments to Oil and Gas Development Regulations for the limited purpose of considering text amendments to the oil and gas regulations necessary to implement transportation fees, if any;

and

Public Hearing to consider adequacy of the length of the current temporary moratorium on Boulder County's processing of applications for oil and gas development in the unincorporated County (Resolution 2012-16, adopted 2/2/12), in terms of finalizing regulations and developing a plan to administer those new regulations, to include discussion of setting appropriate permit review and related fees necessary to administer the regulations.

Coordinating Staff: George Gerstle, Transportation Director
Kimberly Sanchez, Planning Division Manager - Land Use Department
Jeff Robbins, Outside Counsel on Oil and Gas Issues

PACKET CONTENTS:

JANUARY 24TH AGENDA

I. COUNTY STAFF PRESENTATION

a. Review results of final Oil & Gas Roadway Impact Study, to include consideration of setting appropriate transportation fees for oil and gas activities in the unincorporated county.

b. Docket DC-12-0003: Amendments to Oil and Gas Development Regulations for the limited purpose of considering text amendments to the oil and gas regulations necessary to implement transportation fees.
*Note: No changes proposed. *

c. Adequacy of the length of the current temporary moratorium on Boulder County's processing of applications for oil and gas development in the unincorporated county and staff's proposed implementation plan to administer the oil and gas regulations adopted in December 2012.

II. PUBLIC COMMENT

3-min. allowance per individual speaker.
Time may be pooled (up to 10 minutes maximum) provided all individuals who are donating time are present. Anyone wishing to exceed 12 minutes must contact the Land Use Department with a request for consideration prior to the hearing.

III. BOARD OF COUNTY COMMISSIONERS DISCUSSION, ACTION AND/OR DIRECTION TO STAFF

OIL & GAS ROADWAY IMPACT STUDY

Action Requested from the Board of County Commissioners:

Staff requests that, following today's presentation and public testimony, the Commissioners provide direction to staff on the next steps you would like to pursue with regard to ensuring that the incremental impacts of oil and gas development on the public transportation system are mitigated and the cost of such mitigation is fairly and equitably allocated.

Background

On December 6 staff and consultants presented at a public study session the results of a study to determine the cost of incremental impacts to county roads that may result from future oil and gas road system and determine the appropriate level and type of fee to offset such impacts.

A copy of the full report is attached (Attachment A).

Policy Direction:

The Transportation Element of the Comprehensive Plan provides policy guidance on funding County transportation needs related to activities such as oil and gas development in the county. This direction includes:

> TR7.01: "Allow for special assessments to fund transportation improvements that specially benefit from such improvements,… and that funding mechanisms may include special assessments or other appropriate revenue-generating programs."

TR7.03: "Explore appropriate user fee programs that take into account the full costs of travel, including immediate and long-term impacts to facilities and the environment, to help fund transportation enhancements."

TR7.04: "Require property owners or developers to provide appropriate off-site transportation improvements that are necessitated by or reasonably related to the impacts of new development."

These Comprehensive Plan policies provide direction that the companies developing oil and gas wells should be responsible for mitigating the impacts to the transportation system associated with their development.

Methodology Summary: The methodology/steps used in the impact analysis included:

1. An inventory of existing county roadways and conditions within the Niobrara formation in eastern Boulder County
2. Information on the number of trips and vehicle types/weights associated with development and operation of oil and gas wells, assuming current commonly used techniques and practices. From this information, a travel model was developed to identify the likely number of trips and vehicle types, and associated vehicle weights on each roadway segment and the associated impacts of such development on the county transportation system.
3. Development of three scenarios: a low, steady and accelerated well development schedules based on expected COGCC spacing of wells and plausible allocation of drill rigs were developed to forecast the potential intensity and time frame oil and gas development. The table below summarizes the three scenarios that have been analyzed.

Summary of Scenarios

Scenario	# of Rigs In Use	# Pads/Year	# of Years	Total # of Producing Wells
Low	1	3	16	180
Steady	5	15	16	824*
Accelerated	10	30	9**	824

** 824 wells are the "maximum" number that can be developed in the study area assuming typical pad spacing and well clustering observed elsewhere in the Niobrara and through consultant discussions with COGCC personnel. In practice, the COGCC can approve a more or less dense field development pattern.*
*** The "Accelerated" scenario results in the same number of wells as the "Steady" scenario, but under this scenario, the wells are drilled more quickly (9 years) however the full 16-yr costs are considered in the fee calculations.*

Areas of Concern: The categories of concern associated with oil and gas development impacts consist of road deterioration and safety.

- Road Deterioration: Roadways used by oil and gas traffic will experience decreased overall pavement/concrete service life, resulting in the need for more frequent, and thicker, overlays and reconstruction sooner than would otherwise be expected under current use. For unpaved roads, the improvements needed to offset the impacts of oil and gas trucks

include more frequent dust suppressant application, grading, graveling, and paving where the truck volume is expected to significantly increase over an extended period of time.

- Roadway Safety: Increased heavy and large truck traffic will have significant safety impacts to both drivers and bicyclists using east Boulder County roads. Eastern Boulder County experience high volumes of bicycle usage. Conflicts between bicyclists and heavy trucks, especially on roads without shoulders, would likely increase with increased heavy truck traffic. Many roads in the eastern portion of the County do not have shoulders or safe passing areas that would be necessitated by the increased demand associated with cars passing slow moving heavy trucks, trucks entering or leaving the roads to access the well sites, or safe locations for either truck or cars to pull off the road out of traffic. Additional shoulders, or other improvements, may be needed to ensure the safety of the traveling public where substandard, or no, shoulders currently exist.

Summary of Oil and Gas Impacts on the County Transportation System

Road Type	Activity	Road Deterioration	Roadway Safety
Unpaved/Gravel Roads	More frequent		
	– grading	X	
	– re- graveling	X	
	– dust suppression	X	
Asphalt Roads	– Increased overlay frequency	X	
	– Poor roads wear out more quickly, require reconstruction sooner.	X	
	– Shoulder widening where substandard shoulders exist for safety		X
Concrete Roads	– Road wears out more quickly, requires reconstruction sooner than programmed.	X	

Impact Cost Analysis

The costs associated with the impacts identified above for the "Road Deterioration" and "Safety" categories were calculated for each scenario on a system-wide basis. A system-wide analysis is necessary since the specific location of wells/pads, the number of wells on each pad, the specific routes associated with well development for a specific well are not currently known, may vary depending on the contractor and source of water, fracking sand, etc. or necessarily controlled by company seeking or holding the permit.

The Oil and Gas Road Deterioration and Roadway Safety Cost Analysis is designed to evaluate only the incremental costs to the County transportation system resulting from oil and gas development based on the proportional expected road usage, and associated costs to the county, from oil and gas development.

For paved and concrete roads currently in good and fair condition, the proportionate share of the remaining service life of the road consumed by oil and gas related traffic was calculated and assigned costs assigned accordingly.

The cost of the asphalt for reconstructing paved segments currently in poor condition used by oil and gas related traffic is assigned to the oil and gas development. This is appropriate since these roads will require reconstruction much more quickly than would otherwise be the case and the county does not have the funds to accelerate reconstruction of these roads. Reprogramming of currently programmed funds to reconstruct of these roads would delay those currently programmed projects, with corresponding increases in their costs.

The safety mitigation costs were determined by identifying the roads with substandard shoulder widths (per Boulder County Transportation Standards) within the study area, and identifying the costs bringing those shoulders up to standard. This is important since the degree and impact of the heavy truck travel increases the risks to the traveling public on these roads beyond what would normally be experienced absent the traffic.

The total road deterioration and road safety mitigation costs resulting from oil and gas development for each scenario were divided by the number of new pads and producing wells installed over the 16 period.

Oil and Gas Transportation Impact Rehabilitation/Mitigation Costs By Scenario (2012 $)

Scenario	Total Road Deterioration Cost	Total Roadway Safety Mitigation Cost	Total Cost of Mitigation	Average Cost/Well by Scenario
Low	$5,965,501	$2,105,360	$8,070,861	$44,838
Steady	$24,661,955	$2,843,220	$27,496,175	$33,369
Accelerated	$24,429,296	$2,843,980	$27,273,276	$33,055

Average Oil and Gas Roadway Deterioration and Safety Costs 2012 $

	Deterioration Cost	Safety Cost	Total Cost
Per Pad	$1,200	-	$1,200
Per Well	$30,600	$6,200	$36,800
Example - 1 pad with 4 wells			
	$124,000	$24,800	$148,000

Cost Allocation by Roadway Category

	Deterioration	Safety	Total
Gravel	<1%	0	<1%
Asphalt/Concrete	83.5%	16%	>99%

AMENDMENTS TO OIL AND GAS DEVELOPMENT REGULATIONS FOR THE LIMITED PURPOSE OF CONSIDERING CHANGES NECESSARY TO IMPLEMENT TRANSPORTATION FEES

Action Requested from the Board of County Commissioners:

No changes are proposed; no action required.

TEMPORARY MORATORIUM ON BOULDER COUNTY'S PROCESSING OF APPLICATIONS FOR OIL AND GAS DEVELOPMENT

Action Requested from the Board of County Commissioners:

Staff requests that following today's staff presentation and public testimony, the Board of County Commissioners take action to extend the moratorium.

Moratoria Background

On February 2, 2012, the Board of County Commissioners enacted a temporary moratorium on the intake and processing of applications for oil and gas operations through adoption of Resolution 2012-16 (see Attachment B1). This six-month moratorium was then extended until February 4, 2013 by adoption of Resolution 2012-46 (Attachment B2). The purpose of these moratoria were to allow County staff a reasonable amount of time to explore the adequacy of the County's Comprehensive Plan policies and Development Plan Review (DPR) regulations, based upon a more informed assessment of industry activities and trends, anticipated associated land use impacts, and an appropriate regulatory response at the County level. The resolutions directed County staff to study the current regulations and to prepare necessary amendments to the current DPR process to ensure that the development of new oil and gas operations within unincorporated Boulder County is regulated in a manner to ensure protection of the environment, and the health, safety and welfare of the county's citizens.

The predominant reasons behind the moratorium included the recently rapid pace of development of the oil and gas industry in the Denver Julesberg Basin generally and Wattenberg Field in particular; potentially major changes in drilling and resource recovery methods and technology; growing public concern, County-wide, statewide and nationwide, over hydraulic fracturing operations including possible adverse water quality impacts and ineffective waste disposal methods; the impacts associated with evolving industry technologies in such areas as truck traffic and road usage, land surface disturbance and reclamation, location and extent of structures (well pads, tank batteries, fencing, and the like), noise and odor, and wildlife, soil, air and water resources; major amendments over the past five or so years to the Colorado Oil and Gas Conservation Commission's (and related state agencies') regulations, as well as the growing involvement of federal agencies such as the U.S. Environmental Protection Agency; the outdated nature of the County's oil and gas DPR regulations which were enacted in 1993 and never substantively amended thereafter; and the outpouring of letters, e-mails, and other expressions of concern by residents of Boulder County over the past several months, worried about existing and future oil and gas development plans and questioning the ability of state and local regulation to deal with associated impacts.

Amendments to the Boulder County Comprehensive Plan

With the renewed interest and activity surrounding oil and gas development and considering the ever-changing oil and gas regulatory environment, staff determined and the BOCC agreed that the existing oil and gas policies of the Boulder County Comprehensive Plan (BCCP) required revision in order to better capture these movements as well as to respond to public concerns about the impacts to health, safety and welfare that may accompany accelerated exploration and development in the Niobrara Formation within Boulder County, known as the Wattenberg Field, which has the potential for substantially increased oil and gas exploration and development into the future. Consequently, following enactment of the moratorium, the Planning Commission (PC) held four hearings to review oil and gas policy amendments for inclusion into the BCCP: one to authorize staff to proceed with drafting oil and gas policy amendments (May 16th) and three more on June 20th, July 18th and August 15th to review, critique and revise the draft proposals. This step was taken at the direction of the County Commissioners and is consistent with one of the principle functions of the BCCP, that being to provide policy guidance for the development of land use regulations. At the

August 15th hearing the Planning Commission adopted new text which consisted of the basis for the amendments, the definition of two terms used throughout the amendments, an Objectives statement, 12 new policies, and two policy revisions for inclusion into the Geology and Agricultural Elements of the BCCP. Extensive written and verbal public commentary was gathered and considered over the course of the process. The policies cover a range of subjects including the County's chosen roles and types of participation at various jurisdictional, stakeholder and policy levels; the identification of issues of concern and effective performance technologies and practices to be considered when reviewing oil and gas development proposals; information sharing and emergency response planning; cooperative use of infrastructure among operators to reduce the proliferation of duplicative facilities; public outreach and engagement; and the complete restoration and reclamation of impacted agricultural lands. In combination the oil and gas BCCP amendments establish a platform for a multi-pronged and comprehensive approach to working with oil and gas development issues across the County and among affected parties.

Amendments to the Boulder County Land Use Code

Following adoption of the Boulder County Comprehensive Plan oil and gas policy amendments, staff drafted and began the review process for proposed revisions to the Boulder County Land Use Code Article 4-900, Development Plan Review for Oil and Gas Operations and related provisions of the Land Use Code.

Planning Commission reviewed the proposed regulations and held public hearings/meetings on September 24th, October 1st, October 17th, and October 30th and recommended approval of the regulations to the Board of County Commissioners. On November 13th staff introduced the proposed regulations and related provisions of the Land Use Code to the Board of County Commissioners (BOCC). The BOCC heard from and asked questions of staff, the County's outside counsel, and the County's oil and gas technical consultant, and held a public hearing. The November 13th meeting was tabled to November 15th and then December 4th for further discussion and refinements to the proposed regulations. The regulations were ultimately adopted by the BOCC on December 13th (final resolution adopted on December 20th). (The adopted regulations and all related staff reports can be found on-line on the County's oil and gas webpage.)

The adopted regulations continue to use a slightly modified Development Plan Review process to review proposed oil and gas operations and contain two primary processes for the permitting of a new oil and gas operation: the Expedited Development Plan Review (Expedited DPR) process and the Standard Development Plan Review (Standard DPR) process. The Expedited DPR is a voluntary process that operators can opt for where approval can be obtained within a shorter timeframe, if the proposed oil and gas operation meets particular siting criteria that allow it to qualify for Expedited review. The Expedited DPR has specific objective standards that must be met and requires compliance with greater air and water quality protection measures than are required under the Standard DPR. The Standard review process is the County's regular (but updated) review process and can be used if operators do not qualify for the Expedited DPR or choose not to meet the requirements. The review criteria employed in the Standard DPR are subjective and goal-based and require an operator to submit site-specific mitigation plans to achieve environmental and other protections. Both the Expedited and Standard review processes provide the most protective land use regulations governing new oil and gas operations and each provides the highest level of protection to public health and the environment. However, the processes differ in their regulatory approach and whether they achieve compliance through objective standards (Expedited DPR) or evaluate impacts and require mitigation on an individual site basis (Standard DPR). Having two processes in the Code provides operators a choice if they can qualify for Expedited DPR.

The adopted regulations are intended to be consistent and harmonized with the authority delegated to the Colorado Oil and Gas Conservation Commission (COGCC). The overall procedural goal contained within the Draft Regulations is to work within the land use authority provided to counties by enacting the most protective land use regulations governing new oil and gas operations while at the same time recognizing the existence and extent of state authority over oil and gas operations by creating processes that harmonize actual application of the local regulations with the state regulations and state goals.

Implementation Plan

On December 4th as part of a combined hearing on the Oil and Gas Regulations, Docket DC-12-0003, the Board of County Commissioners held a public hearing to consider adequacy of the length of the current temporary moratorium on Boulder County's processing of applications for oil and gas development in the unincorporated County (Resolution 2012-16, adopted 2/2/12). Staff recommended that the Board table any decision to extend the moratorium until the regulations were finalized and in order for staff to develop an implementation plan to see if more time is warranted, as well as to allow opportunity for the County to coordinate with the COGCC in the State rulemaking hearings (see COGCC Rulemaking Hearings section below). The Board tabled the moratorium item until January 24th to receive additional information from staff.

Implementation is an essential part of adopting any new regulations. As was first indicated at the December 4th public hearing, in order for County staff to be equipped to start processing oil and gas development applications under the new, recently adopted set of oil and gas regulations there are a number of tasks that need to be accomplished. Over the past several weeks, staff has worked with the key involved County departments to identify needs and develop a plan to administer and implement the County's new (Article 12) oil and gas development regulations.

The Implementation Work Plan (Attachment C) identifies tasks and the estimated duration of time it will take to complete each of those tasks. The major components of the Implementation Work Plan include:

- Development of a RFQ and hiring of consultants / outside expertise
- Staff trainings
- Coordination with involved departments and agencies
- Preparation of application materials, handouts, and public information including website
- Development and adoption of planning and permit fees
- Inspection schedules
- Updating internal databases and tracking systems (i.e., Accela)
- Coordination with Industry on submission of applications
- Coordination with the COGCC to harmonize new State rules with County regulations

Each of these items is parsed out in Attachment C, along with an associated timeframe and can be discussed in detail at the public hearing. The estimated timeline was developed with the understanding that the oil and gas regulations are a complicated set of regulations that are much different than the regulations the County had been applying to oil and gas proposals in the past. Additionally there are a number of other new regulations that Land Use Department staff is in the process of implementing simultaneously, including both the recently adopted Stormwater (Docket DC-12-0003) and Agricultural (Docket DC-11-0003) regulations. Simply put, the County does not have the resources to dedicate solely to the oil and gas regulations so the implementation piece of the regulations will require some additional time.

Staff estimates that in order to prepare for processing of applications four additional months are necessary; therefore, staff is recommending that the BOCC extend the moratorium on Boulder County's processing of applications for oil and gas development in the unincorporated County until June 10, 2013.

Staff plans to have discussions with Industry regarding the creation of test applications, as well as the potential phasing of application submittals so the overall timeline could be adjusted depending on those discussions. Staff is also evaluating the idea of potential text amendments related to the phasing of application submittals or allowing more time for processing should there be an initial wave of applications greater than staff can practically process within the prescribed timeframes.

COGCC Rulemaking Hearings

In addition, staff and outside counsel Jeff Robbins participated in the recent Colorado Oil and Gas Conservation Commission (COGCC) hearings concerning ground water protection and setbacks. Boulder County was a party to the rulemaking and filed hearing briefs articulating its position on each proposed new rule. The County also reviewed the briefs filed by the other parties to the proceedings and filed rebuttal statements to the positions as advocated by Industry. The County and its staff attended both the two day December and the three day January hearings and presented extensive evidence and testimony on the setbacks rulemaking in particular. The time commitment associated with effective participation in the COGCC rulemaking hampered staff's ability to dedicate additional time to the implementation of the recently adopted Boulder County Oil and Gas Regulations to date. Also, once the new state rules are finalized, staff and outside counsel will need to evaluate the new rules to: (1) determine whether they mandate any changes to the County's oil and gas regulations, (2) determine whether the County needs to respond to the water sampling rule as applied to Boulder County, and (3) determine what implementation measures are necessary to ensure the state's rules and the County's rules can be applied harmoniously.

Industry Input

Staff continues to actively engage in discussions with Encana and Noble, the primary operators in Boulder County, and is talking with Encana regarding various aspects of implementation and opportunities to coordinate with Industry on January 17th.

Public Input

Many citizens provided initial input supporting a moratorium extension at the December 4th public hearing. All public comment received to date is available on the County's oil and gas website at: http://www.bouldercounty.org/dept/landuse/pages/oilgas.aspx

Summary and Recommendation Regarding Moratorium Extension

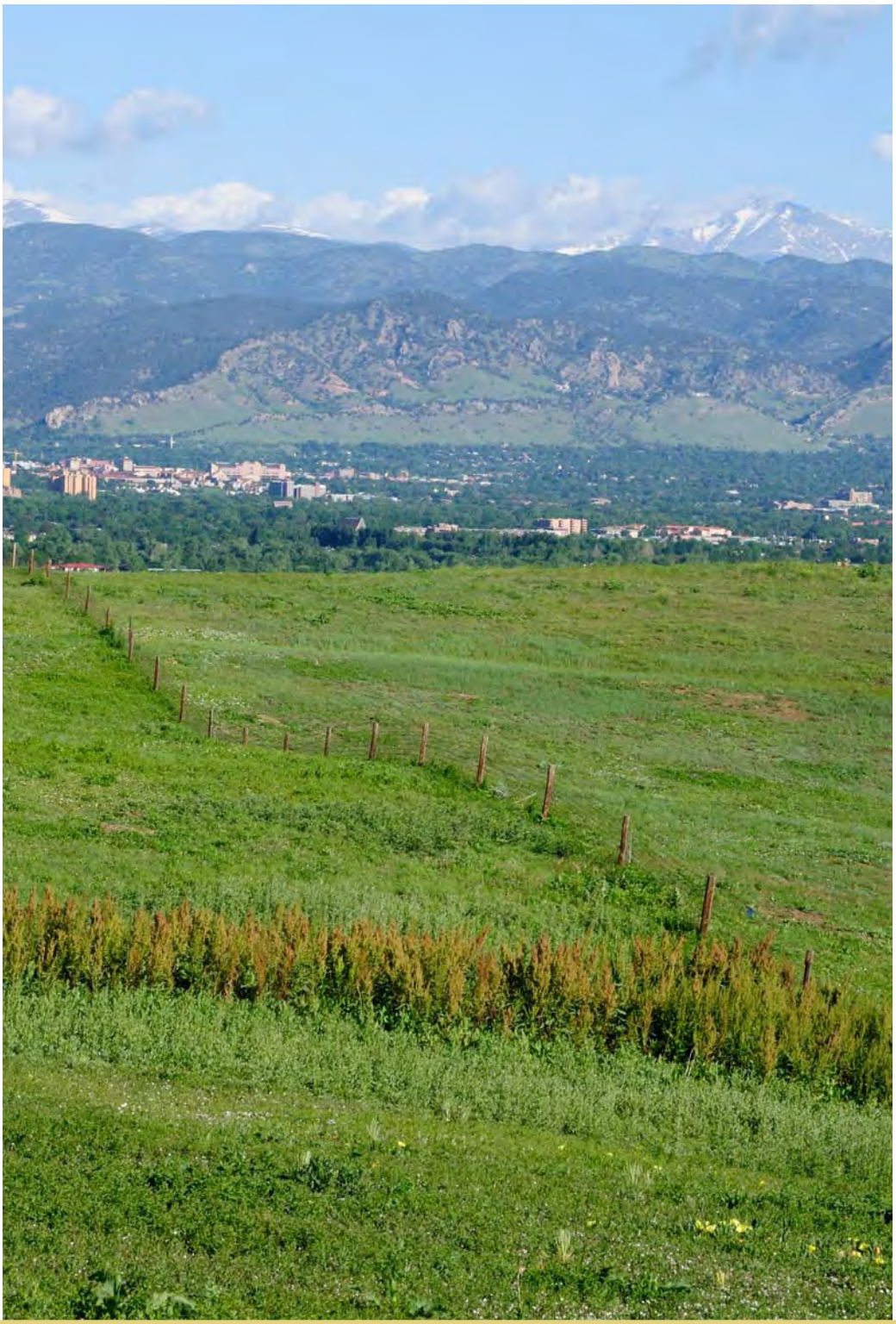
The County's recently adopted oil and gas development regulations enact the most protective regulations governing new oil and gas operations while at the same time recognizing the extent of state authority over oil and gas operations. Although the regulations were approved by the Board of County Commissioners in December 2012, implementation of those regulations is a necessary piece of their adoption for which County staff needs adequate time. Consequently, County staff is requesting an extension of the moratorium, which is currently set to end on February 4, 2013.

