ENERGY RESOURCES TECHNICAL MEMORANDUM

April 2014

EB I-70 Peak Period Shoulder Lane

CATEGORICAL EXCLUSION

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Acronyms and Abbreviations

AGS	Advanced Guide way System
BTU	British Thermal Unit
CDOT	Colorado Department of Transportation
CH_4	Methane
CO_2	Carbon Dioxide
CSS	Context Sensitive Solutions
DRCOG	Denver Regional Council of Governments
EA	Environmental Assessment
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
MP	Milepost
mph	miles per hour
MPO_S	Metropolitan Planning Organizations
NOx	Nitrous Oxide
PPSL	Peak Period Shoulder Lane
VMT	Vehicle Miles of Travel

Section 1. Purpose of the Memorandum

The Federal Highway Administration (FHWA), in cooperation with the Colorado Department of Transportation (CDOT), is preparing a Categorical Exclusion for proposed changes to the eastbound lanes of I-70 between approximately milepost (MP) 230 and MP 243, in Clear Creek County, Colorado. The proposed changes would improve operations and travel time reliability in the eastbound direction of I-70 in the project area. Additionally, the improvements would be consistent with the *I-70 Mountain Corridor Programmatic Environmental Impact Statement (PEIS) Record of Decision (ROD)*, I-70 Mountain Corridor Context Sensitive Solutions (CSS) process, and other commitments of the PEIS. The Proposed Action fits within the definition of “expanded use of existing transportation infrastructure in and adjacent to the corridor” as an element of the Preferred Alternative Minimum Program.

This technical memorandum discusses the regulatory setting and describes the affected environment and the impacts of the No Action Alternative and Proposed Action on energy consumption and greenhouse gas (GHG) emissions within the identified study area. This memorandum also documents mitigation measures, including applicable measures identified in the *I-70 Mountain Corridor PEIS*, which would reduce any impacts during construction and operation. The I-70 PEIS identified comprehensive improvements for the corridor. The Proposed Action would immediately address mobility and operations in the eastbound direction between Empire Junction and east Idaho Springs, but would not address all of the transportation needs in this area. The Proposed Action would not preclude other improvements needed and approved by the I-70 PEIS ROD.

Section 2. How Does the Analysis Relate to the Tier 1 PEIS?

The Tier 1 *I-70 Mountain Corridor Final PEIS* provided a comparative operational energy analysis of corridor alternatives: this I-70 Peak Period Shoulder Lane (PPSL) Categorical Exclusion analysis builds on the PEIS by conducting a detailed energy analysis specific to the Proposed Action outlined in this technical memorandum. As done in the Tier 1 PEIS, the energy analysis for Tier 2 includes additional construction and operational analysis based on the specific Proposed Action. Tier 2 further considers power sources and mixes of energy supply types (renewable/alternative energy, fossil fuel, and other future concepts), as well as development of best management practices for the Proposed Action.

Section 3. What Process was Followed to Analyze Energy Resources?

3.1 Study Area

The study area, presented in Figure 1, for this energy analysis extends between the I-70/US 40 interchange (MP 232) and the Twin Tunnels (MP 241.5) and encompasses both the I-70 corridor and frontage roads. This study area is the limit of physical change to the I-70 corridor pavement width and not based on signing locations, which may reside outside of these study limits. This study area may experience a peak period reduction in congestion because of the Proposed Action, as described in Section 4 of this technical memorandum.

3.2 Methodology

Energy resources reported in this study are used during both construction and peak period operations of the transportation facility. This analysis examines each operation's energy usage. The energy resources used during construction operations along the transportation facility includes the fuel used to manufacture and transport construction materials, as well as the operation of construction equipment.

