AIR QUALITY ANALYSIS OF MDT TRANSPORTATION IMPROVEMENTS:

Cost-Effectiveness Analysis of the MACI Program

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16. Abstract

Under TEA-21, part of Montana's CMAQ apportionment is dedicated to Missoula and at the direction of the Montana Transportation Commission, the Montana Department of Transportation (MDT) directs the remainder of the CMAQ apportionment to areas in non-attainment status that were previously ineligible for CMAQ funds to proactively address air quality and automobile congestion problems through the Montana Air & Congestion Initiative (MACI) Program. The purpose of this project was to assess the cost-effectiveness of projects funded to date through the MACI/CMAQ program. To establish a common framework for comparing different projects, total costs and estimated emissions were converted to annualized estimates and project costs were amortized over the project life using a discount rate. Annualized costs for the PM_{10} projects ranged from $15,581 to nearly $1.8 m. The most cost-effective projects tended to be paving projects and projects associated with purchasing air quality equipment with traffic flow projects the next most cost-effective. Transit projects and bicycle-pedestrian projects tend to be least cost-effective relative to others that have been funded through the MACI/CMAQ program. Annualized costs for the CO projects ranged from $14,185 to nearly $1.8 m. The most-effective CO reduction projects tended to be traffic flow projects and transit projects tended to be least cost-effective relative to others that have been funded through the MACI program.

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EXECUTIVE SUMMARY

The Montana Air Quality and Congestion Initiative (MACI) was established to take advantage of the flexibility in funding provided by TEA-21. Under TEA-21, part of Montana's CMAQ apportionment is dedicated to Missoula and the remainder of the CMAQ apportionment can be used to support any type of federal-aid project in nonattainment and maintenance areas. At the direction of the Montana Transportation Commission, the Montana Department of Transportation (MDT) uses the remainder of the CMAQ apportionment to provide funding to areas in non-attainment status that were previously ineligible for CMAQ funds and to proactively address air quality and automobile congestion problems through the Montana Air & Congestion Initiative (MACI) Program. The purpose of this project is to assess the cost-effectiveness of projects funded to date through the MACI/CMAQ program.

Different types of projects will have different life spans, which prevent comparisons between project costs and emissions benefits from being performed directly. To establish a common framework to compare different projects, total costs and estimated emissions are converted to annualized estimates using MDT provided total costs and estimated emissions benefits. For eight projects in which emission reductions were not complete, additional calculations were performed. In the analysis project costs were amortized over the project life using a discount rate. The annualized costs are derived using capital recovery factors (CRFs), which depend on the service life of the project and a given discount rate.

Annualized costs for the PM_{10} projects ranged from $15,581 to nearly $1.8 m. The most cost-effective projects tended to be paving projects and projects associated with purchasing air quality equipment with traffic flow projects the next most cost-effective. Transit projects and bicycle-pedestrian projects tend to be least cost-effective relative to others that have been funded through the MACI/CMAQ program. The PM_{10} reduction projects also tended to have the least amount of variability (i.e., they tended to be cost-effective regardless of project location), followed by traffic flow projects bicycle/pedestrian projects, and, lastly, transit. Annualized costs for the CO projects ranged from $14,185 to nearly $1.8 m. The most-effective projects tended to be traffic flow projects and transit projects tended to be least cost-effective relative to others that have been funded through the MACI program.

MDT appears to have generally done a good job of selecting cost-effective projects for implementation under MACI using project performance comparisons to the generally accepted standard of less than 10,000. Additional recommendations for program improvement are provided in the Recommendations section.

BACKGROUND

Particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and carbon monoxide (CO) are the pollutants giving rise to the most common causes of transportation-related air quality problems in Montana. Particulate matter is generated from a variety of sources, including both area (e.g., agricultural) and stationary (e.g., industrial) sources. A significant percentage also comes from paved and unpaved roadways. Most of this material is dust entrained from human activity: entrained agricultural and mining, road dust on paved and unpaved roads from motor vehicle activity, and construction operations. Carbon monoxide gas emissions are released from incomplete combustion, biomass burning, industrial processes, and the oxidation of hydrocarbons. High concentrations of CO occur in areas with heavy traffic congestion and industry. In urban areas as much as 95% of all CO emissions may come from automobile exhaust.

Emission sources are divided into very general categories: stationary, area wide, and mobile. Stationary sources refer to point source emissions, usually industrial emissions from manufacturing processes. Area wide sources, such as emissions from consumer products, are stationary but dispersed over a large area. Mobile emissions are divided into emissions from on-road motor vehicles and emissions from other mobile sources like trains, airplanes, ships, and etc. Stationary sources are often controlled through regulations requiring the removal or reduction of toxic chemicals from consumer products, or regulations that limit the amount of a pollutant a manufacturing facility is allowed to emit. Mobile sources are more difficult to control because travel activity is challenging to predict and regulate. Control measures span a variety of types and include measures aimed at improving speed, reducing travel, and decreasing tailpipe pollutants. However, when travel activity increases, emissions of all pollutants from mobile sources increase despite reductions of pollutants emitted from individual vehicle trips.

The Montana Air and Congestion Initiative (MACI) was established to provide funding to areas previously ineligible for CMAQ funding under ISTEA and to proactively address transportation-air quality problems before areas reach nonattainment. MACI projects have been funded using allocations from the Congestion Mitigation and Air Quality Improvement (CMAQ) program, which was established under Intermodal Surface Transportation and Efficiency Act (ISTEA) and expanded under the Transportation Equity Act for the 21st Century (TEA-21). The purpose of the CMAQ program is to fund transportation projects that improve air quality by reducing transportation-related emissions. CMAQ programs support projects that result in measurable reductions in emissions for criteria pollutants and each state must provide an annual report specifying how CMAQ funds have been spent and the expected air quality benefits. FHWA's CMAQ Program Guidance states that, consistent with the Clean Air Act Amendments (CAAA), transportation projects that reduce emissions are given funding priority and transportation control measures (TCMs) listed in CAAA section 108(f) are the "kinds of projects intended by the TEA-21 for CMAQ funding".

The purpose of this project is to assess the cost-effectiveness of projects funded to date through the MACI/CMAQ program. The report begins with a brief overview of previous research and evaluations conducted on CMAQ projects. This is followed by a discussion of the MACI/CMAQ program and an overview of the cost-effectiveness calculations. We conclude

with a detailed discussion of the results and recommendations for improving future analyses and for better targeting MACI efforts.

The CMAQ Program

The CMAQ program was established under ISTEA and reauthorized under TEA-21. Funding is provided by the Highway Trust Fund and amounted to about 4% of the authorized TEA-21 funding [1]. It is important to recognize that the state CMAQ allocation formula does not account for PM_{10}, although funds can be used to offset PM_{10} emissions. States with designated CO, PM_{10}, or ozone non-attainment or maintenance areas are required to spend CMAQ funds in those areas, with national guidance identifying transportation control measures contained in the state implementation plans (SIPs) as the highest funding priority. All projects funded under CMAQ must also come from a conforming transportation implementation plan (TIP).

The types of projects eligible for CMAQ funding include new facilities, equipment and services designed to reduce emissions. CMAQ funds can be used for inspection and maintenance programs, alternative fuel vehicle programs, public education, experimental projects, and projects that focus on PM_{10} reduction (e.g., paving dirt roads, replacing diesel vehicles, and purchasing street sweeping equipment). The transportation control measures (TCMs) listed in Section 108(f) of the CAAA are also eligible for funding with the exception of the vehicle scrappage programs.

Despite their funding priority, TCMs are generally considered to contribute only a small fraction of regional emission reductions (e.g., less than 1%) in comparison to other on-road motor vehicle control programs such as new vehicle tailpipe emission standards, fuel reformulation, and motor vehicle inspection and maintenance [1, 2]. Tailpipe standards, fuels changes, and I/M programs are implemented at the national, state, and regional levels, and within a given metropolitan area will affect a large fraction of the vehicle fleet. TCMs, in contrast, will typically be implemented in more geographically constrained areas.

The O_3 and CO requirements included in the CAAA vary depending upon an area's nonattainment classification (see Appendix D for a list of the classifications). The worst-polluted regions are required to implement a more comprehensive set of controls than areas with less challenging air pollution problems. TCMs become a required component of air quality strategies, or SIPs, beginning with serious O_3 nonattainment areas, and with moderate CO nonattainment areas identified by the CAAA as having exceeded the CO 8-hr NAAQS[1] with concentrations greater than 12.7 ppm CO. (The CAAA requires specific time periods be used to identify whether CO concentrations greater than 12.7 ppm occurred and refers to the concentrations measured during these time periods as "design values.")

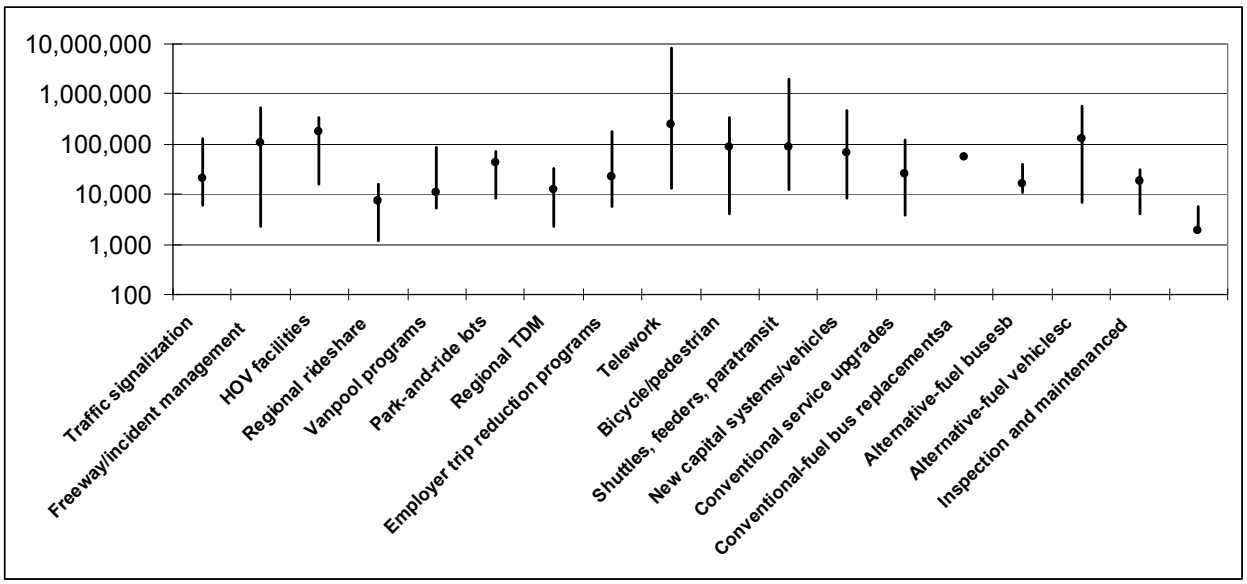
Cost-Effectiveness of CMAQ Projects

In the recent National Research Council (NRC) CMAQ study [1], a review of project cost-effectiveness literature was undertaken; the primary measure used by the committee in evaluating cost-effectiveness was cost per ton of emissions reduced. The TCM projects

[1] National Ambient Air Quality Standards

evaluated included both traffic management and travel demand strategies. There are a number of limitations to the review including the relatively localized and modest impacts when evaluated from a regional perspective, the limitations associated with the current modeling tools, and the lack of post-implementation analysis to assess whether predicted travel and emissions effects have actually been realized. In particular, it is very difficult to assess if a TCM strategy actually results in a change in ambient air quality conditions, because the change is likely to be on the order of 1% or less from a regional perspective [2].

Figure 1 shows the range of cost-effectiveness in $2000/ton for project included in the NRC review. The plot shows the high, low and median values for projects grouped by type. For example, there were 10 telework projects evaluated and the highest, lowest and median cost-effectiveness values were $8,230,000, $13,300, and $251,800, respectively. As Figure 1 shows projects have a range of cost-effectiveness. As the NRC report identifies, it is difficult to know whether locally implemented projects will achieve these specific cost-effectiveness ratios or not because performance seems to be a function of where and how a particular project is implemented.



Adapted from: NRC 2002
Note: Y-axis is in $2000/ton VOC equivalent units

Figure 1: NRC-Based Cost-Effectiveness Values

Another study by Pansing *et al* ([3] examined the cost-effectiveness for 58 transportation control measures using a standardized procedure. The results (Table 1) showed that, in general, TDM projects other than telecommunications were cost-effective when compared with alternative fuel and fixed route transit projects. In this analysis, the primary pollutants were all valued equally. These results are generally consistent with the NRC findings.

Table 1: Cost-Effectiveness Analysis

	Cost-Effectiveness ($/ton)	
	Low	**High**
Alternative Fueled Projects	6,120	2,702,000
TDM		
Bicycle Projects	1,660	52,000
Financial Incentives	(1,260)	39,960
Organizational TDM	15,700	18,460
Telecommunications	(9,120)	1,322,000
Vanpools	2,900	93,340
Fixed Route Transit/Shuttles		
Line Haul	6,120	2,234,000
Shuttle	13,040	1,220,000

Adapted from: Pansing et al, 1998

One additional control measure that has been supported in a number of communities, including several in Montana, for reducing PM_{10} emissions is that of street sweepers. A number of studies have been conducted both for determining the PM_{10} emission factors for fugitive road dust and for estimating the benefits of street sweeping in reducing PM_{10} fugitive road dust.

Cost-Effectiveness of Street Sweepers

PM_{10} research includes determining the contribution of paved and unpaved roads to PM_{10} concentrations [4, 5] as well as assessing methods for measuring concentrations [6, 7]. Fugitive PM_{10} dust is very difficult to measure directly because there are many factors affecting it that cannot be controlled such as wind, precipitation, solar radiation, and vehicle and traffic characteristics.

A number of studies have been done in which PM_{10} is measured upwind and downwind of paved roads and compared to road characteristics such as Average Daily Traffic (ADT), average vehicle weight, average vehicle speed, average number of wheels and silt loading (the amount of loose material on the roadway with aerodynamic diameter less than 75 micrometers per unit area). The Environmental Protection Agency (EPA) acquired data from six such studies and used regression analyses to develop an emission factor equation. The result was a predictive equation, relating emission factors to silt loading and average vehicle weight, known as AP-42,

$$E = k\,(sL/2)^{0.65}(W/3)^{1.5}$$

where,

E = particulate emission factor
k = base emission factor, depending on the units desired (see table in AP-42)
sL = road surface silt (particles with aerodynamic diameter < 75 μm) loading (g/m^2)
W = average weight of the vehicles traveling on the road (tons).

The emission factor determined by AP-42 depends on vehicle miles of travel (i.e., if VMT increases, emissions increase), the average vehicle weight, and the surface silt-loading factor. Theoretically street sweeping decreases silt loadings, which, in turn, result in a proportionate decrease in PM_{10} emissions. Early studies showed that paved road emissions decreased with street sweeping (e.g., [8]), while more recent studies have suggested little to no relationship between street sweeping and ambient PM_{10} concentrations [9, 10]. In the Fritz *et al* study, sweeper effectiveness was determined by deriving silt loadings before and after sweeping. Silt loadings were determined by vacuuming the active traffic lane and sieving the material collected for one arterial, one connector, and one local over three seasons: fall, spring and summer. The results indicated that sweeping was to be most effective on low volume streets rather than streets with high traffic counts.

The MACI Program

The Montana Air Quality and Congestion Initiative (MACI) was established to take advantage of the flexibility in funding provided by TEA-21 [11]. Under TEA-21, part of Montana's CMAQ apportionment is dedicated to Missoula [12]. The remainder of the CMAQ apportionment is flexible can be used to support any type of federal-aid projects anywhere in the state. At the direction of the Montana Transportation Commission, the Montana Department of Transportation (MDT) uses the remainder of the CMAQ apportionment to provide funding to areas in non-attainment status that were previously ineligible for CMAQ funds and to proactively address statewide air quality and automobile congestion problems through the Montana Air & Congestion Initiative (MACI) Program.

The MACI Program is divided into two categories [13]:

- <u>MACI - Guaranteed</u>
  This program applies to Great Falls (originally CO non-attainment) and Billings (originally CO non-attainment). Although originally designated non-attainment, these areas are not eligible for CMAQ funding due to their “not classified” status. (Note that both MPOs are no longer non-attainment but are now designated as limited maintenance plan).

- <u>MACI - Discretionary</u>
  The MACI – Discretionary Program applies to areas that are designated non-attainment or identified as “high risk” for becoming non-attainment of an air quality standard. The Montana Department of Environmental Quality (DEQ) identified the “at-risk” areas and the Environmental Protection Agency (EPA) designates the non-attainment regions.

The guaranteed program provides funding for Great Falls and Billings (Table 2). The discretionary program provides funding for projects in areas designated non-attainment for PM_{10} or at non-attainment risk for CO and/or PM_{10} areas [14]. The “at risk” areas were identified by DEQ using monitoring data and include areas in which the measured ambient concentrations were qualitatively considered close to exceeding the NAAQS [15].

Table 2: MACI Funding Eligible Areas

Area (County)	At-Risk Designation	Non-Attain/ LMP[1] Designation
Billings		CO
Great Falls		CO
Libby		PM_{10}
Thompson Falls		PM_{10}
Kalispell	CO	PM_{10}
Whitefish		PM_{10}
Columbia Falls		PM_{10}
Polson		PM_{10}
Ronan		PM_{10}
Butte	CO	PM_{10}
Lame Deer		PM_{10}
Bozeman	PM_{10}/CO	
Belgrade	PM_{10}	
Lincoln	PM_{10}	
Wolf Point	PM_{10}	
Helena	PM_{10}/CO	
W. Yellowstone	CO	
Pablo	PM_{10}	
Hamilton	PM_{10}	
Missoula		PM_{10}/CO

[1] **Limited Maintenance Plan designation (LMP)**

Eligible projects must meet federal eligibility guidelines and show a clear air quality benefit. For non-attainment funding, projects must be within the geographic boundary of the non-attainment region and for discretionary funding, projects must be within the city limits or urban boundary. There is a minimum project size of $100,000 with a 13.42% hard match (i.e., funding or real property). Guaranteed projects are prioritized using the respective metropolitan planning process (i.e., Great Falls and Billings) based on air quality benefits using MDT guidance [12] and must be consistent with RTPs/TIPs. Projects funded using discretionary funding are selected based on air quality benefits "with additional factors also being considered" ([12], pg 1). The minimum sized project to be considered under both programs is $100,000, which includes all costs associated with the project. Projects are typically expected to fall in those categories noted in Table 3.

Table 3: Projects Typically Eligible Under MACI

Project Type	Guaranteed	Discretionary
Traffic Flow	Yes	Yes
Transit	Yes	Yes
Bicycle/Pedestrian	Yes	Yes
PM_{10}	---	Yes
Demand Management	Yes	---

Among the problems that MDT has identified with the MACI Program, particularly with the discretionary funding program, are difficulty with local governments providing the match required for federal funding, a dwindling set of eligible and/or effective projects (e.g., unpaved roads with high enough VMT), and lack of information and resources for preparing project submittals [14].

Project Description

Since 1993, a total of 63 projects have been funded (Table 4). Missoula, which is in non-attainment for CO and PM_{10}, has received by far the largest amount of MACI/CMAQ funding over the past 11 years. A number of projects have also been funded in Billings, Great Falls, Butte, Kalispell, and Bozeman. Excluding the statewide projects, Kalispell, and Butte (which have both non-attainment and at-risk designations), funding in non-attainment/LMP regions totals $57,705,510 and funding for projects in at-risk areas totals $5,975,952. The statewide/Kalispell/Butte projects total $16,335,322.

Table 4: Funded MACI Projects

Location	No. Projects	Total Funding ($)	Area Designation[1]
Hamilton	1	126,500	At-R (PM_{10})
Polson	1	239,514	At-R (PM_{10})
W. Yellowstone	1	323,000	NA (CO)
Thompson Falls	1	418,766	NA (PM_{10})
Lame Deer	1	600,000	NA (PM_{10})
Wolf Point	1	627,882	At-R (PM_{10})
Whitefish	1	725,000	NA (PM_{10})
Helena	4	2,020,286	At-R (PM_{10}/CO)
Bozeman	3	2,961,770	At-R (PM_{10}/CO)
Kalispell	5	3,971,325	At-R (CO), NA (PM_{10})
Butte	4	4,516,647	At-R (CO), NA (PM_{10})
Great Falls	9	5,435,054	NA (CO)
Statewide	3	7,847,350	---
Billings	4	8,566,780	NA (CO)
Missoula	24	41,636,910	NA (CO/PM_{10})

[1] *NA*: Non-Attainment/LMP; *At-R*: At-Risk (Table 2).