STAFF RECOMMENDS THAT THE BOARD OF COUNTY COMMISSIONERS EXTEND THE CURRENT TEMPORARY MORATORIUM ON BOULDER COUNTY'S PROCESSING OF APPLICATIONS FOR OIL AND GAS DEVELOPMENT IN THE UNINCORPORATED COUNTY UNTIL JUNE 10, 2013 AT 8:00 A.M.

boulder county oil and gas roadway impact study

Final Draft

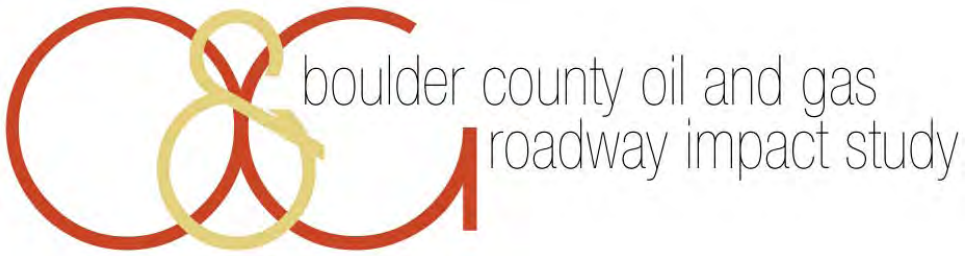
January 2013



FELSBURG HOLT & ULLEVIG

BBC RESEARCH & CONSULTING

Boulder County



FINAL DRAFT

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January 14, 2013
FHU Reference No. 12-109-01

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I. INTRODUCTION

Colorado is one of the nation's leading energy producing states. In 2011, Colorado was the 7th largest in total energy production, 10th in crude oil production and 5th in natural gas production. Oil and gas energy, in particular, is a growing sector in the region and ten of the nation's 100 largest natural gas fields and three of its 100 largest oil fields are found in Colorado (source: U.S. Energy Information Administration). One of the state's largest oil and gas producing areas is the Wattenberg Field and the Niobrara shale formation, including eastern Boulder County.

In 1901, oil was discovered in Boulder County and there are now hundreds of wells in the county. Because of Boulder County's close proximity to Weld County and the Wattenberg Oil Field, there has recently been a marked increase in the number of Boulder County oil and gas drilling permit applications.

The center of the Boulder Oil Field, 1902.
Source: Art Source International

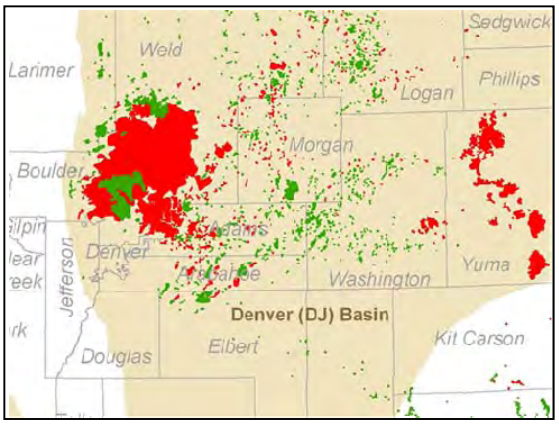
In February of 2012, the Boulder County Board of County Commissioners approved a temporary moratorium on local oil and gas permits. In April of 2012, the moratorium was extended to February 4, 2013 in order to study the potential impacts of significantly expanded oil and gas drilling in the region. During the moratorium the Planning Commission, Board of County Commissioners and Land Use Staff are working to study and update new oil and gas land use code regulations last updated in 1993. In November and December of 2012, the Planning Commission, Land Use staff and Board of County Commissioners entered into the review and public hearings stage to discuss the draft regulations.

Oil and gas drilling and production can impact local road systems, as well as other public infrastructure and services. Boulder County has commissioned this study to understand the potential impacts of oil and gas development and production on the County's road system and to design a road deterioration and safety fee to offset increased transportation maintenance, rehabilitation, and safety costs associated with heavy truck traffic and road damage.

Background

The Niobrara Shale

The Niobrara shale formation is a large geologic zone located in the central plains of North America. Remnants of ancient microorganisms that lived in the ancient inland sea about 85 million years ago comprise the shale formation. The geological zone spans portions of four states, including eastern Colorado, southeast Wyoming, western Nebraska and a small portion of northwest Kansas. The area is also referred to as the Denver-Julesburg Basin.



Oil and gas well locations in the Niobrara Shale in Colorado. Red indicates gas wells and green indicates petroleum wells.
Source: Buffalo Royalties, an energy management and investment company, 2011.

In 1901, the discovery of petroleum in Boulder County introduced energy production to the region. Because of advancements in technology and growing demand, oil and natural gas development began to dominate resource extraction activity in the basin. The production of natural gas in the Niobrara occurs predominately in the Colorado counties of Weld, Yuma and Washington and in southwestern Nebraska. Oil production is scattered throughout the region with higher concentrations in the north central and southwest part of the shale formation. As of December 2012, there were 49,993 producing oil or gas wells in Colorado, over 25,000 (approximately one-half) of which were in Niobrara Shale counties. A majority (about 19,700) of these wells is located in Weld County.

Colorado Front Range resource development over the past decade has been concentrated in Weld County. In the first 11 months of 2012, over 1,680 drilling permits were issued in Weld County while only a total of 103 drilling permits were issued in Adams, Arapahoe, Boulder, Morgan and Washington counties combined.

Boulder County Energy Development

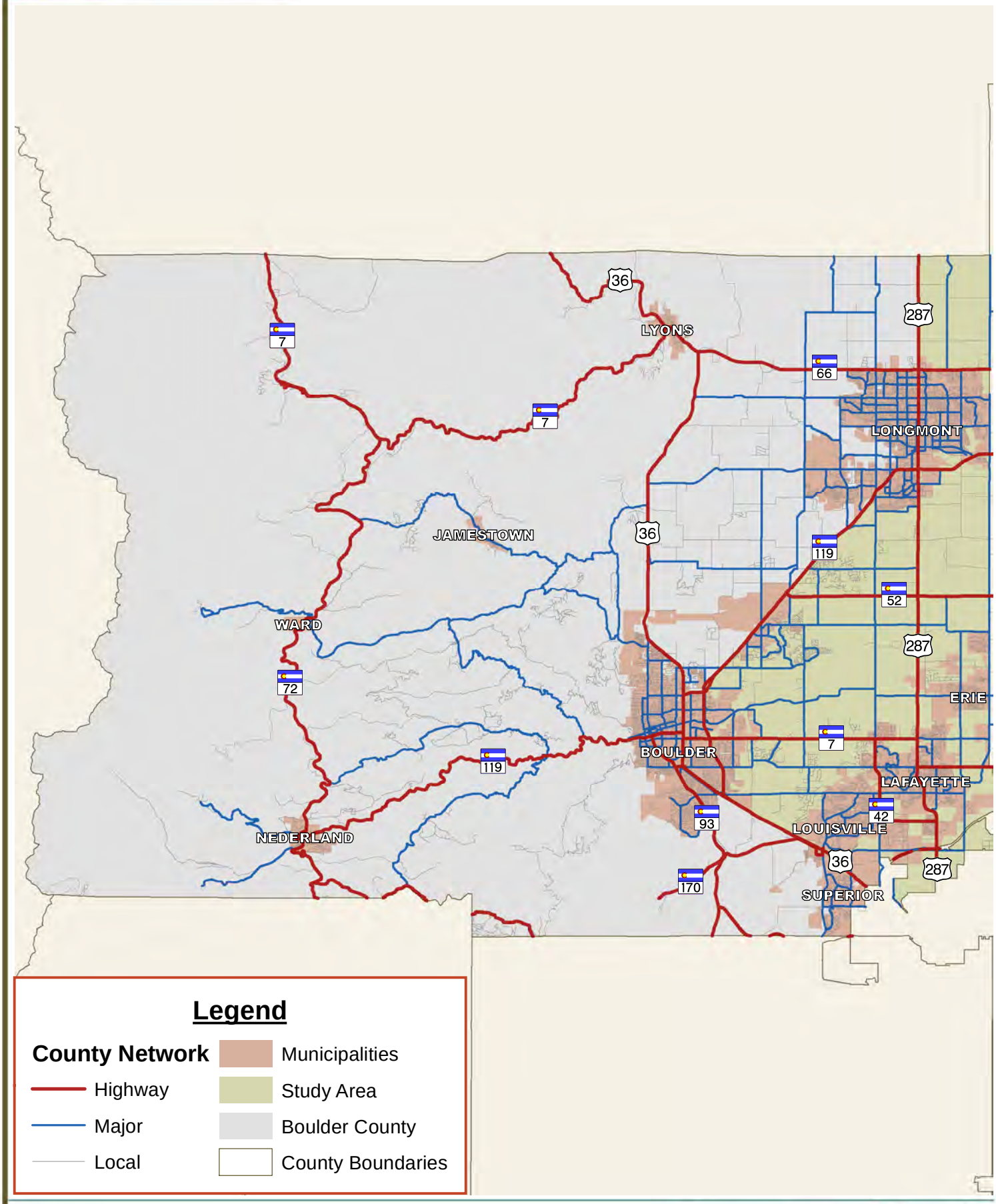
Due to Boulder County's location along the western edge of the Wattenberg Field, energy companies are in the early stages of a new wave of exploration and drilling in Boulder County. Many national and international factors will shape future levels of drilling activity, including oil and gas prices, national economic growth prospects, and the merit of the Niobrara Shale relative to other production areas. Locally, a host of additional factors will influence how quickly efforts are made to determine a new field's prospects. Boulder County is one of several counties that lie above the Niobrara Shale. Depending on the geology of the shale, drilling could occur in any of the counties.

As of December 2012, there were 323 active oil and gas wells in Boulder County. In the first 11 months of 2012, the state (COGCC) approved 22 drilling permits in Boulder County. These permits await local approval after the moratorium is lifted in 2013.

Figure 1 on the following page shows the study area that includes the eastern portion of Boulder County. This area is home to the highest concentration of currently producing wells in the county and is likely to be the target area of new development. The oil and gas study area is defined as the unincorporated county land bordered by US 36 to the south, SH 119 and US 287 to the west and the eastern county line. All municipalities within the boundaries are excluded from the study area.

Based on producing wells in neighboring counties, energy companies will likely be primarily drilling for natural gas, and well depths will likely be between 6,000 and 8,000 feet.

Figure 1
Study Area



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Boulder County
NORTH

Study Purpose

With the heightened interest in future oil and gas activity in and around Boulder County, the County issued a moratorium on drilling in February 2012. Since then, the County has worked to research and characterize many facets of oil and gas land use. This study is part of the broader update of the proposed oil and gas land use regulations. The study seeks to understand the potential impacts of oil and gas development to the county roadway system and to design fees as a prospective method to recover incremental costs associated with road deterioration and safety.

Because of the uncertainties associated with renewed oil and gas development in Boulder County, this study looks at three potential development scenarios (accelerated, steady, and low) in order to provide a range of potential road deterioration and safety costs. This study is not intended to predict oil and gas development location or intensity, rather to provide County officials with information about the potential impacts to the transportation system and associated county costs using an informed set of development scenarios based on the best available data.

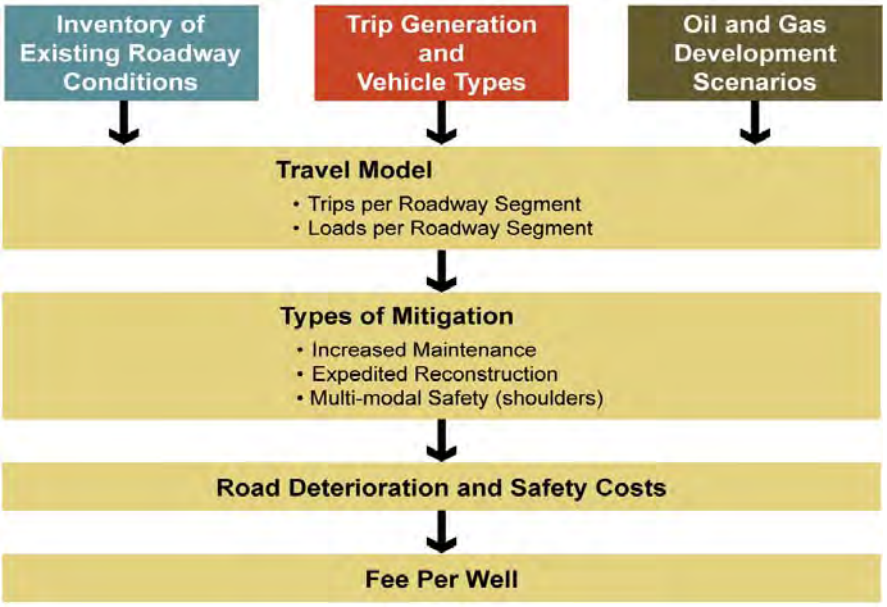
This study includes the design and calculation of road deterioration and safety fees that could offset the transportation-related damage of oil and gas development. Boulder County has broad power derived from state statutes to regulate public roads over which it has jurisdiction. The oil and gas road deterioration and safety fees are designed and structured within these parameters in cooperation with the Boulder County Transportation Department and County Attorney's office.

Process

To achieve the study purpose of assessing the potential impacts to the transportation system, quantifying maintenance, rehabilitation, and safety needs and calculating an appropriate road deterioration and safety fee, a series of analytical techniques have been used. The three primary inputs to the study process are shown on the top row of **Figure 2**. The inventory of existing roadway conditions provides a baseline for identifying investment needs that might result from oil and gas truck impacts. The trip generation and vehicle types provide the foundation for assigning trips and vehicle loads to the county roadway network. Finally, the oil and gas development scenarios serve to bracket the potential levels of impact.

All three primary inputs have been used in the development of a travel model, which assigns both oil and gas trips and loads to individual county road segments. Using the results of the travel model, mitigation strategies can be identified based on roadway maintenance needs, roadway rehabilitation and roadway safety improvements, resulting in incremental roadway deterioration and safety costs associated with each development scenario. After the incremental costs of road deterioration and road safety costs are calculated, a fee is designed to recover these costs during the oil and gas land use application process.

Figure 2. Study Process Diagram



Each box in **Figure 2** represents a set of calculations, many of which require assumptions because of the uncertainties of oil and gas development in general (e.g., the intensity of development), as well as the development potential of the field in Boulder County. The study team has relied heavily on input from previous studies pertaining to the impacts of oil and gas development from the Marcellus Shale in Pennsylvania, Barnett Shale in Texas and Uinta Basin in Utah. Likewise, the study team conducted a series of interviews with key industry representatives and COGCC staff for insight in establishing the development scenarios and understanding how and where oil and gas trucks could potentially impact the county roads. A list of references and a summary of the interviews are provided in **Appendix A** and **Appendix B**, respectively.

II. RESOURCE DEVELOPMENT

Well Development Overview

There are five stages in the development and operation of an oil or gas well:

- **Leasing and exploration** – Obtaining mineral rights and developing a well drilling program.
- **Pad construction** – Preparing the site, including building the access road and the well pad.
- **Drilling** – The process of drilling the well to the desired depth and completing the requisite number of horizontal bores.
- **Completion** – Converting the well system to a producing well, typically by fracturing the shale and completing the production well requirements. Removing flowback water from the well pad.
- **Production** – Extracting, storing and distributing the resource.

This process, as it is likely to occur within Boulder County, is described in greater detail in the following sections.

Leasing and Exploration

Drilling requires acquisition of subsurface mineral rights, which are often, but not exclusively, owned apart from a property's surface rights. Energy companies that have an interest in exploring an area for energy prospects, or extracting resources from a known reserve, must first buy or lease the appropriate subsurface ownership rights. Companies often negotiate mineral right acquisition on speculation, before the presence of productive resource is certain. In many instances, there can be aggressive leasing activity, which is followed by very little immediate development activity, or an area can be determined to be an unproductive source after a few test wells. Active mineral leasing efforts do not ensure future energy extraction.

Geologists and petroleum engineers will target an area for exploration, typically based on nearby well development patterns, and then company representatives will seek out property owners to acquire leases. Companies often try to maintain secrecy in this process in order to reduce speculation and keep lease costs down. Most companies will try to control a large area so that multiple wells can be drilled and the economic benefits of expensive exploration, leasing and well field development can be efficiently recovered. Often multiple companies will share in an individual well's, or a field's, financial returns.

With mineral rights secured, energy companies will approach the Colorado Oil and Gas Conservation Commission (COGCC) for confirmation of a drilling and spacing plan, which suggests the area in which initial drilling will occur. Companies may approach drilling operations slowly, spending time researching and surveying to determine the best locations for individual well development. If mineral rights are secure, companies sometimes allow other operators to proceed, modifying their own plans based on their competitors' success or failures. Many factors can influence how quickly efforts are made to determine a new field's prospects. Geological surveys, seismic exploration, core sampling and exploratory wells are common tools used to gauge the potential productivity of a region.

Exploratory wells are placed in order to obtain core samples and determine the likely productivity of the target shale. Results from the exploratory wells and the geography of an individual company's mineral rights holdings will dictate the larger field development strategy.

Pad Construction

The first stage of development is the construction phase. In the construction phase, crews build a road to the drilling site and construct a well pad. This process requires building a gravel road and grading a pad site generally 3 to 5 acres in area. Some pad sites contain multiple wells that may range from one to twenty, however the road and the pad require roughly the same amount of construction equipment, materials and truck trips.

Constructed well pad in Pennsylvania.
Source: Linde Corporation

Drilling

The next stage of development is the drilling stage. This stage requires one drilling rig to drill the well bore into the earth and continue horizontally in the direction of the intended extraction locations. In the Niobrara Shale, typical wells reach depths of between 6,000 to 8,000 feet and can extend a mile horizontally into the shale formation. If the site is a multi-well pad, the same single rig generally drills all wells on the pad. While the drilling rig transport is sensitive to the number of pads constructed, transportation of other materials including drilling fluid and materials, drilling equipment, casing and drill pipe are all "well sensitive", meaning each well will require additional materials. The number of trips required to transport the drilling materials will increase with each well on the pad. A well requires about 15-25 days to be drilled depending on the desired depth and lateral extension of the well.

Horizontal Drilling Rig in Pennsylvania.
Source: Matthew Burns, Go Marcellus Shale

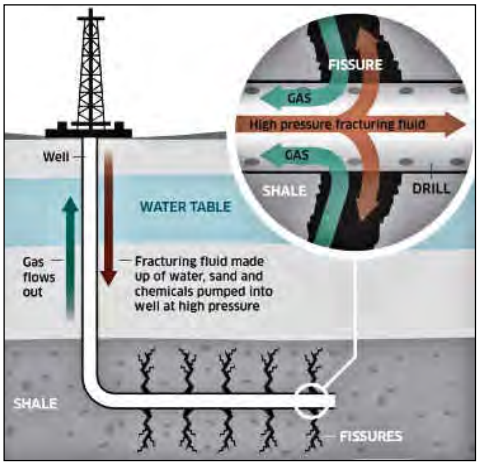
Completion

Once drilling is complete, the drilling rig is replaced with a multitude of hydraulic fracturing equipment including blender trucks, pump trucks, water tanks, flowback water trucks and fracture sand. Most of the completion equipment is well sensitive, meaning the number of trips will increase depending on the number of wells

Completion rig and trucks on a well pad.
Source: MIT Technology Review, Les Stone/Corbis

on each pad. Well completion requires significant truck trips primarily because of the water required in fracking the wells and the disposal of flowback water. On average, well completion requires between two and four million gallons of water. A typical water truck has capacity of between 5,000 and 6,000 gallons. Thus, on average, hauling water to the site and flowback water away from the site requires about 700 water round trips or about 1,400 one-way trips.

The workers first use a fracking gun to penetrate through the well casing and fracture the shale at the furthest depths of the well. Once the well has been penetrated by the fracking gun in the appropriate areas, a highly pressurized mixture of water is pumped into the fractures starting at the deepest end of the well. The fracking fluid flows through the fractures and begins to crack the shale along natural weaknesses in the rock. Proppant, usually a sand mixture, is introduced into the fractures to keep the cracks open and help oil and gas escape into the well. The workers use a series of plugs to maintain the pressure of a fracked segment and continue to frack the shale along the horizontal well. During this stage, between three and five million gallons of water are pumped at high pressures into the shale and then subsequently retrieved. Under the state's Oil and Gas Commission guidelines, all water used in this process is either recycled or properly disposed of under Commission regulations. The importation of water to the well and the subsequent removal to an approved disposal site is the most truck intensive element of a well's development.



Drilling and completion stage technology: hydraulic fracking and horizontal drilling. *Source: Sustainable Online Magazine, 2010*

Once each of the arms of a well is sufficiently fractured, the plugs are removed and the well is ready for production, or the extraction of oil and gas. The completion stage takes between 15-20 days, depending on the depth and horizontal extension of the well.

Production

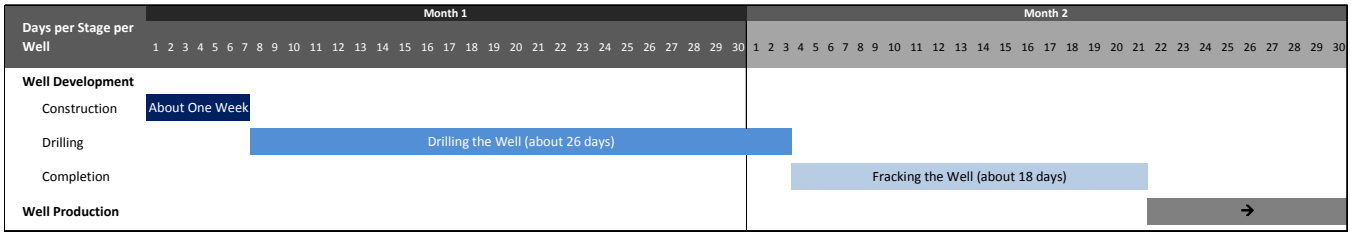
Once the well is complete, the well pad transitions to the production phase of pumping oil or gas and produced water from the well for storage, disposal or distribution. This requires the removal of completion machinery and the installation of production machinery including a wellhead, machines that separate the oil, gas and water, resource storage tanks and other well monitoring equipment. As oil and gas is pumped from the well, the contents are sent to machines that separate the oil, gas, water, and other gases. The produced water is either released into evaporative ponds or injected into underground injection wells, which often requires transport by pipeline or truck. The well maintains optimal pressure to continue the production of energy resources and is monitored by pressure gauges. If any abnormality is indicated, the well maintenance crew, located off-site, is automatically notified.

During the production phase, the number of truck trips required for each well drops significantly to about two truck trips per day or 730 trips annually. These trucks are necessary for minor well maintenance while larger vehicles are required for resource collection and any other major tasks supporting production. Production trips continue throughout the life of the well, possibly 15 to 25 years. In areas of highly clustered energy development, pipelines transport energy and waterlines transport produced water away from the site to common holding or distribution facilities.

Duration of Well Development

The approximate timing of constructing, drilling and completing a traditional single-well oil and gas well in a shale formation is between 45 and 60 days. **Figure 3** shows the schedule of developing one well on one pad site. Constructing the access road and pad takes about a week to complete. The drilling phase, including horizontal drilling, takes about 20-30 days to complete. The completion stage, including hydraulic fracturing, takes roughly 15-20 days to complete. Finally, the production phase lasts for the remaining life of the well, possibly 15-25 years. Multi-well pads have an extended development schedule.