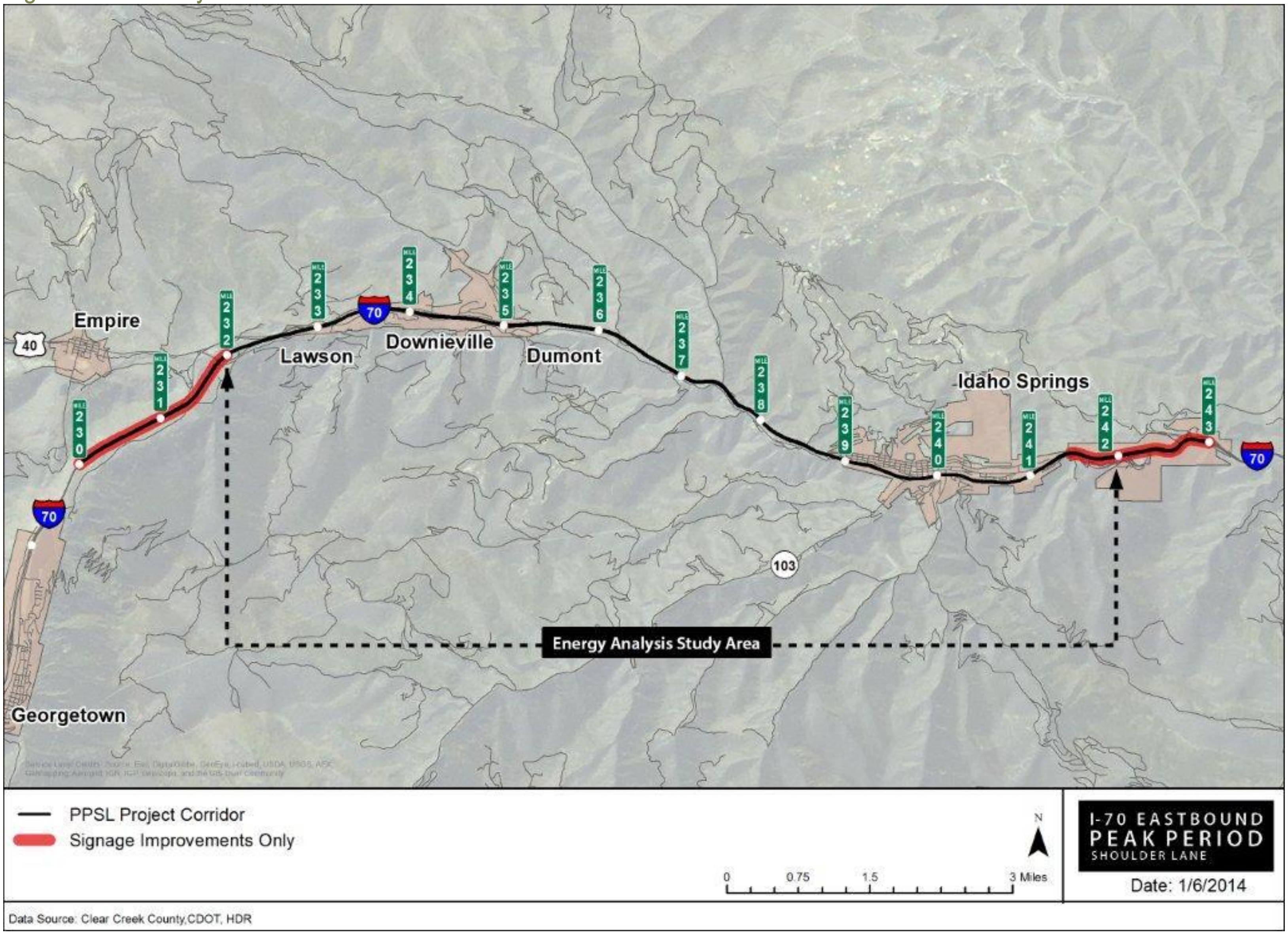
Peak period operations along the transportation facility include the fuel to power the vehicles and trucks using the facility. For this study, the period analyzed is a typical peak period during the summer/winter months, on a Sunday, between 9:00 AM and 11:00 PM. The time period for this analysis was based on the *I-70 Peak Period Shoulder Lane Traffic Analysis Feasibility Study*. Therefore, analysis contained in this report adheres to the data presented in the Feasibility Study. Final Peak Period time selection is fully described in the *Concept of Operations for I-70 Peak Period Shoulder Lane,* which recommends that the time period use of the Peak Period Shoulder Lane be determined based on congestion of the corridor, and may include Saturdays and holidays. Utilization of the Proposed Action during these congested times will further increase the benefits reported in this study.

Fuel consumption emits GHGs in the air along the study corridor primarily consisting of carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (NO_X). These primary GHG emissions resulting from fuel consumption are summarized for the No Action Alternative and the Proposed Action.

The units used to measure daily consumption of energy in this study is the British Thermal Unit (BTU); however, to better quantify energy consumption, results are provided in equivalents of gallons of gasoline.

In the study area, there is an approximate overall change in elevation of 1.5 percent uphill in the westbound direction. Therefore, the fuel economy of the eastbound vehicles, which are traveling downhill, is better than average fleet statistics; while the fuel economy of all westbound vehicles is lower than average. Because the overall grade change is relatively minor, and because energy and emissions calculations consider both eastbound and westbound traffic, grade is not taken into account in the energy analysis. For this study, fossil fuels are analyzed as energy resources, because in the current year these supplies are the predominant energy source for the operational and construction vehicle fleets. Alternative and renewable energy sources may be the predominant energy source by 2035, and into the future; however, this study assumes

Figure 1. Study Area



future vehicles are powered by fossil fuels with the current fuel efficiencies. It is assumed for this study that the passenger vehicle class consists of passenger cars and light-duty trucks (consisting of passenger vans, pickup trucks, and SUVs). The passenger vehicle class is powered by conventional gasoline fuel. The heavy-duty truck class consists of buses, recreational vehicles, single-unit delivery-type trucks, and combination trucks. This class is assumed to be powered by conventional diesel fuel.