It is common to classify projects into categories associated with the types of emissions benefits that are expected. The Federal Highway Administration (FHWA) maintains a database of all projects funded under CMAQ. States are asked to classify projects into six broad categories: transit, traffic flow, other shared ride, pedestrian/bike, demand management, and inspection and maintenance. The NRC report further refined these project type categories as shown in Table 5.

Table 5: NRC Project Classifications

Project Classification	Subcategories
Transit	Alternative fueled vehicles Conventional fuel vehicles Park and ride facilities Station and bus stop improvements Transit service expansion Other transit improvements
Traffic Flow	Congestion and incident management HOV Lanes Traffic signal improvements Traveler information Turn lanes, intersection, roadway improvements Other traffic flow improvements
Shared Ride	Park and ride facilities Other shared ride
Pedestrian/Bicycle	[No subcategories]
Demand Management	Employee trip reduction Other demand management
STP/CMAQ	[No subcategories]
Other (and unclassifiable)	Alternative fueled vehicles Paving and sweeping Rail freight Vehicle inspection and maintenance All other improvements

Organizing the projects by NRC categories, Table 6 shows all the projects funded to date under MACI and included in this evaluation. A total of 22 pedestrian/bicycle projects, 16 paving and sweeping (mainly the purchase of new equipment) projects, 18 traffic flow projects plus three transit and one travel demand project have been funded. It should also be noted that funds were provided for two traffic flow studies, one in Billings and one in Great Falls, and for a bicycle coordinator in Missoula. These three projects generate no direct emissions benefits, and therefore were excluded from the analysis. A listing by project number (instead of the Table 6 listing by NRC project type) can be found in Appendix A.

Table 6: Project Listing by NRC Category

Project	Year	Project Name	Location	MDT Project Type	NRC Class	NRC Subcategory	NRC Lifespan (years)	Assumed Lifespan (years)	Cost	Construct Status[2]
15	1994	Bike/Ped Coordinator	Missoula	Bike/Ped	?	?	?	?	$190,050	Complete
26	2001	South Arterial Study	Great Falls	Traffic Flow (study)	?	?	?	?	$200,000	Not Complete
38	2000	2000 Air Quality Equipment	Statewide	PM-10 Reduction	?	?	?	?	$568,087	Complete
50	2002	I-90 Interchange Study - Billings	Billings	Traffic Flow (study)	?	?	?	?	$330,000	Not Complete
62	2001	Missoula/Ravalli TMA	Missoula	Transit	Demand Management	Trip Reduction	1 to 2	1	$320,000	Not Complete
1	1993	Street Sweepers	Missoula	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$1,194,585	Complete
10	1994	Missoula County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$1,089,461	Complete
13	1994	Missoula City Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$2,150,611	Complete
19	incl. in # 10	County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	incl. In # 10	incl. In #10
28	1998	1998 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	5	$4,424,107	Complete
30	2002	Off System Paving - Lame Deer	Lame Deer	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$600,000	Not Complete
31	2001	Off System Paving - Butte	Butte	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$506,959	Complete
33	2001	Division/5th St - Polson	Polson	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$239,514	Complete
34	2001	FoxField Ave - Hamilton	Hamilton	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$126,500	Complete
35	2001	Paving - Thompson Falls	Thompson Fls.	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$418,766	Complete
36	2001	Brady St/Joslyn St - Helena	Helena	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$383,486	Complete
37	2001	Paving - Wolf Point	Wolf Point	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$627,882	Complete
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	Traffic Flow	Other	Paving and Sweeping	30 to 35	30	$323,000	Not Complete
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	Other	Paving and Sweeping	30 to 35	30	$1,118,086	Not Complete
49	2002	2002 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$2,855,156	Complete
3	1997	North Reserve Street	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$5,350,750	Complete
4	1995	California Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,380,399	Complete
5	1995	Northside Access	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,857,693	Complete
6	1995	Bicycle Commuter Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$622,500	Complete
7	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$9,362,648	Complete
9	incl. in # 8	City Bike Shelter	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$24,255	incl. In # 8
11	1995	Primary Sidewalk Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$3,595,700	Complete
12	1995	Bicycle Lane Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$286,110	Complete
16	1995	Reserve Street Landscaping	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$53,492	Complete
17	1998	Missoula TDM	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$630,194	On-going
18	1995	South Avenue Bike/Ped Path	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$171,107	Complete
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000	Not Complete
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$115,000	Not Complete
23	2002	Annual Sidewalk Prog.	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$2,311,320	Not Complete
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000	Not Complete
25	2001	West Bank Trail Connection	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$554,399	Complete
29	2001	Sidewalks - Kalispell	Kalispell	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$607,681	Complete
45	incl. in # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 11	Not Complete
46	2002	Sidewalks - Great Falls	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,100,000	Not Complete
47	2002	Bike/Ped Path - Whitefish	Whitefish	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$725,000	Not Complete
48	2002	Swords Park Path - Billings	Billings	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$770,000	Not Complete
60	incl. in # 7	**Clark Fork - Missoula	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 7	Complete
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,880,556	Not Complete
41	2002	South 19th & College - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	792,000	Not Complete
42	2002	Dewey Blvd Extension - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,388,695	Not Complete
51	2000	Kalispell-Main St	Kalispell	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,574,263	Complete
57	2000	Custer & McHugh - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$470,178	Complete
59	2000	19th & Main Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$894,770	Not Complete
61	2001	Arthur Ave - Missoula	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$600,000	Not Complete
27A	2001	6th Ave N to Bench Blvd	Billings	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$6,915,000	Not Complete
2	1993	Areawide Signal	Missoula	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$4,920,000	Complete
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$210,000	Not Complete
39	2001	Citywide Signals - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,275,000	Not Complete
43	2002	Signal Upgrade - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,094,561	Not Complete
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$481,179	Complete
53	1999	North 93 Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$190,116	Complete
54	2001	Main St - Billings Heights	Billings	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$551,780	Complete
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$244,335	Complete
56	2000	1999 Signal Upgrade - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$2,274,493	Not Complete
58	1999	Custer Ave - Signal Synch - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$72,061	Complete
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Transit (bus purch.)	Transit	New or AFV Buses	10 to 12	10	$5,756,799	Complete
27	2000	FTA Fund Transfer	Great Falls	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	$500,000	Complete
32	2001	FTA Transfer - Butte	Butte	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	$346,500	Complete

[2] Project statuses provided by T. Steyaert (Dec. 2003). Note that full benefits and costs have been assumed for projects not yet completed.

COST-EFFECTIVENESS ANALYSIS

In this section, we review the basic methodology used to establish cost-effectiveness values for each of the 60 MACI projects (recall that three projects were eliminated because they had no emissions benefits). It can be very difficult to compare disparate projects so establishing a common framework is important. Most of the more recent studies of cost-effectiveness [1, 3] have used the California Air Resources 1999 Guidance [16]. The Guidance was updated in 2002 [17] to include methods for handling street sweepers and to reflect the latest emissions factors. We have largely used this basic framework for estimating cost-effectiveness for the MACI projects.[3]

Overview of Analysis Tasks

As might be expected, different types of projects are expected to produce different levels of emissions benefits. For example, travel demand projects reflect those projects that are intended to create a change in trip distribution patterns [18]; changes in trip distribution may affect overall trip length (and thus, running stabilized emissions) as well as the number of trip ends (start and park emissions). Alternatively, a transportation systems management project will affect only the speed and/or acceleration. For these projects, for example, we would not expect trip lengths or origins-destinations to change. Finally, technology-based or paving projects will impact the overall emission rates. For example, alternative-fueled vehicles will produce emission rates that are different from gasoline-fueled vehicles. Most of the MDT projects in this category are directly related to expected changes in PM_{10} emission rates (i.e., street sweepers and paving projects). For example, new street sweepers may impact silt loading, which in turn will impact PM_{10} emission rates. These projects do not generally impact travel speeds, vehicle miles of travel, or trip patterns.

MDT provided total costs and estimated emissions benefits for all but eight of the projects. Different types of projects will have different life spans, which prevent comparisons between project costs and emissions benefits from being performed directly. To establish a common framework to compare different projects, total costs and estimated emissions are converted to annualized estimates. For the eight projects in which emission reductions were not complete, additional calculations (described below) were performed.

Consistent with the California Air Resources Board (ARB) methodology, project costs were amortized over the project life using a discount rate[4]. The annualized costs are derived using capital recovery factors (CRFs), which depend on the service life of the project and a given discount rate,

$$CRF = \frac{(1+i)^n (i)}{(1+i)^n - 1}$$

[3] Although the CARB reference guide does not specifically address CO, the calculation procedures are generally the same.

[4] The discount rate reflects the opportunity costs of public funds were they invested in alternative financial markets (e.g., U.S. Treasury securities).

where i is the discount rate, and n is the project service life.

In Table 7, we show the CRFs that were calculated for a variety of discount rates. We also show the types of projects by estimated project service life using the NRC report service life categories. All dollar costs for projects were converted to a 2000 base by using a Consumer Price Index from the U.S. Statistical Abstract. CPI values for respective years in relation to 2000 are shown in Appendix B, along with the corresponding adjustment factor. The final cost-effectiveness values are calculated by dividing annualized costs by annual emission reductions. In the next few sections, we discuss key details used in estimating changes in travel and changes in emissions.

Table 7: Project Lifespans and CRFs

Project Lifespan	Types of Projects or Facilities	CRFs					
		4.5%	5%	6%	7%	8%	10%
1-2 years	Existing transit service imp. Travel demand mgmt pgms Ridesharing programs Vanpool programs Pricing/fair strategies	0.53 (2yrs)	0.54 (2yrs)	0.55 (2yrs)	0.55 (2yrs)	0.56 (2yrs)	0.58 (2yrs)
4-5 years	Telework programs Paratransit vehicles	0.23 (5yrs)	0.23 (5yrs)	0.24 (5yrs)	0.24 (5yrs)	0.25 (5yrs)	0.26 (5yrs)
10-12 years	Roadway signal systems Freeway mgmt systems New buses	0.13 (10yrs)	0.13 (10yrs)	0.14 (10yrs)	0.14 (10yrs)	0.15 (10yrs)	0.16 (10yrs)
	Alt. fueled buses Sidewalk or bike facilities Street sweepers[1]	0.11 (12yrs)	0.11 (12yrs)	0.12 (12yrs)	0.13 (12yrs)	0.13 (12yrs)	0.15 (12yrs)
20 years	Roadway improvements Rail signalization	0.08 (20yrs)	0.08 (20yrs)	0.09 (20yrs)	0.09 (20yrs)	0.10 (20yrs)	0.12 (20yrs)
30-35 years	Rail transit systems Parking structures Locomotive rail cars	0.06 (30yrs)	0.07 (30yrs)	0.07 (30yrs)	0.08 (30yrs)	0.09 (30yrs)	0.11 (30yrs)
	Pavement improvements Bridge improvements	0.06 (35yrs)	0.06 (35yrs)	0.07 (35yrs)	0.08 (35yrs)	0.09 (35yrs)	0.10 (35yrs)

[1] Source: CARB (2002) Methods to find the cost-effectiveness of funding air quality projects for evaluating motor vehicle registration and CMAQ projects.

A few additional assumptions were also applied to estimate the annualized costs and emissions reductions:

- **Project Lifetimes.** Project lifetimes were assigned using the NRC/CARB lifetimes;

- **Costs.** The total project costs and benefits provided by MDT were converted to annualized costs. The discount rate was assumed to be 5%; this assumption can be easily modified in future cost-effectiveness analyses;

- **Emissions**. The estimates of emissions benefits provided by MDT were converted to kilograms per year over the lifespan of the project.

Other general assumptions in the cost-effectiveness analysis included:

- *Number of Applicable Days Per Year*: While the number of applicable days that a trip reduction (and therefore an air quality control) measure can fluctuate depending on the type of facility and its use (e.g. a traffic signal improvement used every day versus a workday transit improvement), we take a conservative estimate that the number of applicable days per year is around 240. In some of the earlier MDT reports, the applicable days per week fluctuate around 240, 250, 260 or 365 days per year, but 240 days per year is a conservative and well-accepted assumption.

- *Average Walking Trip Distance*: 0.7 mi, according the 1995 Nationwide Personal Transportation Survey [20]

- *Average Bicycling Trip Distance*: 1.8 mi, according the 1995 National Nationwide Transportation Survey [20]

- *Average Carpool Vehicle Occupancy:* 2.0. Project 62 required carpool occupancy. A personal communication with Missoula/Ravilli Transportation Management Association (M/R TMA) suggested that "2 to 3 persons" were in each carpool. An average vehicle occupancy (AVO) of 2.0 persons per vehicle was used in the analysis.

- *Average Vanpool vehicle Occupancy*: 6.0. An average vehicle occupancy of 11 persons per vehicle was suggested by the Missoula/Ravilli TMA, but that was thought to be too optimistic and an AVO of 6.0 persons per vehicle was used in the analysis.

- *"Non-Attainment" Area Emissions Weight*: We assumed that the emissions value for a pollutant in a non-attainment area was more valuable than a pollutant outside a non-attainment area. As a result, pollutants in a non-attainment area were valued as being twice as valuable as the same amount of emissions reductions outside of the non-attainment area. This assumption can be easily modified in future cost-effectiveness analyses.

Projects with Missing Costs/Emissions Estimates

As noted earlier, eight projects did not have complete information provided (Table 8). For these projects we obtained estimates of travel changes and multiplied these activity estimates by the appropriate emission factors. Although MOBILE6 is the currently approved mobiles emissions factor model, Montana's currently approved SIP, and the various conformity determinations to date are based on MOBILE5a emission factors. There are some differences in the emissions rates under MOBILE5a and MOBILE6, but in order to quantify the contribution of these MACI projects relative to the current SIP and to ensure consistency with MDT project calculations, all calculations were done using MOBILE5a.

For PM_{10} calculations, calculations were made consistent with previous MDT MACI reports, which cite EPA AP-42. In these calculations, an auto running-emission factor of 0.52 g/mi was used to compute PM_{10} emissions. Details for the calculations can be found in Appendix C.

Table 8: Calculation Results for Projects with Missing Information

Project	Total Cost	Total Estimated CO Benefits (kg)	Total Estimated PM_{10} Benefits (kg)
#7 - Clark Fork-Orange Street Bridge	$9,362,648	74,316	1,327
#17 – Missoula TDM	$630,194	144,842	4,968
#28 – 1998 Air Quality Equipment	$4,424,107	0	4,824,826
#32 – Butte FTA Transfer	$346,500	95	5
#43 – Helena Signal Upgrade	$1,094,561	141,850	0
#49 – 2002 Air Quality Equipment	$2,855,156	0	6,728,205
#61 – Missoula Arthur Ave	$600,000	16	0
#62 – Missoula/Ravalli TMA	$320,000	24,270	3,746

Combined Projects

Finally, there were some projects that were combined with other projects when estimating air quality benefits. It is possible that these projects were considered together as having an area-wide impact on travel and/or were thought to have a complementary affect on emissions. This decision to combine projects was made as part of the original MACI/CMAQ funding decision. These include:

- Projects #4 (1995), #5 (1995), #6 (1995), #11(1995), #12 (1995), #16 (1995), #18 (1995), and #3 (1997) were all bicycle/pedestrian projects in which Missoula calculated combined air quality benefits. The air quality benefits of Project #45 were also included with Project #11.

- The emission benefits from Project #52 (1999) were combined with those from Project #53 (1999), both of which were traffic flow improvement (signal upgrade) projects on Idaho & Lasalle and North 93, respectively, in Kalispell.

- The emission benefits from Project #57 (2000), a roadway improvement project at the intersection of Custer Avenue and McHugh Drive in Helena, was combined with the benefits from Project #58 (1999), a traffic signal synchronization project in Helena on Custer Avenue. Both projects were traffic flow improvements.

- The air quality benefits of Project #19 were included in Project #10, both of which were Missoula County paving projects.

- The air quality benefits of Project #60 were included in Project #7, both of which were bicycle/pedestrian improvement on the Clark Fork-Orange Street Bridge in Missoula.

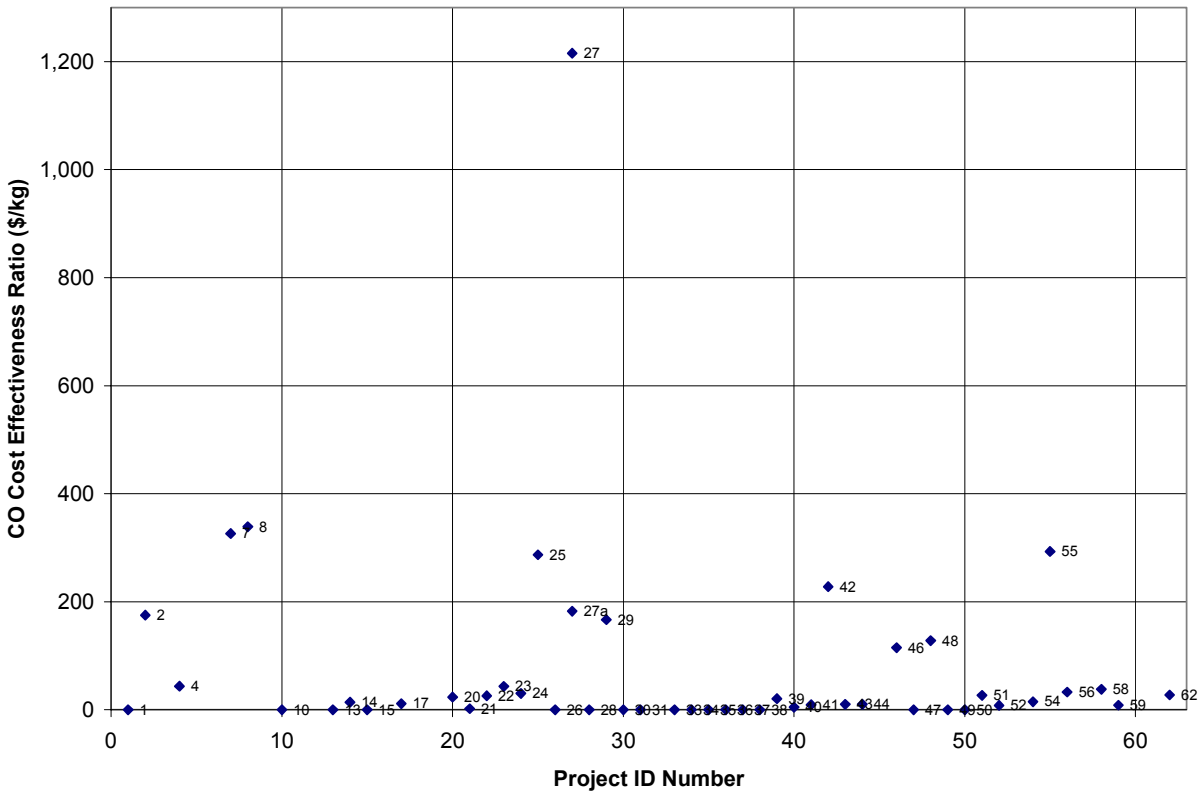
- The air quality benefits of Project #9, a bike shelter in Missoula, were included in Project #8 (1993), Missoula transit system improvements.

RESULTS

In the section, we review the results for both the PM_{10} and CO analysis. A total of 37 projects were selected for MACI/CMAQ funding to reduce PM_{10} emissions and 45 projects were selected for MACI/CMAQ to reduce CO emissions.[5]

PM_{10} Cost-Effectiveness

Beginning with Table 9, it can be seen that annualized costs for the PM_{10} projects ranged from $15,581 to nearly $1.8 m for a series of bicycle-pedestrian related projects in Missoula. As might be expected the most (highest ranked) cost-effective projects tended to be paving projects and projects associated with purchasing air quality equipment. If we look at the annualized cost-effectiveness ratios shown in Figure 2, it is clear that there is steep drop-off in terms of identifying those projects that tend to be far less cost-effective than the majority of the remaining projects.



Note: Combined projects were plotted together (identified by the first project number) using the combined CE ratio

Figure 2: PM_{10} Cost-Effectiveness by Project Number

[5] MDT did not implement all projects with the intent of reducing PM10 (per T. Steyaert, 11/4/03).