Figure 3. Approximate Time Schedule to Develop One Well on One Pad Site



Sources: Capita Wells/Stagecoach Area Final Environmental Impact Statement, 2005; Tribal Energy and Environmental Information Clearinghouse, 2010.

Transportation Demands of Oil and Gas Development

Trip Generation

Oil and gas development requires the transport of heavy equipment to the well site to build access roads, construct a well pad and transport a drilling rig. Heavy trucks are also required to bring fresh water to the well site and often to transport produced water and extracted resources off site. There are three independent studies that inform a model of approximate truck trip generation in Boulder County. These studies were conducted by the National Parks Service, NTC Consultants and the Utah Department of Transportation (UDOT). Multiple studies focused in the Marcellus Shale formation in Pennsylvania, New York and Ohio refer to the truck trip data of the National Park Service study. In addition, other Marcellus Shale development studies use NTC truck trip data. The UDOT study quantifies potential truck trips of oil and gas development in the Utah's Uinta Basin.

The study team also conducted a literature review to determine if new research has been published related to energy development and transportation effects. The team interviewed knowledgeable persons that are connected to oil and gas development in the Niobrara Basin, including extensive discussions with well permitting staff at the COGCC.

National Data Sources on Single Well Trip Generation

Table 1 shows data extracted from multiple national and regional studies examining vehicle trip production by well development phase. The trips of each study are averaged across each phase of development and then summed to calculate trip generation figures.

Table 1. National Data on Trip Generation per Well

Phase		NPS 2008 1 pad, 1 well	NTC 2011 1 pad, 1 well	NTC 2009 1 pad, 1 well	UDOT 2006 1 pad, 1 well	Average 1 pad, 1 well
Construction	Pad and Road Construction	55	180	56	55	87
Drilling	Drilling Rig	60	190	60	60	93
	Drilling Fluid and Materials	75	90	75	30	68
	Drilling Equipment (casing, drill pipe, etc.)	75	190	75	-	113
Completion	Completion Rig	30	-	30	65	42
	Completion Fluid and Materials	30	40	30	70	43
	Completion Equipment (pipe, wellhead, etc.)	10	10	10	-	10
	Fracturing Equipment (pump trucks, tanks, etc.)	250	350	350	-	317
	Fracture Water	1,052	1,000	1,000	1,100	1,038
	Fracture Sand	48	46	45	52	48
	Flowback Water Disposal	-	200	500	-	350
Total Development Trips						**2,206**

Sources:

"Potential Development of the Natural Gas Resources in the Marcellus Shale", National Park Service, December 2008

"MIT Study on the Future of Natural Gas", NTC Consultants, 2010

"Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low-Permeability Gas Reservoirs", NTC Consultants, September 2009.

"Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low-Permeability Gas Reservoirs", NTC Consultants, February 2011.

"Highway Freight Traffic Associated with the Development of Oil and Gas Wells", Utah Department of Transportation, October 2006.

All trip estimates in **Table 1** include both inbound and outbound trips (Example: NTC 2011 identified 180 construction trips or 90 inbound and 90 outbound trips). The average trips per well data are for a specified development period of roughly 1.5 to 2 months, while the production related trips are expressed as annual trips and will continue for the duration of the well's production.

These data suggest that a typical well will generate about 2,206 trips during its two month development period or an average of 36 trips per day, largely related to water delivery and removal.

Production Phase Trip Generation

There are a number of factors that determine trip generation during the production stage including the nature of the field, success of wells and storage capacity for produced water and resource at the well pad. Based on a number of studies including a report by the Texas Department of Transportation (TXDOT) on the Barnett Shale, we expect an annual trip count of 730, based on 2 trips per day per well pad.

According to the TXDOT study, about 706 total trips are required per year to maintain a well pad (353 trucks per year). In addition, every five years another 1,994 trips (997 loaded trucks) are needed to "re-frack" a well. This brings the annual total trips to about 1.93 trips per day and an additional 5.5 daily trips every 5th year. However, the frequency and extent of re-fracking is uncertain. Because of this, an estimate two trips per day over the life of a well has been used.

Multi-Well Pad Site Trip Generation

As new horizontal drilling and fracturing techniques come into Boulder County, the regional standard practice is likely to become multiple wells on a single pad.

In order to make a reasoned and informed estimate on truck trip generation, the project team used the data from the four studies outlined in **Table 1**. The studies contain essentially the same stages of well development and are in one rig, one well format. However, based on industry trends, recent well permits and regional well-per-pad ratio intensities, Boulder County well development is expected to consist of a one rig, four well design. This change in development intensity and pattern will affect traffic generation and the traffic profile associated with drilling activity.

Table 2 shows the trip sensitivity by development stage from the 2009 NTC study. The project team used the underlying relationships in the study to adapt trip generation figures in all studies from one pad, single well pads to one pad, four well pads. The process involves increasing well-sensitive trips, such as fracking water and drilling fluid hauling, while holding pad-sensitive trips, such as pad construction trips and drilling rig transport, constant.

Table 2. Trip Generation Sensitivity for Single to Multi-Well Pad Conversion

Activity	Trip sensitivity
Construction Stage	
Pad and Road Construction	Pad sensitive
Drilling Stage	
Drilling Rig	Pad sensitive
Drilling Fluid and Materials	Well sensitive
Drilling Equipment (casing, drill pipe, etc.)	Well sensitive
Completion Stage	
Completion Rig	Pad sensitive
Completion Fluid and Materials	Well sensitive
Completion Equipment (pipe, wellhead, etc.)	Pad sensitive
Fracturing Equipment (pump trucks, tanks, etc.)	Pad sensitive
Fracture Water	Well sensitive
Fracture Sand	Well sensitive
Flowback Water Disposal	Well sensitive

Source: NTC Consulting, 2009

III. OIL AND GAS DEVELOPMENT SCENARIOS

This chapter provides potential future oil and gas development scenarios in Boulder County based on a blended methodology using expected well spacing and historic drilling rig counts. The study team also examined historic well development in active counties in Colorado to validate the development scenario estimates.

Due to its location in the Niobrara region along the western edge of the Wattenberg Field, energy companies are in the early stages of a new wave of exploration and drilling in Boulder County. Many national and international factors will shape future levels of drilling activity, including oil and gas prices, national economic growth prospects, and the merit of the Niobrara Shale relative to other production areas. Locally, a host of additional factors will influence how quickly efforts are made to determine a new field's prospects. Boulder County is one of several counties that lie above the Niobrara Shale. Depending on the geology of the shale, drilling could occur in any of the counties.

The study team developed a set of three future development scenarios based on expected well spacing and historic rig counts. The following exercise is not an attempt to predict the future, but rather an effort to develop an informed set of development scenarios based on the best available data.

Scenario Development Methodology

As part of the background research effort, the study team reviewed information from multiple sources, including local news outlets, energy company investor literature and the Colorado Oil and Gas Conservation Commission (COGCC). The goal of the literature review was to document current statewide and Front Range well drilling activity and field spacing patterns.

Future development scenarios were derived by mapping Boulder and neighboring counties and determining potential well development given expected well spacing patterns. The study team used historic drilling rig utilization rates to derive an estimate of the potential pace of well development over a 16-year period.

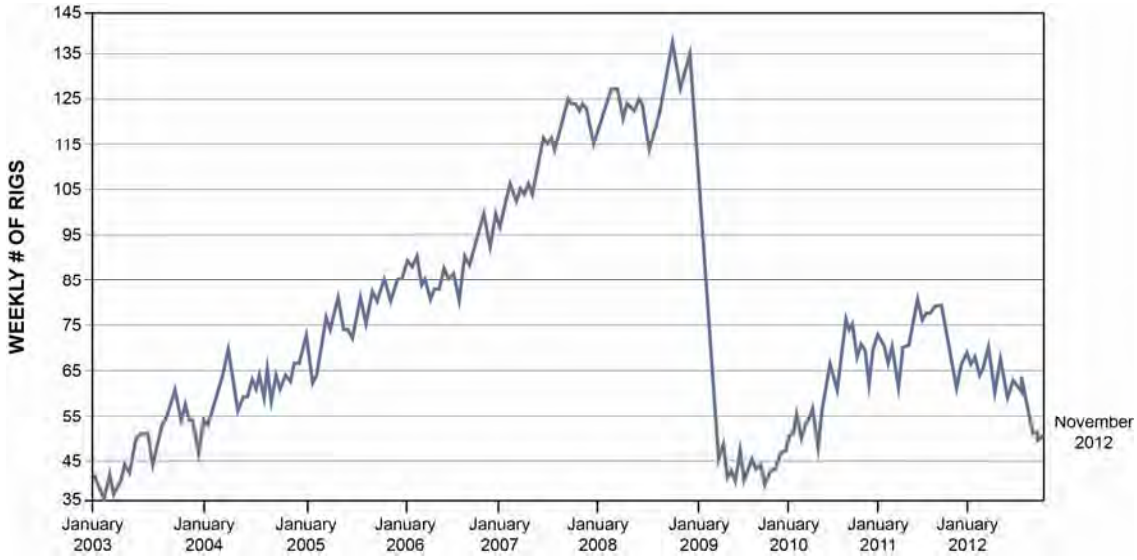
Rig Utilization

Drilling rigs are a large capital investment for any oil and gas development company. Drilling rig purchase or rental costs represent a significant barrier to entry into the industry. According to Baker Hughes, an oil field service company that tracks drilling rigs, there were 1,800 drilling rigs operating in the U.S. on December 7, 2012. Of those rigs, about 53 were operating in Colorado according to the COGCC.

Figure 4 shows the number of drilling rigs in operation in Colorado by week from 2003 to the present. The graph above shows operating drilling rigs peaked in fall 2008, before dropping precipitously. In fall 2008, there were nearly 140 drilling rigs in operation in Colorado. According to the most current estimate, there is less than half of the historic peak rig activity currently in operation in the state.

As of December 10, the COGCC reports that about 33 rigs are operating in Weld County, 9 rigs in Garfield County and 11 rigs spread among other counties in the state. Rig allocation has not topped 40 rigs in any one county in Colorado since the beginning of 2011.

Figure 4. Total Drilling Rigs Running in Colorado (2003-November 2012)



Source: COGCC Colorado Weekly & Monthly Oil & Gas Statistics, November 27, 2012.

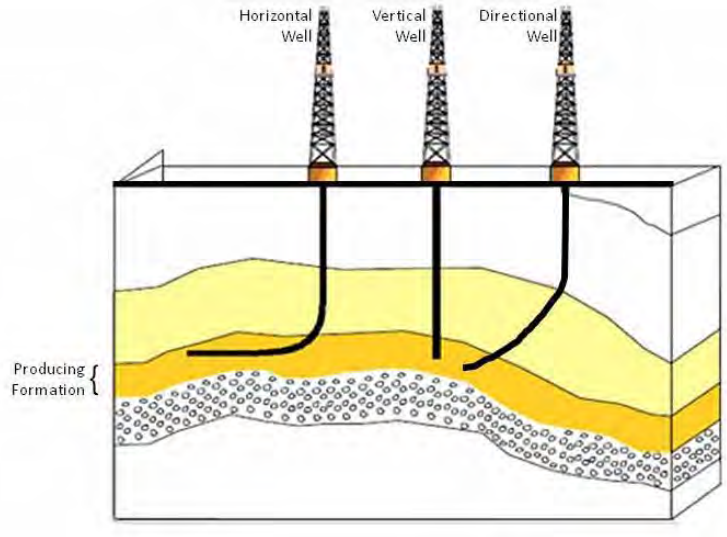
The study team contacted COGCC staff to discuss drilling scenario development. COGCC staff described a favored methodology, where drilling rigs and the well drilling period can be used to calculate the total amount of annual wells drilled per year. The information presented in Chapter II indicates that, in general, a typical well would take approximately 30 days to drill. Therefore, one rig can drill about 12 wells per year. Oil and gas companies have a finite amount of capital resources and operating a drilling rig is expensive and requires a significant capital commitment.

Oil and gas operators will allocate drilling rigs to areas that show the most promise in developing a productive well. Depending on their land holdings, oil and gas companies will consider other counties along the Front Range, Western Slope and across the nation, when deciding where to drill.

Boulder County Well Types and Spacing

The Wattenberg Field is one of the oldest oil and gas fields in Colorado and has seen a variety of drilling techniques to reach the resource rich formations. Past well development techniques in the area include directional and vertical wells to reach targeted resource deposits. **Figure 5** illustrates the types of drilling techniques in the Wattenberg Field.

Figure 5. Well drilling techniques

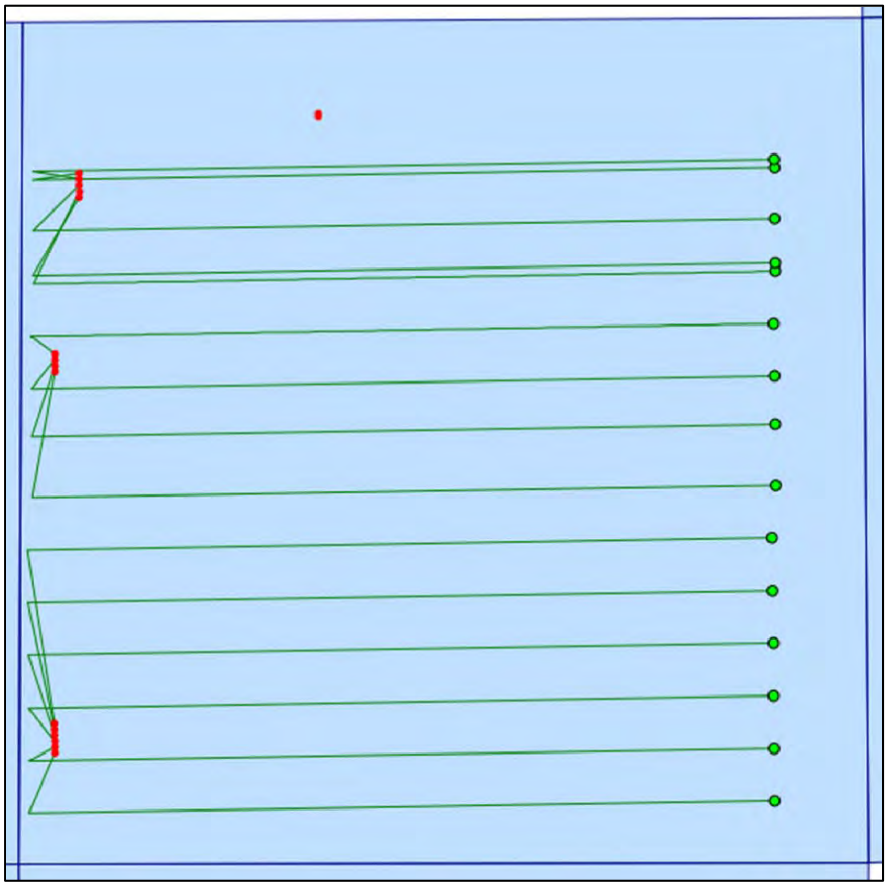


Source: Energy Information Administration, Office of Oil and Gas, BBC Research & Consulting.

Energy companies have learned over time that the most effective method to extract the hydrocarbons from shale formations is to drill horizontal wells and frack the shale to release the resource.

The study team met with COGCC well permitting staff to discuss current trends in the Wattenberg Field and possible future well development scenarios in Boulder County. The identified development study area lies within the boundaries of the Greater Wattenberg Area (GWA) and is subject to Rule 318A to guide the spacing parameters of new wells based on setbacks from lease lines, other well heads and frack lines. The most current spacing guidelines and setbacks for the Wattenberg allow generally for a maximum number of 16 horizontal wells in one square mile section. This rare and high-intensity development pattern is found primarily in Weld County above the Wattenberg Field "sweetspot." **Figure 6** shows a sample square-mile section in Weld County obtained from the COGCC online GIS tool.

Figure 6. Horizontal Wells in Square-Mile Section, Weld County, December 2012



Source: COGCC GIS Online.

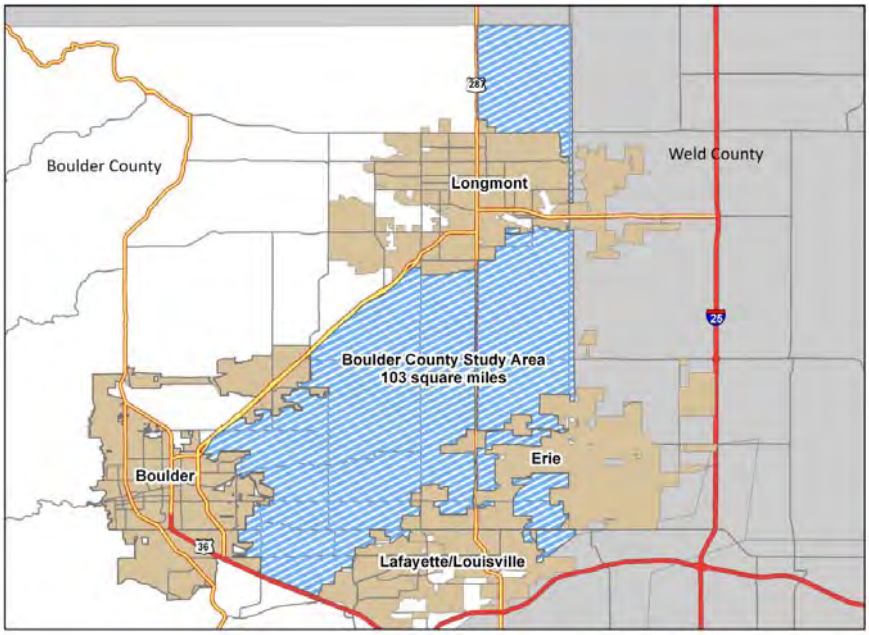
The Weld County square-mile section (**Figure 6**) shows a three pad development pattern with four, five, and six horizontal wells on the pads. The three clusters of red dots indicate the well pad and the well entry point of each well at the surface. The green lines represent the direction of the vertical and horizontal well bores. The angled green lines of the vertical wells spread to the desired depth and bend to the horizontal straight lines to show the extent of the horizontal drilling pattern. The green dots at the end of each horizontal line represent the "bottom holes" or the end of each well bore. Given this particular section, there are 15 horizontal wells in one square mile section.

The study team used well density in Weld County as a guide to future oil and gas scenario development. According to recent permits observed in the region, energy companies are mainly receiving permission to develop two pads and between four and 12 horizontal wells on each pad. Given this precedent, a typical development pattern of two well pads with four horizontal wells per 640-acre spacing unit (or one square mile) can be expected in unincorporated portions of Boulder County.

Boulder County Development Scenarios

The study team used the historic drilling rig activity and COGCC regulated spacing units to derive three hypothetical future well development scenarios. **Figure 7** shows the 103 square-miles study area in eastern Boulder County. The map also illustrates the study area's location and proximity to major roads in and outside of the county.

Figure 7. Boulder County oil and gas development region



Source: BBC Research & Consulting

Based on the 103 square-mile size of the study area and the expected pad spacing, the capacity in the area is 206 pads, or two pads per square-mile section. Given the expected four wells per pad drilling method, there is a capacity of 824 wells in the study area. **Table 3** presents the Boulder County baseline development assumptions for the oil and gas study area.

Table 3. Boulder County Baseline Capacity Assumptions

Category	Value
Baseline Assumptions	
Boulder County Area (Sq. Mi.)	751
Study Area (Sq. Mi.)	103
Pads per Square Mile	2
Wells per Pad	4
Boulder County Development Capacity (Pads)	206
Boulder County Development Capacity (Wells)	824

Note: The underlying assumptions are a calculation of development capacities in Boulder County, given the standard COGCC spacing.

Source: BBC Research & Consulting

Table 4 shows three hypothetical development scenarios during a 16-year development period. In the accelerated scenario, 10 rigs operate within the county, which is about one-third of current Weld County rigs. This would allow for a maximum of 120 new wells per year. There are five rigs operating in the county in the steady scenario, which is about one-sixth of current Weld County rigs. This would allow for a maximum of 60 new wells per year. While the accelerated and steady scenarios result in the same number of wells at the end of the analysis period, the drilling would occur over a much shorter duration in the accelerated scenario compared to the steady scenario. Lastly, the low scenario expects a single rig allocation allowing for a maximum of 12 new wells per year. In the low scenario, the study area would reach capacity in 69 years. All well development scenarios are assumed to involve a clustered four well per pad development pattern and horizontal drilling techniques. Each of the scenarios show the rig allocation, maximum pads constructed per year, the number of years required to reach capacity and the number of wells at the end of the 16-year analysis period.

Table 4. Hypothetical Development Scenarios

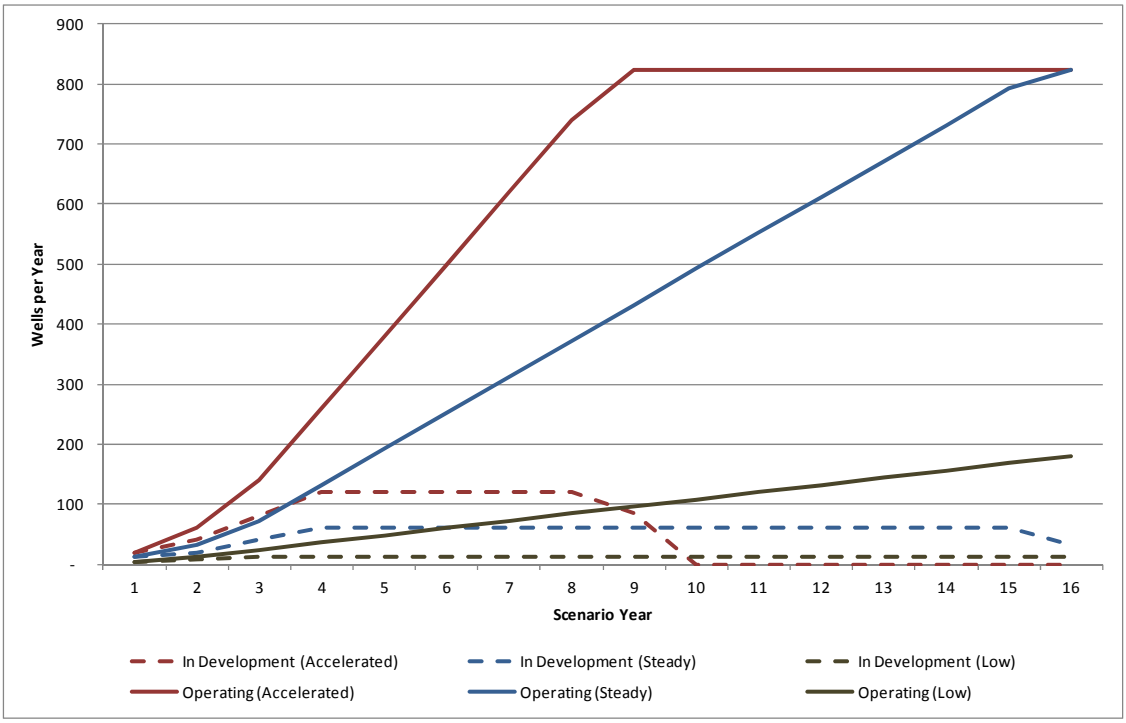
Category	Value
Accelerated Scenario	
Maximum wells per year (10 rigs)	120
Maximum pads per year	30
Years of development	9
Wells at end of analysis period	824
Steady Scenario	
Maximum wells per year (5 rigs)	60
Maximum pads per year	15
Years of development	16
Wells at end of analysis period	824
Low Scenario	
Maximum wells per year (1 rig)	12
Maximum pads per year	3
Years of development	16
Wells at end of analysis period	180

Note: Details on three hypothetical development scenarios include: drilling rig utilization; number of pads and wells developed per year; years required to reach development capacity; and wells developed at the end of the analysis period.