Energy consumption is directly proportional to VMT and takes into account the average speed through the corridor; therefore, energy consumption does acknowledge vehicle congestion. The calculation for energy consumption includes the following variables:

- Vehicle volume
- Distance traveled
- Vehicle speed
- Vehicle type
- Speed dependent fuel economy per vehicle type

The truck percentage used in this analysis is taken from the *Twin Tunnels Environmental Assessment Transportation Technical Memorandum* (CDOT, 2012). The report states that the average weekday truck percentage is 8.75 percent, while the weekend percentage is notably lower, at 2.5 percent. This study uses the weekend truck percentage for analysis because the Proposed Action is anticipated to be operational primarily during the weekend and holiday peak periods. In this study, fuel consumption is calculated for both the eastbound and westbound directions of travel along the study corridor, and for the typical peak period analysis, between 9:00 AM and 11:00 PM. The flow charts presented in Figure 2 and Figure 3 illustrate the calculation of energy consumption and GHG emissions.

Calculation of VMT

The study area corridor was divided into segments based on mileposts. The study traffic volume data was extracted from the DynusT traffic model developed by Atkins. This DynusT model and assumptions were previously approved by the project stakeholders for the Twin Tunnels Environmental Assessment, an adjacent roadway project. DynusT is a dynamic traffic assignment simulation model that has the capability of producing meso-scale modeling results along the study corridor. The model can estimate the change in travel demand and patterns resulting from the Proposed Action. Peak period (14 hours from 9:00 AM to 11:00 PM) traffic volume outputs from the model are used for the typical peak period energy consumption analysis. Peak period volumes are necessary to evaluate the impacts of ski and other recreational traffic along the I-70 corridor, which significantly vary from weekday patterns.

The consumption of energy is calculated differently for the passenger vehicle class and heavy-duty truck class. For this analysis, heavy-vehicles are anticipated to utilize the general purpose lanes due to the wider lane width, possible travel restrictions, and/or surcharge. Publicly operated buses may occasionally use the peak period shoulder lane. The total VMT is calculated separately for both passenger vehicles and heavy duty trucks by multiplying the number of vehicles by the length of each I-70 corridor segment.

Figure 2. Greenhouse Gas Emission Calculation Flow-Chart

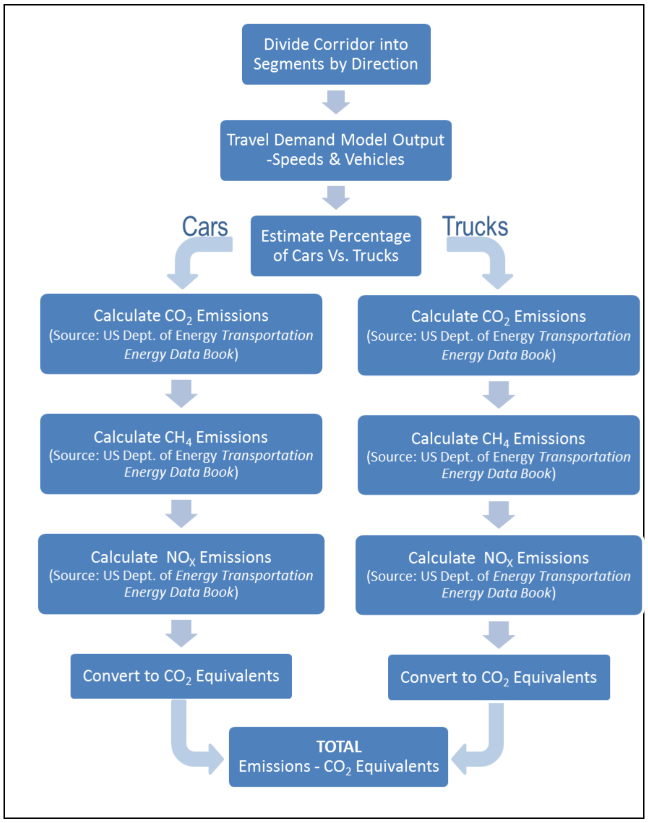
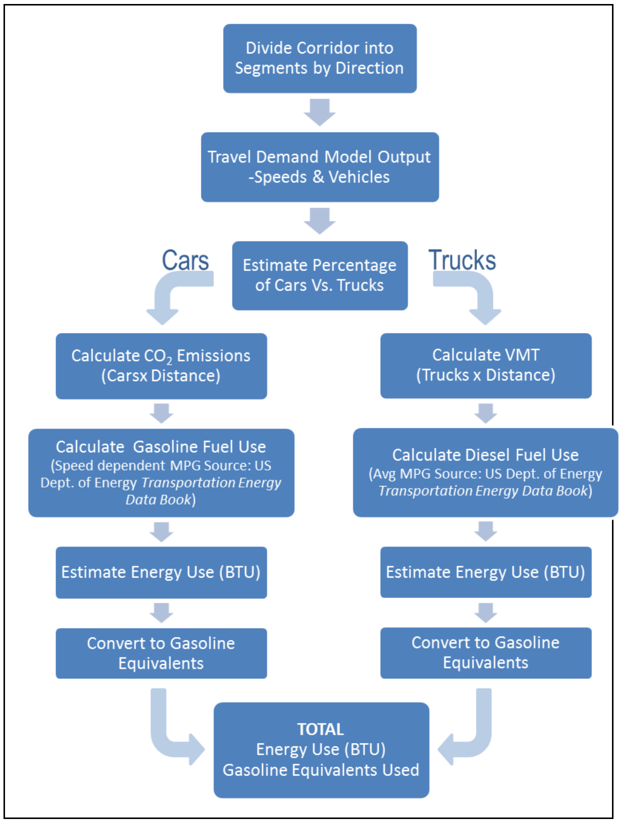