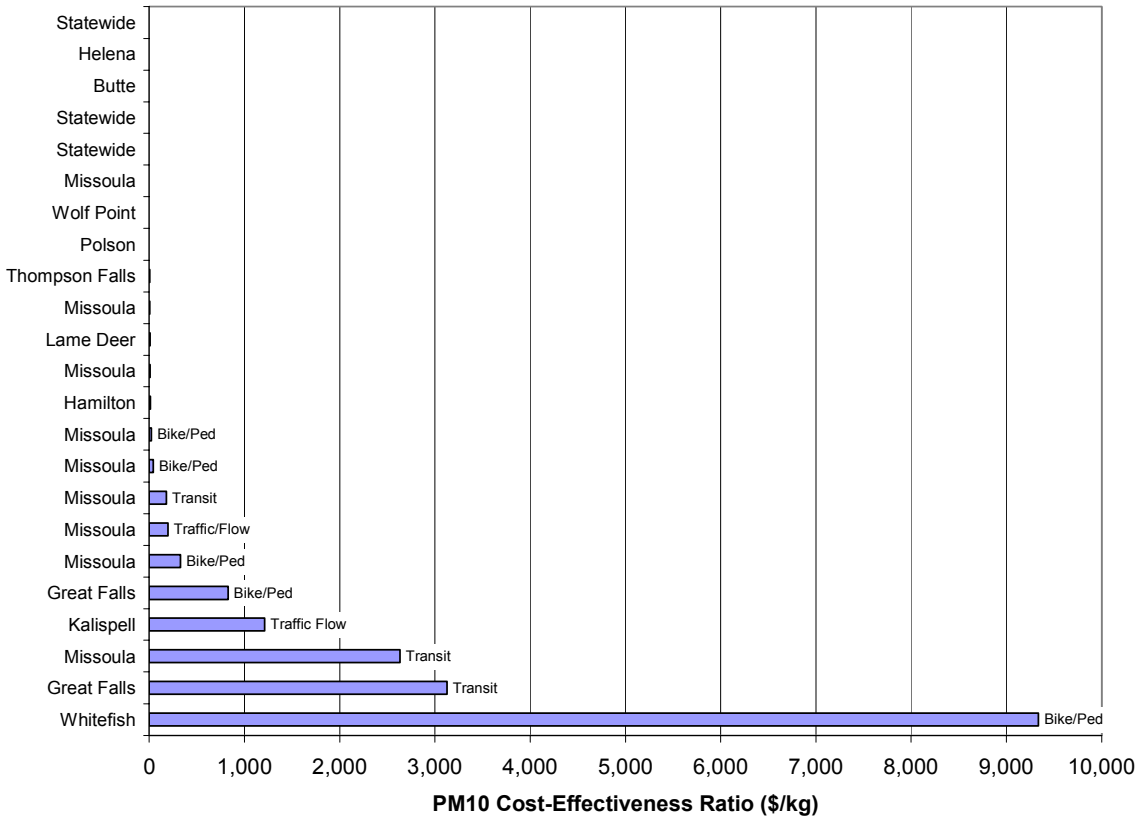
In the most of the current literature, projects exceeding a cost-effectiveness ratio of 10,000 are typically considered to be economically inefficient. As can be seen above and in Table 9, three projects (#32, #29 and # 7/60, which is a combined project) exceeded this threshold, and one project closely approaches it (#47). All of the five projects with cost-effectiveness ratios that exceed 5,000 (shown in light gray in Table 9) are bicycle-pedestrian projects, two of which were located in Missoula, one of which was located in Whitefish, and one of which was located in Kalispell. The majority of projects had cost-effectiveness ratios less than 5,000 and can be organized into two groups: those with ratios between 100 and 5,000 (shaded in darker gray) and those below 100 (not shaded). Figure 3 also shows the projects rankings by location, type, and cost-effectiveness.

As Table 9 shows, the first group of projects with the highest cost-effectiveness ratios comprises eight projects, two of which are combined. These projects vary by project type and include: transit, traffic flow improvements, and bicycle-pedestrian projects. In general, most of these projects tended to have a higher cost with lower benefits. The most cost-effective projects are street equipment projects, which are implemented with the primary goal of removing road dust emissions. Other projects, such as transit or roadway improvement, tend to be of – sometimes – much lower cost-effectiveness.

The large capital improvement projects (e.g., transit) show low benefits (< ~1,500 kg/year); for these projects, accessibility or mobility may be the primary goals, while air quality benefits may be considered a secondary (albeit beneficial) side effect. All of most cost effective projects (except one, #34, which has a small cost) have benefits that are almost an order of magnitude higher (~ 9,000 kg/year to 1.1 million kg/year) than the projects with low CE ratios.

Table 9: Projects Ranked by PM-10 Cost-Effectiveness (From Least to Most Cost-Efficient)

Project	Year	Project Name	Location	MDT Project Type	Annual Cost ($)	Annual Benefit (kg)	Cost-Eff Ratio ($/kg)
32	2001	FTA Transfer – Butte	Butte	Transit (bus facilities)	$363,825	5	139,932
29	2001	Sidewalks – Kalispell	Kalispell	Bike/Ped	$78,697	5	31,926.0
7	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	$1,212,506	133	18,279.6
60	Incl. In # 7	**Clark Fork - Missoula	Missoula	Bike/Ped			
47	2002	Bike/Ped Path - Whitefish	Whitefish	Bike/Ped	$93,891	20	9,337.7
27	2000	FTA Transfer - Great Falls	Great Falls	Transit (bus facilities)	$525,000	168	3,125.0
8	1993	$ Transfers – Transit (1993-2003)	Missoula	Transit (bus purch.)	$748,673	569	2,632.5
9	Incl. In # 8	City Bike Shelter	Missoula	Bike/Ped			
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	$72,733	120	1,212.2
22	2003 - NR	13th St S/13th Ave S Sidewalk	Great Falls	Bike/Ped	$14,893	18	827.4
17	1998	Missoula TDM	Missoula	Bike/Ped	$81,613	497	328.6
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	$150,901	1,538	196.2
62	2001	Missoula/Ravalli TMA	Missoula	Transit	$336,000	3,746	179.4
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	$25,901	1,269	40.8
4	1995	California Street Bridge	Missoula	Bike/Ped	$1,724,710	149,165	23.1
5	1995	Northside Access	Missoula	Bike/Ped			
6	1995	Bicycle Commuter Network	Missoula	Bike/Ped			
11	1995	Primary Sidewalk Network	Missoula	Bike/Ped			
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Bike/Ped			
12	1995	Bicycle Lane Network	Missoula	Bike/Ped			
16	1995	Reserve Street Landscaping	Missoula	Bike/Ped			
18	1995	South Avenue Bike/Ped Path	Missoula	Bike/Ped			
3	1997	North Reserve Street	Missoula	Bike/Ped			
34	2001	FoxField Ave - Hamilton	Hamilton	PM-10 Reduction	$8,229	765	10.8
1	1993	Street Sweepers	Missoula	PM-10 Reduction	$154,704	33,216	9.3
30	2002	Off System Paving - Lame Deer	Lame Deer	PM-10 Reduction	$39,031	8,953	8.7
13	1994	Missoula City Paving	Missoula	PM-10 Reduction	$139,900	70,560	4.0
35	2001	Paving - Thompson Falls	Thompson Fls.	PM-10 Reduction	$27,241	14,983	3.6
33	2001	Division/5th St - Polson	Polson	PM-10 Reduction	$15,581	9,435	3.3
37	2001	Paving - Wolf Point	Wolf Point	PM-10 Reduction	$40,845	15,980	2.6
10	1994	Missoula County Paving	Missoula	PM-10 Reduction	$70,871	104,160	1.4
19	incl. In # 10	County Paving	Missoula	PM-10 Reduction			
28	1998	1998 Air Quality Equipment	Statewide	PM-10 Reduction	$572,942	482,483	1.2
49	2002	2002 Air Quality Equipment	Statewide	PM-10 Reduction	$369,756	672,821	0.5
31	2001	Off System Paving - Butte	Butte	PM-10 Reduction	$32,978	177,617	0.4
36	2001	Brady St/Joslyn St - Helena	Helena	PM-10 Reduction	$24,946	94,436	0.3
38	2000	2000 Air Quality Equipment	Statewide	PM-10 Reduction	$73,570	569,758	0.1



[1] *Note: Combined projects are plotted together (identified by first project number) using the combined CE ratio*

Figure 3: PM_{10} Projects by Location and Cost-Effectiveness

Finally, if we look at the range of project cost-effectiveness by project type (Table 10), we see that, on average, PM_{10} reduction projects tend to be the most cost-effective with traffic flow projects the next most cost-effective. As might be expected, transit projects and bicycle-pedestrian projects tend to be least cost-effective relative to others that have been funded through the MACI/CMAQ program. This is also illustrated in Figure 4.

Table 10: PM Cost-Effectiveness by Project Type

Project Type	Least CE ($/kg)	Average CE ($/kg)	Most CE ($/kg)
PM_{10} Reduction	10.8	3.5	0.1
Traffic Flow	1,212.2	704.2	196.2
Bike-Pedestrian	31,926.0	8,680.4	23.1
Transit	139,932.7	36,422.7	0.7

Figure 4 shows the variability in cost-effectiveness ratios associated with each project type. It shows that PM_{10} reduction projects have the least amount of variability (i.e., they tended to be cost-effective regardless of project location), followed by traffic flow projects bicycle/pedestrian projects, and, lastly, transit. This figure shows that the transit and bicycle/pedestrian projects have an extremely large amount of variability, which may be a function of the high variability associated with their implementation costs, as well as their location and usage, which would

affect the variability of benefits. These results suggest that care must be taken when funding projects that tend to be highly variable in terms of costs and benefits.

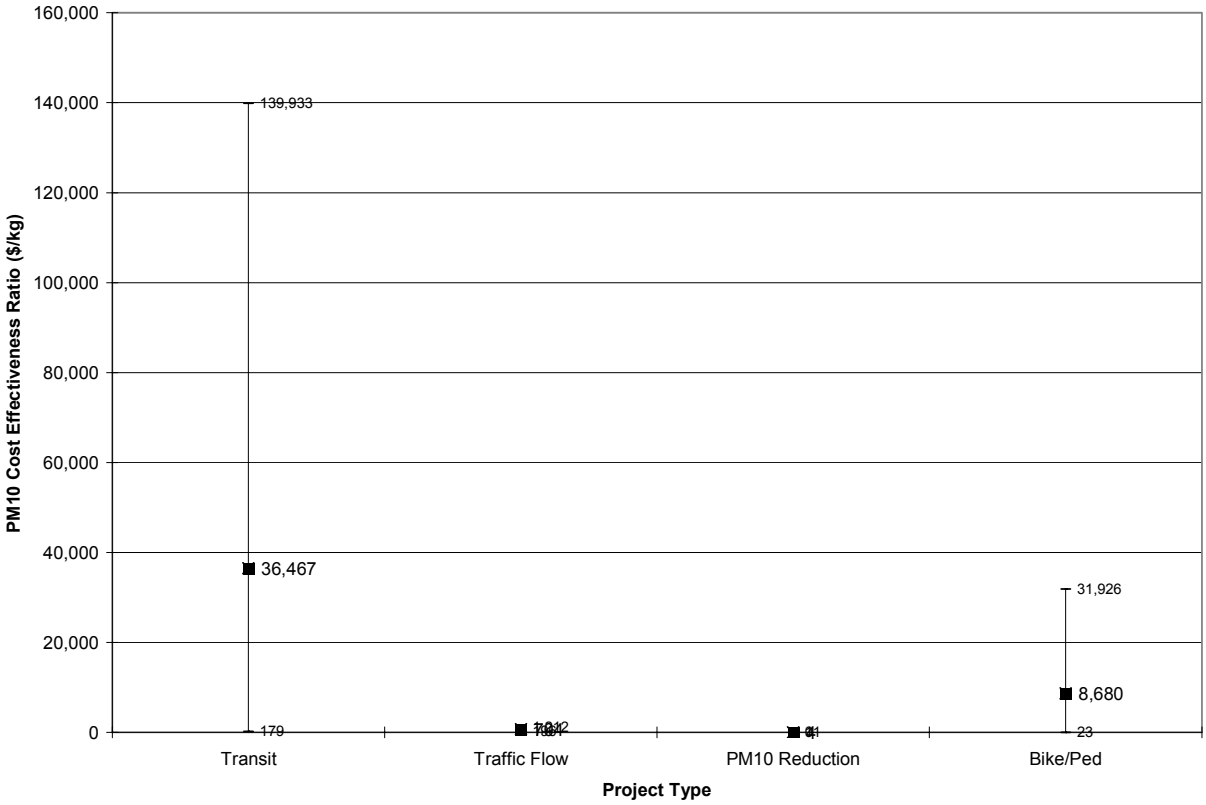


Figure 4: Variability in PM_{10} Cost-Effectiveness by Project Type

CO Cost-Effectiveness

Table 11 shows the cost-effectiveness rankings for the 33 projects with non-zero benefits funded to date through the MACI/CMAQ program. Annualized costs for the funded CO projects ranged from $14,185 to nearly $1.8 million. Note here that the Missoula bicycle projects are the same ones identified in the PM_{10} analysis. The most-effective projects tended to be traffic flow projects. From Figure 5, we can see that there are really three groups of cost-effectiveness ratios: less than 100, between 100 and 400, and greater than 400. It should also be noted that the worst performing project in terms of cost-effectiveness was Project 61, a traffic flow improvement project in Missoula. The second worst performing project was Project 32, a transit improvement project in Butte. These projects are excluded in the graph of cost-effectiveness ratios by project number, shown in Figure 5.

Project 61 has a poor cost-effectiveness ratio because of low benefits, which is in part because: 1) the length of roadway improved was limited, 2) the average daily traffic along the improved roadways were assumed to be moderate, and 3) the estimated speed changes were assumed to be minimal. Together, these factors lead to a small number of vehicles with small emission

improvements over a small distance. Since MDT did not provide the costs and benefits for this project and very little data were available, we applied a very conservative approach. It is possible that some of the assumptions in this analysis may be modified to improve the cost-effectiveness ratio, perhaps better representing project benefits. Project 32 has a poor cost-effectiveness ratio because of low ridership impacts from small but relatively expensive capital improvements to a transit center. Again, taking the perspective that projects exceeding a cost-effectiveness ratio of 10,000 are considered economically inefficient, only project 61 exceeds this suggested threshold.

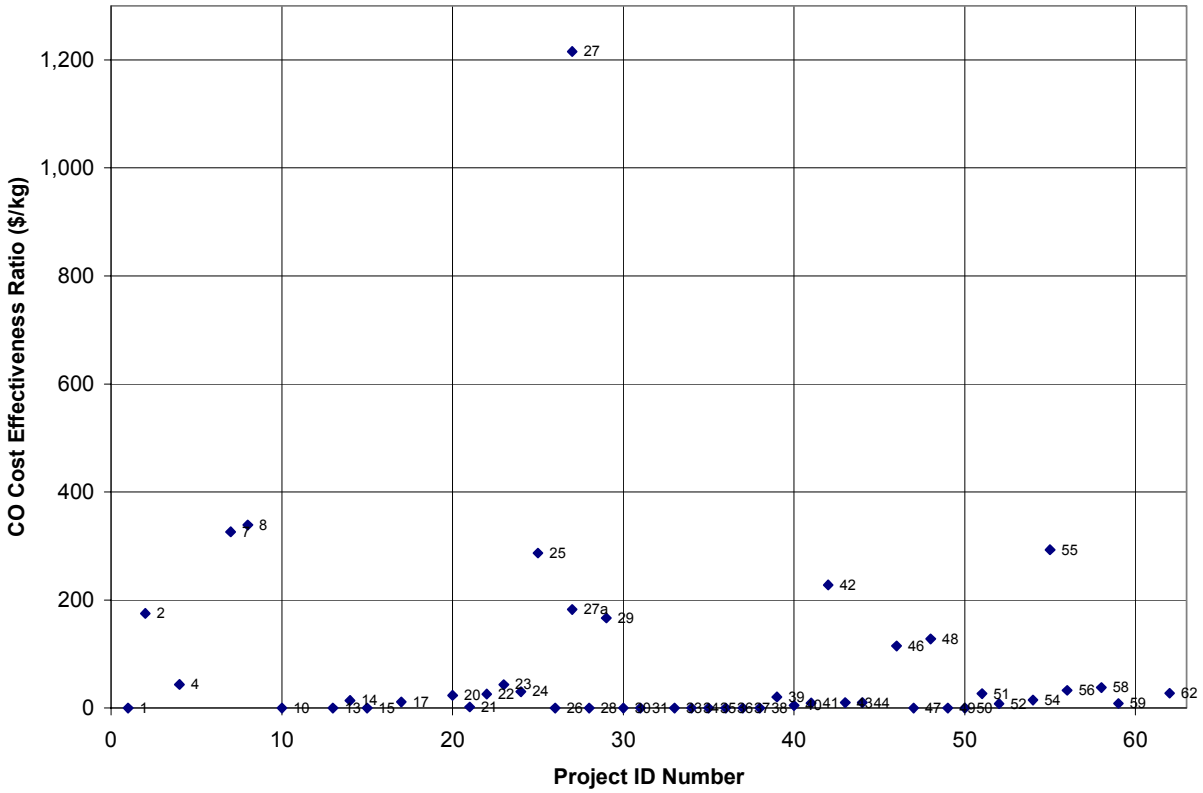


Figure 5: Project Cost-Effectiveness by Project Number

Table 11: Projects Ranked by CO Cost-Effectiveness (From Least to Most Cost-Efficient)

Project	Year	Project Name	Location	MDT Project Type	Annual Cost ($)	Annual Benefit (kg)	Cost-Eff Ratio ($/kg)
61	2001	Arthur Ave - Missoula	Missoula	Traffic Flow	$48,146	1	120,503.8
32	2001	FTA Transfer - Butte	Butte	Transit (bus facilities)	$363,825	95	3842.7
27	2000	FTA Transfer - Great Falls	Great Falls	Transit (bus facilities)	$525,000	864	1,215.3
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Transit (bus purch.)	$748,673	4,421	338.7
9	incl. in # 8	City Bike Shelter	Missoula	Bike/Ped			
7	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	$1,212,506	7,432	326.3
60	incl. in # 7	**Clark Fork - Missoula	Missoula	Bike/Ped			
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Traffic Flow	$31,643	216	293.0
25	2001	West Bank Trail Connection	Great Falls	Bike/Ped	$71,797	500	287.2
42	2002	Dewey Blvd Extension - Butte	Butte	Traffic Flow	$111,432	489	227.9
27A	2001	6th Ave N to Bench Blvd	Billings	Traffic Flow	$554,877	6,077	182.6
2	1993	Areawide Signal	Missoula	Traffic Flow	$637,163	7,277	175.1
29	2001	Sidewalks - Kalispell	Kalispell	Bike/Ped	$78,697	472	166.9
48	2002	Swords Park Path - Billings	Billings	Bike/Ped	$99,719	1,557	128.1
46	2002	Sidewalks - Great Falls	Great Falls	Bike/Ped	$142,455	2,479	114.9
4	1995	California Street Bridge	Missoula	Bike/Ped	$1,724,710	78,531	43.9
5	1995	Northside Access	Missoula	Bike/Ped			
6	1995	Bicycle Commuter Network	Missoula	Bike/Ped			
11	1995	Primary Sidewalk Network	Missoula	Bike/Ped			
45	incl. in # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Bike/Ped			
12	1995	Bicycle Lane Network	Missoula	Bike/Ped			
16	1995	Reserve Street Landscaping	Missoula	Bike/Ped			
18	1995	South Avenue Bike/Ped Path	Missoula	Bike/Ped			
3	1997	North Reserve Street	Missoula	Bike/Ped			
23	2002	Annual Sidewalk Prog.	Great Falls	Bike/Ped	$299,327	13,761	43.5
58	1999	Custer Ave - Signal Synch - Helena	Helena	Traffic Flow	$70,222	1,853	37.9
57	2000	Custer & McHugh - Helena	Helena	Traffic Flow			
56	2000	1999 Signal Upgrade - Butte	Butte	Traffic Flow	$294,557	8,944	32.9
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Bike/Ped	$25,901	1,707	30.3
62	2001	Missoula/Ravalli TMA	Missoula	Transit	$336,000	24,270	27.7
51	2000	Kalispell-Main St	Kalispell	Traffic Flow	$126,323	4,713	26.8
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Bike/Ped	$14,893	1,154	25.8
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	$25,901	2,217	23.4
39	2001	Citywide Signals - Bozeman	Bozeman	Traffic Flow	$165,118	7,986	20.7
54	2001	Main St - Billings Heights	Billings	Traffic Flow	$71,458	9,567	14.9
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	$150,901	21,314	14.2
17	1998	Missoula TDM	Missoula	Bike/Ped	$81,613	14,484	11.3
43	2002	Signal Upgrade - Helena	Helena	Traffic Flow	$141,751	14,185	10.0
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	$72,733	7,279	10.0
41	2002	South 19th & College - Bozeman	Bozeman	Traffic Flow	$63,552	6,745	9.4
59	2000	19th & Main Bozeman	Bozeman	Traffic Flow	$71,799	8,299	8.7
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Traffic Flow	$86,936	10,608	8.2
53	1999	North 93 Signals - Kalispell	Kalispell	Traffic Flow			
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	Traffic Flow	$21,012	4,198	5.0
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Traffic Flow	$27,196	24,580	2.2

Table 12 shows the range of project cost-effectiveness by project type. We see that, on average, traffic flow projects tend to be the most cost-effective. As might be expected, transit projects tend to be least cost-effective relative to others that have been funded through the MACI program. This is also illustrated in Figure 4. The most cost-effective project was Project 21, which was a traffic flow improvement in the Great Falls area.