Source: BBC Research & Consulting.

The year-by-year profile of each of the development scenarios is shown in **Figure 8.** Each scenario assumes that oil and gas development would begin in year 1 in the figure with leasing and exploration occurring in the years leading up to year 1.

Figure 8. Boulder County Development Scenarios



Source: BBC Research and Consulting.

Figure 8 shows the addition of new wells in each scenario begins at a slow rate and increases to the annual development rate shown on **Table 4**. For the purpose of this study, a well's development is assigned to a single year, and that well will be in production in all subsequent years for the remainder of the 16-year study period. As seen in the **Figure 8**, the accelerated scenario reaches the study area capacity limit in year 9. The steady and low scenarios show constant operating well growth throughout the analysis period. A detailed breakdown of the development scenarios is included in **Appendix D**.

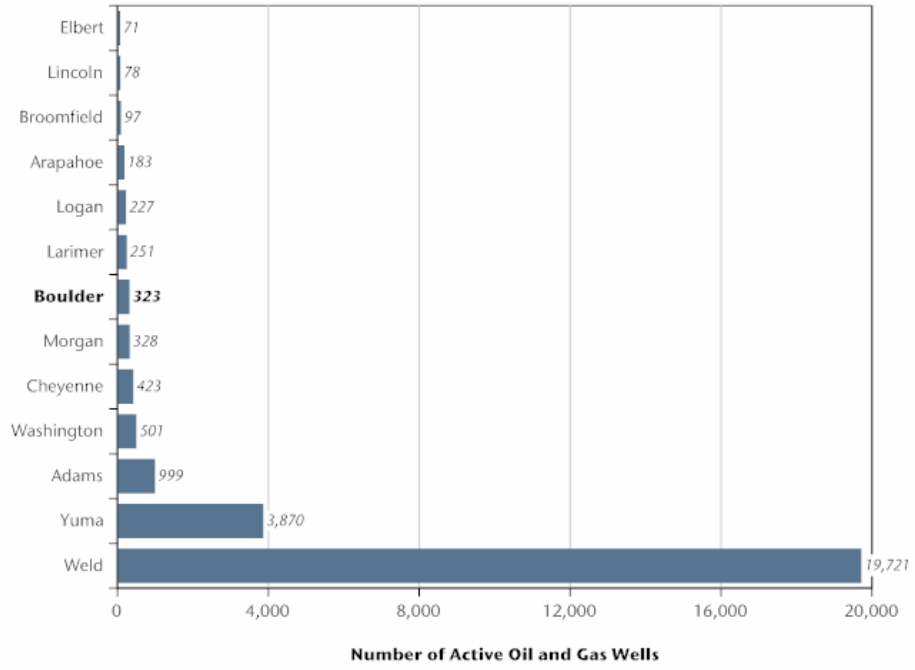
Recent Oil and Gas Development in Colorado

The following provides a discussion of recent oil and gas development in active counties in the Niobrara Shale area and elsewhere across the state to provide context for the drilling scenarios.

Existing Colorado Oil and Gas Wells

As of December 2012, Colorado has about 50,000 active wells, Boulder County has 323 active wells and neighboring Adams County has nearly 1,000 active wells. Most Boulder County wells were drilled decades ago and do not employ horizontal drilling or multi-well pads. Over the past five years, Boulder County's active well count has increased by 93 wells. The majority of Colorado's Front Range oil and gas wells are located in Weld County, which currently has over 19,700 active wells or nearly 40 percent of all active wells within the state. **Figure 9** shows COGCC data on active oil and gas wells in Weld County and other producing Front Range Counties.

Figure 9. Active Oil and Gas Wells in Colorado's Front Range (December 2012)



Source: COGCC, December 2012

Figure 9 shows most production occurring in Weld County, Yuma County and Adams County. Most other counties that lie above the Niobrara Shale currently have about 500 active oil and gas wells or fewer. Historically, most drilling and production activity has occurred in the northern Front Range and in counties in the northeastern portion of the state.

Well Development

The study team obtained data on active wells by county for the five most active producing counties from the COGCC for each of the last seven years and calculated the year-over-year change in active wells to examine well development activity in Colorado. **Table 5** shows the annual change in active wells for the five most active resource producing counties.

Table 5. Change in Active Wells per Year Colorado's Top 5 Producing Counties (2006-2012)

	2006	2007	2008	2009	2010	2011	2012	Average
Weld	566	546	548	1,286	1,262	1,424	1,314	992
Garfield	575	641	845	1,042	1,272	1,337	1,029	963
Yuma	245	468	580	331	186	189	133	305
Las Animas	272	274	412	324	113	38	26	208
La Plata	143	37	132	147	100	120	64	106
Annual Average Growth per County								**514**

Source: COGCC; BBC Research & Consulting.

Between 2006 and 2012, active wells have increased by over 18,000 in the five most active counties in the state. Weld County had the largest increase in active wells—an annual average increase of nearly 1,000. Garfield County had an annual average increase of over 960 wells over the same period. Active wells in Las Animas County and Yuma County increased by between 200 and 300 wells per year, respectively, in the last seven years. Active wells in La Plata County increased by about 100 per year over the same period. The average annual increase in active wells in the top five producing counties in the last seven years is just over 510 new wells per year. This figure is used in establishing context for the accelerated development scenario, which includes 120 wells drilled per year.

Table 6 shows the three well development scenarios, the number of drilling rigs required for each scenario and the percentage of historic peak and current statewide drilling rigs allocated to Boulder County in each scenario.

Table 6. Rig Utilization by Scenario

Scenario	Wells Drilled per Year	Required Drill Rigs	Percent of Historical Peak Rig Count	Percent of Current Rig Count
Accelerated	120	10	7%	19%
Steady	60	5	4%	9%
Low	12	1	0.7%	1.8%

Source: COGCC, BBC Research and Consulting

The accelerated scenario also requires a significant allocation of statewide drilling rigs (about 19% of current) to Boulder County. Based on this information, the study team believes the accelerated scenario to be a plausible upper limit. Again, it is important to note that this exercise is not intended to assign a probability to any of the scenarios occurring, but to appropriately define potential high and low levels of well development activity.

IV. Travel Model

Travel Model Methodology

A travel model has been developed using TRAFFIX software to assign the trips and vehicle-loads associated with the accelerated, steady and low development scenarios to the Boulder County roadway system. TRAFFIX is a GIS-based interactive computer program that assigns traffic to a network based on trip generation, trip distribution, and roadway network characteristics. Although the travel model includes roadways outside the jurisdiction of Boulder County (US and State Highways, and municipal roads), the transportation impacts (and associated improvement needs and costs) have been assessed only on roads under the jurisdiction of Boulder County.

The most intense transportation impacts of oil and gas development occur during the well pad construction, drilling, and completion activities. For a single pad site, these three activities are estimated to occur over a nearly six month period. Because oil and gas development occurs year-round, it has been assumed that the cumulative impacts of well pad development will be evenly distributed over the course of a calendar year. Therefore, all outputs from the travel model are on an annual basis. To assess the potential transportation impacts over time, the study team has evaluated four time periods in five year increments: Year 1, Year 6, Year 11, and Year 16.

Oil and gas development will result in increased traffic on the roadway network (vehicle-trips), as well as increased loads on the County's roads from the many heavy vehicle trips associated with the industry. For this reason, the TRAFFIX model has been used to estimate not only vehicle trips, but also loads as measured in equivalent single-axle loads (ESALs). The impact of heavy vehicles is dependent on a roadway's surface type (flexible pavement [gravel or asphalt] versus rigid pavement [concrete]). To properly calculate the ESAL impacts on Boulder County's roads, two ESAL model iterations are required; one for flexible pavement and one for rigid pavement.

The trip generation characteristics for oil and gas development phase are substantially different from the trip generation characteristics during the on-going well production phase. Therefore, for each evaluation year, the travel model has been run separately for the two phases.

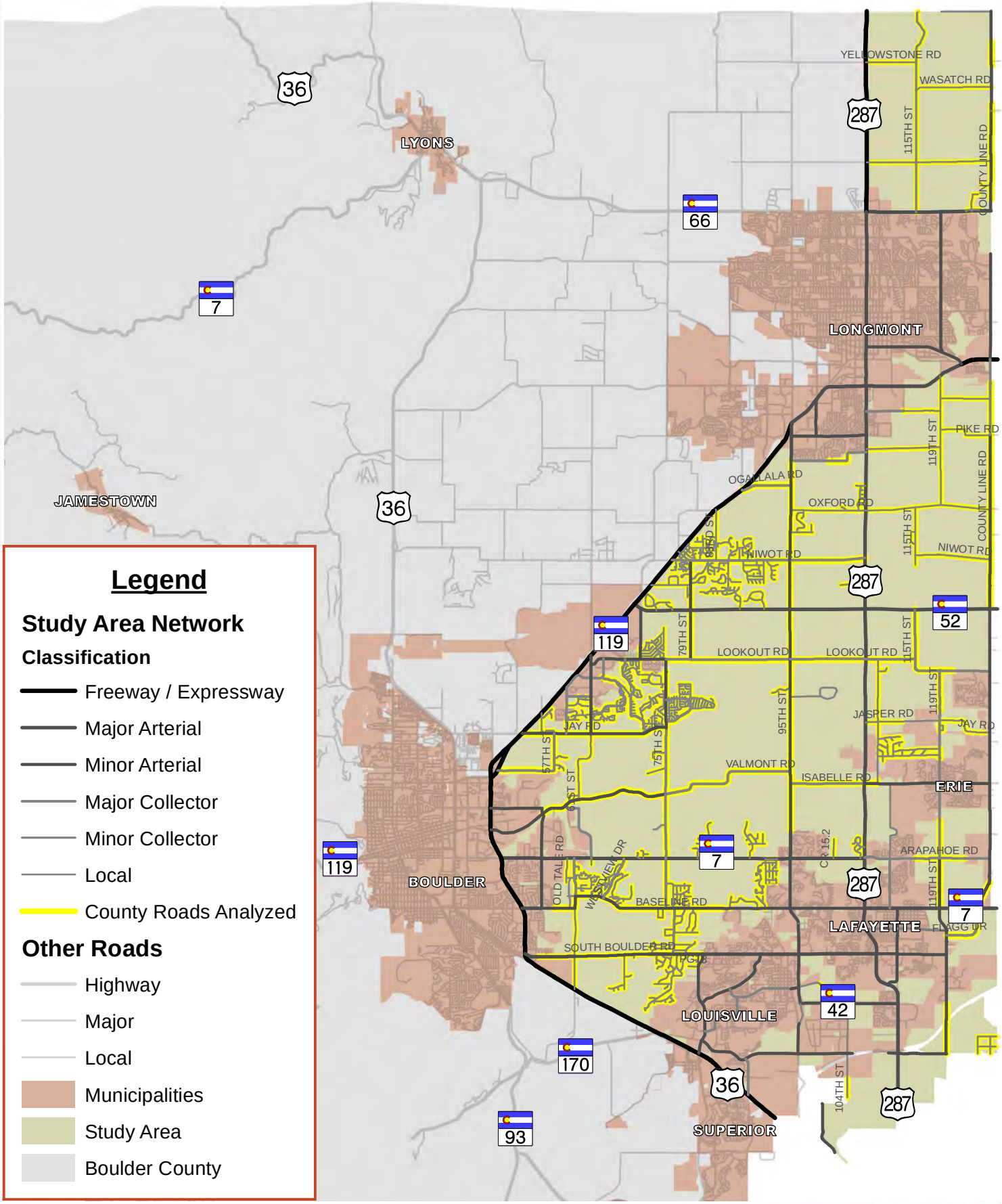
The assignment process was conducted for a combination of each development scenario (low, steady, and accelerated), each analysis year (Years 1, 6, 11, and 16), for trips by phase (development and production), and for ESALs by surface type (flexible and rigid), resulting in a total of 57 iterations of the travel model (the accelerated scenario has no development in Years 11 or 16).

A summary of assumptions used to develop the travel model is provided in **Appendix E**.

Inventory of Study Area Roadways

The first step in modeling the oil and gas travel in Boulder County was to understand the existing conditions of the study area roadways. The following data were collected for study area roadways under the jurisdiction of Boulder County, which are highlighted in **Figure 10**.

Figure 10
Study Area Road Network



Legend

Study Area Network

Classification

- Freeway / Expressway
- Major Arterial
- Minor Arterial
- Major Collector
- Minor Collector
- Local
- County Roads Analyzed

Other Roads

- Highway
- Major
- Local
- Municipalities
- Study Area
- Boundary County

Traffic Counts

One of the primary goals of the modeling process is to estimate traffic volumes on the County roads as a result of oil and gas activity. It is useful to compare these estimates to existing and future background traffic to provide perspective and determine if the travel demand on any roadway segments might exceed the existing capacity. Daily traffic counts, including classification of vehicles at locations where available, were gathered from Boulder County's database. **Figure 11** illustrates current traffic volumes for a typical weekday.

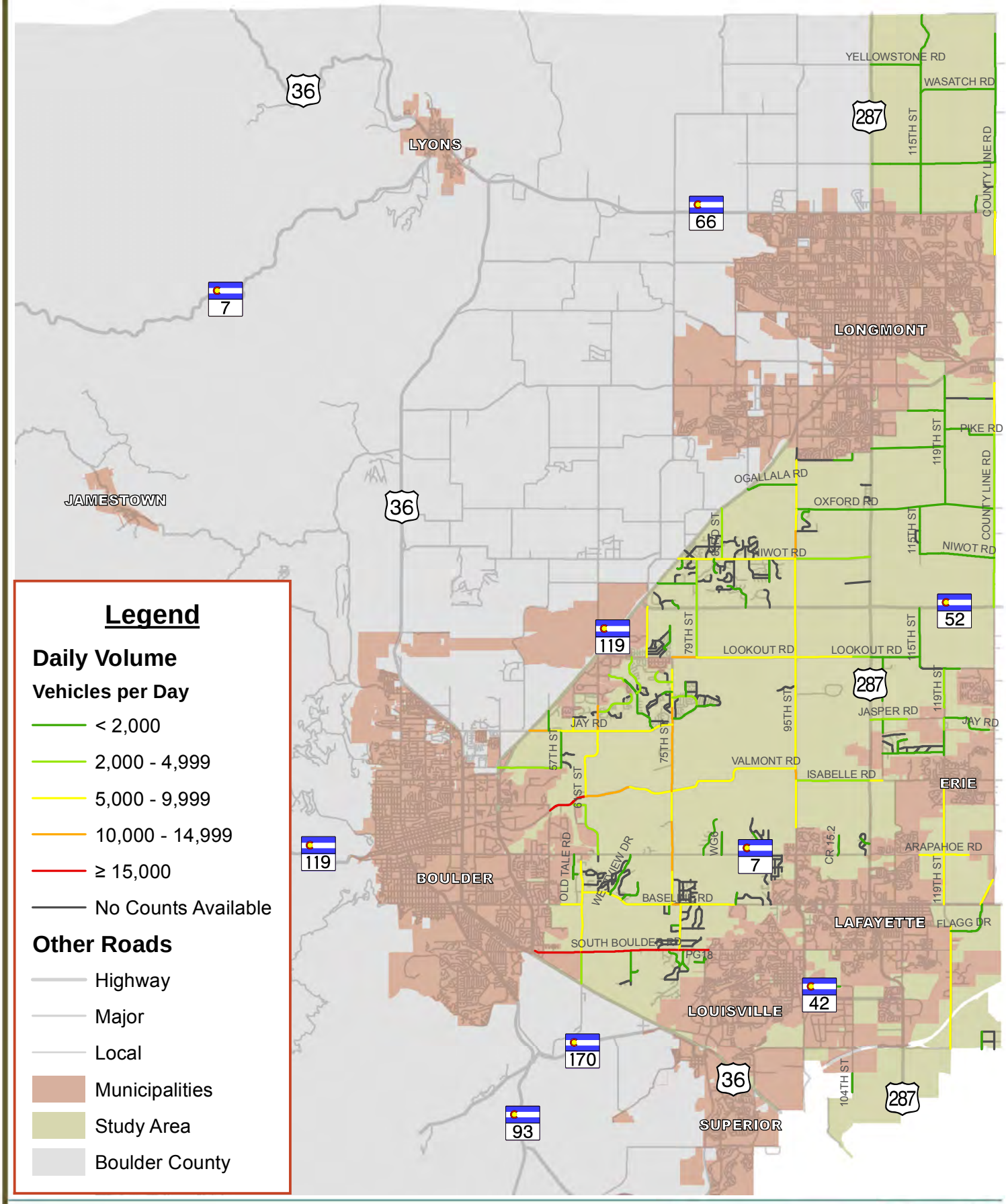
Surface Conditions

Of the study area roads, approximately 88 percent (by centerline mileage) are asphalt, 10 percent are gravel, and two percent are concrete. **Figure 12** shows the surface type for each of the travel shed roadways. The surface condition, including the surface type, and the remaining service life, significantly affect how well a particular roadway segment can accommodate heavy truck traffic. The addition of numerous heavy trucks will, over time, cause a roadway to age at a greater rate than may have been originally anticipated. In order to estimate the degree to which the schedule for improvements on these roads would be accelerated, and to provide time-based costs of these improvements, the pavement quality index (PQI) of each road segment paved road was obtained. The PQI of each road segment was used to appy a rating of either Good, Fair, or Poor condition. **Figure 13** displays ratings for each paved roadway segment within the study area maintained by Boulder County.

Shoulders

Varying geometric configurations affect how well a roadway could accommodate the heavy truck traffic associated with the oil and gas industry. Wider shoulders provide space for bicyclists separate from the travel lanes. Shoulders also provide safety benefits for all roadway users: they serve as a countermeasure to run-off-road crashes and provide a stopping area for breakdowns or other emergencies. Boulder County's roadway design standards include a five foot shoulder for arterial roads and a four foot shoulder for collector roads. The shoulder widths of the study area roads in Boulder County area are shown on **Figure 14**. Approximately 32 percent (by centerline mileage) of paved roadways maintained by Boulder County have some kind of shoulder facility. Of those segments, 40 percent have a shoulder that is four feet or wider and 54 percent have a shoulder that is 3-4 feet wide. The remaining six percent are within a municipality's bike system and have some kind of bike facility (shoulder, bike lane, etc.).

Figure 11
Existing Daily Traffic Volumes



Legend

Daily Volume

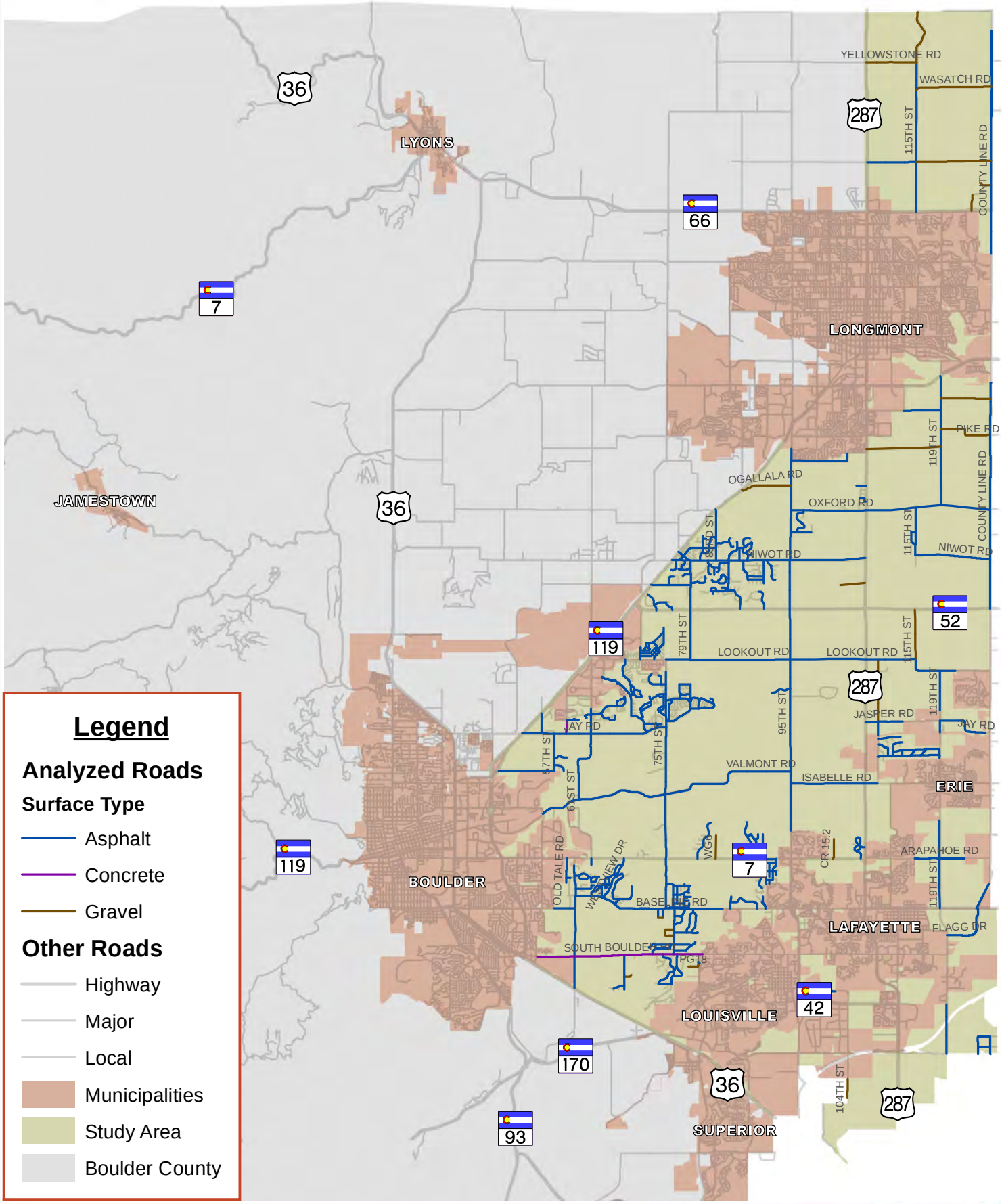
Vehicles per Day

- < 2,000
- 2,000 - 4,999
- 5,000 - 9,999
- 10,000 - 14,999
- ≥ 15,000
- No Counts Available

Other Roads

- Highway
- Major
- Local
- Municipalities
- Study Area
- Boulder County

Figure 12
Surface Types



Legend

Analyzed Roads

Surface Type

- Asphalt
- Concrete
- Gravel

Other Roads

- Highway
- Major
- Local
- Municipalities
- Study Area
- Boulder County

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Figure 13
Pavement Conditions