Figure 3. Energy Consumption Estimation Flow-Chart



Calculation of Fuel Consumption

Table 4.28, from the *United States Department of Energy Transportation Energy Data Book: Edition 32* (Energy Data Book), published by the Oak Ridge National Laboratory in June 2013, lists the average fuel efficiency statistics, in miles per gallon, for gasoline powered vehicles at various operating speeds. Table 5.11 lists the average fuel statistics for a diesel-powered combination truck. Taking the calculated VMT for each I-70 segment and dividing by the fuel statistics for the average vehicle speed calculated for each segment as determined by the DynusT model output, the daily gallons of gasoline and diesel fuel consumption can be analyzed. Table B.4 in the Energy Data Book list the heat content for various fuel types, therefore, a gallon of conventional gasoline and diesel fuel can be expressed in BTUs per gallon by multiplying the calculated gallons of fuel by the gross BTU equivalent conversion factors.

Following the same methods, the daily operational energy consumption during construction is calculated. It is assumed that the work zone will be posted at a speed of 50 miles per hour (mph). Fuel consumption during construction can be dynamic due to operating speeds in the work zone. For example, work zone operating speeds of 50 mph will consume less fuel than at 55 mph. For this analysis, it was assumed that the operating speed in the work zone was 50 mph—slower than the posted speed, because of potential narrower lane widths and reduced shoulder widths, which impact free-flow speeds.

Calculation of Greenhouse Gases

Variables, such as fuel consumption and VMT for passenger vehicles and heavy-duty truck classes in each segment, are used in this report to develop the calculation of GHG emissions. Calculation of CO_2-type emissions uses the consumption of fuel, while calculations of CH_4-type and NO_x-type emissions are calculated by the VMT. Each GHG emission type is then multiplied by a specific equivalent and is expressed in CO_2 equivalents.

Calculation of CO_2

Table 11.11 from the Energy Data Book summarizes the typical CO_2 emissions from one gallon gasoline and diesel fuel types. The daily fuel consumption in gallons per fuel type multiplied by the corresponding CO_2 emissions factor results in the estimated weight of CO_2 emitted during the study period.

Calculation of CH_4 and NO_X

Calculations for CH_4 and NO_x are based on data from the "Emission Factors for Greenhouse Gas Inventories," in Table 3 and Table 4, released by the United States Environmental Protection Agency (EPA) in November, 2011. The VMT for each passenger vehicles and heavy duty truck class per segment is used to calculate both CH_4 and NO_X emissions. Table 3 from the EPA's report lists the various model years of gasoline powered passenger cars and light-duty trucks (the passenger vehicle class) and corresponding CH_4 and NO_X emission factors. For this study, an average of the model year emission factors was taken and then multiplied by the VMT for the passenger vehicle class to obtain the corresponding estimated CH_4 and NO_X emissions by weight for the study period. Similarly, Table 4 from the EPA's report lists the average vehicle year CH_4 and NO_X equivalent factors for diesel powered heavy duty trucks and this number was multiplied by the segment VMTs for the heavy duty vehicle class to obtain the corresponding estimated CH_4 and NO_X emissions by weight for the study period.

Calculation of equivalent CO_2

The GHG emissions calculated for CO_2, CH_4, and NO_X are multiplied by the "Global Warming Potential" factor listed in the Energy Data Book Table 11.3 to obtain the CO_2 equivalent for each emission. These equivalents are then summed to get to obtain the total GHG emissions during the study period.

3.3 Data Sources

The following data sources are used for the Energy Consumption analysis:

1) United States Department of Energy Transportation Energy Data Book: Edition 32, (Oak Ridge National Laboratory, June 2013)

2) United States Environmental Protection Agency, "Emission Factors for Greenhouse Gas Inventories", (EPA, November, 2011)

3) Twin Tunnels Environmental Assessment Transportation Technical Memorandum, (CDOT, 2012)

Section 4. Description of the Proposed Action

The purpose of the I-70 PPSL project is to provide short-term eastbound operational improvements to relieve traffic congestion during periods when traffic volumes are highest. This segment is the most congested stretch of the entire I-70 Mountain Corridor. During both the summer and winter peak season, traffic volumes are highest on weekends when recreational travelers comprise more than 90 percent of traffic. In 2010 drivers experienced speeds of less than 20 miles per hour for 35 percent of the time on Sundays, which have the highest volume. Some motorists divert to the frontage road along I-70, which affects its ability to function as a local access county road.