Table 12: CO Cost-Effectiveness by Project Type

Project Type	Least CE ($/kg)	Average CE ($/kg)	Most CE ($/kg)
Traffic Flow (w/ Proj 61)	120,503.8	6,754.6	2.2
Transit	3,842.7	1,356.1	27.7
Traffic Flow (w/o Proj 61)	292.99	63.5	2.2
Bike-Pedestrian	326.3	109.2	11.3

Figure 6 shows the project cost-effectiveness by location. Recall here that bigger numbers represent less cost-effective projects.

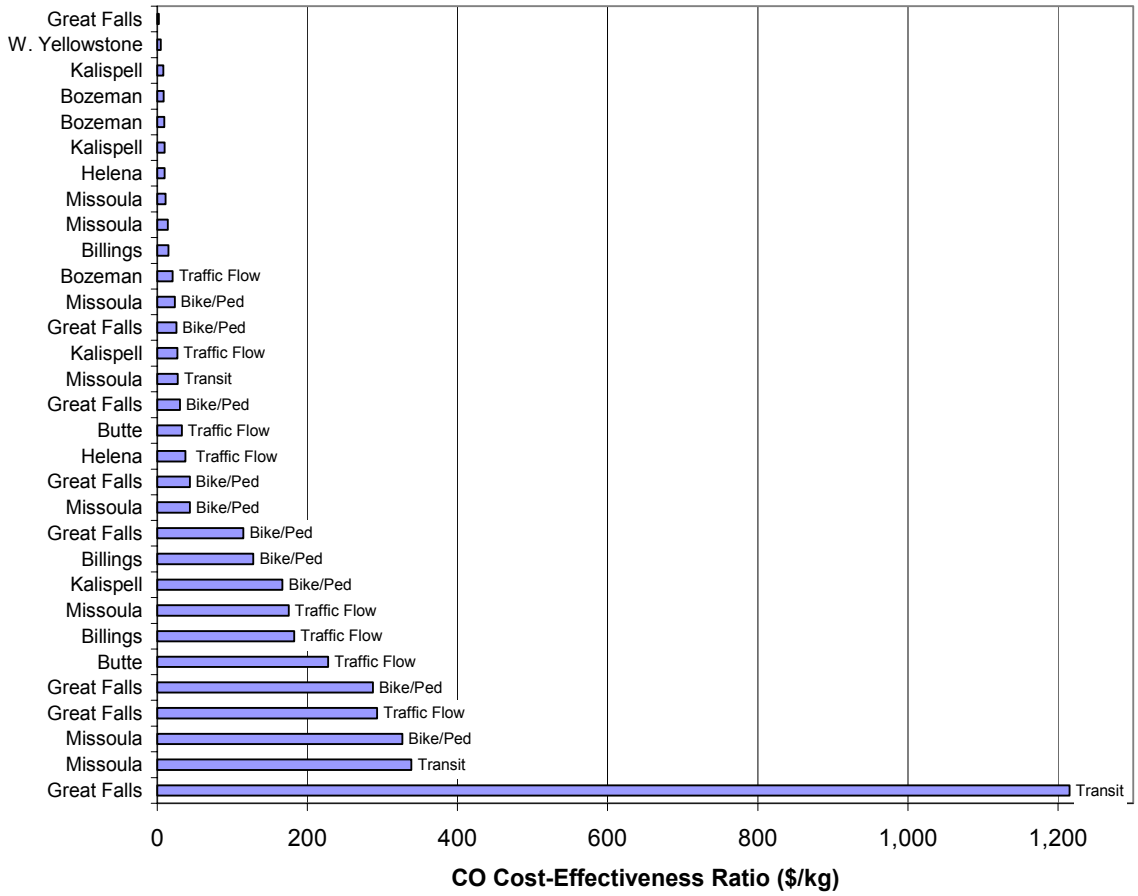


Figure 6: CO Projects by Location and Cost-Effectiveness

Finally, when looking at the variability of CO cost-effectiveness by project type (Figure 7), we see that Project 61 is substantially less cost-effective than all other CO reduction projects funded to date. If we

plot the variability of CO cost-effectiveness by project type without Project 61, Figure 8, we see that traffic flow projects are generally comparable to bicycle/pedestrian projects and that transit project are the most variable in terms of the cost-effectiveness. A review of Table 11 shows that transit projects are among the most and least cost-effective projects for reducing CO emissions.

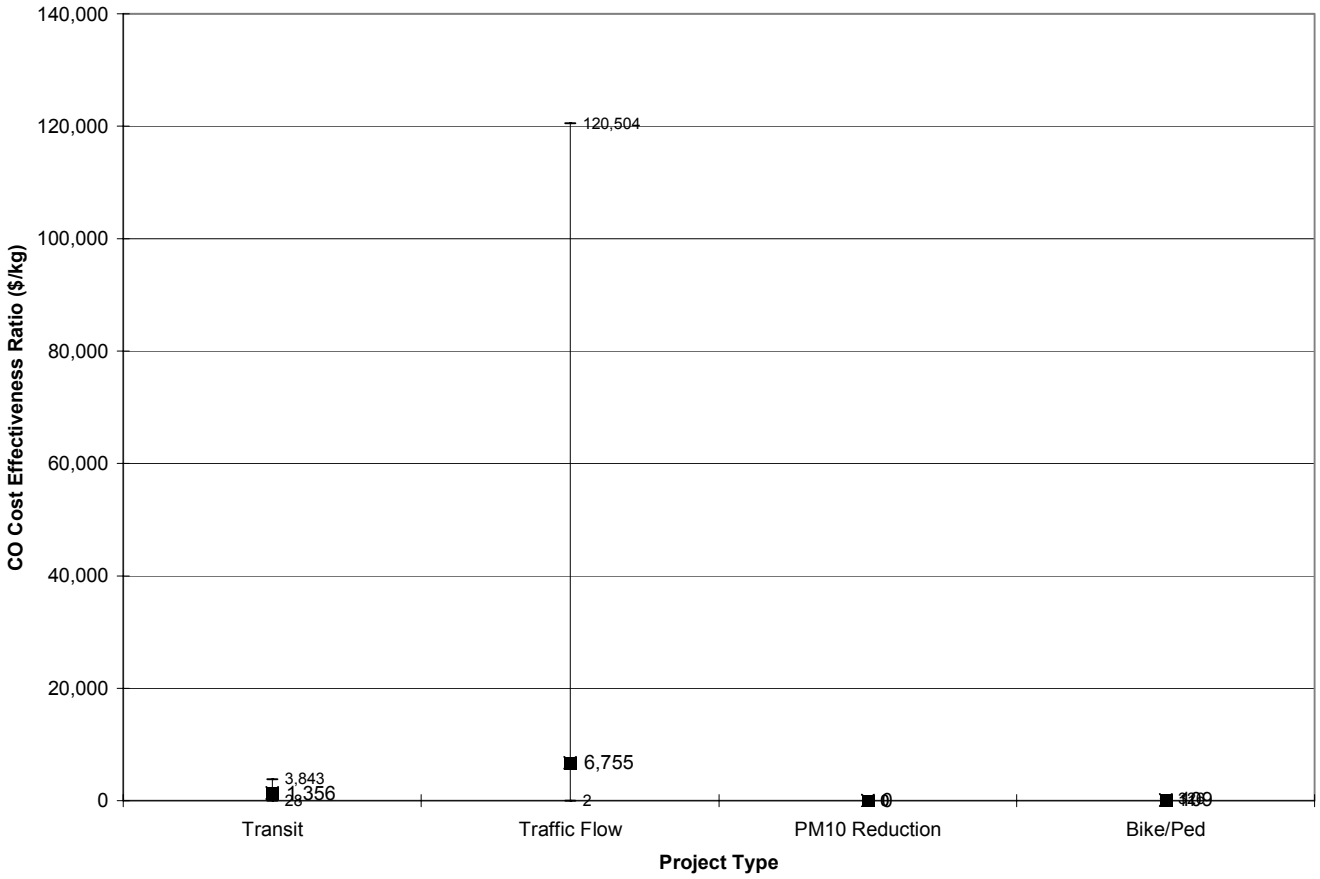


Figure 7: Variability in CO Cost-Effectiveness by Project Type with Project 61

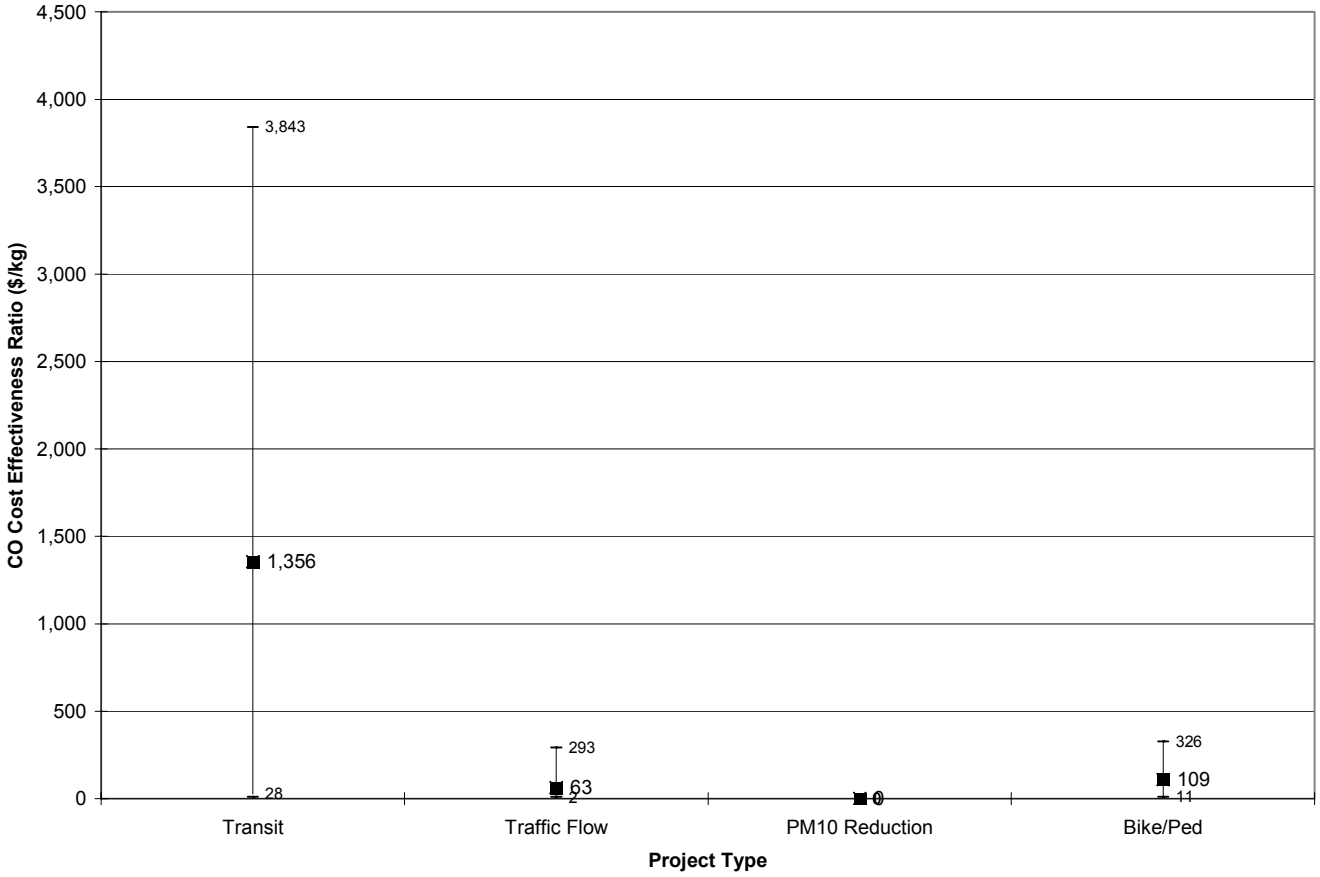


Figure 8: Variability in CO Cost-Effectiveness by Project Type Without Project 61

RECOMMENDATIONS

In this section, we discuss the main findings of this analysis and make a number of recommendations that will help to focus the MACI program and improve the calculations of costs and benefits for future projects.

Program Effectiveness

- Annualized costs for the PM_{10} projects ranged from $15,581 to nearly $1.8 m. The most cost-effective projects tended to be paving projects and projects associated with purchasing air quality equipment with traffic flow projects the next most cost-effective. Transit projects and bicycle-pedestrian projects tend to be least cost-effective relative to others that have been funded through the MACI/CMAQ program. The PM_{10} reduction projects also tended to have the least amount of variability (i.e., they tended to be cost-effective regardless of project location), followed by traffic flow projects bicycle/pedestrian projects, and, lastly, transit. In terms of the PM_{10} reduction projects, it is important to note that the cost-efficiency of paving unpaved roads is a function of wintertime dust reduction. That is, in order for these projects to be cost-efficient from an air quality perspective, the reduction in wintertime PM_{10} alone should large enough to offset costs.

- Annualized costs for the funded CO projects ranged from $14,185 to nearly $1.8 m. The most-effective projects tended to be traffic flow projects and transit projects tended to be least cost-effective relative to others that have been funded through the MACI program.

- MDT appears to have generally done a very good job of selecting cost-effective projects for implementation under MACI using project performance comparisons to the generally accepted standard of less than 10,000. However, it is important to recognize that this standard has been set largely in regions that receive significantly greater allocations of CMAQ funding. This generally accepted standard would tend to suggest that a better (lower) cost-effectiveness threshold be set for selecting future projects (e.g., <5,000). That is, since there is significantly less CMAQ funding available, projects should tend to be more cost-effective.

- Qualitative discussions with several local officials and the Department of Environmental Quality indicate that, in particular, projects aimed at roadway paving and flushing/sweeping have been very effective. These discussions are supported by cost-effectiveness analysis shown in the previous sections.

- It is important to note that the CMAQ allocation formula does not account for PM_{10} even though CMAQ funds can be used for PM_{10} mitigation. MDT might want to consider a ranking scheme that prioritizes PM_{10} projects since CO is generally considered to be declining in importance as vehicle technology improves.

- At some point in the very near future, new MOBILE6 budgets will need to be established for non-attainment areas. At this point, all calculations for new projects should be converted to MOBILE6 emissions factors. It would also be beneficial to derive targets for regions in which mobile budgets are archived and difficult to access.

Project Submittal and Evaluation

- In the past, local regions have submitted projects without sufficient documentation. In some cases, project impacts seem out of scale with national trends. We suggest that a standard package of material requiring inputs similar to those shown in Appendix C be developed and used in any future solicitations of MACI projects. This will serve two purposes: first, the data will be available for MDT to directly compute cost-effectiveness using the spreadsheets developed in this project and second, CMAQ funding requires a state report on CMAQ effectiveness and these inputs will provide the necessary data to complete these reports.

- As mentioned in the literature review, there is some new research that suggests that lower VMT roads, not higher, actually show the greatest benefits from street sweeping. DEQ has indicated that data collection of silt loadings is required in a number of areas in the state. We suggest that review and analysis of the previously collected silt loadings be conducted with the goal of refining both the spatial and operational effectiveness of the street sweeping equipment specific to Montana.

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APPENDIX A. PROJECTS INCLUDED IN THE MACI PROGRAM TO DATE

Project	Year	Project Name	Location	MDT Project Type	NRC Class	NRC Subcategory	Lifespan (years)		Cost
							NRC	Assumed	
1	1993	Street Sweepers	Missoula	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$1,194,585
2	1993	Areawide Signal	Missoula	Traffic Flow	Roadway Signal Systems	Roadway Signal Systems	10 to 12	10	$4,920,000
3	1997	North Reserve Street	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$5,350,750
4	1995	California Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,380,399
5	1995	Northside Access	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,857,693
6	1995	Bicycle Commuter Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$622,500
7	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$9,362,648
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Transit (bus purch.)	Transit	New or AFV Buses	10 to 12	10	$5,756,799
9	incl. In # 8	City Bike Shelter	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$24,255
10	1994	Missoula County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$1,089,461
11	1995	Primary Sidewalk Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$3,595,700
12	1995	Bicycle Lane Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$286,110
13	1994	Missoula City Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$2,150,611
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,880,556
15	1994	Bike/Ped Coordinator	Missoula	Bike/Ped	--	--	--	--	$190,050
16	1995	Reserve Street Landscaping	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$53,492
17	1998	Missoula TDM	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$630,194
18	1995	South Avenue Bike/Ped Path	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$171,107
19	incl. In # 10	County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	incl. In # 10
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$210,000
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Traffic Flow(?)	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$115,000
23	2002	Annual Sidewalk Prog.	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$2,311,320
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000
25	2001	West Bank Trail Connection	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$554,399
26	2001	South Arterial Study	Great Falls	Traffic Flow (study)	Traffic Flow	--	--	--	$200,000
27	2001	6th Ave N to Bench Blvd	Billings	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$6,915,000
28	1998	1998 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$4,424,107
29	2001	Sidewalks - Kalispell	Kalispell	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$607,681
30	2002	Off System Paving - Lame Deer	Lame Deer	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$600,000
31	2001	Off System Paving - Butte	Butte	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$506,959
32	2001	FTA Transfer - Butte	Butte	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	$346,500
33	2001	Division/5th St - Polson	Polson	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$239,514
34	2001	FoxField Ave - Hamilton	Hamilton	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$126,500
35	2001	Paving - Thompson Falls	Thompson Fls.	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$418,766
36	2001	Brady St/Joslyn St - Helena	Helena	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$383,486
37	2001	Paving - Wolf Point	Wolf Point	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$627,882
38	2000	2000 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$568,087
39	2001	Citywide Signals - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,275,000
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30	$323,000
41	2002	South 19th & College - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	792,000
42	2002	Dewey Blvd Extension - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,388,695
43	2002	Signal Upgrade - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,094,561
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30	$1,118,086
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 11
46	2002	Sidewalks - Great Falls	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,100,000
47	2002	Bike/Ped Path - Whitefish	Whitefish	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$725,000
48	2002	Swords Park Path - Billings	Billings	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$770,000
49	2002	2002 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$2,855,156
50	2002	I-90 Interchange Study - Billings	Billings	Traffic Flow (study)	Traffic Flow	--	--	--	$330,000
51	2000	Kalispell-Main St	Kalispell	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,574,263
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$481,179
53	1999	North 93 Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$190,116
54	2001	Main St - Billings Heights	Billings	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$551,780
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$244,335
56	2000	1999 Signal Upgrade - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$2,274,493
57	2000	Custer & McHugh - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$470,178
58	1999	Custer Ave - Signal Synch - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$72,061
59	2000	19th & Main Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$894,770
60	incl. In # 7	**Clark Fork - Missoula	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 7
61	2001	Arthur Ave - Missoula	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$600,000
62	2001	Missoula/Ravalli TMA	Missoula	Transit	Travel Demand Management	Trip Reduction	1 to 2	1	$320,000

APPENDIX B. CPI VALUE BY YEAR

Year	CPI	Factor
1993	130.4	1.112
1994	134.3	1.080
1995	139.1	1.042
1996	143.0	1.014
1997	144.3	1.005
1998	141.6	1.024
1999	144.3	1.005
2000	145.0	1.000

APPENDIX C. DETAILED CALCULATIONS FOR PROJECTS WITH INCOMPLETE INFORMATION

Out of the 63 projects included in this analysis, project costs and estimated emissions reductions were not provided for a number of projects. These projects, listed in Table 8, required additional information in order to develop cost-effectiveness ratios. The detailed calculations for each project are provided below.

BICYCLE-PEDESTRIAN FACILITIES

Improvements to bicycle-pedestrian facilities are generally expected to reduce or eliminate auto trips, thus reducing overall VMT. They are not expected to significantly change trip lengths or average travel speeds.