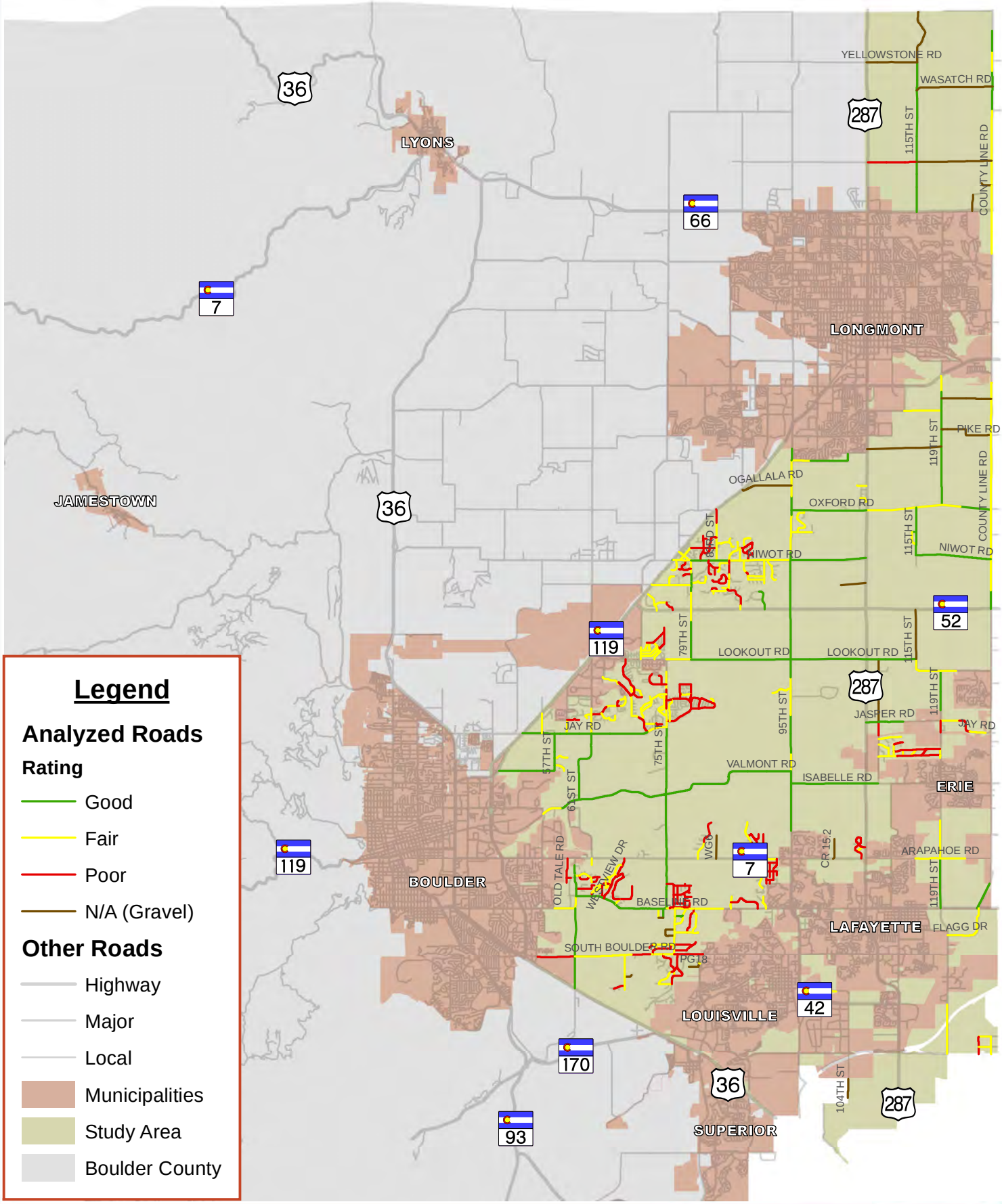

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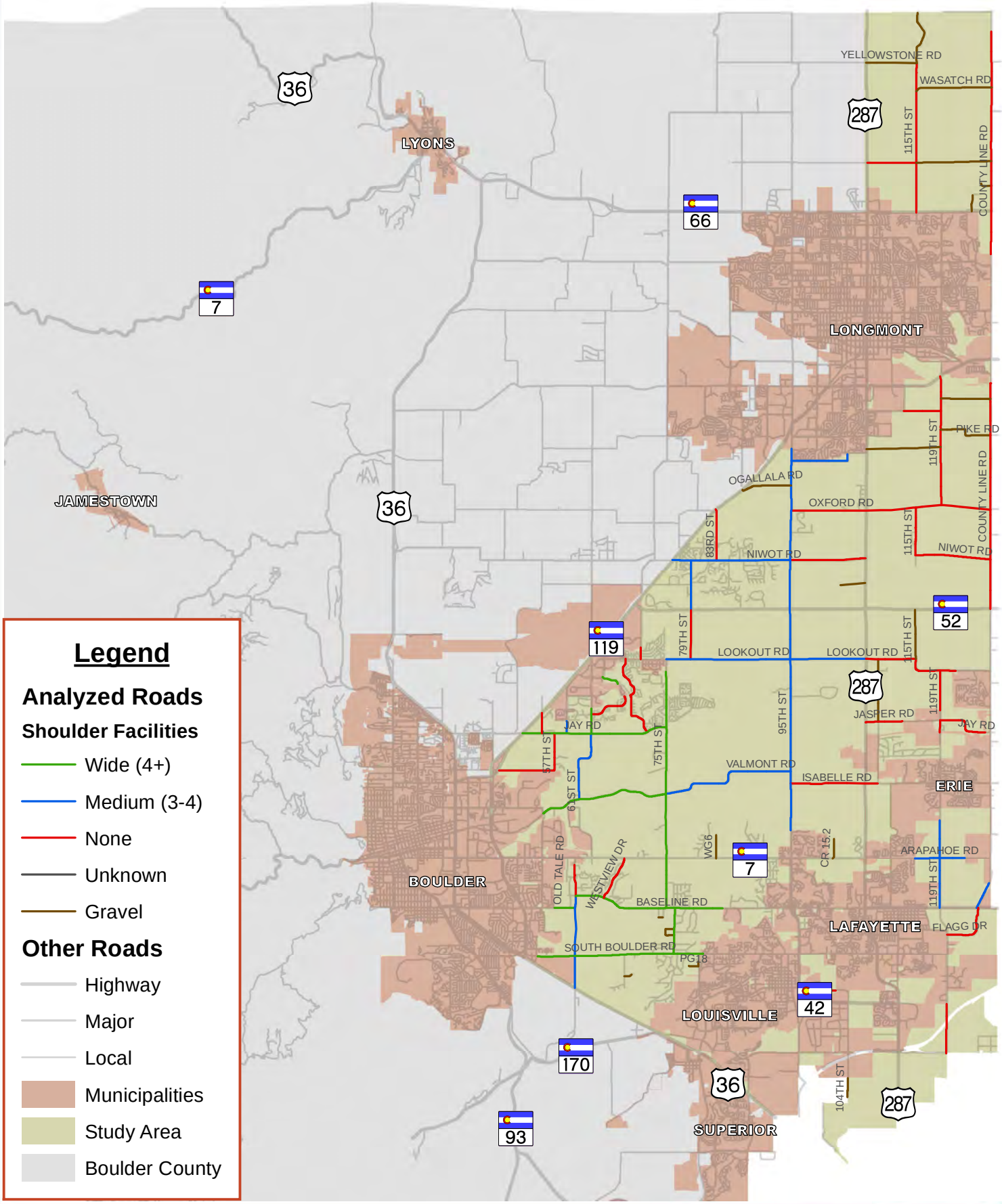
Figure 14
Shoulder Widths



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Bridge Postings

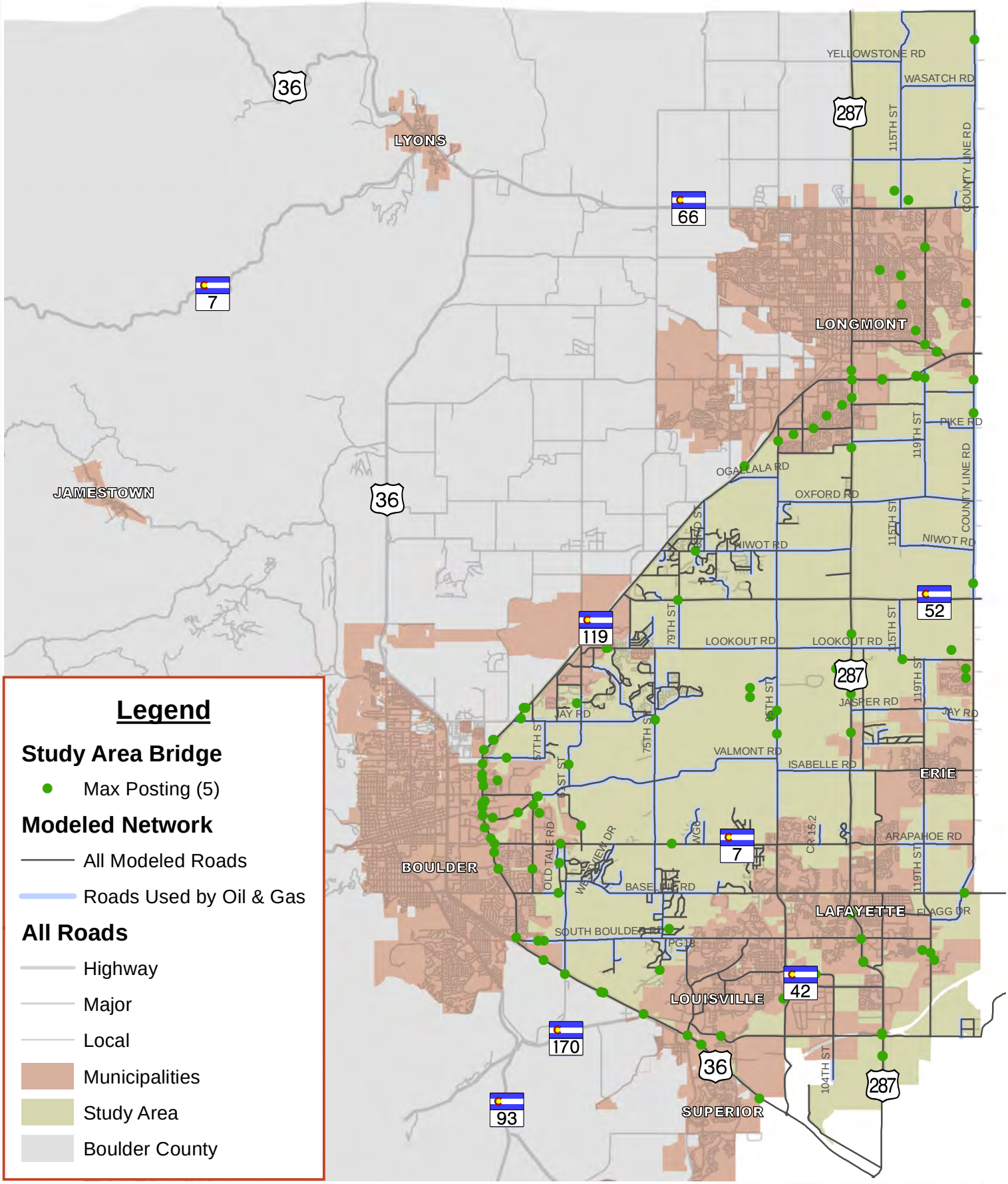
Data from the 2011 Federal Highway Administration's (FHWA) National Bridge Inventory (NBI) for bridges on the potential travel shed was also obtained in order to determine if there would be any weight or height restrictions that would limit use by oil and gas trucks. None of the bridges on the study area roads were identified to potentially have a weight concern (less than 5 out of 5 posting rating). However, bridges also have operational ratings that are specific to truck configurations (axle spacing, axle width, etc.). The County and the oil and gas industry should work together to ensure that actual truck types, weights, and configurations used during development and production can safely cross any bridge on a planned travel route. No bridges were found to have a height restriction or concern. (Federal Highway Administration, 2011). The bridge postings for County maintained bridges within the study area are shown on **Figure 15**. A listing of smaller structures not documented in the NBI was provided, but no height or posting information was available at the time of this study.

Trip Origins/Destinations

Trip origins and destinations were identified by determining where oil and gas development trips will likely be traveling to and from. For all trips, the pad site serves as either the point of origin or the destination. Trips will either involve a loaded truck delivering items to the site, removing elements to an off-site location, or transporting workers and machinery to and from the pad. Based on the geological formation and discussions with Boulder County staff, all wells are assumed to be located within the study area boundary shown on **Figure 1**. Given the uncertainty of where oil and gas pads may be developed within the study area, the area has been divided into one-mile sections, and the pads are assumed to be located near the center of each section.

In order to model where trucks would likely travel, pad sites had to be selected for each analysis year of each scenario. This selection allows the trips to be distributed across the County at locations where oil and gas could occur (within the study area); at the accelerated, steady, and low development scenarios; and at a frequency depending on the year of observation. Because there is no certainty as to when pad sites would be developed and where, pad locations were randomly selected from the one-mile sections within the study area. This selection was based on how many sites were estimated to be developed within the specific analysis year of each development scenario. The selection also ensured that each higher development scenario retained the same pads being developed as the previous scenario, and within the same year. Within each scenario, pads developed in one year were carried forward as producing pads from that point forward in order to maintain the reality of the oil and gas development and production process.

Figure 15
Major Bridge Postings



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With active pads for the development and production phases identified for each analysis year of each scenario, the trips and ESALs for those pads could be applied and totaled. This step was necessary due to some scenario years needing more pads in development and/or production than the number of one-mile sections, requiring more than one pad being developed and/or in production at a given section in a given year. Again, the centers of the sections are representative of pad development within that particular section. Each section could include up to two pads given spacing requirements, although a small number of sections in the model have three pads since the one-mile sections do not perfectly cover the study area.

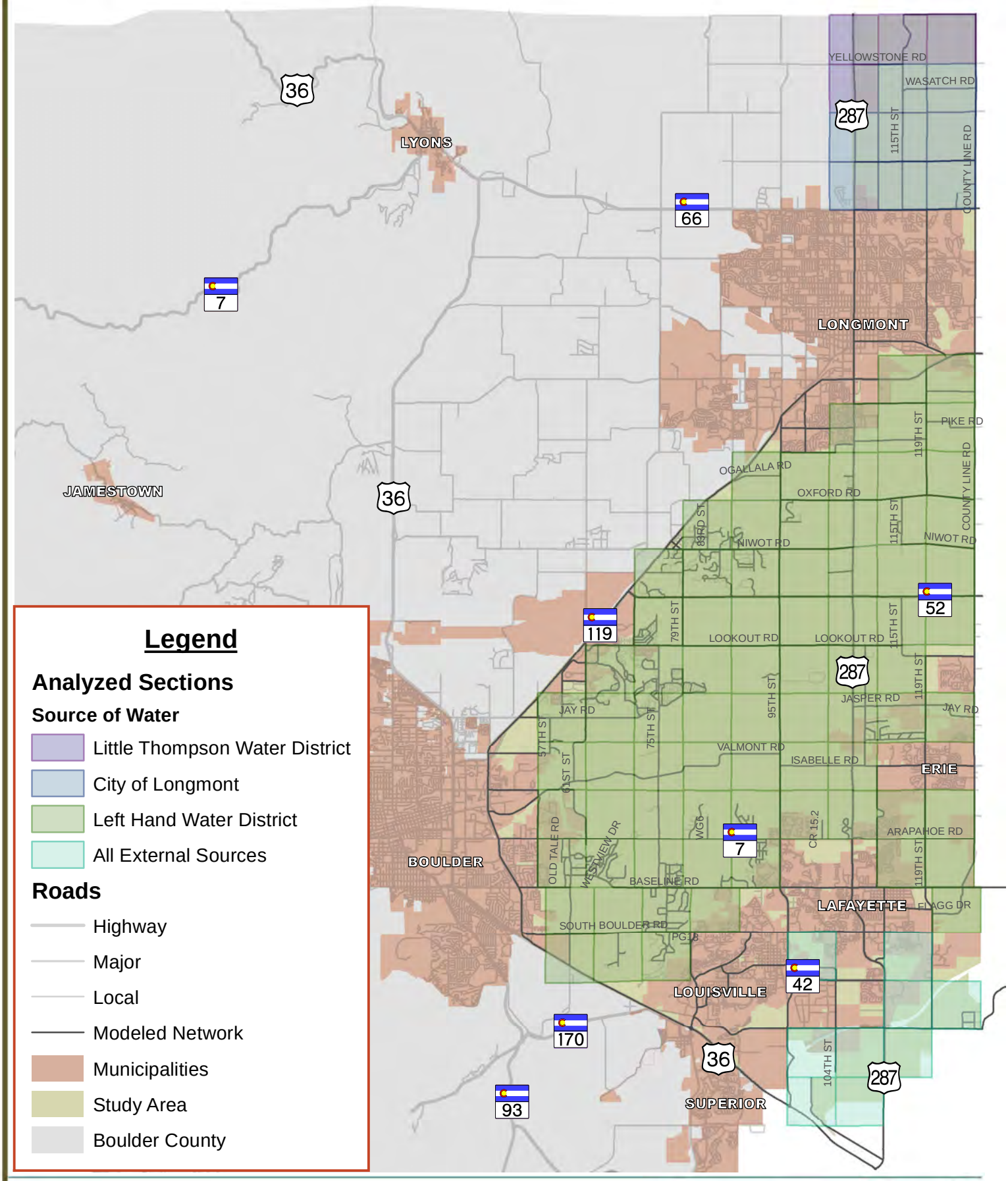
Locations of the other end of oil and gas trips were estimated by categorizing and researching the reasons for travel (trip purposes). There are four primary trip purposes associated with oil and gas development, each of which uniquely impact where oil and gas trucks will travel:

- Bringing fresh water to the site
- Removing produced water from the site
- Transporting equipment
- Transporting other materials

Fresh Water

Water is a key resource in the well drilling process as well as during the high pressure fracturing stage, where water is mixed with sand and chemicals. For oil and gas development in Boulder County, fresh water would likely be purchased from local water providers. Most of the study area is within the Left Hand Water District. The portion of the study area north of Longmont is covered by the Longs Peak and Little Thompson water districts, but only the Little Thompson Water District provides water for the oil and gas industry. Based on conversations with water providers in Boulder County, Left Hand Water is the most likely water provider within the County (summaries of phone interviews with water providers are included in **Appendix B**). Left Hand Water currently provides water to the oil and gas industry in Weld County through water hydrants. Depending on pricing and transport costs, it is conceivable that fresh water could be purchased from further outside of Boulder County. Given the uncertainty of these factors, it was assumed that oil and gas developers would acquire water from the nearest resources (90 percent), and the remaining 10 percent would transport water from areas outside of the County. Aurora Water, as an example, has established a pricing agreement with the industry. Sections in the extreme southeast corner of the county were assumed to acquire all of their water from external supply, as a confirmed local water source was not identified. **Figure 16** illustrates which water source each developable section is assumed to acquire its water from.

Figure 16
Water Source Assumptions



Legend

Analyzed Sections

Source of Water

- Little Thompson Water District
- City of Longmont
- Left Hand Water District
- All External Sources

Roads

- Highway
- Major
- Local
- Modeled Network
- Municipalities
- Study Area
- Boulder County

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Produced Water

Water is also a major byproduct of both the development and production phases. Produced water from the fracturing process and from the extraction of oil and/or gas is generated and must be appropriately treated. Based on an interview with the head of COGCC's Underground Injection Well Unit , for most fields in Colorado's Front Range, roughly 20 percent of the produced water is put into onsite evaporation ponds, another 20 percent is typically either discharged to local water bodies (if it meets quality standards) or used as dust abatement on dirt roads. The remaining 60 percent is usually injected into underground injection control (UIC) wells. No Class II UIC wells (which are associated with oil and gas production) currently exist in Boulder County and they would not likely be drilled until the field is proven with numerous producing oil or gas wells. Colorado has roughly 800 UIC wells, with the nearest UIC wells located in Weld County. Thus it was assumed that produced water that needs to be removed from the site would be trucked to Weld County via the nearest state highway to the pad site with access to I-25.

Equipment

An oil derrick being hauled.
Source: Colorado Motor Carriers Association

The equipment required for oil and gas development, including the drilling rig, the well structure, pumps, and well casings, could come from any location where oil and gas companies have operations, or where contractors providing such services are located. This equipment is ever moving from site to site or between storage locations and new sites. With this in mind, two sources were identified as likely suppliers of oil and gas equipment. The first is other oil and gas producing counties in Colorado that likely have equipment in use or in storage. Most of the relevant equipment within Colorado was identified to exist primarily in the Weld County-Denver area or in western Colorado. Trips to/from the study area were assumed to use the nearest state highway to access I-25, both northbound and southbound.

Transport of well equipment.
Source: Colorado Motor Carriers Association

Equipment could also come from the Gulf of Mexico region. Some specialty equipment is scarce in Colorado and may be brought in from other regions with a greater supply. Places such as Louisiana and Texas have previously been identified as possible source locations for such equipment for oil and gas operations in Utah, so such travel patterns could exist for operations in Colorado as well (Kuhn, 2006). State highways accessing I-25 were again used as the points of entry/exit.

Materials

Oil and gas development requires a variety of other materials in addition to water. Gravel, sand, piping, cement, chemicals, and other construction materials must be trucked to the site at different stages of the development phase. These resources would likely come from where supply is the greatest, trucking distance is shortest, and prices are the cheapest. Because these factors create a great deal of uncertainty as to where a resource may arrive from, it has been assumed that materials would arrive via I-25 from the north and south, with some preference towards trips to the south given the greater Denver area's capacity to provide a wide array of materials or to receive materials via rail from locations outside of Colorado.

Trip Generation and Vehicle Classification

The development and production phases have different stages and activities that use a variety of truck types to complete each activity. Each activity also generates a unique number of trips and may have varying origins/destinations for those trips. To best estimate where oil and gas traffic would travel and the impacts those trips would have, the trips and typical configurations for each activity have been estimated. **Appendix C** provides greater detail into truck types, configurations, and impacts.

Trip Generation by Activity

In anticipation of horizontal drilling and multiple wells per pad site in Boulder County, the trip generation rates used for this study have been developed using the resources and methodology described in Chapter II. **Table 7** documents the results of adapting trip generation rates from other studies to a four well per pad development pattern. Once the sources are averaged across each well development activity, the averages were adjusted according to pad and well sensitive trips. Average trip figures were then summed to derive the average truck traffic required to develop a typical clustered four-well pad. This calculation amounts to 7,184 total truck trips for the development of a well pad with four wells. After development, the activities during the production phase generate about 730 trips annually per operating well pad. The four wells per pad trip generation estimates shown in **Table 7** have been used as the basis the travel model.

Vehicle Classification

There are a variety of vehicle types used in oil and gas development and operations, with varying levels of impact. The load impact of oil and gas trucks can be as much as 6,000 to 30,000 times that of a passenger car. To account for the load impacts, equivalent single axle loads (ESALs) of each truck trip has been estimated and modeled. Some truck types are used in multiple stages and activities, while others are used only once. And for those trucks operating within more than one activity, their number of trips varies by activity. This variation requires each activity to have a vehicle classification profile where truck types, trip shares, and impacts are identified for input into the travel model.

Table 7. Trip Generation Estimates

Activity	1 Pad, 4 Wells
Construction Stage	
Pad and Road Construction	90
Drilling Stage	
Drilling Rig	90
Drilling Fluid and Materials	270
Drilling Equipment (casing, drill pipe, etc.)	450
Completion Stage	
Completion Rig	40
Completion Fluid and Materials	170
Completion Equipment (pipe, wellhead, etc.)	10
Fracturing Equipment (pump trucks, tanks, etc.)	320
Fracture Water	4,200
Fracture Sand	190
Flowback Water Disposal	1,400
Total Development Trips	**7,230**
Production Stage	
Oil & Water Removal	580
Operations and Maintenance	150
Total Production Trips (per year)	**730**

The most frequent heavy-truck activity during the development of a well comes from the transportation of water to and from the well during the drilling and hydraulic fracturing process (completion stage). According to Chesapeake Energy, between three and five million gallons of water are used during the drilling and completion stages of developing a well. This water is used to assist with cutting through rock and cooling the drill. This demand for water translates into about 4,200 trips (2,100 inbound and 2,100 outbound). Workers transport produced water and flowback water, extracted during the production phase, to a separate wastewater site, resulting in about 1,400 additional trips (700 inbound and 700 outbound).