The Proposed Action would add a peak period shoulder lane between the US 40/I-70 interchange and east Idaho Springs. This managed lane would be used during peak periods, defined as Saturdays, Sundays, and holidays, improving travel times and operations. The project extends from milepost 230 to milepost 243, with improvements proposed as follows:

- Milepost 230 to milepost 232: signage improvements only. Signage would notify motorists of the status of the managed lane, entrance and exit points, and cost.
- Milepost 232 to milepost 242: roadway improvements, including: up to 3.5 feet of widening in select areas to accommodate the managed lane, up to 14 feet of widening at the SH 103 on ramp and 4 feet to 8 feet of widening at all other on-ramps in the corridor, replacement of the existing SH 103 bridge, bridge replacement and interchange improvements at Exit 241, improvements to Water Wheel Park, signage, rock fall mitigation in two locations, and construction of 11 retaining walls.
- Milepost 242 to milepost 243: signage improvements only.

The managed lane, which would be tolled, would operate up to, but not exceed, 20 percent of the annual days or 7.5 percent of the time, and connect to the three-lane section provided by the Twin Tunnels project, east of Idaho Springs, thereby capitalizing on that investment.

The improvements will be consistent with the *I-70 Mountain Corridor Programmatic Environmental Impact Statement* (PEIS) *Record of Decision* (ROD), I-70 Mountain Corridor Context Sensitive Solutions process, and other commitments of the PEIS. The Proposed Action fits within the definition of “expanded use of existing transportation infrastructure in and adjacent to the corridor” as an element of the Preferred Alternative Minimum Program.

See Figure 4 for an overview of the proposed improvements.

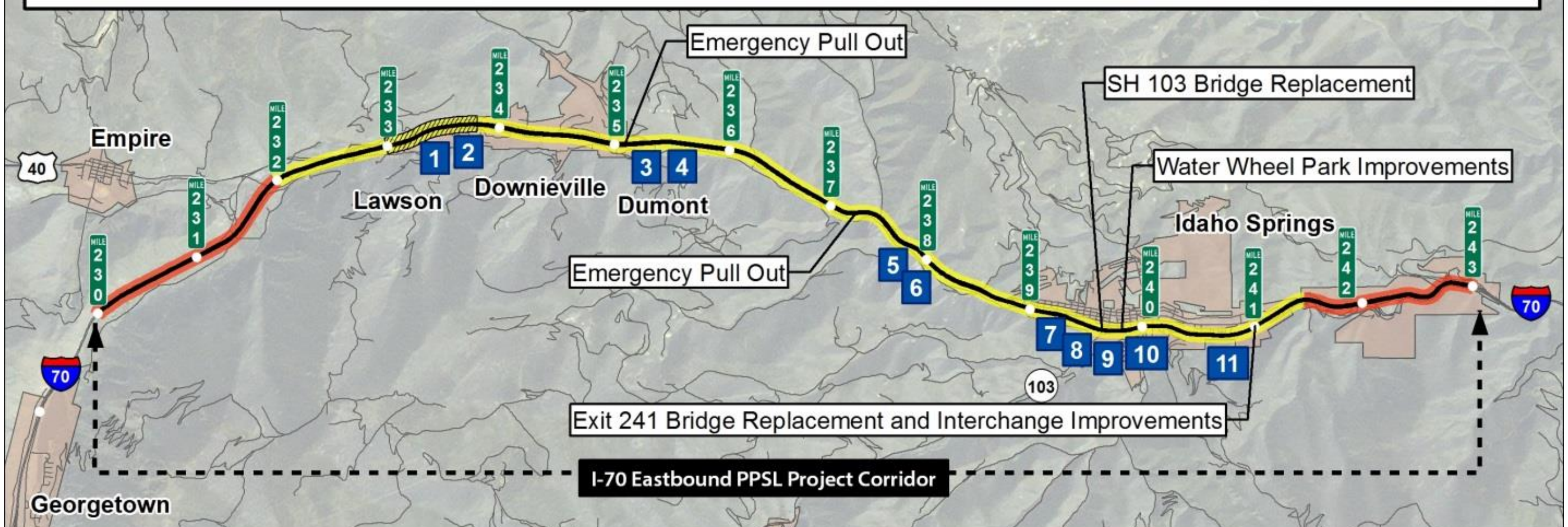
Figure 4. Overview of Proposed Improvements

Proposed Improvements

- Widening to accommodate a peak period shoulder lane.
- SH 103 bridge replacement and the Exit 241 bridge replacement and interchange improvements, including a new retaining wall.
- Construction of 10 retaining walls and rehabilitation of an existing retaining wall.
- Construction of 2 emergency pull outs.
- Signage throughout the corridor.
- Up to 14 feet of widening at the SH 103 on-ramp and approximately 4-8 feet of widening at all other on-ramps.
- Improvements to Water Wheel Park.
- Water quality treatment measures throughout the corridor.
- Two areas of rock fall mitigation near milepost 240.