Ideally, a survey of travel behavior would be used to identify the fraction of automobile drivers shifting to non-motorized modes at project completion. Often this information is not readily available. As a result, the first part of estimating emission benefits from bicycle-pedestrian projects require the calculation of the total estimated number of automobile trips and vehicle miles of travel that will be reduced. When survey data are not available, it is typical to use assumptions based on prior studies. For the purposes of this report, we assume that an additional 2% of average daily traffic (ADT) by vehicles along the corridor will convert to pedestrian trips, and that 2% of ADT will convert into bicycling trips.[6] According to a 2001 report accompanying Project #45 (39th Street/South Higgins Ave)[7], the City of Missoula completed a study at four intersections to conclude that a mode split of 3% of vehicle ADT exists for bicycles and 5% of ADT for pedestrians when bicycle lanes and sidewalks are available. When the bicycle and pedestrian facilities are poor or non-existent, the mode split for bikes and pedestrians drops to 1% and 3%, respectively. As a result of the addition of non-motorized facilities, a 2% increase can be expected for each non-motorized mode. These figures are consistent with recent MDT reports, such as Project #44 (Kalispell, 2003) and Project #47 (Whitefish, 2002), which also refer to the findings in Missoula and assume a bicycle mode shift of 3% and 2% of vehicle ADT, respectively. One of the most recent CMAQ reports, for the Clemens/Spurgin Walkway (Project #20 2003), assumed that 5% of vehicle trips would switch to non-motorized modes.

PROJECT NAME: CLARK FORK RIVER - ORANGE STREET BRIDGE (PROJECT #7)
Location: Missoula
Year: 1998
Project Type: Pedestrian/ Bicycle

Project Description: This project involved the add-on construction of a bicycle and pedestrian facilities on the existing Orange Street Bridge, which crosses the Clark Fork River in Missoula. The construction of bicycle facilities increased accessibility over the Clark Fork River and is thought to have resulted in fewer SOV trips and reduced VMT.

Travel Impacts Assumptions and Sources: Current estimates of travel impacts by this project are not available. About 2% of the trips are believed to switch from the vehicles to each of the non-motorized modes as a result of this project. This assumption is consistent with similar assumptions made by MDT on similar CMAQ projects, as it is assumed that adding bicycle and pedestrian facilities enhance accessibility, safety and circulation in nearby neighborhoods, especially along school routes for children who bicycle or walk to school. It also provides connections to the non-motorized network of walkways and trails, expanding non-motorized travel opportunities in the area.

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[6] In 1995, MDT CMAQ-funded project report assumed that 1% of all Missoula area workers shifted to non-motorized modes as a result of building or improving bicycle/pedestrian facilities for the purpose of estimating air quality benefits for CMAQ-funded projects in the Missoula area, regardless of the size, location, or average daily traffic of the improved facility.
[7] "MACI – Discretionary Program Project Proposal" by WGM Group Inc on July 30, 2001.

Table C-1. Travel Activity Input and Assumptions

Average Daily Traffic[1]	21,621 vehicles
Pedestrian Trip Increase[2]	2% of Auto ADT
Bicycle Trip Increase[3]	2% of Auto ADT
Auto Trip Reduction[4]	Pedestrian + Bicycle Trip Increases
Average Pedestrian Trip Distance[5]	0.7 mi
Average Bicycle Trip Distance[6]	1.8 mi
Applicable Days per Year[7]	240

1. 1998 Montana State Traffic Counts of the Orange Street Bridge, Montana Department of Transportation (2002). "Montana's Automatic Traffic Counters" On-line at: http://www.mdt.state.mt.us/departments/transportation%5Fplanning/pdf/2002_atrbook.pdf.
2. MDT CMAQ Reports Projects #47 (2002), #20 (2003), #44 (2003).
3. MDT CMAQ Reports Projects #47 (2002), #20 (2003), #44 (2003).
4. MDT CMAQ Reports Projects #47 (2002), #20 (2003), #44 (2003).
5. 1995 National Personal Transportation Survey
6. 1995 National Personal Transportation Survey
7. Assumed. See discussion below.

Table C-2. Emissions Assumptions and Calculations

Emissions Reduction Assumptions and Sources

Emissions reductions were calculated from VMT reduction, based on MOBILE5 model; consistent with previous MDT emission benefit calculations, such as MDT Projects #25 (2001), #29 (2001), #44, (2003). Mobile6 running emissions are based on an average running speed of 40 mph.

MOBILE5
· Auto CO Trip-End Emission Factor = 32.79 g/trip
· Auto Running CO Emission Factor = 2.91 g/mi
· Auto Running PM10 Emission Factor = 0.52 g/mi

MOBILE6
Auto Running CO Emission Factor = 14.88 g/mi (Source: MOBILE6 Emissions Model)
· Auto Hot Soak CO Emission Factor = 0.143 g/mi (Source: MOBILE6 Emissions Model)
· Auto Resting Loss CO Emission Factor = 0.138 g/mi (Source: MOBILE6 Emissions Model)
· Auto Running PM-10 Emission Factor = 0.52 g/mi (Source: AP 42)

MOBILE5 Emissions Reduction Calculations

Daily Pedestrian Emission Reduction = [(Pedestrian Trips) × (Auto Trip-End Emission Factor) + (Pedestrian Trips) × (Average Walking Trip Distance) × (Auto Running Emission Factor)] × (Number of Applicable Days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to pedestrian trips replacing auto trips

Daily Bicycle Emission Reduction = [(Bicycle Trips) × (Auto Trip-End Emission Factor) + (Bicycle Trips) × (Average Bicycle Trip Distance) × (Auto Running Emission Factor)] × (Number of Applicable days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to bicycle trips replacing auto trips

MOBILE6 Emissions Reduction Calculations

Daily Pedestrian Emission Reduction = [(Pedestrian Trips) × (Average Walking Trip Distance) × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (Number of Applicable Days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to pedestrian trips replacing auto trips

Daily Bicycle Emission Reduction = [(Bicycle Trips) × (Average Bicycle Trip Distance) × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (Number of Applicable days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to bicycle trips replacing auto trips

Table C-3. CO Calculations for Clark Fork-Orange Street Bridge Bike/Ped Project (MOBILE5 parameters)

Mode	Total Vehicle ADT	Percent Vehicle Trip Decrease	Bike/ Ped Trip Increase (trips)	Average Bike/Ped Trip Distance (mi)	Daily Avoided VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Applicable Days Per Year (days/yr)	CO Emission Reduction (kg/yr)
Ped	21,261	2.0%	425	0.7	298	32.79	2.91	240	3,553
Bikes	21,261	2.0%	425	1.8	765	32.79	2.91	240	3,879
								TOTALS (kg/yr)	7,432

Table C-4. PM-10 Calculations for Clark Fork-Orange Street Bridge Bike/Ped Project (MOBILE5 parameters)

Mode	Total Vehicle ADT	Percent Vehicle Trip Decrease	Bike/Ped Trip Increase (trips)	Average Bike/Ped Trip Distance (mi)	Daily Avoided VMT (mi)	Auto Running PM-10 Emission Factor (g/mi)	Applicable Days Per Year (days/yr)	PM-10 Emission Reduction (kg/yr)
Ped	21,261	2.0%	425	0.7	298	0.52	240	37
Bikes	21,261	2.0%	425	1.8	765	0.52	240	95
							TOTALS (kg/yr)	133

Note also that in each of MDT's past CMAQ reports, different assumptions were made about the number of applicable days that emission benefits would accrue from bicycle and pedestrians projects. In 1995, 260 was cited, in July 21, 1995, Karen Jaworsky, the Missoula Bicycle/Pedestrian Coordinator, wrote a memo to MDT titled, "Building Bicycle Pedestrian facilities to Encourage Single-Occupancy vehicle Reduction" which contained calculations to illustrate resulting air quality benefits, and used 250 work days per year for bicycle and pedestrian projects. In 1996, CM0002(12) traffic improvement reports 260 weekdays per year were used. In 2001, Project #55 used 365 days per year was used. In more recent reports, such as Project #44 (2003), the applicable days per year range from 25 to 365 based on the location of the facility. A value of 240 was used in this report to be conservative and consistent with most MDT reports.

ROADWAY FACILITIES TRAFFIC FLOW IMPROVEMENTS

Traffic flow improvements can generally take on two forms: signalization improvements and roadway geometric improvements. While both types of projects aim to improve traffic flow, the signalization improvements focus on reducing stopped delay while the geometric improvements serve to expand capacity and reduce out-of-direction travel, along with improving safety. Neither project type, however, aims to reduce or eliminate auto trips or overall VMT. Most often, the goal of these projects is often just to improve vehicle speeds (and travel times) while maintaining the existing VMT.

Ideally, a survey of roadway speed and vehicle count study would be performed before and after any roadway improvements to identify changes in VMT (if any) and changes in delay or speed. Any changes in average vehicle speed would affect the emission factors used and the quantity of pollution produced. Sometimes this information is available and serves as the justification for the improvements but not always.

When this information is not available, emissions can be estimated by estimating changes in speed and calculating the resulting emissions savings, based on the changes in speed-based emission factors, to the total estimated amount of vehicle miles of travel. When traffic speed and count data are not available, it is typical to use assumptions based on prior studies. "Before" improvement speeds can be assumed based on the type of facility and by using speed studies. The State of Montana completed its most recent speed study in 2000, and it completes annual traffic count studies on various road facilities.[8] Additionally, FHWA recommends that the "after" improvement speed be equal to 1.15 times the "before" improvement speed. Both of these assumptions are consistent with MDT's recent traffic flow improvement study emission calculations, such as Projects #58 (1999), #52 & #53 (1999), #56 (2000), #55 (2001).[9] The changes in emissions result from the estimated vehicle miles of travel along all of the roadway segments based on the changes in emission factors before and after the improvements.

PROJECT NAME: ARTHUR STREET (PROJECT #61) – NOT COMPLETED

Location: Missoula
Year: 2001
Project Type: Traffic Flow – Roadway Improvements

Project Description: This project involved the reconstruction of Arthur Avenue from 6th Street to 5th Street, including the intersections. The work also included a realignment of: the eastbound leg of the Madison Street Bridge and the 6th St/Maurice Avenue intersection, the westbound couplet between the Madison Street Bridge and the Arthur/5th Avenue intersection. The purpose of the project is to improve traffic flow, reduce out-of-direction travel, and improve safety near the University of Montana.

Travel Impacts Assumptions and Sources: Current estimates of travel impacts by this project are not available. In addition, the project is not yet completed, so all estimates here are based on the limited traffic data from a preliminary field review report by C.S. Peil, PE, dated September 12, 2001:

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[8] 1998 Montana State Traffic Counts of the Orange Street Bridge, Montana Department of Transportation (2002). "Montana's Automatic Traffic Counters" On-line at: http://www.mdt.state.mt.us/departments/transportation%5Fplanning/pdf/2002_atrbook.pdf.

[9] The earlier MDT reports (e.g.fs, 1999 & 2000) used data from 1996 MDT speed studies.

Table C-1. Estimated Road Segment Data

Section	Road Segment	AADT (veh)	Approx. Segment Length (m)
1	6th St from Arthur to Maurice, and NB Maurice from 6th to 5th	7,250	200
2	EB couplet from Maurice & 5th to Madison St Bridge	13,155	150
3	WB couplet from Madison St Bridge to 5th & Arthur	19,060	150
4	5th St/Maurice Ave intersection	20,530	100
5	5th St between Arthur & Maurice	2,870	200
6	Arthur Ave from 5th to 6th Streets	7,430	100
	TOTAL	70,295	

1. Source: C.S. Peil, PE, September 12, 2001.
2. Segment lengths approximated from Missoula city street map.

Based on similar traffic flow improvements done by MDT (similar to Project #56, 2000), the average core speed before traffic improvements along principle arterials is assumed to 31 mph, based on a 2000 MDT Speed Study. The speed assumed after improvements is recommended to be 1.15 of the initial ("before") speed, based on a FHWA recommendation. The associated CO emissions factors come from MOBILE5. The net result is shown below.

Table C-2. Traffic Input and Assumptions

Assumed Facility Type[1]	Principle Arterial
"Before" Improvement Speed[2]	31 mph
"After" Improvement Speed[3]	1.15 x "Before" Improvement Speed (35.65 mph)
Applicable Days per Year[4]	365

1. Source: C.S. Peil, PE, September 12, 2001.
2. MDT CMAQ Report Project #56 (2000).
3. MDT CMAQ Report Project #56 (2000), reference of FHWA recommendation.
4. MDT CMAQ Report Project #56 (2000).

Table C-3. Emissions Assumptions and Calculations

Emissions Reduction Assumptions and Sources

· Emissions reductions were calculated from changes in speed-based emissions, similar to those assumptions made in MDT CMAQ Project #56 (2000) Report.

MOBILE5
· "Before" Improvement Speed (31 mph) Emission Factor = 2.916 g/mi
"After" Improvement Speed (35.65 mph) Emission Factor = 2.551 g/mi

MOBILE6
· "Before" Improvement Speed (31 mph) Emission Factor = 9.27 g/mi
"After" Improvement Speed (35.65 mph) Emission Factor = 9.38 g/mi

Emissions Reduction Calculations

"Before" Improvement Emissions: (VMT × "Before" Emission Factor) × (Applicable Days per Year) × (0.001 kg/g) = kg/year of CO emissions before improvement

After Improvement Emissions: (VMT × "After" Emission Factor) × (Applicable Days per Year) × (0.001 kg/g) = kg/year of CO emissions after improvement

where VMT is estimated by: *VMT = Segment Length × Segment ADT*

Change in Emissions = Before Imp Emissions – After Imp Emissions = kg/ton

Note that only emission factors would change if using MOBILE5 and MOBILE6 assumptions. Also, note that it is possible for emissions to increase with traffic flow improvements because the emission factors do not continually linearly decrease as speed increases.

Table C-4. CO Calculations for Arthur Avenue Traffic Flow Improvements (MOBILE5 parameters)

Section	Improvement	Speed (mph)	Running CO Emission Factor (g/mi)	Roadway Section Length (mi)	ADT (veh)	VMT (veh-mi)	Applicable Days Per Year (days/yr)	CO Emissions (g/yr)	Emission Reductions (kg/yr)
1	Before	31.00	2.916	0.12	7,250	901	365	959	0.12
	After	35.65	2.551	0.12	7,250	901	365	839	
2	Before	31.00	2.916	0.09	13,155	1,226	365	1,305	0.16
	After	35.65	2.551	0.09	13,155	1,226	365	1,142	
3	Before	31.00	2.916	0.09	19,060	1,777	365	1,891	0.24
	After	35.65	2.551	0.09	19,060	1,777	365	1,654	
4	Before	31.00	2.916	0.06	20,530	1,276	365	1,358	0.17
	After	35.65	2.551	0.06	20,530	1,276	365	1,188	
5	Before	31.00	2.916	0.12	2,870	357	365	380	0.05
	After	35.65	2.551	0.12	2,870	357	365	332	
6	Before	31.00	2.916	0.06	7,430	462	365	491	0.06
	After	35.65	2.551	0.06	7,430	462	365	430	
							MOBILE5	**CO EMISSIONS REDUCTION (kg/yr)**	**0.8**

TRANSIT SYSTEM IMPROVEMENTS: PROJECT #32

Improvements to existing transit systems can take on many forms, such as bus upgrades and expansions, facility improvements, or service improvements. While difficult to quantify, transit programs are generally expected to reduce or eliminate single occupancy vehicle auto trips, thus reducing overall VMT. Usually it is assumed that they do not significantly change trip lengths.

Ideally, a survey of travel behavior would be used to identify change in transit usage that resulted from any system improvement. Often this information is not readily available, because it can be difficult to identify changes in the ridership that are exclusively from the transit system changes. Still, transit operators generally have a method for approximating ridership, and they can often make an educated guess as to the impact of specific improvements.

When a transit center was built in Butte, there was no transit data before and after the transit center was built to identify the number of new riders and their foregone travel behavior. Instead, the transit operator, Gary Keeler, Director Butte-Silver Bow Transit System, did his best to estimate the percent of new riders and the average travel distance that the new rider would have otherwise taken, presumably in a single occupancy vehicle. From these estimates, the amount of avoided auto trips and related emissions can be calculated. Along with the lack of ridership travel behavioral data, there are no past MDT CMAQ reports which serve as a good reference in this case.

PROJECT NAME: FTA TRANSFER – BUTTE (PROJECT #32)
Location: Butte
Year: 2001
Project Type: Transit/Bus Facilities (Existing Transit Service Improvements)

Project Description: This project involved the design and construction of a new transit center. The transit center provided a shelter to transit riders when transferring, with hopes of increasing ridership.

Travel Impacts Assumptions and Sources: Current estimates of travel impacts by this project were not immediately available. Gary Keeler, the director of the Butte-Silver Bow Transit System was contacted, and he estimated that the new transit center was attributable to an approximate 2% increase in total system ridership, of about 100,000 riders. While the ridership increase was difficult to quantify, Mr. Keeler deducted that the transit center was part of an 8% overall system ridership increase that was due to the addition of a new transit center and system route enhancements.

Table C-1. Travel Activity Input and Assumptions

Average System Ridership[1]	100,000 trips/year
Percent Transit Trip Increase[2]	2% of total ridership
SOV Auto Trip Reduction[3]	Transit Trip Increases
Average Transit Trip Distance[4]	5.0 mi

1. Gary Keeler, Director Butte-Silver Bow Transit System, personal communication July 2003. .
2. Gary Keeler, Director Butte-Silver Bow Transit System, personal communication July 2003.
3. Gary Keeler, Director Butte-Silver Bow Transit System, personal communication July 2003.
4. Gary Keeler, Director Butte-Silver Bow Transit System, personal communication July 2003.

Table C-2. Emissions Assumptions and Calculations

· Emissions reductions were calculated from trip elimination and VMT reduction, based on MOBILE5 model; consistent with previous (non-transit) MDT emission benefit calculations.

MOBILE5
· Auto CO Trip-End Emission Factor = 32.79 g/trip
· Auto Running CO Emission Factor = 2.91 g/mi
· Auto Running PM10 Emission Factor = 0.52 g/mi

MOBILE6
Auto Running CO Emission Factor = 14.88 g/mi (Source: MOBILE6 Emissions Model)
· Auto Hot Soak CO Emission Factor = 0.143 g/mi (Source: MOBILE6 Emissions Model)
· Auto Resting Loss CO Emission Factor = 0.138 g/mi (Source: MOBILE6 Emissions Model)
· Auto Running PM-10 Emission Factor = 0.52 g/mi (Source: AP 42)

MOBILE5 Emissions Reduction Calculations

Daily Transit Emission Reduction = [(Increase in Transit Trips) × (Average Transit Trip Distance) × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to transit trips replacing auto trips

MOBILE6 Emissions Reduction Calculations

Daily Transit Emission Reduction = [(Increase in Transit Trips) × (Trip-End Running Emission Factor) + (Increase in Transit Trips) × (Average Transit Trip Distance) × (Auto Running Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to transit trips replacing auto trips

Table. CO Calculations for FTA Butte Transit Project

Mode	Total Anunal System Trips	Percent Transit Trip Increase	Transit Trip Increase (trips)	Average Transit Trip Distance (mi)	Annual Avoided VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	CO Emission Reduction (kg/yr)
Transit	100,000	2.0%	2,000	5	10,000	32.79	2.91	95
							TOTALS (kg/yr)	95

Table. PM-10 Calculations for FTA Butte Transit Project

Mode	Total Daily System Trips	Percent Transit Trip Increase	Transit Trip Increase (trips)	Average Transit Trip Distance (mi)	Daily Avoided VMT (mi)	Auto Running PM-10 Emission Factor (g/mi)	PM-10 Emission Reduction (kg/yr)
Transit	100,000	2.0%	2,000	5	10,000	0.52	5
						TOTALS (kg/yr)	5

TRANSIT SYSTEM IMPROVEMENTS: PROJECT #62

Project Name: Missoula/Ravalli TMA (PROJECT #62)
Location: Missoula
Year: 2001
Project Type: Transit (Trip Reduction)

Project Description: This project involved the development of a carpool and vanpool programs in the Missoula area.

Travel Impacts Assumptions and Sources: Current estimates of travel impacts by this project were obtained directly from the Missoula/Ravalli Transportation Management Association (TMA). Here, we assume that the passengers of each car/van pool avoided the same amount of VMT that the car/vanpool exhibited. In other words, each passenger would have driven the same distance as the pool, if the pool did not exist. So in the carpool the one passenger saved 1,016,799 miles of travel over the course of the year, while each passenger in the carpool saved 1,598,813 miles, assuming they would have otherwise driven alone. Clearly, these estimates from the Missoula/Ravalli TMA are optimistic, as they indicate that each carpool trip traveled over 130 miles.