A variety of resources including environmental impact studies of oil and gas development within the Rocky Mountain and Great Plains regions were used to identify truck types and their configurations. An initial list of specific trucks used was compiled by stages/activities of development and production. Where available, the percentage makeup of different truck types by activity was noted. Likewise a list of typical truck configurations for oil and gas operations was compiled, which documented the following characteristics:

- Axle configurations
- Weight configurations (total empty and full, and per axle)
- Level of impact expressed in equivalent single-axle load (ESAL) factors

Some of the resources consulted provided all three of these characteristics, but most provided only one or a combination of two. In order to best estimate the impact on roads, any configuration that could have a unique ESAL value was recorded. Once all unique configurations were identified, any holes in information for configuration were estimated based on other similar configurations. For configurations without a documented ESAL factor, the factor has been estimated based on the Pavement Tools Consortium's ESAL equations for flexible and rigid surfaces, which produce ESAL factors consistent with the American Association of State Highway and Transportation Officials (AASHTO) *Guide for Design of Pavement Structures* that defines ESALs for different truck configurations. Because these equations take roadway characteristics into account that were not obtained during this study (such as the serviceability index and structural number), values were generalized.

The specific truck types and their respective characteristics were assigned to the truck configurations identified based on the truck's purpose and observed descriptions within the various reports and studies consulted. This simplified the impact estimation process by grouping similar truck types and their uses into one configuration, thus assigning an ESAL value to a truck type.

Merging Trip Generation and Vehicle Classifications

The truck configuration profiles were linked with their respective activity within each stage of the development and production phases. Because descriptions were not available as to exactly which trucks are used for each activity, the reports and studies consulted were used to produce a best estimate as to how trucks are used. These resources were also referenced to estimate the average share of an activity's trips that each truck configuration would account for, and if the truck is loaded for inbound, outbound, or both trip directions. With trips and loads estimated for each truck per activity, their ESAL factors were calculated for a round-trip to be run through the travel model in order to estimate the trucks' impacts on the County roadways.

Table 8 documents the stages and activities for the development phase, along with each activity's number of generated one-way trips, most common truck types, estimated average ESAL factors for flexible and rigid surfaces, and origins/destinations. **Table 9** documents the same information for the production phase.

Table 8. Development Phase Trip Summary

Stage	Activity	1-Way Truck Trips (1 Pad, 4 Wells)	Duration (Days)	Average Truck Trips per Day (by Stage)	Average Truck Trips per Day (by Activity)	Typical Truck Types	ESAL Factors (Average for 1-Way Trip)	Origin (or Destination) of Trucks
Construction	Pad and Road Construction	90	7	12.9	12.9	3-axle & 5-axle haulers	Flex: 1.009 Rigid: 1.537	I-25 N/S
Drilling	Drilling Rig	90	103	7.9	0.9	Heavy 5-axle, other 3-axle	Flex: 0.888 Rigid: 1.047	I-25 N/S
	Drilling Fluid and Materials	270			2.6	3-axle & 5-axle tankers	Flex: 1.362 Rigid: 1.988	I-25 N/S
	Drilling Equipment (casing, drill pipe, etc)	450			4.4	5-axle haulers	Flex: 0.405 Rigid: 0.621	I-25 N/S
Completion	Completion Rig	40	70	90.4	0.6	Heavy 5-axle, other 3-axle	Flex: 0.979 Rigid: 1.203	I-25 N/S
	Completion Fluid and Materials	170			2.4	3-axle & 5-axle tankers	Flex: 1.362 Rigid: 1.988	I-25 N/S
	Completion Equipment (pipe, wellhead, etc)	10			0.1	5-axle haulers	Flex: 0.405 Rigid: 0.621	I-25 N/S
	Fracturing Equipment (pump trucks, tanks, etc)	320			4.6	Specialty, 3-5 axles	Flex: 0.724 Rigid: 0.782	I-25 N/S
	Fracture Water	4,200			60.0	5-axle tankers	Flex: 1.363 Rigid: 2.260	Local, I-25 N/S
	Fracture Sand	190			2.7	5-axle haulers	Flex: 1.363 Rigid: 2.260	I-25 S
	Flowback Water Disposal	1,400			20.0	5-axle tankers	Flex: 1.363 Rigid: 2.260	I-25 N
Total		**7,230**	**180**	**40.2**	**40.2**			

Table 9. Production Phase Trip Summary

Stage	Activity	1-Way Truck Trips (1 Pad, 4 Wells)	Duration (Days)	Average Truck Trips per Day (by Stage)	Average Truck Trips per Day (by Activity)	Typical Truck Types	ESAL Factors (Average for 1-Way Trip)	Origin (or Destination) of Trucks
Production	Oil & Water Removal	500	Daily	2.0	1.4	5-axle tankers	Flex: 1.363 Rigid: 2.260	I-25 N/S
	Operations & Maintenance	230	Daily		0.6	Work Trucks	Flex: 0.143 Rigid: 0.174	I-25 N/S
Total		**730**	**365**	**2.0**	**2.0**			

Trip Distribution and Assignment

With trips per pad site and their vehicular makeup established, the accelerated, steady, and low development and production scenarios could be modeled. To model where trips would go and the impacts they would generate, trips and ESALs were loaded (separately) in the TRAFFIX model. This process consists of two primary steps: distributing the trips and ESALs, and assigning them to the network.

Trip Distribution

Once the trips and ESALs per pad were calculated, they were entered into the TRAFFIX travel model at each pad, distributing trips and ESALs to origins and destinations based on activities as described previously. **Table 10** outlines how trips were allocated to/from each pad site.

Table 10. Trip Distribution Assumptions

Trip Profile	Trip Origin or Destination		
	I-25 to the North	I-25 to the South	Nearby Local Water District
North Access	via US 287, SH 66, SH 119, SH 52, or SH 7	--	--
South Access	--	via SH 66, SH 119, SH 52, SH 7, or US 36	--
North or South Access	50%	50%	--
Fresh Water Access	5%	5%	90%

Trip Assignment

With trips and ESALs distributed and linked, the TRAFFIX travel model was used to assign the trips and ESALs to the network based on which path would provide the shortest travel time. Because oil and gas trips take place at all hours of the day and every day of the week, background traffic and congestion were not factored into the modeling process to impact assignment.

The assignment process was conducted for a combination of each scenario level (low, steady, and accelerated), each analysis year (2016, 2021, 2026, and 2031), for trips by phase (development and production), and for ESALs by surface type (flexible and rigid), resulting in a total of 57 iterations of the travel model (the accelerated scenario has no development in 2026 and 2031).

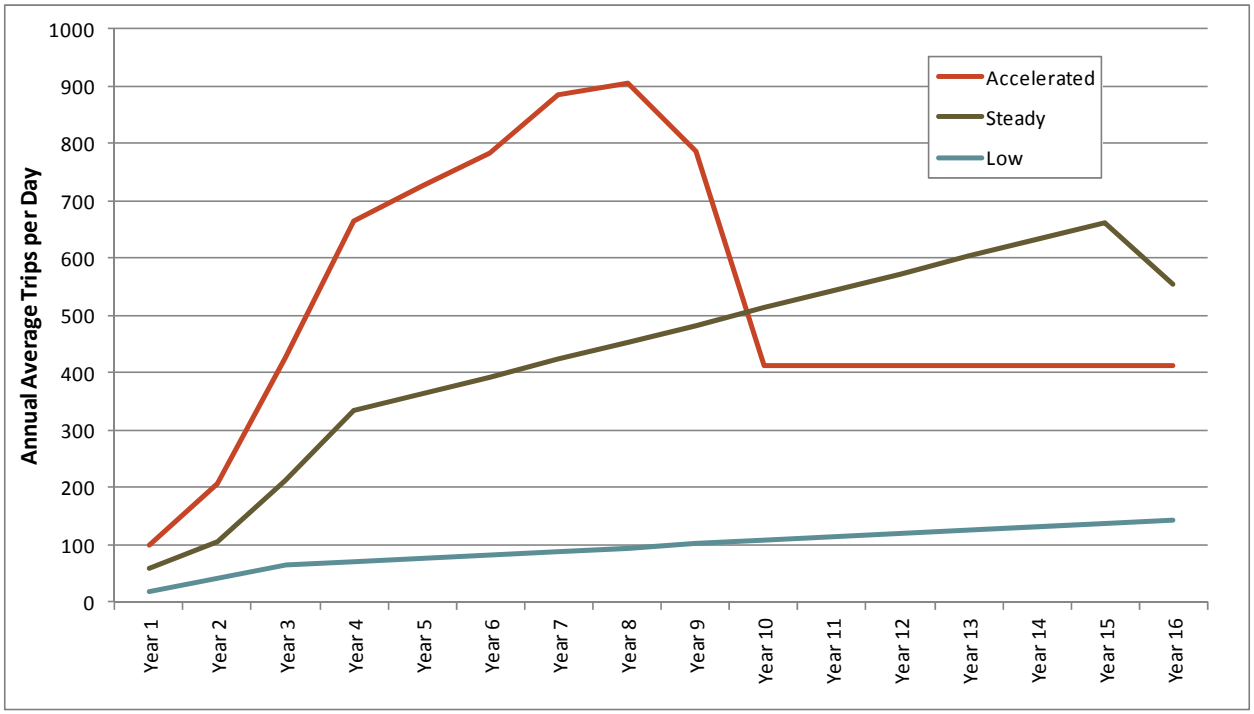
Model Results

As described previously, the TRAFFIX travel model output the number of trips and ESALs on each road segment. Based on these model runs and exported data, the following sections summarize the results.

Trips

The trips were modeled on an annual basis; in order to present trips in more manageable fashion, trips from both phases (development and production) were aggregated and converted to average annual daily trips by simply dividing the annual trips by 365. **Figure 17** illustrates the average number of oil and gas trips per day for each scenario over the 16 year study period. This figure depicts the cumulative trips of all pads being developed and producing wells. By dividing the annual trips evenly over the year, it is assumed that well development will be distributed over time resulting in a relatively even distribution of trips in total. It is important to note that trip generation will peak during the development phase at a particular pad site, resulting in a more profound local impact.

Figure 17. Estimated Oil & Gas Annual Average Trips per Day



Based on the travel model results, these trips are expected to occur over a large portion of the County roads within the study area. Some corridors handle a large portion of these trips, while others handle only one pad's worth or less. The highest concentration of trips on any one roadway segment was found to be approximately 40 trips per day (annual average) in the steady scenario. No County roads are expected to exceed the existing traffic volume capacity threshold due to the added oil and gas trips.

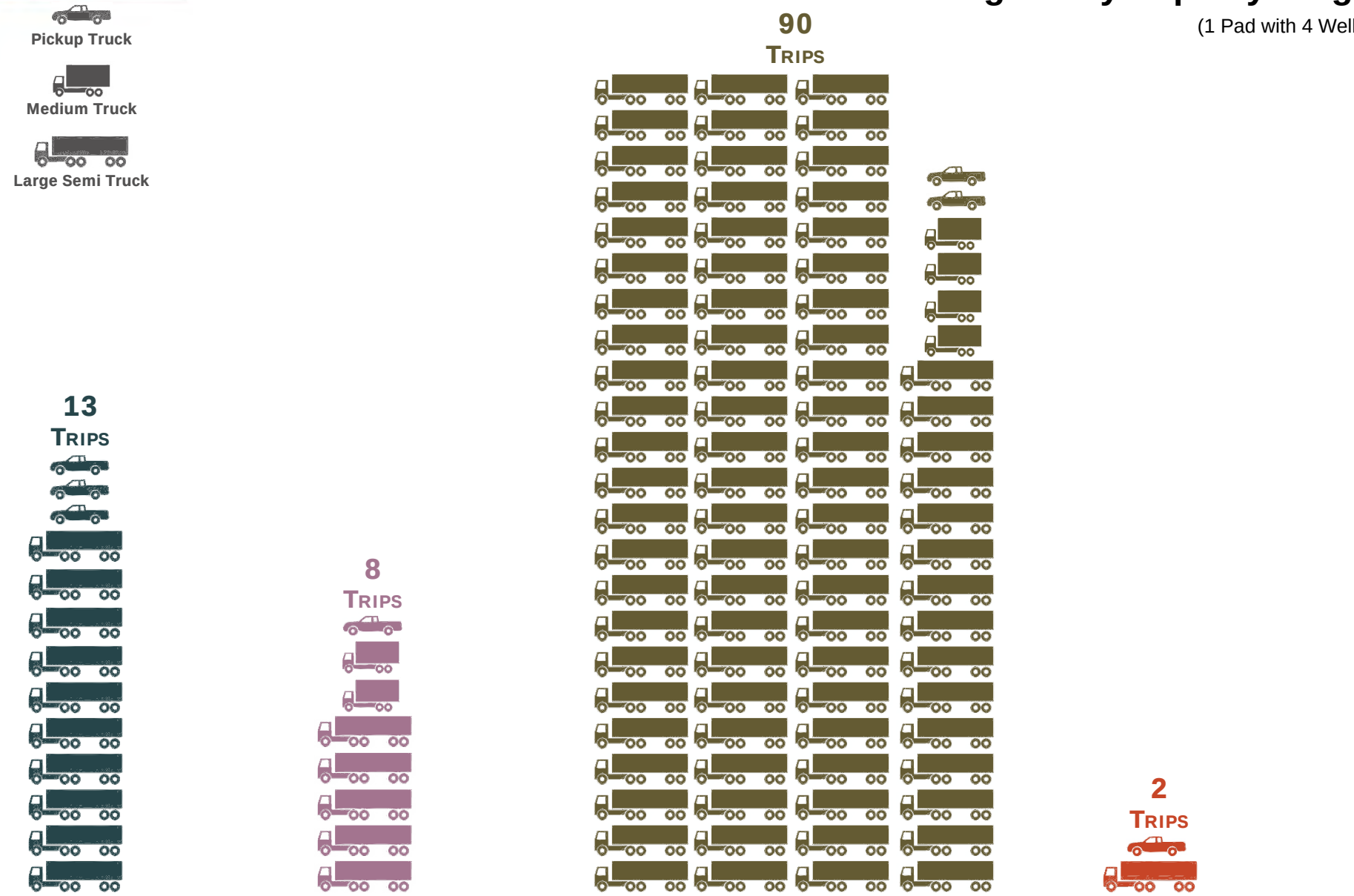
Although the total number of trips generated in the three scenarios is not particularly high, the impact that a Boulder County resident might experience if a well pad were developed in close proximity to their home could be significant, particularly during the development phase. **Figure 18** provides a graphical depiction of the number and types of trucks that are estimated per day for a pad with four wells during each stage of development and production. The duration of each stage is approximate; if a development stage occurs over a shorter duration of time, the number of daily truck trips would be intensified.

Attachment A

Figure 18

Average Daily Trips by Stage

(1 Pad with 4 Wells)



*Approximate Durations

Figure 19 illustrates the magnitude of development trips on the study area County roads for the accelerated scenario in Year 6 (the peak development year modeled), while **Figure 20** illustrates the same information for production trips in Year 16 (the highest level of production trips. These maps illustrate how many oil and gas trips each road segment is expected to carry relative to the other oil and gas travel routes. Note that earlier analysis years and other scenarios (low and steady) have fewer pads in operation, meaning not all lease sites may have an active pad. Given the random selection of active pads, paths could change if active pads were rearranged. However, the arrangement tested with the TRAFFIX travel model is as likely as any other potential arrangement of active pads given the information obtained for this study. Furthermore, routes with high volumes in these scenarios and years are major routes regardless of how pad sites are arranged, as they provide essential links that eventually must be used.

Vehicle Miles Traveled

The trips assigned by TRAFFIX were also converted into vehicle miles traveled (VMT) to compare the increase in VMT caused by oil and gas operations with existing VMT on the study area County roads and predicted VMT growth based on the *Boulder County Transportation Master Plan*. All VMT values were calculated for roads maintained only by Boulder County and were shown to be used by in the travel model for oil and gas trips. At the highest level of oil and gas development assumed in the three scenarios, the additional VMT resulting from oil and gas trips would be less than one percent of the existing plus background VMT.

Although the number of the trips generated by the oil and gas industry in the three scenarios is relatively small in comparison to the existing traffic, the much greater transportation impact associated with industry is due to the weight of the vehicles. As described in the following section, the load impact of oil and gas trucks can be several magnitudes greater than that of a passenger car.

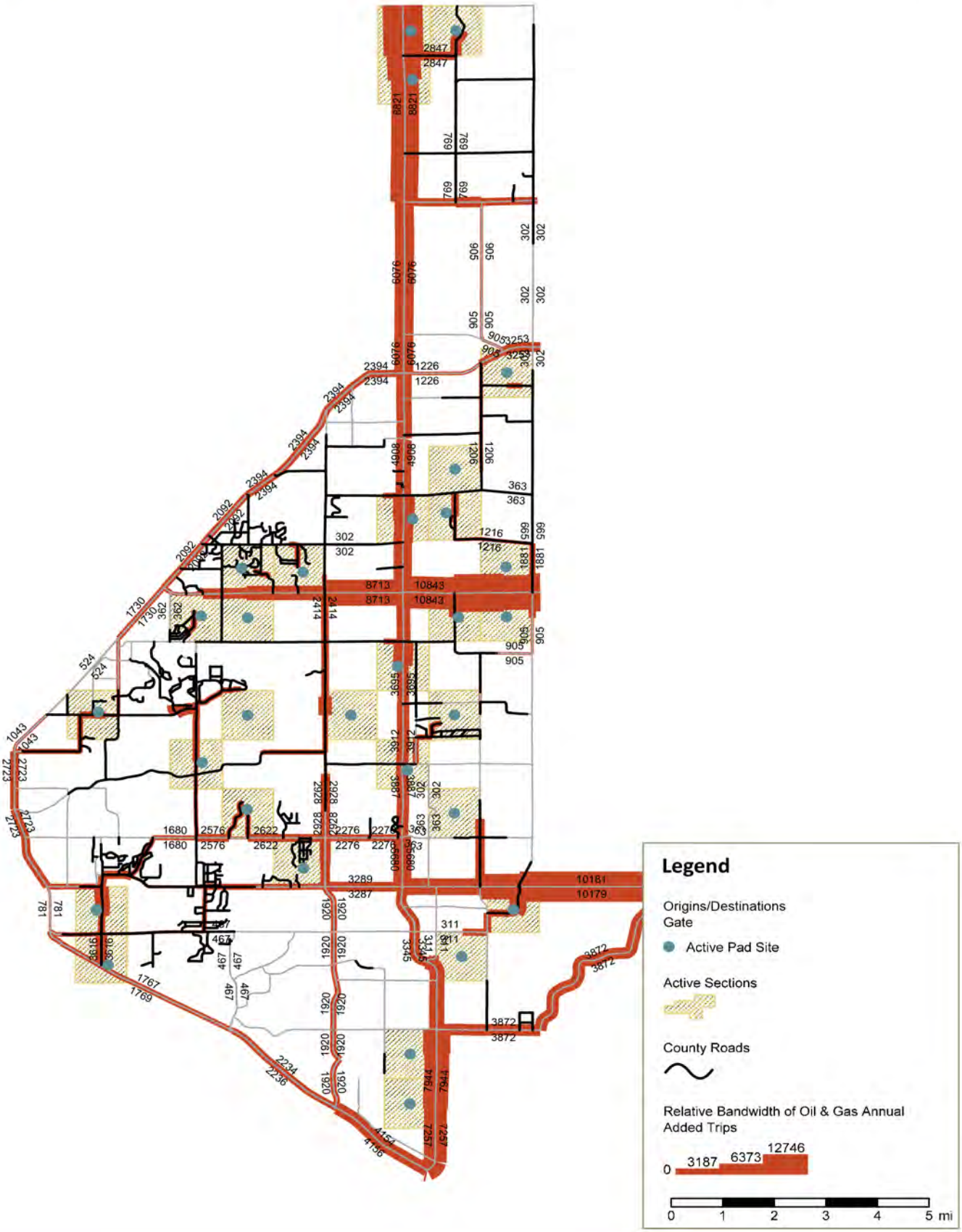
Equivalent Single-Axle Loads

Due to the high impact of heavy vehicles on roads, ESALs are essential in calculating potential improvements needed and the costs associated with those improvements.

To translate ESALs into a useable format from TRAFFIX, ESALs from the flexible ESAL model runs were used for gravel and asphalt roads, while ESALs from the rigid ESAL model runs were used for concrete roads. ESALs from each phase were aggregated for each road segment. These final ESAL aggregations were then used in calculating reductions in the remaining service life of each analyzed road segment, forming the basis for estimating needed improvements and costs.

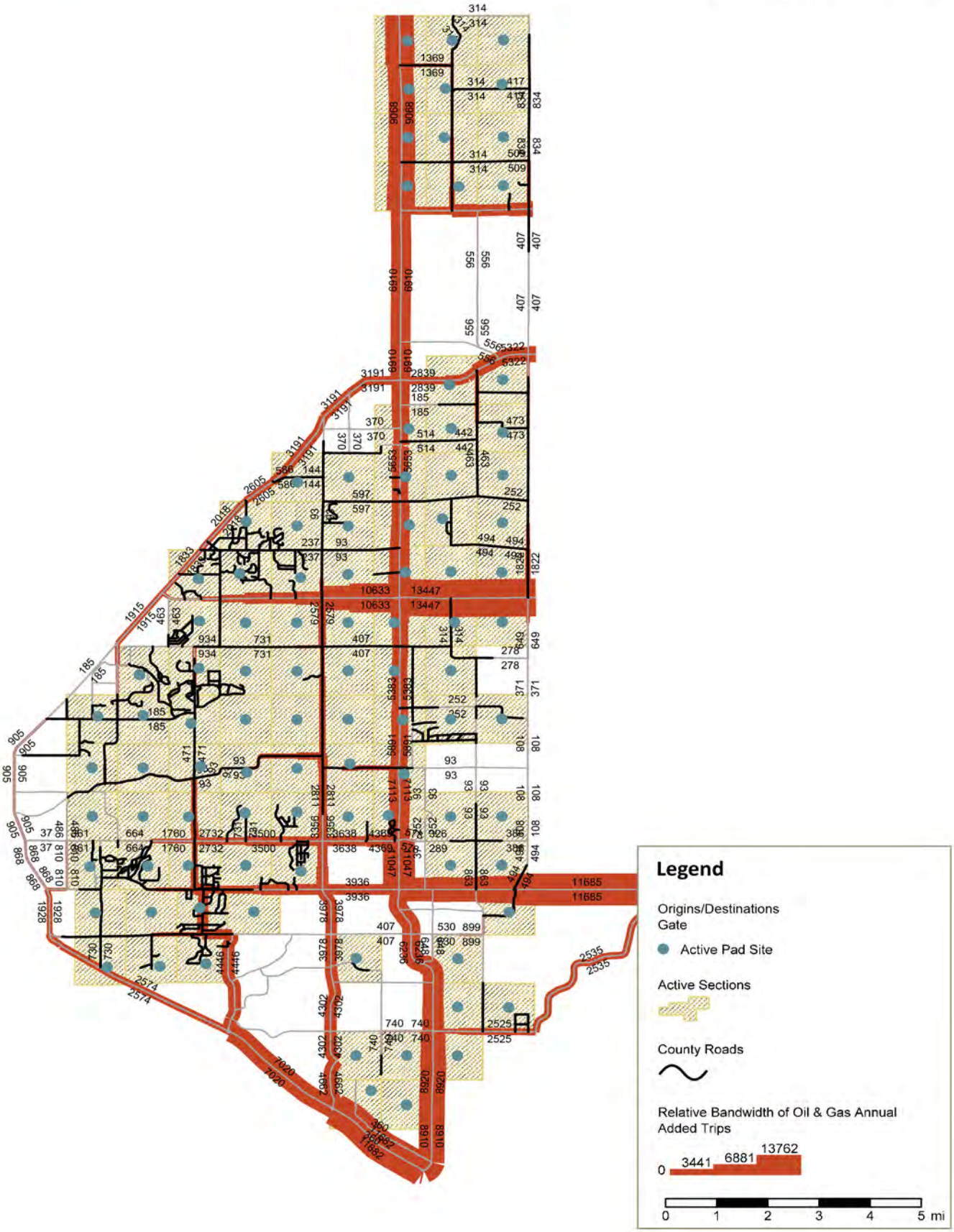
To put ESAL factors for oil and gas vehicles into perspective, an average 4,000 pound passenger vehicle (2,000 pounds per axle) has an estimated ESAL factor of 0.0004 when using the Pavement Tools Consortium's equations for both flexible and rigid pavements. In comparison, the largest and heaviest oil and gas truck used in this study has an estimated full-load ESAL factor of 7.7 on flexible pavement and 12.6 on rigid pavement (Source: Upper Great Plains Transportation Institute, 2010). That is, the load impact to a road is 20,000 – 30,000 times that of a passenger car. A loaded water truck (the vehicle with the highest frequency of trips to and from an oil and gas well) has an estimated ESAL factor of 2.6 on flexible pavement and 4.4 on rigid pavement, 6,500 – 11,000 times the load impact of a passenger car.