Retaining Wall Summary

	Wall Location Description	Mainline or Ramp Widening	Length Wall (Feet)	Maximum Exposed Wall Height (Feet)
1	Lawson	Mainline	750	4.3
2	East of Lawson	Mainline	375	2.4
3	Dumont On-Ramp	Ramp	275	2.6
4	Between Dumont and Fall River	Mainline	875	2.6
5	Fall River On-Ramp Wall #1	Ramp	325	3.4
6	Fall River On-Ramp Wall #2	Ramp	325	2.9
7	SH 103 Off-Ramp	Ramp	210	5.8
8	SH 103 Off-Ramp (existing wall to be rehabilitated)	Ramp	400	Existing
9	SH 103 On-Ramp	Ramp	TBD	4.0
10	Approach to Bridge over Clear Creek	Ramp	75	2.0
11	Exit 241 Ramp (walls on both sides)	Ramp	500	12.0
			4,110	N/A



PPSL Project Corridor
Signage Only
Roadway Improvements (Minimal to No Mainline Widening)
Roadway Improvements (Widening of 3 to 3.5 Feet)
X Retaining Wall Location
N
0 0.75 1.5 3 Miles
I-70 EASTBOUND PEAK PERIOD SHOULDER LANE
Date: 3/31/2014

Data Source: Clear Creek County,CDOT, HDR Note: TBD=To Be Determined N/A=Not Applicable

Section 5. What are the Energy Resources in the Study Area?

5.1 Current Conditions of Energy Resources in the Study Area

As described in the *Twin Tunnels Environmental Assessment Transportation Technical Memorandum* (CDOT, 2012), the average weekday (Monday through Thursday), eastbound and westbound traffic volumes are relatively balanced in both the summer and winter months. However, on a typical peak period day during the summer and winter months, the eastbound direction is greater than the westbound direction, and eastbound is congested for much of the analysis period. The *Twin Tunnels Environmental Assessment Transportation Technical Memorandum* (CDOT, 2012), reports that the overall energy usage is higher on a typical peak period than for a weekday period because of the eastbound congestion.

Operational Energy Resources and Greenhouse Gas Emissions

The DynusT peak period traffic volume outputs from the 2015 No Action model were used for the peak period energy consumption analysis. Results from this study show the Operational Energy Resources and GHG Emissions in the study area summarized in Table 1. To clarify, these results represent the fuel, energy, and emissions equivalents for one 14-hour peak period of operation.

Table 1. Operational Energy Resources and GHG Emissons (2015 No Action)

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
I-70 Eastbound Summary Totals	16,000	2,066,800,000	148,100
I-70 Westbound Summary Totals	5,800	735,000,000	53,000
Ramps Summary Totals	540	69,600,000	5,000
Totals	**22,340**	**2,871,400,000**	**206,100**

Source: HDR Engineering

5.2 Anticipated Future Conditions of Energy Resources in the Study Area

Future changes in transportation patterns could alter the consumption of energy in the study area, providing an uncertainty to the future year analyses; however, for the purposes of this study, the impacts of these changes are unknown and are not taken into account. These major changes could include:

- Vehicle technology—Vehicles may become more fuel efficient and/or there could be a significant increase in vehicles powered by non-fossil fuels.
- Future fossil fuel supply and demand, fuel costs, and future environmental policies, taxes, and credits may change user behavior regarding fossil fuels.
- Implementation of mass transit in the study corridor may change user behavior and reduce VMT by passenger vehicles.
- Deployment of ITS, “Smart Car,” and/or “Self-Driving” technologies along the corridor to

increase travel efficiency, congestion awareness, and additional lane management.

Two statewide initiatives could potentially impact transportation patterns in the study area are the *Advanced Guideway System (AGS) Feasibility Study* and the *Colorado Energy Smart Transportation Initiative*. However, it should be noted that the AGS initiative is not financially feasible at the time this report was published and was, therefore, not considered.

The AGS Feasibility Study evaluated transit system technologies in the I-70 Mountain Corridor. This study coordinated with the Inter-Regional Connectivity Study, which looked at high-speed rail. The potential AGS project was not taken into account in this study, because the PPSL project is considered a short-term operational improvement project. And although the AGS project is in the *I -70 Mountain Corridor ROD,* no funding has been identified for it.

Secondly, the *Colorado Energy Smart Transportation Initiative* is a policy to promote energy efficiency and reduction of GHG emissions when making transportation decisions. This policy may specifically incorporate guidelines and standards into the CDOT Design Manual and construction specifications, as well as be considered when developing transportation infrastructure planning and project development. Future standards and guidelines from this policy may impact GHG emissions. However, because these are unknown at this time they are not taken into account in this study.

5.3 What Agencies Were Involved in This Analysis and What Are Their Issues?

No formal coordination occurred with federal, state, or local agencies. Information from the U.S. Department of Energy and the U.S. EPA was used to develop the energy consumption and GHG emission calculations.