Table C-1. Travel Activity Input and Assumptions

Annual Carpool Trips Avoided[1]	7,578 trips
Annual Vanpool Trips Avoided[2]	21,287 trips
Annual Carpool VMT Avoided[3]	1,016,799 miles
Annual Vanpool VMT Avoided[4]	1,598,813 miles
Average Carpool Occupancy[5]	2
Number of Saved SOV Trips Per Carpool[4]	1
Average Vanpool Occupancy[5]	6
Number of Saved SOV Trips Per Vanpool[6]	5

1. Judee Harrison, MR TMA. July 2003.
2. Judee Harrison, MR TMA, July 2003.
3. Judee Harrison, MR TMA, July 2003.
4. Judee Harrison, MR TMA, July 2003.
3. Judee Harrison, MR TMA, recommendation of "2 to 3" in personal communication July 2003.
4. Assumed, one carpool passenger (excluding driver) equals one saved SOV trip.
5. Judee Harrison, MR TMA, recommendation of "11" in personal communication July 2003.
6. Assumed, each carpool passenger (excluding not driver) totals five saved SOV trips.

Table C-2. Emissions Assumptions and Calculations

· Emissions reductions were calculated from trip elimination and VMT reduction, based on MOBILE5 model; consistent with previous (non-transit) MDT emission benefit calculations.

MOBILE5
· Auto CO Trip-End Emission Factor = 32.79 g/trip
· Auto Running CO Emission Factor = 2.91 g/mi
· Auto Running PM10 Emission Factor = 0.52 g/mi

MOBILE6
Auto Running CO Emission Factor = 14.88 g/mi (Source: MOBILE6 Emissions Model)
· Auto Hot Soak CO Emission Factor = 0.143 g/mi (Source: MOBILE6 Emissions Model)
· Auto Resting Loss CO Emission Factor = 0.138 g/mi (Source: MOBILE6 Emissions Model)
· Auto Running PM-10 Emission Factor = 0.52 g/mi (Source: AP 42)

MOBILE5 Emissions Reduction Calculations

Annual Carpool Emission Reduction = [(Annual Carpool Trips) × 1 passenger × (Trip-End Emission Factor) + (Carpool VMT) × 1 passenger × (Auto Running Emission Factor)] × (Number of Applicable Days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to carpool trips replacing single-occupancy auto trips

Annual Vanpool Emission Reduction = [(Annual Vanpool VMT) × 5 passengers × (Trip-End Emission Factor) + (Auto Running Emission Factor)] × 1 passenger × (0.001 conversion from g to kg)

= kg/year emissions due to vanpool trips replacing single-occupancy auto trips

MOBILE6 Emissions Reduction Calculations

Annual Carpool Emission Reduction = [(Annual Carpool VMT) × 1 passenger × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to carpool trips replacing single-occupancy auto trips

Annual Vanpool Emission Reduction = [(Annual Vanpool VMT) × 5 passengers × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to vanpool trips replacing single-occupancy auto trips

Table. CO Emission Calculations for 2001 M/R TMA Carpool/Vanpool Project

Mode	Total Vehicle Trips	Total Vehicle VMT (miles)	Average Vehicle Occupancy	Avoided SOV trips (trips)	Avoided Auto VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	CO Emission Reduction (kg/yr)
Carpool	4,707	606,408	2.0	4,707	606,408	32.79	2.91	1,919
Vanpool	19,217	1,319,586	6.0	96,085	6,597,930	32.79	2.91	22,351
							TOTALS (kg/yr)	24,270

Table. PM10 Emission Calculations for 2001 M/R TMA Carpool/Vanpool Project

Mode	Total Vehicle Trips	Total Vehicle VMT (miles)	Average Vehicle Occupancy	Avoided SOV trips (trips)	Avoided Auto VMT (mi)	Auto Running PM-10 Emission Factor (g/mi)	PM-10 Emission Reduction (kg/yr)
Carpool	4,707	606,408	2.0	4,707	606,408	0.52	315
Vanpool	19,217	1,319,586	6.0	96,085	6,597,930	0.52	3,431
						TOTALS (kg/yr)	3,746

In reviewing the data provided by the planning agency, we adjusted the Project 62 data to reflect vehicle occupancies more consistent with the literature. We had no basis for adjusting VMT and did not revise the 1.0M and 1.5M VMT, which equates to 134 and 75 mi/trip, respectively reported by the planning agency. We believe that in actuality this is likely to be high and provide a sensitivity analysis to show the change in cost-effectiveness under varying VMT scenarios. Note here that we assume that car and vanpools have approximately the same VMT per trip.

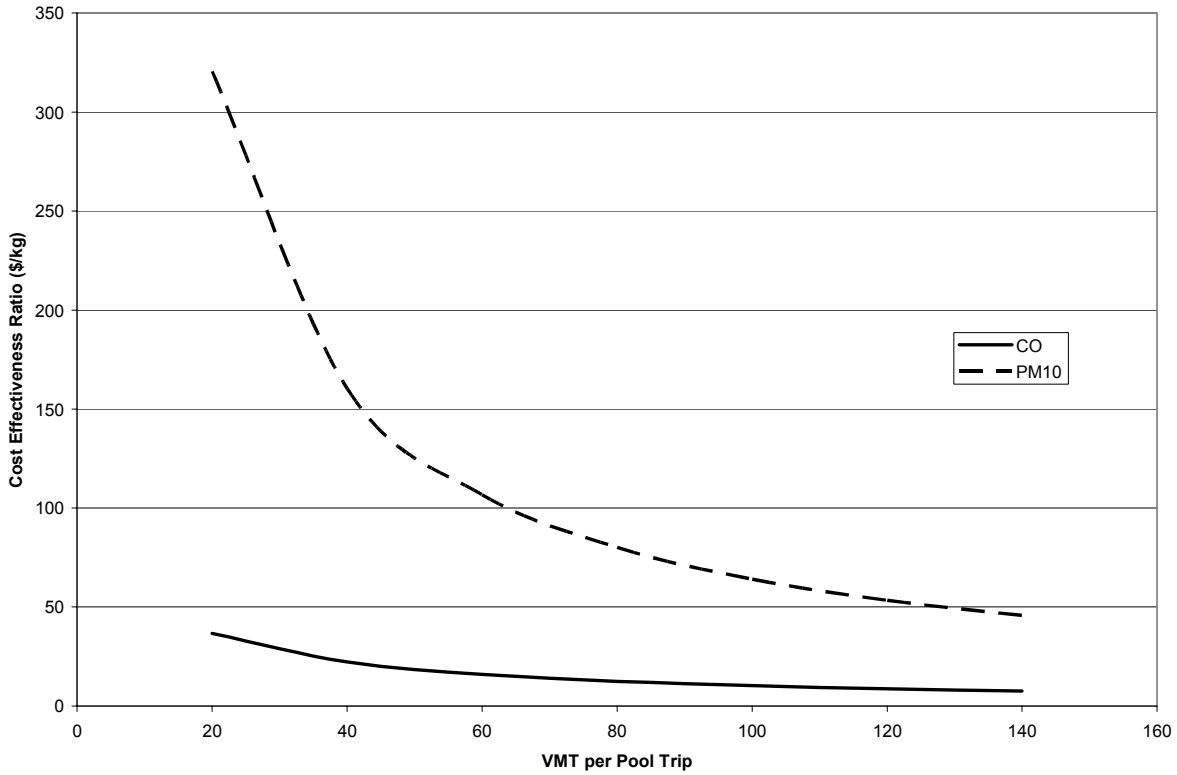

Figure. Sensitivity of Cost-Effectiveness to Changes in VMT per Trip

TRANSIT SYSTEM IMPROVEMENTS: PROJECT #17

Project Name: Missoula TDM (Project #17)
Location: Missoula
Year: 1998
Project Type: Listed as Bike/Ped but is as much a TDM

Project Description: Missoula In Motion encourages the use of a wide variety of transportation options including biking, walking, transit, carpooling, vanpooling, and flexible work schedules. Each of these transportation options helps to reduce traffic congestion and decrease air pollution in the Missoula valley.

Travel Impacts Assumptions and Sources: To fully assess the impact of Missoula in Motion, it would be helpful to have an idea of the number of people who have changed their travel behavior as a result of their services. Unfortunately, there is little data on the impacts of Missoula in Motion. One program that does have some information available is its *Way to Go Club*, a community-wide incentives program that rewards those who pledge to commute to work by biking, walking, transit, carpooling and vanpooling at least one day per week. The *Way to Go Club* has been remarkably successful in raising awareness about traffic congestion and air quality and has also proven effective in changing transportation habits.

Table C-1. Travel Activity Input and Assumptions

VMT Avoided per year[1]	955,362
Average Commute Distance (miles)	12

[1.] Melissa Wangler, Missoula in Motion, July 2003.
[2.] 1995 National Personal Transportation Survey.

Table C-2. Emissions Assumptions and Calculations

· Emissions reductions were calculated from trip elimination and VMT reduction, based on MOBILE5 model; consistent with previous (non-transit) MDT emission benefit calculations.

MOBILE5
· Auto CO Trip-End Emission Factor = 32.79 g/trip
· Auto Running CO Emission Factor = 2.91 g/mi
· Auto Running PM10 Emission Factor = 0.52 g/mi

MOBILE6
Auto Running CO Emission Factor = 14.88 g/mi (Source: MOBILE6 Emissions Model)
· Auto Hot Soak CO Emission Factor = 0.143 g/mi (Source: MOBILE6 Emissions Model)
· Auto Resting Loss CO Emission Factor = 0.138 g/mi (Source: MOBILE6 Emissions Model)
· Auto Running PM-10 Emission Factor = 0.52 g/mi (Source: AP 42)

MOBILE5 Emissions Reduction Calculations

Annual Program Emission Reduction = [[(Avoided Annual Veh Miles) / (Average Trip Length) × (Trip-End Emission Factor) + (Avoided Annual VMT) × (Auto Running Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to avoided auto trips

MOBILE6 Emissions Reduction Calculations

Annual Program Emission Reduction = [(Avoided Annual VMT) × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (0.001 conversion from g to kg)

= kg/year emissions due to pedestrian trips replacing auto trips

Annual Carpool Emission Reduction = [(Vanpool VMT) × 5 passengers × (Auto Running Emission Factor + Auto Hot Soak Emission Factor + Auto Resting Loss Emission Factor)] × (Number of Applicable Days per year) × (0.001 conversion from g to kg)

= kg/year emissions due to bicycle trips replacing auto trips

Table. Missoula TDM CO Emission Calculations

Program	Annual Avoided VMT (mi)	Annual Avoided Veh Trips	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	CO Emission Reduction (kg/yr)
Way to Go Club	955,362	79,614	32.79	2.91	5,391
				TOTALS (kg/yr)	5,391

Table. Missoula TDM PM10 Emission Calculations

Program	Annual Avoided VMT (mi)	Annual Avoided Veh Trips	Auto Running PM-10 Emission Factor (g/mi)	PM-10 Emission Reduction (kg/yr)
Way to Go Club	955,362	79,614	0.52	497
			TOTALS (kg/yr)	497

AIR QUALITY EQUIPMENT: _PROJECTS #28 & #49

Project Names: 1998 and 2002 Air Quality Equipment (Projects #28 & #49)
Location: Statewide
Years: 1998 & 2002
Project Type: PM-10 Reduction

Project Description: These two separate projects allowed for the acquisition of new sweepers, flush trucks, and liquid de-icer application equipment in 1998 and again in 2002. The equipment was distributed to and used in areas throughout the state identified as being non-attainment or "at-risk" of being non-attainment regions for PM-10.

Travel Impacts Assumptions and Sources: There are no travel impacts associated with these projects. PM-10 was reduced through the application of sweepers, flush trucks, and liquid deicer equipment without any implications on travel.

Typically, the calculation of benefits for this type of project involves the calculation of PM10 reductions based on: the type of equipment used (and its associated efficiency characteristics), the number of roadway lane-miles covered, the type of roadway facility (and its associated traffic volume characteristics). Unfortunately, none of these data were available, and little could be done to accurately estimate them.

There was little information available (aside from project costs) from existing MDT reports and information from the MDT Maintenance data available on the web. Because deicer equipment was one type of equipment purchased as part of these projects, it was assumed that their application of deicing agents would provide a representative indication of how much the purchased air quality equipment was in use, particularly since no other data were available.

Table C-1. Input and Assumptions

2000 Annual PM10 benefits (kg/year) [1]	569,758
1998 Quantities of Deicer (gal)[2]	1,700,000
2000 Quantities of Deicer (gal)[2]	2,007,510

[1.] 2000 MDT CMAQ report – 2000 Air Quality Equipment.
[2.] 2003 MDT Maintenance web site: http://www.mdt.state.mt.us/departments/maintenance/.

Table C-2. Emissions Assumptions and Calculations

· Emissions reductions were calculated by assuming that air quality benefits were proportional to the amount of deicer (in gallons) applied:

$$\frac{\text{1998 Quantities of Deicer}}{\text{1998 Annual PM10 Benefits}*} = \frac{\text{2000 Quantities of Deicer}}{\text{2000 Annual PM10 Benefits}} = \frac{\text{2002 Quantities of Deicer}*}{\text{2002 Annual PM10 Benefits}*}$$

The quantities denoted by an asterisk (*) are unknown quantities. Quantities of deicer in 2002 were estimated by linearly extrapolating available deicer data from 1998 and 2000.

Emissions Reduction Calculations

From this relationship, we can solve for the emission benefits by assuming the same proportionality of deicer to benefits exhibited in 2000. The two quantities of deicer in 1998 and 2000 were used to extrapolate the amount of decier used in 2002 before the emission benefits were calculated in 2002 by assuming the same proportionality of deicer to benefits exhibited in 2000 and 1998.

$$\frac{1{,}700{,}000 \text{ gallons}}{482{,}483 \text{ kg/yr}^{*}} = \frac{2{,}007{,}510 \text{ gal}}{482{,}483 \text{ kg/yr}} = \frac{2{,}370{,}645 \text{ gal}^{*}}{672{,}821 \text{ kg/yr}^{*}}$$

APPENDIX D. AIR QUALITY AREA AND LEVEL DESIGNATIONS

Moderate and Above CO Areas Exceeding 12.7 ppm CO Design Value

Section 187(a)(3) of the CAAA requires SIPs to include contingency control measures that take effect if the area's actual vehicle miles traveled (VMT) exceeds the VMT forecast included in the SIP. Although the 187(a)(3) language does not explicitly mention TCMs, EPA has provided guidance to states suggesting the use of TCMs as appropriate contingency measures (EPA, 1993).

Serious CO Nonattainment Areas

In addition to the contingency provisions applicable to moderate CO areas, section 187(b)(2) requires serious CO areas to identify and adopt TCMs to offset any growth in emissions that result from a growth in VMT or trips. The state must explicitly consider the section 108(f) TCMs and, if the state chooses not to implement any of the measures listed in section 108(f), provide an explanation as to why the measure was not adopted. The 187(b)(2) provisions are identical to those that apply to severe O_3 nonattainment areas under section 182(d)(1). Serious CO nonattainment areas that fail to meet their attainment deadline must also submit a new SIP within nine months that includes control measures sufficient to reduce emissions five percent per year until the standard is attained (CAAA; section 187(g)). EPA guidance provided to the states suggested that TCMs were appropriate contingency measures for consideration (EPA, 1993).

PM_{10} Nonattainment Areas

Although the CAAA do not include explicit TCM requirements for PM_{10} nonattainment areas, EPA has stated that as a matter of policy, where mobile sources contribute significantly to the PM_{10} problem, areas must consider TCMs as a potential control strategy, including those measures listed in section 108(f) (EPA, 1992; p. 340). EPA further notes that in areas where a section 108(f) measure is reasonably available, sections 189(a)(1)(C) (moderate PM_{10} area plan provisions to assure implementation of RACM), and 172(c)(1) (general CAAA requirements for RACM; see above) compel TCM implementation (EPA, 1992; p. 340).

Comment Regarding CAAA Provisions for Employer-Based Trip Reduction Programs

When originally enacted, the 1990 CAAA included requirements for severe and extreme O_3 and serious CO nonattainment areas to implement employer-based trip reduction programs. The O_3 provisions were originally included in section 182(d)(1)(B); the CO provisions were in section 187(b)(2). Due to the unpopularity of the requirement and the relatively small emission reduction benefits associated with its implementation, Congress passed and President Clinton signed into law a repeal of the requirement on December 23, 1995; following the federal repeal, some states (including California) repealed previously adopted employer-based programs (e.g., NJ, 1998; p. 9).

Comment Regarding 8-hr O_3 and $PM_{2.5}$ Nonattainment Areas

As of early 2003, EPA had yet to issue final implementation policies for either the 8-hr O_3 or $PM_{2.5}$ NAAQS. It is possible that additional TCM requirements may be established once implementation policies exist for the new air quality standards.

Comment Regarding Limited Maintenance Plans

With respect to transportation conformity and TCM requirements, for those areas designated as 'Not Classified' nonattainment under limited maintenance plans (e.g., Billings), the transportation conformity provisions of CAA Section 176(c) apply, but are slightly different than those under a full maintenance plan. Transportation conformity ensures that federally funded or approved projects and actions conform to air quality planning goals [19].

The transportation conformity rule of November 24, 1993 (58 FR 62188) and the general conformity rule of November 30, 1993 (58 FR 63214) apply to nonattainment areas and maintenance areas operating under maintenance plans. In areas with limited maintenance plans (LMPs), conformity determinations are still required, but the "emissions budgets in limited maintenance plan areas may be treated as essentially not constraining for the length of the initial maintenance period" ("Limited Maintenance Plan Option for Nonclassifiable CO Nonattainment Areas," memorandum from Joseph Paisie to the EPA Regional Air Branch Chiefs, October 6, 1995).

For transportation conformity, federal actions requiring conformity determinations are considered to satisfy the budget test specified in sections 93.118, 93.119 and 93.120 of the conformity rule once EPA finds the LMP adequate. Transportation plans, transportation improvement programs and Federal projects still require conformity determinations in order to proceed, and Federal projects are still subject to the hotspot modeling requirements of the transportation conformity rule.

ATTAINMENT STANDARDS

Federally, attainment refers to areas that meet the national standards; nonattainment refers to areas that exceed the national standard, and unclassified means that there is not enough information to classify the area. State definitions are essentially the same, however, the geographic extent of attainment categories varies. In order to move from a nonattainment status to attainment status, the air district must show three years of air quality data without any violations of the NAAQS within the air basin.

Table D1. Federal Definitions of Attainment Status

Federal Attainment Designations
Nonattainment: any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.
Attainment: any area (other than an area identified in clause (i)) that meets the national primary or secondary ambient air quality standard for the pollutant.

Unclassifiable: any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

See §70300 through §70306 & Appendices 1 through 4 of the California Code of Regulations, Title 17
See §107(d)1 of the Federal Clean Air Act http://www.epa.gov/oar/caa/caa107.txt

Levels of nonattainment were established for ozone, CO, and PM10 to communicate the degree to which air basins exceed the federal standards, Table D2. Ozone has eight different levels of nonattainment in which extreme is the worst level of ozone pollution and transitional describes an area is close to showing attainment. There are two levels of PM10 and CO nonattainment, serious and moderate.

Table D2 Federal Attainment Categories for PM10, and CO

Criteria Pollutant	Nonattainment Classification	Definition
PM10	Serious	• A PM10 nonattainment area that cannot practicably reach attainment by Dec 31, 1994 (or with the one time five-year extension from Dec 31, 1994).
	Moderate	• A PM10 nonattainment area that can practicably reach attainment by Dec 31, 1994 (or with the one time five-year extension from Dec 31, 1994).
Carbon Monoxide	Serious	• Area has a design value of 16.5 ppm and above
	Moderate	• Area has a design value of 9.1 up to 16.4 ppm.
	Not Classified	• An area that did not have enough data to determine whether or not it was violating the national CO standard.

(See §181, §186, and §188 of the Clean Air Act. http://www.epa.gov/oar/caa/contents.html)

APPENDIX E. ALL SPREADSHEET CALCULATIONS

Assumptions

Input	Value	Source
Workdays Per Year	240	Assumed.
Annual Discount Rate	5.0%	Maricopa Assoc of Gov, 2001
Running CO Emission Factor (g/mi)	14.88	MOBILE6 emissions model, assuming a speed of 40 mph.
Hot Soak CO Emission Factor (g/mi)	0.143	MOBILE6 emissions model, assuming a speed of 40 mph.
Resting Loss CO Emission Factor (g/mi)	0.138	MOBILE6 emissions model, assuming a speed of 40 mph.
Auto Running PM-10 Emission Factor (g/mi)	0.52	EPA AP-42
Average Walk Trip Distance (mi)	0.7	1995 National Personal Transportation Survey
Average Bicycle Trip Distance (mi)	1.8	1995 National Personal Transportation Survey
Average Commute Distance (mi)	12.0	1995 National Personal Transportation Survey

"Non-Attainment" Area Emissions Weight	2	Assumed.
"At-Risk" Area Emissions Weight	1	Assumed.