Figure 19
Peak Annual Development Trips
(Accelerated Scenario Year 6)



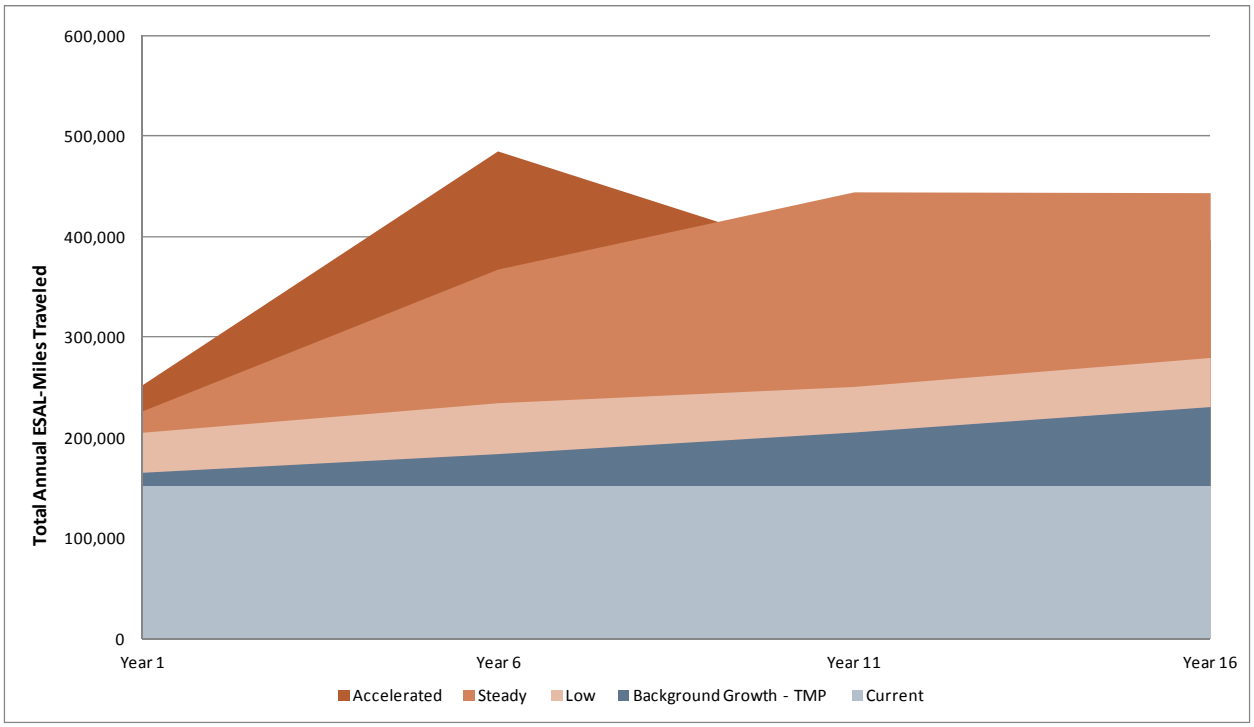
FELSBURG HOLT & ULLEVIG
BBC RESEARCH & CONSULTING
Boulder County
NORTH

Figure 20
Peak Annual Production Trips
(Accelerated Scenario Year 16)



The ESALs assigned by TRAFFIX were also converted into ESAL-miles traveled (a concept similar to VMT) to compare the increase in ESAL-miles caused by oil and gas operations with existing ESAL-miles on the study area County roads and predicted ESAL-mile growth based on the *Boulder County Transportation Master Plan*. All ESAL-mile values were calculated for roads maintained only by Boulder County and were shown to be used by in the travel model for oil and gas trips. The ESAL loads for existing and future background traffic on the study area roads are based on existing vehicle classification counts from across the study area and typical ESAL values for medium and large truck classifications. As shown on **Figure 21**, the load (ESAL-mile) increase associated with the oil and gas trucks is significant. In the low scenario, the load increase is approximately 20 – 25 percent over the background. The load increase in the steady and accelerated scenarios ranges from 35 to nearly 165 percent over the background.

Figure 21. Loads on Roadway Network



V. Mitigation Needs

The mitigation measures and associated costs presented herein represent the additional costs or funding needs attributable to oil and gas traffic. They do not include baseline maintenance and/or improvement costs incurred by the County prior to substantial growth of oil and gas traffic.

For this study, oil and gas traffic was distributed to the County's network of roads, and an Equivalent Single Axle Load (ESAL) was applied to the associated traffic. The ESALs were determined at 5-year increments over the 16 year study period. Road mitigation measures and costs were then defined for the paved and unpaved roads impacted by oil and gas traffic based on the accelerated, steady, and low development scenarios.

Unpaved Road Analysis

The unpaved roads analyzed in this study were classified by the estimated additional truck traffic due to oil and gas development. The categories include:

- Low (0-25 average daily traffic [ADT])
- Elevated (25-50 ADT)
- Moderate (50-100 ADT)
- High (100+ ADT)

The following methodology describes how costs were attributed to each category.

Methodology

The increase in maintenance and rehabilitation costs are a key element in determining the improvement cost for unpaved roads. On gravel surfaces, as the ADT increases, the frequency of grading and gravel applications must increase to preserve the surface quality.

Maintenance and Rehabilitation Costs

The County's average cost of a grading operation is approximately $224 per mile each time the road is graded. The grading cycle within the County is dependent on the traffic volume of the road as well as if a dust suppressant can be applied. Some low volume, non-impacted gravel roads need to be graded only once every two months. However, if the road cannot be treated with a dust suppressant material (e.g., because of vertical grade, sensitive vegetation, etc.), the non-impacted, unpaved road may be graded up to two to three times per month.

The County's average cost per mile for gravelling is $44,200 per mile. This cost includes material, labor and equipment. Similar to the grading cycle, the graveling cycle within the County is dependent on the traffic volume of the road. For this study, the gravelling cycle time is six years for non-impacted unpaved roads. For purposes of this analysis, all graveling intervals were converted to a base yearly interval. That is, since the County provides a six-year cycle, the costs were converted to a yearly graveling cost that corresponds to the traffic projections.

If oil and gas trucks use an unpaved road as a transportation route, the road will have to be treated with a dust suppressant material to satisfy the State's Regulation 1 requirements. For this study, the impacted unpaved roads will have to be treated once each year. The County's average cost utilized for applying a dust suppressant material to a non-impacted gravel road is $2,100 per mile.

The maintenance and rehabilitation costs described above are based on the capacity that County resources can be utilized for these services. These costs may be increased if the County has to utilize outside resources to provide these additional services.

Low Category – Unpaved Roads

For the low-impact category, it is assumed that little additional work will be done to the road surface. Therefore, the only improvement costs attributed to low impact roads are increased maintenance costs for additional grading. For this study, the grading cycle would be increased to once per month instead of once every two months. The graveling cycle and application of dust suppressant would still occur as described above.

Elevated, Moderate and High Categories – Unpaved Roads

There were no segments of unpaved road sections that were categorized as elevated, moderate or high impacts for this study. As a reference, elevated and moderate impact categories would include maintenance and rehabilitation improvements that shorten the gravel application cycle, increase the application of dust suppressant as well as the grading cycle. For the high impact category, paving the gravel road becomes a lower cost option when life-cycle cost is considered. These categories can be further defined if the County encounters actual oil and gas traffic conditions for unpaved road segments that would fall into these categories.

Paved Road Analysis

Two factors are critical in analyzing the capabilities of paved roads to accommodate additional truck traffic: the current condition of the pavement and the structural rating, which is measured through the structural number (SN). The structural number is a function of the thickness of the surface and base layers and the materials of these layers.

The County provided a weighted average for the Pavement Quality Index (PQI) for all of the paved roads within this study. Surface treatments were not included in the improvement cost because these treatments do not have an impact on the structural ability of the pavement. However, it is noted that surface treatments aid in the prevention of oxidation of the pavement, which in turn, prolongs the life of the pavement. The following sections describe the methodology that was utilized to quantify the rehabilitation needs for Hot Mix Asphalt (HMA) Pavement and Concrete Pavement.

Hot Mix Asphalt Pavement Methodology

The approach to determine the rehabilitation needs to offset the impacts of oil and gas traffic on hot mix asphalt pavement roads requires the determination of the pavement structural number (SN) for existing traffic as well as existing traffic plus oil and gas traffic.

In order to determine the existing SN, the existing serviceability, initial serviceability, terminal serviceability, background ESAL, reliability level and standard deviation have to be defined. The existing serviceability is based on the weighted average PQI, as provided by the County, for each travel shed roadway. The existing serviceability is interpolated based on the PQI and values shown in **Figure 22**. The values shown in **Table 11** are based on industry standards for the different roadway classifications.

Figure 22. Pavement Condition Rating

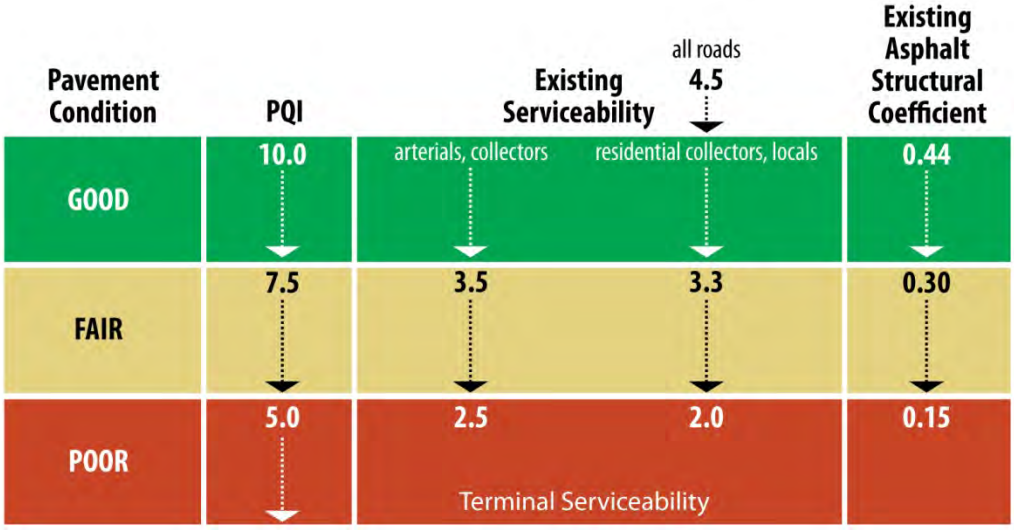


Table 11. Assumptions for Existing Pavement Sections

Roadway Classification	Design EDLA	Design ESAL	Reliability (%)	Standard Normal Deviate (Z_R)	Initial Serviceability	Terminal Serviceability	Standard Deviation	Structural Number[1] (SN) (New)
Principal Arterial	250	1,825,000	95	-1.645	4.5	2.5	0.44	5.02
Minor Arterial	200	1,460,000	90	-1.282	4.5	2.5	0.44	4.62
Collector	100	730,000	85	-1.037	4.5	2.5	0.44	4.03
Res. Collector	50	365,000	85	-1.037	4.5	2.0	0.44	3.49
Local	10	73,000	80	-0.841	4.5	2.0	0.44	2.68

[1] A subgrade resilient modulus (M_R) of 3,500 psi was used for all roadway classifications.

These values are then utilized to solve for SN within the following 1993 AASHTO Guide equation for flexible pavement:

$$\log W_{18} = Z_R \times S_0 + 9.36\log(SN+1) - 0.20 + \frac{\log\left(\frac{\Delta PSI}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\log(M_R) - 8.07$$

W_{18} = predicted number of 18,000 lbs. (ESALs)

Z_R = Standard Normal Deviate

S_0 = Standard Deviation

SN = Structural Number

ΔPSI = Existing Serviceability – Terminal Serviceability

M_R = Subgrade Resilient Modulus (in psi)

After the SN is calculated for the existing conditions, the SN is calculated for the existing traffic plus the oil and gas traffic. The SN Deficiency is then calculated ($SN_{COMBINED}$ - $SN_{EXISTING}$). The required pavement overlay for the oil and gas traffic is then calculated by dividing the SN Deficiency by the Standard Deviation. A cost for the required overlay was then calculated for each respective section of hot mix asphalt road. An example of this process follows.

Poor Condition Asphalt Methodology

Heavy truck traffic such as the oil and gas traffic will expedite the need to reconstruct HMA roadways especially if the roadways have a poor current pavement condition. In order to program a portion of this impact into this study, the replacement cost of the pavement is calculated with the unit prices shown in **Table 12** for the poor segments of pavement as oil and gas traffic utilize these sections of roadway. After the roadway is reconstructed, the pavement is analyzed as a new pavement condition in subsequent years and utilizes the same methodology as described above. The segments that did not have poor pavement conditions were still considered with the same methodology as previously described.

Table 12. Assumptions for Poor PQI HMA Replacement

Roadway Classification	Standard Pavement Thickness	Unit Price per Mile per 1-Foot of Roadway Width
Principal Arterial	12”	$25,600
Minor Arterial	10”	$21,800
Collector	8”	$17,900
Res. Collector	8”	$17,900
Local	6”	$14,000

Hot Mix Asphalt Pavement Example

76th Street (Watonga Way to Wewoka Drive)

Roadway Classification – Collector

PQI Rating Score = 6.4

Pavement Condition = Fair

Design ESAL = 730,000 (from Table 2)

2016 Design ESAL = EDLA x Design Period = 100 x 365 = 36,500

Existing Serviceability = 3.06 (Interpolate from **Figure 22**)

Terminal Serviceability = 2.5 (from **Table 11**)

Reliability Level = 85% (from **Table 11**)

Standard Normal Deviate (Z_R) = -1.037 (from **Table 11**)

Existing SN = Solving AASHTO Equation = 2.98

2016 Oil & Gas ESAL = 8,090

Combined ESAL = 36,500 + 8,090 = 44,590

Combined SN = Solving AASHTO Equation = 3.15

SN Deficiency = $SN_{COMBINED}$ - $SN_{EXISTING}$ = 3.15 – 2.98 = 0.17

Required Overlay to achieve the Same Remaining Life = SN Deficiency/Standard Deviation = 0.17/0.44 = 0.39”

Associated Costs = Inches of HMA x Length of Road x Roadway Width x HMA Unit Costs ($60/Ton)

Associated Costs = 0.39” x (0.055 Tons/SY/1” Thickness) x 0.166 Miles x (5280 Feet/Mile) x 36 Feet x (1 Sq Yard/9 Sq Feet) x $60/Ton = $4,512 (Rounded to $4,600)

Concrete Pavement Methodology

The approach to determine the rehabilitation needs to offset the impacts of oil and gas traffic on concrete pavement roads requires the determination of the pavement service life. Standard design for pavement service life is a span of 20 years. The associated ESAL for the 20 year pavement service life are shown in **Table 13**.

Table 13. Standard Design ESALs for Concrete

Roadway Classification	Design ESAL
Principal Arterial	1,825,000
Minor Arterial	1,460,000
Collector	730,000
Res. Collector	365,000
Local	73,000

Oil and gas traffic will decrease the overall pavement service life for concrete roads. The amount of this decrease is calculated as a percentage and based on the calculated ESAL amount for oil and gas traffic divided by the overall Design ESAL. This percentage is then multiplied by the improvement costs per mile to reconstruct a concrete pavement road in its entirety. In the analysis, a reconstruction cost of $572,725 per lane per mile is utilized for reconstruction. This cost was derived from the Colorado Department of Transportation (CDOT) Transportation Facts for 2011 publication.

Concrete Pavement Example

South Boulder Road

Roadway Classification – Principal Arterial

Weight of Average PQI = 5.2

Pavement Condition = Fair

Design ESAL = 1,825,000

2016 ESAL = 14,764 (Oil & Gas Traffic)

Pavement Service Life Impact = 2016 ESAL/Design ESAL = 14,764/1,825,000 = 0.0081 or 0.81%

Associated Costs = Impact x Length of Road x Lanes x Reconstruction Cost

Associated Costs = 0.81% x 0.216 Miles x 4 Lanes x $572,725/Lane/Mile = $4,008 (Rounded to $4,100)

Safety Mitigation

In addition to the mitigation measures needed to offset the road deterioration, the study team identified measures to address the safety of the study area roads. The safety mitigation is based on the need for shoulder widening to maintain safe multi-modal roads with the increased truck traffic associated with the oil and gas traffic. Wider shoulders provide space for bicyclists separate from the

travel lanes. Shoulders also provide safety benefits for all roadway users: they serve as a countermeasure to run-off-road crashes and provide a stopping area for breakdowns or other emergencies. Using the County's inventory of shoulder widths and their roadway design standards, the study team identified those roadways in the study area with sub-standard shoulders. If oil and gas trucks were assigned to those roadways in any of the three development scenarios in the travel model, it has been assumed that expedited shoulder widening would be needed to improve the multi-modal safety. The costs to widen the shoulders are based on the information presented in **Table 14** .Some of the shoulders would require only partial widening (that is, a narrow shoulder exists) which is reflected in the two foot width unit prices for minor arterials and collectors.

Table 14. Shoulder Widening Unit Costs

Road Classification	Shoulder Width	Unit Price/Mile
Principal Arterial	6' (Full Width - Both Sides)	$140,000
Minor Arterial	5' (Full Width - Both Sides)	$100,000
	2' (Partial Width - Both Sides)	$40,000
Collector	4' (Full Width - Both Sides)	$80,000
	2' (Partial Width - Both Sides)	$20,000

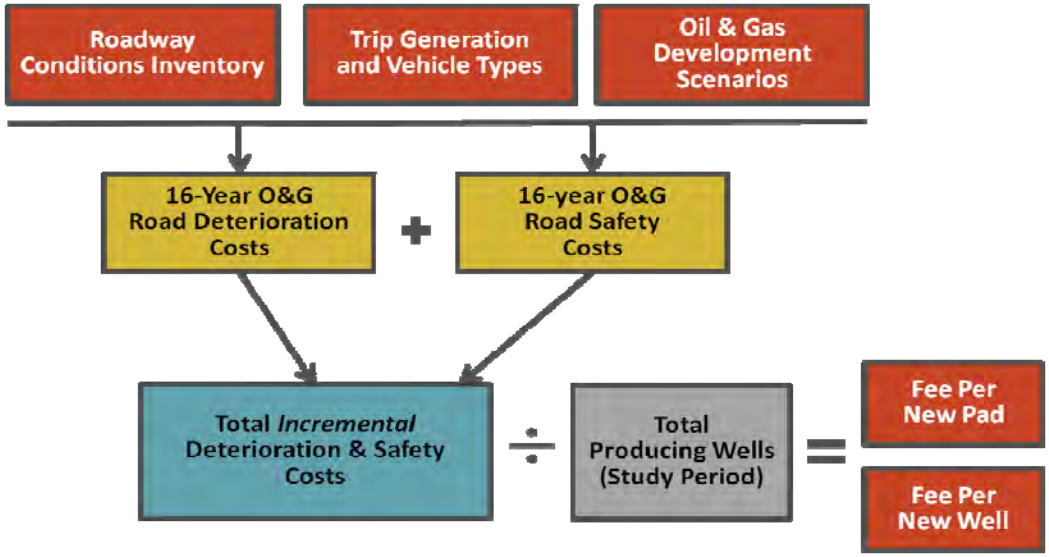
VI. Oil and Gas Road Deterioration and Safety Fee Design

The purpose of designing oil and gas road deterioration and safety fees is to recover the incremental costs associated with the energy industry's impact on the county road network. Because of the nature of oil and gas development, the most intense impact occurs during the first few months of a well's life. After the development stage, the well enters the less trip-intensive production stage for the remainder of the well's lifetime (15 to 25 years). The capital required to recover the costs of the development stage is ideally recovered before development begins or during the permitting process. This is accomplished through oil and gas road deterioration and safety fees.

In designing oil and gas road deterioration and safety fees, it is critical to isolate the oil and gas damage on the county roads. The fees are designed to recoup the *incremental* county cost associated with road deterioration and safety. The fees are based on a blend of the costs per well of the three scenarios and expected average trip lengths. The fees are also designed to be integrated into the oil and gas land use application process in the County's newly adopted regulations.

The methodology for calculating the oil and gas road deterioration and safety fees is shown in **Figure 23**. The process requires the combination of the inventory of roadway conditions, trip generation and vehicle types and development scenarios to find the 16-year incremental oil and gas road deterioration and road safety costs. The road deterioration costs are based on the unpaved and paved road methodologies described in Chapter V, and the safety costs are based on the shoulder widening methodology, also described in Chapter V. In the final step of the process, the incremental road deterioration and safety costs are divided by the expected total number of producing wells at the end of the study period. The fee is then separated into pad-specific and well-specific components according to the relative impact of pad construction compared to well development and production.

Figure 23. Fee Calculation Methodology



Fee Calculation

The oil and gas road deterioration and safety fees are calculated by finding total road deterioration and safety costs incurred by the oil and gas scenarios and dividing that total cost by the number of producing wells at the end of the study period. **Table 15** shows the deterioration and safety costs for each of the scenarios for a four-well pad and a single well.

Table 15. Calculation of Road Deterioration and Safety Fees

	Road Deterioration Cost	Safety Cost	Total Cost
Accelerated Scenario			
Total Cost (16-year period)	$24,393,296	$2,843,980	$27,237,276
Average Cost per 4-Well Pad	$118,414	$13,806	$132,220
Average Cost per Well	$29,604	$3,451	$33,055
Steady Scenario			
Total Cost (16-year period)	$24,661,955	$2,843,220	$27,496,175
Average Cost per 4-Well Pad	$119,718	$13,758	$133,476
Average Cost per Well	$29,929	$3,440	$33,369
Low Scenario			
Total Cost (16-year period)	$5,965,501	$2,105,360	$8,070,861
Average Cost per 4-Well Pad	$132,567	$46,786	$179,353
Average Cost per Well	$33,142	$11,696	$44,838
Scenario Average			
Average Cost per 4-Well Pad	$123,566	$24,783	$148,350
Average Cost per Well	$30,583	$6,196	$36,779
Average Cost per Pad Construction (1% of total cost)	$1,236	-	$1,236
Fee per Pad (rounded)			**$1200**
Fee per Well (rounded)			**$36,800**

The average cost per four-well pad is derived by dividing the total costs over the 16-year period by the number of four-well pads developed in each scenario. Then the average cost per well is found by dividing the average cost per four-well pad by four. This process is repeated for each scenario.