Energy efficiency and reduction of GHG emissions are considered in the State of Colorado's *Colorado Energy Smart Transportation Initiative* (see Section 5 of this technical memorandum).

Section 6. What are the Environmental Consequences?

6.1 How does the No Action Affect Energy Resources?

Operational Energy Resources and Greenhouse Gas Emissions

The DynusT model was coded with the 2035 No Action peak period Sunday volumes. The No Action scenario is defined as not implementing the proposed PPSL project along I-70. Results from the 2035 No Action study are summarized in Table 2 for the operational energy resources and the operational GHG emissions. As noted previously, these results represent the fuel, energy, and emissions equivalents for one 14-hour peak period of operation.

Table 2. Operational Energy Resources and GHG Emissions (2035 No Action)

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
I-70 Eastbound Summary Totals	20,200	2,596,300,000	185,500
I-70 Westbound Summary Totals	6,200	797,300,000	57,500
Ramps Summary Totals	630	81,000,000	5,800
Totals	**27,030**	**3,474,600,000**	**248,800**
2015 No Action	22,340	2,871,400,000	206,100
Comparison to 2015 No Action		121%	

Source: HDR Engineering

On a typical peak period, the 2035 No Action's energy consumption and GHG emissions increased by 21 percent over the 2015 No Action levels. It should be noted in this study that the typical peak period traffic volume growth rate is expected to be lower than the average weekday growth rate, because of the typical peak-period being constrained by capacity as indicated in the *I-70 Eastbound Peak Period Shoulder Lane Categorical Exclusion Transportation Technical Memorandum (CDOT, 2014).*

6.2 How Does the Proposed Action Affect Energy Resources?

What Are the Direct Effects Including A Managed Lane

The DynusT model was coded with the Proposed Action and analyzed during the typical peak period. As indicated in the *I-70 Peak Period Shoulder Lane Traffic Analysis Feasibility Study (Atkins, APEX, 2013),* the Proposed Action is expected to produce better travel times for the eastbound direction along the project area during the typical peak period. The outputs from the DynusT model for the typical peak period Proposed Action volumes show higher volumes than the No Action. For the purposes of this study, the speed limits for the No Action and Proposed Action alternatives are assumed the same. However, it should be noted that the Proposed Action may include variable speed limits throughout the corridor (to be defined based upon a speed study conducted upon implementation of the project but are anticipated to be 45 mph).

Vehicles operating at 45 mph would be operating closer to their optimal efficiency and, therefore, would have less energy use. It is anticipated that benefits beyond those reported in this analysis could be realized.

Since energy consumption is lower in the Proposed Action compared to the No Action, the GHG emissions are also expected to be lower for the Proposed Action than the No Action alternative.

Operational energy resources and greenhouse gas emissions

The 2015 and 2035 Proposed Action analyses were developed using the same methodology. The DynusT models were updated with the Proposed Action operating during the typical peak period. Results from the 2015 and 2035 Proposed Action analyses, summarized in Table 3, show the operational energy resources and the operational GHG emissions in the study area. Table 4 summarizes the 2035 Proposed Action results.

On a typical peak period, Table 3 indicates that the 2015 Proposed Action energy consumption and GHG emissions decreases by 4 percent compared to the 2015 No Action levels.

Similarly, Table 4 indicates that the 2035 Proposed Action energy consumption and GHG emissions decreases by 11 percent compared to the 2035 No Action levels but increases by 12 percent over the 2015 Proposed Action levels.

Table 3. Operational Energy Resources and GHG Emissions (2015 Proposed Action)

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
I-70 Eastbound Summary Totals	15,300	1,979,400,000	142,500
I-70 Westbound Summary Totals	5,700	724,000,000	52,200
Ramps Summary Totals	410	52,700,000	3,800
Totals	**21,410**	**2,756,100,000**	**198,500**
2015 No Action	22,340	2,871,400,000	206,100
Comparison to 2015 No Action		96%	

Source: HDR Engineering

Table 4. Operational Energy Resources and GHG Emissions (2035 Proposed Action)

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
I-70 Eastbound Summary Totals	17,300	2,238,000,000	161,000
I-70 Westbound Summary Totals	6,100	780,500,000	56,200
Ramps Summary Totals	500	63,900,000	4,600
Totals	**23,900**	**3,082,400,000**	**221,800**
2035 No Action	27,030	3,474,600,000	248,800
Comparison to 2035 No Action		89%	
2015 Proposed Action	21,410	2,756,100,000	198,500
Comp. to 2015 Proposed Action		112%	

Source: HDR Engineering

Table 5, which summarizes the energy consumption of the Proposed Action and No Action, shows that the implementation of the Proposed Action would result in a decrease in energy consumption of approximately 9 to 9.5 percent