Alternate Input	Value	Source
Vehicle Trip End CO Emission Fatcor (g/trip)	32.79	MOBILE5 emissions model, consitent with past MDT reports.
Vehicle Running CO Emission Factor (g/mi)	2.91	MOBILE5 emissions model, consitent with past MDT reports.
Auto Running PM-10 Emission Factor (g/mi)	0.52	EPA AP-42

Project	Year	Project Name	Control#	Location	Project#	MDT Project Type	NRC Class	NRC Subcategory	NRC Lifespan (years)	Assumed Lifespan (years)	Cost
1	1993	Street Sweepers	2539	Missoula	CM 0002(115)	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$1,194,585
2	1993	Areawide Signal	2483	Missoula	CM 0002(274)(114)	Traffic Flow	Roadway Signal Systems	Roadway Signal Systems	10 to 12	10	$4,920,000
3	1997	North Reserve Street	2445	Missoula	CM 0002(110)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$5,350,750
4	1995	California Street Bridge	3040	Missoula	CM 8199(27)(34)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,380,399
5	1995	Northside Access	3168	Missoula	CM 8199(28)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,857,693
6	1995	Bicycle Commuter Network	3169	Missoula	CM 8199(32)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$622,500
7	1998	Clark Fork-Orange Street Bridge	2462	Missoula	CM 8107(10)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$9,362,648
8	1993	$ Transfers - Transit (1993-2003)	Missoula1,2,4,5,11	Missoula	CM 8199(XX)	Transit (bus purch.)	Transit	New or AFV Buses	10 to 12	10	$5,756,799
9	incl. In # 8	City Bike Shelter	none	Missoula	CM 8199(XX)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$24,255
10	1994	Missoula County Paving	2739	Missoula	CM 8199(19)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$1,089,461
11	1995	Primary Sidewalk Network	3140	Missoula	CM 8199(31)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$3,595,700
12	1995	Bicycle Lane Network	3139	Missoula	CM 8199(30)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$286,110
13	1994	Missoula City Paving	2770	Missoula	CM 8199(21)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$2,150,611
14	1993	Brooks/South/Russell	2418	Missoula	CM 0002(105)	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,880,556
15	1994	Bike/Ped Coordinator	2740	Missoula	CM 8199(XX)	Bike/Ped	?	?	?	?	$190,050
16	1995	Reserve Street Landscaping	2584	Missoula	CM 8103(11)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$53,492
17	1998	Missoula TDM	3679	Missoula	CM 8199(XX)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$630,194
18	1995	South Avenue Bike/Ped Path	3064	Missoula	CM 8120(2)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$171,107
19	incl. In # 10	County Paving	2739	Missoula	CM 8199(XX)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	incl. In # 10
20	2003	Kelley Island Walkway	none	Missoula	CM 8199(62)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000
21	2001	Traffic Signals-Telemetry-Great Falls	4502	Great Falls	CM 5299(46)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$210,000
22	2003	13th St S/13th Ave S Sidewalk	4563	Great Falls	CM 5215(2)	Traffic Flow(?)	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$115,000
23	2002	Annual Sidewalk Prog.	4568	Great Falls	CM 5299(49)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$2,311,320
24	2000	Annual Bike/Ped Facil. Impvts		Great Falls	CM 5299( )	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$200,000
25	2001	West Bank Trail Connection	4201	Great Falls	CM-STPE 5299(33)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$554,399
26	2001	South Arterial Study	4566	Great Falls	CM 5299(44)	Traffic Flow (study)	?	?	?	?	$200,000
27	2000	FTA Fund Transfer	none	Great Falls	MT-90-X055-01	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	$500,000
27A	2001	6th Ave N to Bench Blvd	4553	Billings	CM 1099(32)	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$6,915,000
28	1998	1998 Air Quality Equipment	3840	Statewide	CM 0002(383)	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$4,424,107
29	2001	Sidewalks - Kalispell	4646	Kalispell	CM 6799(24)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$607,681
30	2002	Off System Paving - Lame Deer	4647	Lame Deer	CM 44(14)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$600,000
31	2001	Off System Paving - Butte	4648	Butte	CM 1899(12)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$506,959
32	2001	FTA Transfer - Butte	none	Butte	CM-STPE 5299(33)	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	$346,500
33	2001	Division/5th St - Polson	4556	Polson	CM 24(18)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$239,514
34	2001	FoxField Ave - Hamilton	4558	Hamilton	CM 41(27)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$126,500
35	2001	Paving - Thompson Falls	4560	Thompson Fls.	CM 45(32)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$418,766
36	2001	Brady St/Joslyn St - Helena	4570	Helena	CM 5899(20)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$383,486
37	2001	Paving - Wolf Point	4559	Wolf Point	CM 43(20)	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	$627,882
38	2000	2000 Air Quality Equipment	4510	Statewide	CM 0002(525)	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	$568,087
39	2001	Citywide Signals - Bozeman	4555	Bozeman	CM 1299(14)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,275,000
40	2003	VIS/Entrance - W Yellowstone	4794	W. Yellowstone	CM 16(39)	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30	$323,000
41	2002	South 19th & College - Bozeman	4918	Bozeman	CM 1209(9)	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	792,000
42	2002	Dewey Blvd Extension - Butte	4919	Butte	CM 1899(17)	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,388,695
43	2002	Signal Upgrade - Helena	4921	Helena	CM 5899(22)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$1,094,561
44	2003	North Meridian Rd - Kalispell	2950	Kalispell	STPU-CM 6701(5)	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30	$1,118,086
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	3140	Missoula	CM 8199(31)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 11
46	2002	Sidewalks - Great Falls	4960	Great Falls	CM 5299(60)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$1,100,000
47	2002	Bike/Ped Path - Whitefish	4922	Whitefish	CM 15(50)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$725,000
48	2002	Swords Park Path - Billings	4936	Billings	CM 1099(35)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	$770,000
49	2002	2002 Air Quality Equipment	4895	Statewide	CM 0002(608)	PM-10 Reduction	?	Paving and Sweeping	10 to 12	10	$2,855,156
50	2002	I-90 Interchange Study - Billings	4917	Billings	CM 1099(34)	Traffic Flow (study)	Traffic Flow	?	?	?	$330,000
51	2000	Kalispell-Main St	1502	Kalispell	CM 5-3(40)112	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$1,574,263
52	1999	Idaho-Lasalle Signals - Kalispell	2701	Kalispell	CM 6799(19)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$481,179
53	1999	North 93 Signals - Kalispell	2701	Kalispell	CM 6799(20)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$190,116
54	2001	Main St - Billings Heights	3440	Billings	CM 16-1(41)1	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$551,780
55	2001	2nd Ave N - Signals - Great Falls	3903	Great Falls	CM 5218(1)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$244,335
56	2000	1999 Signal Upgrade - Butte	4180	Butte	CM 1899(7)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$2,274,493
57	2000	Custer & McHugh - Helena	4146	Helena	CM 5802(3)	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$470,178
58	1999	Custer Ave - Signal Synch - Helena	A146	Helena	CM 5802(4)	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	$72,061
59	2000	19th & Main Bozeman	4179	Bozeman	CM 50-2(37)88	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$894,770
60	incl. In # 7	**Clark Fork - Missoula	2462	Missoula	CM-BR 8107(12)	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	incl. In # 7
61	2001	Arthur Ave - Missoula	4611	Missoula	CM-STPP 7-2(36)94	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	$600,000
62	2001	Missoula/Ravalli TMA	4749	Missoula	CM 0002(596)	Transit	Travel Demand Management	Trip Reduction	1 to 2	1	$320,000

Project	Year	Project Name	Costs										
			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	1993	Street Sweepers	$1,194,585										
2	1993	Areawide Signal	$4,920,000										
8	1993	$ Transfers - Transit (1993-2003)	$5,756,799										
9	incl. In # 8	City Bike Shelter	$24,255										
14	1993	Brooks/South/Russell	$1,880,556										
10	1994	Missoula County Paving		$1,089,461									
19	incl. in # 10	County Paving											
13	1994	Missoula City Paving		$2,150,611									
15	1994	Bike/Ped Coordinator			$190,050								
4	1995	California Street Bridge			$1,380,399								
5	1995	Northside Access			$1,857,693								
6	1995	Bicycle Commuter Network			$622,500								
11	1995	Primary Sidewalk Network			$3,595,700								
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave											
12	1995	Bicycle Lane Network			$286,110								
16	1995	Reserve Street Landscaping			$53,492								
18	1995	South Avenue Bike/Ped Path			$171,107								
3	1997	North Reserve Street					$5,350,750						
7	1998	Clark Fork-Orange Street Bridge						$9,362,648					
60	incl. In # 7	**Clark Fork - Missoula											
17	1998	Missoula TDM						$630,194					
28	1998	1998 Air Quality Equipment						$4,424,107					
52	1999	Idaho-Lasalle Signals -Klspl							$481,179				
53	1999	North 93 Signals - Klspl							$190,116				
58	1999	Custer Ave - Signal Synch - HLNA							$72,061				
24	2000	Annual Bike/Ped Facil. Impvts								$200,000			
27	2000	FTA Fund Transfer								$500,000			
38	2000	2000 Air Quality Equipment								$568,087			
51	2000	Kalispell-Main St								$1,574,263			
56	2000	1999 Signal Upgrade - Butte								$2,274,493			
57	2000	Custer & McHugh - Helena								$470,178			
59	2000	19th & Main Bozeman								$894,770			
21	2001	Traffic Signals-Telemetry-Great Falls									$210,000		
25	2001	West Bank Trail Connection									$554,399		
26	2001	South Arterial Study									$200,000		
27A	2001	6th Ave N to Bench Blvd									$6,915,000		
29	2001	Sidewaks-Kalispell									$607,681		
31	2001	Off System Paving-Butte									$506,959		
32	2001	FTA Transfer - Butte									$346,500		
33	2001	Division/5th St - Polson									$239,514		
34	2001	FoxField Ave - Hamilton									$126,500		
35	2001	Paving - Thompson Falls									$418,766		
36	2001	Brady St/Joslyn St - HLNA									$383,486		
37	2001	Paving - Wolf Point									$627,882		
39	2001	Citywide Signals - Bozeman									$1,275,000		
54	2001	Main St - Billings Heights									$551,780		
55	2001	2nd Ave N - Signals - Great Falls									$244,335		
61	2001	Arthur Ave - Missoula									$600,000		
62	2001	Missoula/Ravalli TMA									$320,000		
23	2002	Annual Sidewalk Prog.										$2,311,320	
30	2002	Off System Paving-Lame Deer										$600,000	
41	2002	South 19th & College - BZMN										792,000	
42	2002	Dewey Blvd Extension - Butte										$1,388,695	
43	2002	Signal Upgrade - Helena										$1,094,561	
46	2002	Sidewalks - Great Falls										$1,100,000	
47	2002	Bike/Ped Path - Whitefish										$725,000	
48	2002	Swords Park Path - Blgs										$770,000	
49	2002	2002 Air Quality Equipment										$2,855,156	
50	2002	I-90 Interchange Study - Blgs										$330,000	
20	2003	Kelley Island Walkway											$200,000
22	2003	13th St S/13th Ave S											$115,000
40	2003	VIS/Entrance-W Yellowstone											$323,000
44	2003	North Meridian Rd - Kalispell											$1,118,086
			$13,776,195	$3,240,072	$8,157,051	$0	$5,350,750	$14,416,949	$743,356	$6,481,791	$14,127,802	$11,966,732	$1,756,086

Project	Year	Project Name	Location	MDT Project Type	NRC Class	NRC Subcategory	Suggested Lifespan	Assumed Lifespan	Project Horizon	Total Cost	1993
1	1993	Street Sweepers	Missoula	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	2002	$1,194,585	$154,704
2	1993	Areawide Signal	Missoula	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2002	$4,920,000	$637,163
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Transit (bus purch.)	Transit	New or AFV Buses	10 to 12	10	2002	$5,781,054	$748,673
9	incl. In # 8	City Bike Shelter	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2002	incl. in #8	
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2012	$1,880,556	$150,901
10	1994	Missoula County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2023	$1,089,461	
19	incl. in # 10	County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	N/A	incl. In # 10	
13	1994	Missoula City Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2023	$2,150,611	
15	1994	Bike/Ped Coordinator	Missoula	Bike/Ped	?	?	?	0	1993	$190,050	
4	1995	California Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$1,380,399	
5	1995	Northside Access	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$1,857,693	
6	1995	Bicycle Commuter Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$622,500	
11	1995	Primary Sidewalk Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$3,595,700	
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	N/A	incl. In # 11	
12	1995	Bicycle Lane Network	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$286,110	
16	1995	Reserve Street Landscaping	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$53,492	
18	1995	South Avenue Bike/Ped Path	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2004	$171,107	
3	1997	North Reserve Street	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2006	$5,350,750	
7	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2007	$9,362,648	
60	incl. In # 7	**Clark Fork - Missoula	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	N/A	incl. In # 7	
17	1998	Missoula TDM	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2007	$630,194	
28	1998	1998 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	2007	$4,424,107	
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2008	$481,179	
53	1999	North 93 Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2008	$190,116	
58	1999	Custer Ave - Signal Synch - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2008	$72,061	
57	2000	Custer & McHugh - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Improvements	20	10	2009	$470,178	
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2009	$200,000	
27	2000	FTA Transfer - Butte	Great Falls	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	2000	$500,000	
38	2000	2000 Air Quality Equipment	Statewide	PM-10 Reduction	?	?	?	10	2009	$568,087	
51	2000	Kalispell-Main St	Kalispell	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2019	$1,574,263	
56	2000	1999 Signal Upgrade - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2009	$2,274,493	
59	2000	19th & Main Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2019	$894,770	
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2010	$210,000	
25	2001	West Bank Trail Connection	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2010	$554,399	
26	2001	South Arterial Study	Great Falls	Traffic Flow (study)	?	?	?	0	2000	$200,000	
27A	2001	6th Ave N to Bench Blvd	Billings	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2020	$6,915,000	
29	2001	Sidewalks - Kalispell	Kalispell	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2010	$607,681	
31	2001	Off System Paving - Butte	Butte	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$506,959	
32	2001	FTA Transfer - Butte	Butte	Transit (bus facilities)	Transit	Transit Service Improvements	1 to 2	1	2001	$346,500	
33	2001	Division/5th St - Polson	Polson	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$239,514	
34	2001	FoxField Ave - Hamilton	Hamilton	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$126,500	
35	2001	Paving - Thompson Falls	Thompson Fls.	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$418,766	
36	2001	Brady St/Joslyn St - Helena	Helena	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$383,486	
37	2001	Paving - Wolf Point	Wolf Point	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2030	$627,882	
39	2001	Citywide Signals - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2010	$1,275,000	
54	2001	Main St - Billings Heights	Billings	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2010	$551,780	
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2010	$244,335	
61	2001	Arthur Ave - Missoula	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2020	$600,000	
62	2001	Missoula/Ravalli TMA	Missoula	Transit	Demand Management	Trip Reduction	1 to 2	1	2001	$320,000	
23	2002	Annual Sidewalk Prog.	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2011	$2,311,320	
30	2002	Off System Paving - Lame Deer	Lame Deer	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30	2031	$600,000	
41	2002	South 19th & College - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2021	792,000	
42	2002	Dewey Blvd Extension - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Improvements	20	20	2021	$1,388,695	
43	2002	Signal Upgrade - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10	2011	$1,094,561	
46	2002	Sidewalks - Great Falls	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2011	$1,100,000	
47	2002	Bike/Ped Path - Whitefish	Whitefish	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2011	$725,000	
48	2002	Swords Park Path - Billings	Billings	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2011	$770,000	
49	2002	2002 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10	2011	$2,855,156	
50	2002	I-90 Interchange Study - Billings	Billings	Traffic Flow (study)	?	?	?	0	2001	$330,000	
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2012	$200,000	
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10	2012	$115,000	
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	Traffic Flow	Other	Paving and Sweeping	30 to 35	30	2032	$323,000	
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	Other	Paving and Sweeping	30 to 35	30	2032	$1,118,086	
											$1,691,440

Annualized Costs																			
1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***
$154,704	$154,704	$154,704	$154,704	$154,704	$154,704	$154,704	$154,704	$154,704											
$637,163	$637,163	$637,163	$637,163	$637,163	$637,163	$637,163	$637,163	$637,163											
$748,673	$748,673	$748,673	$748,673	$748,673	$748,673	$748,673	$748,673	$748,673											
$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	$150,901	
$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871
$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900
	$178,768	$178,768	$178,768	$178,768	$178,768	$178,768	$178,768	$178,768	$178,768	$178,768									
	$240,580	$240,580	$240,580	$240,580	$240,580	$240,580	$240,580	$240,580	$240,580	$240,580									
	$80,617	$80,617	$80,617	$80,617	$80,617	$80,617	$80,617	$80,617	$80,617	$80,617									
	$465,660	$465,660	$465,660	$465,660	$465,660	$465,660	$465,660	$465,660	$465,660	$465,660									
	$37,053	$37,053	$37,053	$37,053	$37,053	$37,053	$37,053	$37,053	$37,053	$37,053									
	$6,927	$6,927	$6,927	$6,927	$6,927	$6,927	$6,927	$6,927	$6,927	$6,927									
	$22,159	$22,159	$22,159	$22,159	$22,159	$22,159	$22,159	$22,159	$22,159	$22,159									
	$692,947	$692,947	$692,947	$692,947	$692,947	$692,947	$692,947	$692,947	$692,947	$692,947									
				$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506	$1,212,506						
				$81,613	$81,613	$81,613	$81,613	$81,613	$81,613	$81,613	$81,613	$81,613	$81,613						
				$572,942	$572,942	$572,942	$572,942	$572,942	$572,942	$572,942	$572,942	$572,942	$572,942						
					$62,315	$62,315	$62,315	$62,315	$62,315	$62,315	$62,315	$62,315	$62,315	$62,315					
					$24,621	$24,621	$24,621	$24,621	$24,621	$24,621	$24,621	$24,621	$24,621	$24,621					
					$9,332	$9,332	$9,332	$9,332	$9,332	$9,332	$9,332	$9,332	$9,332	$9,332					
					$60,890	$60,890	$60,890	$60,890	$60,890	$60,890	$60,890	$60,890	$60,890	$60,890					
						$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901				
						$525,000													
						$73,570	$73,570	$73,570	$73,570	$73,570	$73,570	$73,570	$73,570	$73,570	$73,570				
						$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323	$126,323
						$294,557	$294,557	$294,557	$294,557	$294,557	$294,557	$294,557	$294,557	$294,557	$294,557				
						$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799	$71,799
							$27,196	$27,196	$27,196	$27,196	$27,196	$27,196	$27,196	$27,196	$27,196	$27,196			
							$71,797	$71,797	$71,797	$71,797	$71,797	$71,797	$71,797	$71,797	$71,797	$71,797			
							$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877
							$78,697	$78,697	$78,697	$78,697	$78,697	$78,697	$78,697	$78,697	$78,697	$78,697			
							$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978
							$363,825												
							$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581
							$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229
							$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241
							$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946
							$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845
							$165,118	$165,118	$165,118	$165,118	$165,118	$165,118	$165,118	$165,118	$165,118	$165,118			
							$71,458	$71,458	$71,458	$71,458	$71,458	$71,458	$71,458	$71,458	$71,458	$71,458			
							$31,643	$31,643	$31,643	$31,643	$31,643	$31,643	$31,643	$31,643	$31,643	$31,643			
							$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146
							$336,000												
								$299,327	$299,327	$299,327	$299,327	$299,327	$299,327	$299,327	$299,327	$299,327	$299,327		
								$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031
								$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552
								$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432
								$141,751	$141,751	$141,751	$141,751	$141,751	$141,751	$141,751	$141,751	$141,751	$141,751		
								$142,455	$142,455	$142,455	$142,455	$142,455	$142,455	$142,455	$142,455	$142,455	$142,455		
								$93,891	$93,891	$93,891	$93,891	$93,891	$93,891	$93,891	$93,891	$93,891	$93,891		
								$99,719	$99,719	$99,719	$99,719	$99,719	$99,719	$99,719	$99,719	$99,719	$99,719		
								$369,756	$369,756	$369,756	$369,756	$369,756	$369,756	$369,756	$369,756	$369,756	$369,756		
									$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	$25,901	
									$14,893	$14,893	$14,893	$14,893	$14,893	$14,893	$14,893	$14,893	$14,893	$14,893	
									$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012
									$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733
$1,902,212	$3,626,921	$3,626,921	$3,626,921	$5,493,982	$5,651,140	$6,768,290	$8,141,868	$8,802,956	$7,396,955	$7,396,955	$5,672,245	$5,672,245	$5,672,245	$3,805,184	$3,648,026	$3,253,998	$2,808,088	$1,661,191	$1,469,497