To calculate a separate fee for pad construction and well development, the project team averaged the costs for each scenario per four-well pad. Pad construction accounts for one percent of the average deterioration cost associated with a four-well pad ($1,236). This percentage is derived based on the construction phase's share of ESAL impact on the road network. Once the share of pad construction cost is taken out of the four-well pad average, the remainder is divided by four to calculate the average road deterioration cost per well ($30,583).

The average safety cost per four-well pad across the three scenarios is $24,783. These costs are only applicable to well development costs because there are no safety related expenditures incurred during the pad construction phase. Per well safety fees are calculated by dividing the average cost per four-well pad by four. The process produces a $6,196 safety fee per well.

The costs have been rounded to simplify the fee payments on a pad and well basis. For each new pad, there is a road deterioration fee of $1,200 to cover road maintenance and rehabilitation costs. For each new well there is a fee of $30,600 to cover road deterioration costs and a fee of $6,200 to cover safety costs. **Table 16** shows the fees for each new pad and new well.

Table 16. Oil and Gas Roadway Fees

	Road Deterioration Fee	Safety Fee	Total Fee
Pad	$1,200	-	**$1,200**
Well	$30,600	$6,200	**$36,800**

Note: Fees are in current year dollars.

Based on the fees above, a new four-well pad would be imposed a $148,800 deterioration and safety fee. The fees in **Table 16** are designed to recover the incremental costs associated with the energy industry's impact on the county road network and are expressed in current year dollars. To account for changing unit costs of roadway construction, rehabilitation, and maintenance, it may be appropriate to apply a cost index annually, such as the *Engineering News Record* or CDOT construction cost index.

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RESOLUTION 2012-16

A RESOLUTION IMPOSING A TEMPORARY MORATORIUM ON BOULDER COUNTY'S PROCESSING OF APPLICATIONS FOR PROPOSED OIL AND GAS DEVELOPMENT IN ALL OF THE UNINCORPORATED COUNTY PENDING CONSIDERATION OF AMENDMENTS TO COUNTY REGULATIONS

A. **WHEREAS**, oil and gas exploration and production is a rapidly developing and evolving industry nationwide, across Colorado, and within Boulder County, with both substantial advances in technology and significant modifications to the laws governing the industry occurring during the past few years; and

B. **WHEREAS**, the western edge of one of the most actively drilled oil and gas producing formations along the Front Range underlies the eastern portion of Boulder County; and

C. **WHEREAS**, oil and gas operations have the potential for significant and immediate impacts on the health, safety, and welfare of the citizens of Boulder County ("the County") through increased noise, odor, dust, traffic, noxious weeds, and other disturbance, as well as the potential to significantly impact the County's air, water, soil, biological quality, geology, topography, plant ecosystems, wildlife habitat, wetlands, floodplains, water, stormwater and wastewater infrastructure, drainage and erosion control, parks and open space lands, transportation infrastructure, emergency response plans, and other aesthetic values and community resources; and

D. **WHEREAS**, in its capacity as surface owner of lands managed as open space where oil and gas drilling development has occurred and continues to occur, the County Parks and Open Space Department has recently witnessed new areas not previously developed being developed by oil and gas companies, an increase in notices of intent to drill from oil and gas companies, technological changes in drilling operations that in some cases result in more land disturbance per well pad, differences in hours of operation, and associated increased impacts on plant ecosystems, wildlife habitat and migration corridors, among other environmental and natural resources; and

E. **WHEREAS**, in its role administering County floodplain regulations, the County Transportation Department is concerned about increased interest in developing oil and gas in mapped floodplain areas, posing potentially serious risks to public health and safety; and

F. **WHEREAS**, in its role managing the County transportation system under the duly adopted Boulder County Multimodal Transportation Standards, through issuance of access permits to ensure safe ingress and egress to the system, issuance of oversize/overweight vehicle permits, and other methods for managing the public rights-of-way, the County Transportation Department is concerned about a potential increase in impacts due to oil and gas development, including increased wear and tear on roads from heavy truck traffic resulting in greater need for road and bridge improvements and maintenance; and

G. **WHEREAS**, the Colorado Oil and Gas Conservation Act, C.R.S. §§ 37-60-101 et seq., declares that it is in the public interest to foster the responsible, balanced development, production, and utilization of the natural resources of oil and gas in the state of Colorado in a

manner consistent with protection of public health, safety, and welfare, including protection of the environment and wildlife resources; and

H. **WHEREAS**, the Colorado Oil and Gas Conservation Act grants the Colorado Oil and Gas Conservation Commission ("COGCC") authority to adopt statewide rules and regulations concerning the development and production of oil and gas resources and the COGCC has done so; and

I. **WHEREAS**, the Colorado Oil and Gas Conservation Act provides that it is not intended to establish, alter, impair, or negate the authority of local and county governments to regulate land use related to oil and gas operations; and

J. **WHEREAS**, Colorado courts have recognized on several occasions that the Colorado Oil and Gas Conservation Act does not expressly or impliedly preempt all aspects of a county's authority to enact land use regulations applicable to oil and gas development and operational activities within the county, and thus the County's regulations pertaining to matters mentioned in the Colorado Oil and Gas Conservation Act are legal and valid as long as their express or implied conditions do not irreconcilably conflict with state law on the basis of operational conflicts that materially impede or destroy the state's interest; and

K. **WHEREAS**, the County Planning Act, C.R.S. § 30-28-106, gives the County the authority to process and adopt a master plan for the physical development of the unincorporated territory of the County, and the duly adopted Boulder County Comprehensive Plan recognizes the potential impacts of oil and gas exploration, development, and production and all accessory activities and encourages such activities to be located and performed to minimize disturbance to land and water resource systems, with affected areas reclaimed and restored once the activities are completed and all other impacts minimized via all appropriate regulatory measures to the extent authorized by law; and

L. **WHEREAS**, the current Boulder County Comprehensive Plan sections addressing oil and gas activities have not been updated in many years and merit a review to determine whether amendments are necessary to reflect today's industry, its practices, and impacts on land use, transportation, public health, parks and open space areas, and other environmental and natural resources across the County; and

M. **WHEREAS**, the Local Government Land Use Control Enabling Act, C.R.S. §§ 29-20-101 et seq., provides the County with the broad authority to plan for and regulate the use of land in order to provide for orderly development and a balancing of basic human needs of a changing population with legitimate environmental concerns, all in a manner consistent with constitutional rights; and

N. **WHEREAS**, the Local Government Land Use Control Enabling Act authorizes each local government within its respective jurisdiction to plan for and regulate the use of land by, among other actions, regulating development and activities in hazardous areas; protecting lands from activities which would cause immediate or foreseeable material danger to significant wildlife habitat and would endanger a wildlife species; preserving areas of historical and archaeological importance; regulating the use of land on the basis of the impact thereof on the community or surrounding areas; and otherwise planning for and regulating the use of land so as to provide planned and orderly use of land and protection of the environment in a manner consistent with constitutional rights; and

O. **WHEREAS**, the Board believes it has not only the right but the responsibility to plan for and regulate the use of land for the purposes laid out in the Local Government Land Use Control Enabling Act as well as those purposes specified in other applicable state and federal statutes and common law grants of authority, to best protect and promote the health, safety, and general welfare of the present and future inhabitants of Boulder County and to guide future growth, development, and distribution of land uses within Boulder County; and

P. **WHEREAS**, to that end, and pursuant to the Local Government Land Use Control Enabling Act, the County Planning Act, and various other state and federal statutory and common law grants of land use authority, the Board has from time to time adopted planning, zoning, and other regulations governing land use in the unincorporated territory of the County; and

Q. **WHEREAS,** the current regulations concerning oil and gas development in §§ 4-900 to 4-913 of the Boulder County Land Use Code were last updated years ago, prior to various changes in oil and gas production practices, prior to changes to state statutes and regulations, and prior to several relevant Colorado court decisions concerning local regulation of oil and gas activities, and therefore are ripe for review for potential amendments in light of the current significant concerns over the impacts of continuing oil and gas development activities within the County; and

R. **WHEREAS,** Boulder County staff have begun to analyze whether the existing zoning and other land use regulations pertaining to oil and gas activities are sufficient to protect the public health, safety, and welfare; and

S. **WHEREAS**, the Board estimates that the time needed to perform the prerequisite studies and planning and analyze regulatory amendments that may be necessary to mitigate the impacts of oil and gas exploration, development, and production activities, may take approximately six months to complete; and

T. **WHEREAS**, the Board reasonably anticipates that applications for additional oil and gas development may be filed in the coming months while the study is undertaken and before the County has had the opportunity to consider the outcome of the study and adopt appropriate regulatory changes; and

U. **WHEREAS**, the Board finds that it is inconsistent with its responsibilities to protect the local environment and population of the County to continue to process and review applications for oil and gas development in piecemeal fashion without thoroughly examining the current County regulations to reflect changes in state law and oil and gas production practices; and

V. **WHEREAS**, the Board is aware of the potential for further changes in state law during the 2012 legislative session, and that legislative proposals in the oil and gas regulatory area, if enacted this session, may further clarify the bounds of County regulatory jurisdiction; and

W. **WHEREAS**, if applications requesting approval to conduct oil and gas exploration, development, and production activities within the unincorporated County are submitted prior to the County having adequate time to conduct the appropriate studies, make necessary revisions to its Comprehensive Plan, be aware of any forthcoming 2012 legislative changes, and consider and process any indicated regulatory amendments, the Board believes irreparable harm may be done to the public health, safety and welfare; and

X. **WHEREAS**, the U.S. Supreme Court and the Colorado Supreme Court recognize that in the field of land use regulation, temporary moratoria of reasonable duration are often employed to preserve the status quo in a particular area while developing a long-term plan for development; indeed, in countering the incentive of property owners to develop their property quickly to avoid the consequences of an impending land use plan for the jurisdiction, moratoria are a crucial tool for local governments and, therefore, pursuant to express and implied authority granted by the Colorado Revised Statutes and multiple Colorado and federal appellate decisions upholding temporary moratoria on land use applications while amendments are considered, the Board has the legal authority to adopt a temporary moratorium in this situation; and

Y. **WHEREAS**, in light of the foregoing recitals and findings, circumstances warrant the immediate enactment of this Resolution establishing a temporary moratorium to protect the public health, safety, and welfare, and to avoid development which, during the County's planning and land use regulation amendment process, may contravene the results of this study and process put the public at risk; and

Z. **WHEREAS**, the Board further determines that it will schedule and hold a public hearing on this temporary moratorium and related matters as soon as practicable after this Resolution's adoption, for the purposes of receiving public comment on the moratorium and considering whether to terminate, extend, or otherwise amend the moratorium.

NOW THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Boulder County:

1. The submittal of notices of intent to drill and land use applications requesting approval to conduct oil and gas development activities within the unincorporated territory of the County limits is imminent. The County may not have updated regulations in place that adequately mitigate impacts of this activity or that incorporate the County's full ability to regulate in this area under evolving state statutes, regulations, and case law to protect and preserve the public health, safety and welfare. Therefore, a temporary moratorium on accepting applications is reasonable and necessary.
2. This temporary moratorium shall take effect immediately. The County Land Use Department is directed not to accept, process, or approve any applications under Article 4-900 of the Land Use Code after the effective date of this Resolution.
3. This temporary moratorium shall remain in place until August 2, 2012, unless earlier terminated or extended.
4. County staff is hereby directed to continue analyzing whether the existing County Comprehensive Plan and existing County regulations pertaining to oil and gas activities are sufficient to protect the public health, safety, and welfare, or whether an amended Comprehensive Plan and amended regulations will be necessary to adequately mitigate impacts.
5. The Board intends to hold a public hearing to take testimony on the merits of the temporary moratorium imposed by this Resolution and to determine whether the moratorium should be terminated, extended, or otherwise amended on Thursday, March 1, 2012, at 4:00 p.m., in the Board's public hearing room on the third floor of the Boulder County Courthouse, 1325 Pearl Street, Boulder, Colorado. Notice of this hearing shall be published in a newspaper of general circulation in Boulder County at

least 14 days prior to the hearing date. Should this hearing be rescheduled for any reason, the Board will publish notice of the new time, date, and location of the hearing in a newspaper of general circulation in Boulder County at least 14 days prior to the hearing date. If necessary, at the Board's discretion, this hearing may be continued one or more times.

6. The Board reaffirms that any oil and gas operations conducted without all necessary County approvals may be in violation of the Boulder County Land Use Code or other applicable County regulations.
7. This Resolution does not apply to the following:
    a. Any complete application for oil or gas exploration, development, or production currently being processed by the Land Use Department, which may continue to be processed and reviewed as provided in the Land Use Code.
    b. Any application for oil or gas exploration, development, or production already approved by the Land Use Department prior to the effective date of this Resolution where such approval is validly maintained thereafter.
    c. Development which possesses either a statutory or common law vested right.
    d. Minor modifications to existing permits.

A motion to approve the foregoing Resolution imposing a temporary moratorium was made at the duly noticed public business meeting held on February 2, 2012 by Commissioner Toor, seconded by Commissioner Gardner, and passed by a 3-0 vote of the Board.

ADOPTED on this 2 day of February, 2012, effective immediately.

BOARD OF COUNTY COMMISSIONERS
OF BOULDER COUNTY:

Cindy Domenico

Cindy Domenico, Chair

Will Toor, Vice Chair

Deb Gardner

Deb Gardner, Commissioner

SEAL OF BOULDER COUNTY, COLORADO

ATTEST:

Cecilia J. Lacey

Clerk to the Board

RESOLUTION 2012-46

A RESOLUTION CONFIRMING AND EXTENDING RESOLUTION 2012-16 IMPOSING A TEMPORARY MORATORIUM ON BOULDER COUNTY'S PROCESSING OF APPLICATIONS FOR PROPOSED OIL AND GAS DEVELOPMENT IN ALL OF THE UNINCORPORATED COUNTY PENDING CONSIDERATION OF AMENDMENTS TO THE COUNTY COMPREHENSIVE PLAN AND REGULATIONS

WHEREAS, in Resolution 2012-16, adopted and effective on February 2, 2012, the Board of County Commissioners of Boulder County ("the Board") adopted a temporary moratorium for a period of six (6) months, until August 2, 2012, and directed the County Land Use Department during this period to not accept, process, or approve any Development Plan Review application for oil and gas operations under Article 4-900 of the Land Use Code ("the Temporary Moratorium"); and

WHEREAS, the Board approved the Temporary Moratorium to allow County staff the time to analyze whether the existing County Comprehensive Plan and County regulations pertaining to oil and gas activities are sufficient to protect the public health, safety, and welfare, and whether an amended Comprehensive Plan and amended regulations are necessary to adequately mitigate impacts; and

WHEREAS, the Board fully specified in Resolution 2012-16 the reasons why it undertook this immediate action to impose the Temporary Moratorium, including, without limitation, the accelerated development and evolution of the oil and gas industry nationwide and in the Wattenberg Basin in the eastern portion of Boulder County and neighboring Weld County; the rapidly changing technology surrounding oil and gas drilling, involving primarily the controversial method of hydraulic fracturing ("fracking") of horizontally drilled wells; and the widespread, growing public concern over the land use, environmental, and public health impacts of fracking focusing on deteriorating air and water quality, questionable waste disposal practices, noxious odor and dust generation, intensification of erosion and other land disturbance impacts, proliferation of industrial-style extraction developments in rural and agricultural areas, increased heavy truck traffic with consequent damage to public roads, aggravation of geologic hazards such as earthquakes, safety concerns related to development in floodplains and floodways, and accelerated consumption of natural resources such as water, open space, productive agricultural land, and plant and wildlife habitat; and

WHEREAS, in enacting Resolution 2012-16 the Board scheduled a follow-up public hearing on the Temporary Moratorium, to be duly noticed and held on March 1, 2012, at 4:00 p.m. ("the Public Hearing"), so that the Board could receive public comment on the appropriateness of the Temporary Moratorium, and consider whether to terminate, extend, or otherwise amend the Moratorium; and

WHEREAS, between the time of the Board adopting the Temporary Moratorium and the Public Hearing, County staff collected information and held numerous meetings to proceed with the study and analysis directed by the Board under the Moratorium, and worked diligently to prepare and compile substantial background materials for the Board's review at the Public Hearing; and

WHEREAS, at the Public Hearing the Board considered the staff materials and background testimony presented by representatives of the County Land Use Department, County Parks and Open Space Department, County Transportation Department, and County Public Health, as well as the comments of many concerned members of the public, and spokespersons for environmental groups, the Colorado Attorney General's Office, and the University of Colorado's Environmental Engineering program, and other speakers; and

WHEREAS, following several hours of testimony, the Board indicated the need for additional time to absorb the extensive information provided at the Public Hearing before it would be in a position to give direction to County staff regarding the nature and scope of the proposed oil and gas master planning and regulatory effort; and

WHEREAS, at the end of the Public Hearing the Board, by spoken consensus, confirmed the necessity of keeping the Temporary Moratorium in effect until the Board had the opportunity to reflect and act upon the information from the Public Hearing; and

WHEREAS, the Board scheduled a continuation of the Public Hearing, for purposes of deliberating on, and giving direction regarding, the Temporary Moratorium, to be held on April 16, 2012, at 4:00 p.m., which was denominated a public meeting as no additional public testimony was then to be taken; and

WHEREAS, at the April 16 public meeting the Board received updated information from County staff on certain topics raised at the Public Hearing, and proceeded to provide direction regarding how County staff should proceed with the study and analysis of the County's planning and regulatory efforts addressing future oil and gas operations in unincorporated Boulder County, and further, in light of that direction, confirmed and extended the duration of the Temporary Moratorium, all as set forth in this Resolution, below.

NOW THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Boulder County, based upon the Public Hearing on the Temporary Moratorium, as follows:

1. The Public Hearing has amply demonstrated that serious and legitimate concerns exist regarding the land use, environmental, and public health impacts of future oil and gas operations in the unincorporated County. Based on the Public Hearing, the Board believes that the responsible state and federal agencies may not be adequately addressing these impacts. Moreover, the County's existing planning and regulatory efforts in this area appear outdated and may not be sufficiently protecting the public health, safety, and welfare within the scope of the County's legal authority.

2. In the land use planning context, County staff, with the assistance of outside consultants (who may be retained as deemed appropriate and approved by the Board), is directed to process: (a) appropriate amendments to the Boulder County Comprehensive Plan, subject to the authorization of the County Planning Commission which County staff shall request; *and* (b) appropriate amendments to the Boulder County Land Use Code, consistent with the County's legal authority, including but not limited to considering the amendments suggested in the County Land Use Director's March 1, 2012 background paper (pp. 14-15) prepared for the Public Hearing, as well as possible transportation infrastructure/road impact fees, setbacks from open water sources, zoning to allow oil and gas operations in areas that will have the least impact, and lighting and noise controls.

The Board also authorizes staff to schedule a joint public meeting or hearing between the Board and the Planning Commission, if staff determines that such a proceeding will facilitate this land use planning and regulatory amendment process.

3. The Board emphasizes the importance of addressing the environmental impacts of oil and gas operations on air, water, and soil quality, on odor production, and from waste disposal, as well as in the context of promoting "clean" or "green" energy. The Board directs staff to consider whether such impacts and concerns can, and should, be addressed through the Land Use Code, or through possible Public Health regulations, or through alternative County efforts such as coordinating with other governmental agencies' regulatory efforts, entering into memoranda of understanding or intergovernmental agreements with other agencies, promoting state or federal legislation, performing public education or outreach, and/or partnering with other involved organizations in the public and private sectors.

4. The Board urges staff to consider the full range of tools and responses that may be available to the County to address legitimate concerns over the impacts of oil and gas operations, particularly in areas where the County may be legally preempted from exercising its regulatory authority, or where other governmental entities are in a significantly better position to exercise their regulatory authority.

5. The Board reserves the ability, based on forthcoming information, to add planning or regulatory areas related to oil and gas development in the unincorporated County that are not specified in this Resolution, should the Board or the Planning Commission determine that other issues are important to encompass within this effort.

6. In light of the extensive work that the Board envisions staff will need to undertake to implement this Resolution, the Board concludes that the Temporary Moratorium's length of six months, initially imposed in Resolution 2012-16, is insufficient. The Board determines, based on present information, that another six months will be necessary to appropriately amend the County's Comprehensive Plan and Land Use Code in light of the Board's direction herein provided. *Therefore, the Board approves extending the duration of the Temporary Moratorium as stated in Resolution 2012-12, to and including February 4, 2013.*

7. In approving this extension of the Temporary Moratorium through February 4, 2013, the Board urges staff to move expeditiously on this project, so that the Board can end the Temporary Moratorium sooner if appropriate plans and regulations are in place. Conversely, the Board reserves the right to extend the Temporary Moratorium if forthcoming circumstances indicate that additional time is reasonably necessary to study, process, and enact appropriate plans and regulations. Any change in the duration or other terms of the Temporary Moratorium shall occur at a duly noticed public hearing of the Board.

A motion to provide direction to the County staff, as stated above, and to confirm the Temporary Moratorium and extend its duration through February 4, 2013, was made at the April 16, 2012 public meeting (convened to act on the information presented at the March 1, 2012 Public Hearing), by Commissioner Toor, seconded by Commissioner Gardner, and passed by a 3-0 vote of the Board.

ADOPTED on this 1st day of May, 2012, nunc pro tunc the 16th day of April, 2012.

BOARD OF COUNTY COMMISSIONERS OF BOULDER COUNTY:

Cindy Domenico, Chair

Will Toor, Vice Chair

Deb Gardner, Commissioner

ATTEST:

Clerk to the Board

	Attachment C: Oil & Gas Regulations Implementation Work Plan *(beginning of Week)*																				
Task	**7-Jan**	**14-Jan**	**21-Jan**	**28-Jan**	**4-Feb**	**11-Feb**	**18-Feb**	**25-Feb**	**4-Mar**	**11-Mar**	**18-Mar**	**25-Mar**	**1-Apr**	**8-Apr**	**15-Apr**	**22-Apr**	**29-Apr**	**6-May**	**13-May**	**20-May**	**27-May**	**3-Jun**
Contact industry regarding test applications																						
Identify RFQ needs w/ depts																						
Develop RFQ & review time																						
Staff trainings:																						
1. Overview																						
2. Preapp																						
3. Completeness Review																						
4. Applic./Criteria Review																						
5. Certifications																						
6. Post-approval/ permits / Inspections																						
Develop test applications																						
Post RFQ and response time																						
Select RFQ interviewees																						
Interview RFQ respondents																						
Select vendors																						
Train key staff on technical components of application review																						
Coordination with OEM/FPDs																						
Develop Transportation fees																						
Discuss Transportation fees with Industry																						
Develop application handouts																						
Develop process checklists																						
Develop staff templates / determinations																						
Develop DPR construction permit																						
Coordination of DPR permit w/ other permits (Access, floodplain, stormwater, etc.)																						
Develop public handout																						
Develop application packets																						
Update O&G website																						
Develop DPR Fees for processing																						
Adopt DPR review Fees																						
Adopt Transportation Fees																						
Add workflows to Accela																						
Test workflows in Accela and correct																						
Coordination with Building Team																						
Set up inspection schedules																						
Coordination with Industry																						
Coordination with COGCC																						
Moratorium ends / Process applications	**10-Jun**																					