Table 5. Summary Table of Energy Resources and GHG Emissions

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
Year 2015			
2015 Proposed Action	21,410	2,756,100,000	198,500
2015 No Action (existing condition)	22,340	2,871,400,000	206,100
Percent change	**-9.6%**	**-9.6%**	**-9.6%**
Year 2035			
2035 Proposed Action	23,900	3,082,400,000	221,800
2035 No Action	27,030	3,474,600,000	248,800
Percent change	**-8.8%**	**-8.9%**	**-8.9%**

Source: HDR Engineering

These decreases in both energy consumption and GHG emissions of the Proposed Action are a result of the vast majority of vehicles being able to operate at a more fuel efficient speed range. Vehicles that travel between 35 mph and 50 mph are operating in the range of highest fuel economy. The Proposed Action is shown to eliminate nearly all of the conditions in which vehicles are traveling between 10 mph and 30 mph, speeds at which vehicles achieve substantially less than optimal fuel economy. Reduction in fuel, energy, and emissions is tempered somewhat by the small increase in VMT due to higher demand brought on by improved travel conditions.

6.3 What Indirect Effects Are Anticipated?

Because of the decrease in congestion along eastbound I-70 in the study area under the Proposed Action conditions (for more information, see the *I-70 Eastbound Peak Period Shoulder Lane Categorical Exclusion Transportation Technical Memorandum)*, there may be a reduction of crashes in the study area and of emergency service calls. Emergency response times would be reduced and less energy used because of consistent travel speed; thus, expending less energy and emitting less GHGs.

6.4 What Effects Occur During Construction?

Operational Energy Resources and Greenhouse Gas Emissions

The 2015 No Action traffic volume outputs from the DynusT model were used for the typical peak period energy consumption analysis in the work zone. Results from this study show the operational energy resources and the operational GHG emissions in the study area as summarized in Table 6.

The operational energy consumption and greenhouse emission from motorists driving through temporary traffic control configurations during construction in 2015 are expected to be lower than that of a typical peak period because of the lower travel speeds in the work zone, as shown in Table 6. Because these lower speeds produce better fuel efficiency, less energy is consumed; therefore, less GHGs are emitted.

Table 6. Operational Energy Resources during Construction (2015)

Scenario	Fuel Equivalents (gal)	Gas Equivalents (BTU)	GHG CO2 Equivalents (kg)
I-70 Eastbound Summary Totals	13,800	1,775,200,000	128,000
I-70 Westbound Summary Totals	5,800	745,300,000	53,700
Ramps Summary Totals	530	68,200,000	4,900
Totals	**20,130**	**2,588,700,000**	**186,600**
2015 No Action	22,340	2,871,400,000	206,100
Comparison to 2015 No Action		90%	

Source: HDR Engineering

It is possible that short-term lane closures, minor ramp-to-ramp detours, and lane reductions of eastbound I-70 may occur during construction of the Proposed Action, which would lead to additional energy consumption and GHG emissions from stop or queued vehicles. In addition, detours may be implemented along side streets and frontage roads in the projects area during areas requiring mainline I-70 bridge construction, such as SH 103 in Idaho Springs. An increase in energy consumption and GHG emissions are likely to occur on impacted side streets as detours will require motorists to drive longer distances or idle longer in the study area. However, these increase in energy consumption and GHG emissions are expected to be minimal compared to that generated along eastbound I-70 that were omitted from this study.

Construction Energy Resources and Greenhouse Gas Emissions

Energy consumption and GHG emissions caused from construction of the Proposed Action is anticipated to consume negligible quantities of energy and GHG emissions, because of the small disturbed envelope along eastbound I-70 and short project duration (anticipated completion in June 2015). Qualitatively, the minor impacts of processing raw materials, deliveries, operating construction equipment to build and maintain the Proposed Action, and the haul of materials is insignificant to the energy consumption and GHG emission savings from implementation of the Proposed Action.

Section 7. What Mitigation is Needed?

7.1 Mitigation

Applicable Tier 1 mitigation strategies include the following:

- Limiting the idling of construction equipment.
- Encouraging employee carpooling or vanpools for construction workers.
- Encouraging the use of the closest material sources (for example, aggregate, concrete).
- Locating construction staging areas close to work sites.
- Using cleaner and more fuel-efficient construction vehicles (for example, low-sulfur fuel, biodiesel, or hybrid technologies).
- Using alternative fuels and asphalt binders.
- Implementing traffic management schemes that minimize motorist delays and vehicle idling.

The following conceptual strategies included as non-infrastructure components of the Proposed Action:

- Carrying out maintenance activities during periods of reduced traffic volumes.
- Encouraging greater use of transit through measures such as incentive programs.
- Working with chambers of commerce or tourist organizations to encourage resort operators to offer incentives for visitors who use transit or who use low-emission or alternative fuel vehicles.
- Promoting carpooling for regular facility users.

Because the Proposed Action result in an improvement in regards to energy consumption, no additional mitigation measures are not necessary at this time.

Section 8. References

CDOT. 2014. Eastbound I-70 PPSL Categorical Exclusion Peak Period Shoulder Lane Transportation Technical Memorandum

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