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871	$70,871										
$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900	$139,900										
$126,323	$126,323	$126,323	$126,323	$126,323	$126,323														
$71,799	$71,799	$71,799	$71,799	$71,799	$71,799														
$554,877	$554,877	$554,877	$554,877	$554,877	$554,877	$554,877													
$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978	$32,978			
$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581	$15,581			
$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229	$8,229			
$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241	$27,241			
$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946	$24,946			
$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845	$40,845			
$48,146	$48,146	$48,146	$48,146	$48,146	$48,146	$48,146													
$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031	$39,031		
$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552	$63,552												
$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432	$111,432												
$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	$21,012	
$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	$72,733	
$1,469,497	$1,469,497	$1,469,497	$1,469,497	$1,469,497	$1,469,497	$1,271,375	$668,352	$493,367	$493,367	$282,596	$282,596	$282,596	$282,596	$282,596	$282,596	$282,596	$132,776	$93,745	$0

Project	Year	Project Name	Location	Lifespan	Horizon	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	*2004*	*2005*	*2006*	*2007*	*2008*
1	1993	Street Sweepers	Missoula	10	2002	0	0	0	0	0	0	0	0	0	0						
2	1993	Areawide Signal	Missoula	10	2002	7,277	7,277	7,277	7,277	7,277	7,277	7,277	7,277	7,277	7,277						
8	1993	$ Transfers - Transit (1993-2003)	Missoula	10	2002	4,421	4,421	4,421	4,421	4,421	4,421	4,421	4,421	4,421	4,421						
9	incl. In # 8	City Bike Shelter	Missoula	10	N/A																
14	1993	Brooks/South/Russell	Missoula	20	2012	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314	21,314
10	1994	Missoula County Paving	Missoula	30	2023		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	incl. in # 10	County Paving	Missoula	30	N/A																
13	1994	Missoula City Paving	Missoula	30	2023		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1994	Bike/Ped Coordinator	Missoula	0	1993																
4	1995	California Street Bridge	Missoula	10	2004			78,531	78,531	78,531	78,531	78,531	78,531	78,531	78,531	78,531	78,531				
5	1995	Northside Access	Missoula	10	2004																
6	1995	Bicycle Commuter Network	Missoula	10	2004																
11	1995	Primary Sidewalk Network	Missoula	10	2004																
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	10	N/A																
12	1995	Bicycle Lane Network	Missoula	10	2004																
16	1995	Reserve Street Landscaping	Missoula	10	2004																
18	1995	South Avenue Bike/Ped Path	Missoula	10	2004																
3	1997	North Reserve Street	Missoula	10	2006																
7	1998	Clark Fork-Orange Street Bridge	Missoula	10	2007						7,432	7,432	7,432	7,432	7,432	7,432	7,432	7,432	7,432	7,432	
60	incl. In # 7	**Clark Fork - Missoula	Missoula	10	N/A																
17	1998	Missoula TDM	Missoula	10	2007						14,484	14,484	14,484	14,484	14,484	14,484	14,484	14,484	14,484	14,484	
28	1998	1998 Air Quality Equipment	Statewide	10	2007						0	0	0	0	0	0	0	0	0	0	
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	10	2008							10,608	10,608	10,608	10,608	10,608	10,608	10,608	10,608	10,608	10,608
53	1999	North 93 Signals - Kalispell	Kalispell	10	2008																
58	1999	Custer Ave - Signal Synch - Helena	Helena	10	2008							1,853	1,853	1,853	1,853	1,853	1,853	1,853	1,853	1,853	1,853
57	2000	Custer & McHugh - Helena	Helena	10	2009																
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	10	2009								1,707	1,707	1,707	1,707	1,707	1,707	1,707	1,707	1,707
27	2000	FTA Transfer - Great Falls	Great Falls	1	2000								864								
38	2000	2000 Air Quality Equipment	Statewide	10	2009								0	0	0	0	0	0	0	0	0
51	2000	Kalispell-Main St	Kalispell	20	2019								4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713
56	2000	1999 Signal Upgrade - Butte	Butte	10	2009								8,944	8,944	8,944	8,944	8,944	8,944	8,944	8,944	8,944
59	2000	19th & Main Bozeman	Bozeman	20	2019								8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	10	2010									24,580	24,580	24,580	24,580	24,580	24,580	24,580	24,580
25	2001	West Bank Trail Connection	Great Falls	10	2010									500	500	500	500	500	500	500	500
26	2001	South Arterial Study	Great Falls	0	2000																
27A	2001	6th Ave N to Bench Blvd	Billings	20	2020									6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077
29	2001	Sidewalks - Kalispell	Kalispell	10	2010									472	472	472	472	472	472	472	472
31	2001	Off System Paving - Butte	Butte	30	2030									0	0	0	0	0	0	0	0
32	2001	FTA Transfer - Butte	Butte	1	2001									95							
33	2001	Division/5th St - Polson	Polson	30	2030									0	0	0	0	0	0	0	0
34	2001	FoxField Ave - Hamilton	Hamilton	30	2030									0	0	0	0	0	0	0	0
35	2001	Paving - Thompson Falls	Thompson Fls.	30	2030									0	0	0	0	0	0	0	0
36	2001	Brady St/Joslyn St - Helena	Helena	30	2030									0	0	0	0	0	0	0	0
37	2001	Paving - Wolf Point	Wolf Point	30	2030									0	0	0	0	0	0	0	0
39	2001	Citywide Signals - Bozeman	Bozeman	10	2010									7,986	7,986	7,986	7,986	7,986	7,986	7,986	7,986
54	2001	Main St - Billings Heights	Billings	10	2010									9,567	9,567	9,567	9,567	9,567	9,567	9,567	9,567
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	10	2010									216	216	216	216	216	216	216	216
61	2001	Arthur Ave - Missoula	Missoula	20	2020									1	1	1	1	1	1	1	1
62	2001	Missoula/Ravalli TMA	Missoula	1	2001									24,270							
23	2002	Annual Sidewalk Prog.	Great Falls	10	2011										13,761	13,761	13,761	13,761	13,761	13,761	13,761
30	2002	Off System Paving - Lame Deer	Lame Deer	30	2031										0	0	0	0	0	0	0
41	2002	South 19th & College - Bozeman	Bozeman	20	2021										6,745	6,745	6,745	6,745	6,745	6,745	6,745
42	2002	Dewey Blvd Extension - Butte	Butte	20	2021										489	489	489	489	489	489	489
43	2002	Signal Upgrade - Helena	Helena	10	2011										14,185	14,185	14,185	14,185	14,185	14,185	14,185
46	2002	Sidewalks - Great Falls	Great Falls	10	2011										2,479	2,479	2,479	2,479	2,479	2,479	2,479
47	2002	Bike/Ped Path - Whitefish	Whitefish	10	2011										DNC	DNC	DNC	DNC	DNC	DNC	DNC
48	2002	Swords Park Path - Billings	Billings	10	2011										1,557	1,557	1,557	1,557	1,557	1,557	1,557
49	2002	2002 Air Quality Equipment	Statewide	10	2011										0	0	0	0	0	0	0
50	2002	I-90 Interchange Study - Billings	Billings	0	2001																
20	2003	Kelley Island Walkway	Missoula	10	2012											2,217	2,217	2,217	2,217	2,217	2,217
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	10	2012											1,154	1,154	1,154	1,154	1,154	1,154
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	30	2032											4,198	4,198	4,198	4,198	4,198	4,198
44	2003	North Meridian Rd - Kalispell	Kalispell	30	2032											7,279	7,279	7,279	7,279	7,279	7,279
			TOTALS			33,012	33,012	111,543	111,543	111,543	133,458	145,919	170,446	243,345	258,197	261,347	261,347	182,817	182,817	182,817	160,901

				Benefits - CO (kg/yr)																				
2009	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***	***2029***	***2030***	***2031***	***2032***	***2033***
21,314	21,314	21,314	21,314																					
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
0	0	0	0	0	0	0	0	0	0	0														
1,707																								
0																								
4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713	4,713														
8,944	8,944																							
8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299	8,299														
24,580	24,580																							
500	500																							
6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077	6,077													
472	472																							
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
7,986	7,986	7,986																						
9,567	9,567	9,567																						
216	216																							
1	1	1	1	1	1	1	1	1	1	1	1													
13,761	13,761	13,761																						
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745	6,745												
489	489	489	489	489	489	489	489	489	489	489	489	489												
14,185	14,185	14,185																						
2,479	2,479	2,479																						
DNC	DNC	DNC																						
1,557	1,557	1,557																						
0	0	0																						
2,217	2,217	2,217	2,217																					
1,154	1,154	1,154	1,154																					
4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	4,198	
7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	7,279	
148,440	146,733	112,021	62,486	37,801	37,801	37,801	37,801	37,801	37,801	37,801	24,789	18,711	11,477	11,477	11,477	11,477	11,477	11,477	11,477	11,477	11,477	11,477	11,477	0

Project	Year	Project Name	Location	Lifespan	Horizon	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	*2004*	*2005*	*2006*	*2007*	*2008*
1	1993	Street Sweepers	Missoula	10	2002	33,216	33,216	33,216	33,216	33,216	33,216	33,216	33,216	33,216	33,216						
2	1993	Areawide Signal	Missoula	10	2002	0	0	0	0	0	0	0	0	0	0						
8	1993	$ Transfers - Transit (1993-2003)	Missoula	10	2002	569	569	569	569	569	569	569	569	569	569						
9	incl. In # 8	City Bike Shelter	Missoula	10	N/A																
14	1993	Brooks/South/Russell	Missoula	20	2012	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538	1,538
10	1994	Missoula County Paving	Missoula	30	2023		104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160
19	incl. in # 10	County Paving	Missoula	30	N/A																
13	1994	Missoula City Paving	Missoula	30	2023		70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560
15	1994	Bike/Ped Coordinator	Missoula	0	1993																
4	1995	California Street Bridge	Missoula	10	2004																
5	1995	Northside Access	Missoula	10	2004																
6	1995	Bicycle Commuter Network	Missoula	10	2004																
11	1995	Primary Sidewalk Network	Missoula	10	2004																
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	10	N/A			149,165	149,165	149,165	149,165	149,165	149,165	149,165	149,165	149,165	149,165				
12	1995	Bicycle Lane Network	Missoula	10	2004																
16	1995	Reserve Street Landscaping	Missoula	10	2004																
18	1995	South Avenue Bike/Ped Path	Missoula	10	2004																
3	1997	North Reserve Street	Missoula	10	2006																
7	1998	Clark Fork-Orange Street Bridge	Missoula	10	2007						133	133	133	133	133	133	133	133	133	133	
60	incl. In # 7	**Clark Fork - Missoula	Missoula	10	N/A																
17	1998	Missoula TDM	Missoula	10	2007						497	497	497	497	497	497	497	497	497	497	
28	1998	1998 Air Quality Equipment	Statewide	10	2007						482,483	482,483	482,483	482,483	482,483	482,483	482,483	482,483	482,483	482,483	
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	10	2008							0	0	0	0	0	0	0	0	0	0
53	1999	North 93 Signals - Kalispell	Kalispell	10	2008																
58	1999	Custer Ave - Signal Synch - Helena	Helena	10	2008							0	0	0	0	0	0	0	0	0	0
57	2000	Custer & McHugh - Helena	Helena	10	2009																
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	10	2009								DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC
27	2000	FTA Transfer - Great Falls	Great Falls	1	2000								168								
38	2000	2000 Air Quality Equipment	Statewide	10	2009								569,758	569,758	569,758	569,758	569,758	569,758	569,758	569,758	569,758
51	2000	Kalispell-Main St	Kalispell	20	2019								0	0	0	0	0	0	0	0	0
56	2000	1999 Signal Upgrade - Butte	Butte	10	2009								0	0	0	0	0	0	0	0	0
59	2000	19th & Main Bozeman	Bozeman	20	2019								0	0	0	0	0	0	0	0	0
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	10	2010									0	0	0	0	0	0	0	0
25	2001	West Bank Trail Connection	Great Falls	10	2010									0	0	0	0	0	0	0	0
26	2001	South Arterial Study	Great Falls	0	2000																
27A	2001	6th Ave N to Bench Blvd	Billings	20	2020									0	0	0	0	0	0	0	0
29	2001	Sidewalks - Kalispell	Kalispell	10	2010									5	5	5	5	5	5	5	5
31	2001	Off System Paving - Butte	Butte	30	2030									177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617
32	2001	FTA Transfer - Butte	Butte	1	2001									5							
33	2001	Division/5th St - Polson	Polson	30	2030									9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435
34	2001	FoxField Ave - Hamilton	Hamilton	30	2030									765	765	765	765	765	765	765	765
35	2001	Paving - Thompson Falls	Thompson Fls.	30	2030									14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983
36	2001	Brady St/Joslyn St - Helena	Helena	30	2030									94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436
37	2001	Paving - Wolf Point	Wolf Point	30	2030									15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980
39	2001	Citywide Signals - Bozeman	Bozeman	10	2010									0	0	0	0	0	0	0	0
54	2001	Main St - Billings Heights	Billings	10	2010									0	0	0	0	0	0	0	0
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	10	2010									0	0	0	0	0	0	0	0
61	2001	Arthur Ave - Missoula	Missoula	20	2020									0	0	0	0	0	0	0	0
62	2001	Missoula/Ravalli TMA	Missoula	1	2001									3,746							
23	2002	Annual Sidewalk Prog.	Great Falls	10	2011										DNC	DNC	DNC	DNC	DNC	DNC	DNC
30	2002	Off System Paving - Lame Deer	Lame Deer	30	2031										8,953	8,953	8,953	8,953	8,953	8,953	8,953
41	2002	South 19th & College - Bozeman	Bozeman	20	2021										0	0	0	0	0	0	0
42	2002	Dewey Blvd Extension - Butte	Butte	20	2021										0	0	0	0	0	0	0
43	2002	Signal Upgrade - Helena	Helena	10	2011										0	0	0	0	0	0	0
46	2002	Sidewalks - Great Falls	Great Falls	10	2011										DNC	DNC	DNC	DNC	DNC	DNC	DNC
47	2002	Bike/Ped Path - Whitefish	Whitefish	10	2011										20	20	20	20	20	20	20
48	2002	Swords Park Path - Billings	Billings	10	2011										DNC	DNC	DNC	DNC	DNC	DNC	DNC
49	2002	2002 Air Quality Equipment	Statewide	10	2011										672,821	672,821	672,821	672,821	672,821	672,821	672,821
50	2002	I-90 Interchange Study - Billings	Billings	0	2001																
20	2003	Kelley Island Walkway	Missoula	10	2012											1,269	1,269	1,269	1,269	1,269	1,269
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	10	2012											18	18	18	18	18	18
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	30	2032											DNC	DNC	DNC	DNC	DNC	DNC
44	2003	North Meridian Rd - Kalispell	Kalispell	30	2032											120	120	120	120	120	120
						35,323	210,043	359,208	359,208	359,208	842,320	842,320	1,412,246	1,729,052	2,407,094	2,374,716	2,374,716	2,225,551	2,225,551	2,225,551	1,742,439

Benefits - PM10 (kg/yr)																								
2009	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***	***2029***	***2030***	***2031***	***2032***	***2033***
1,538	1,538	1,538	1,538																					
104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160	104,160										
70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560	70,560										
DNC																								
569,758																								
0	0	0	0	0	0	0	0	0	0	0														
0																								
0	0	0	0	0	0	0	0	0	0	0														
0	0																							
0	0																							
0	0	0	0	0	0	0	0	0	0	0	0													
5	5																							
177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617	177,617			
9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435	9,435			
765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765	765			
14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983	14,983			
94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436	94,436			
15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980	15,980			
0	0																							
0	0																							
0	0																							
0	0	0	0	0	0	0	0	0	0	0	0													
DNC	DNC	DNC																						
8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953	8,953		
0	0	0	0	0	0	0	0	0	0	0	0	0												
0	0	0	0	0	0	0	0	0	0	0	0	0												
0	0	0																						
DNC	DNC	DNC																						
20	20	20																						
DNC	DNC	DNC																						
672,821	672,821	672,821																						
1,269	1,269	1,269	1,269																					
18	18	18	18																					
DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	DNC	
120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	
1,742,439	1,172,681	1,172,676	499,835	497,010	497,010	497,010	497,010	497,010	497,010	497,010	497,010	497,010	497,010	497,010	322,290	322,290	322,290	322,290	322,290	322,290	322,290	9,073	120	0

Project	Year	Project Name	Location	Designation	Lifespan	Horizon	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	*2004*	*2005*	*2006*	*2007*
1	1993	Street Sweepers	Missoula	Non-Attainment	10	2002	-	-	-	-	-	-	-	-	-	-					
2	1993	Areawide Signal	Missoula	Non-Attainment	10	2002	175	175	175	175	175	175	175	175	175	175					
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Non-Attainment	10	2002	339	339	339	339	339	339	339	339	339	339					
9	incl. In # 8	City Bike Shelter	Missoula	Non-Attainment	10	N/A															
14	1993	Brooks/South/Russell	Missoula	Non-Attainment	20	2012	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
10	1994	Missoula County Paving	Missoula	Non-Attainment	30	2023		-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	incl. in # 10	County Paving	Missoula	Non-Attainment	30	N/A															
13	1994	Missoula City Paving	Missoula	Non-Attainment	30	2023		-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	1994	Bike/Ped Coordinator	Missoula	Non-Attainment	0	1993		-	-	-	-	-	-	-	-	-	-				
4	1995	California Street Bridge	Missoula	Non-Attainment	10	2004															
5	1995	Northside Access	Missoula	Non-Attainment	10	2004															
6	1995	Bicycle Commuter Network	Missoula	Non-Attainment	10	2004															
11	1995	Primary Sidewalk Network	Missoula	Non-Attainment	10	2004															
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Non-Attainment	10	N/A			44	44	44	44	44	44	44	44	44	44			
12	1995	Bicycle Lane Network	Missoula	Non-Attainment	10	2004															
16	1995	Reserve Street Landscaping	Missoula	Non-Attainment	10	2004															
18	1995	South Avenue Bike/Ped Path	Missoula	Non-Attainment	10	2004															
3	1997	North Reserve Street	Missoula	Non-Attainment	10	2006															
7	1998	Clark Fork-Orange Street Bridge	Missoula	Non-Attainment	10	2007						326	326	326	326	326	326	326	326	326	326
60	incl. In # 7	**Clark Fork - Missoula	Missoula	Non-Attainment	10	N/A															
17	1998	Missoula TDM	Missoula	Non-Attainment	10	2007						11	11	11	11	11	11	11	11	11	11
28	1998	1998 Air Quality Equipment	Statewide	-	10	2007						-	-	-	-	-	-	-	-	-	-
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	At-Risk	10	2008							8	8	8	8	8	8	8	8	8
53	1999	North 93 Signals - Kalispell	Kalispell	At-Risk	10	2008															
58	1999	Custer Ave - Signal Synch - Helena	Helena	At-Risk	10	2008							38	38	38	38	38	38	38	38	38
57	2000	Custer & McHugh - Helena	Helena	At-Risk	10	2009															
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Non-Attainment	10	2009								30	30	30	30	30	30	30	30
27	2000	FTA Transfer - Great Falls	Great Falls	Non-Attainment	1	2000								1,215							
38	2000	2000 Air Quality Equipment	Statewide	-	10	2009								-	-	-	-	-	-	-	-
51	2000	Kalispell-Main St	Kalispell	At-Risk	20	2019								27	27	27	27	27	27	27	27
56	2000	1999 Signal Upgrade - Butte	Butte	At-Risk	10	2009								33	33	33	33	33	33	33	33
59	2000	19th & Main Bozeman	Bozeman	At-Risk	20	2019								9	9	9	9	9	9	9	9
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Non-Attainment	10	2010									2	2	2	2	2	2	2
25	2001	West Bank Trail Connection	Great Falls	Non-Attainment	10	2010									287	287	287	287	287	287	287
26	2001	South Arterial Study	Great Falls	Non-Attainment	0	2000															
27A	2001	6th Ave N to Bench Blvd	Billings	Non-Attainment	20	2020									183	183	183	183	183	183	183
29	2001	Sidewalks - Kalispell	Kalispell	At-Risk	10	2010									167	167	167	167	167	167	167
31	2001	Off System Paving - Butte	Butte	At-Risk	30	2030									-	-	-	-	-	-	-
32	2001	FTA Transfer - Butte	Butte	At-Risk	1	2001									3,843						
33	2001	Division/5th St - Polson	Polson	-	30	2030									-	-	-	-	-	-	-
34	2001	FoxField Ave - Hamilton	Hamilton	-	30	2030									-	-	-	-	-	-	-
35	2001	Paving - Thompson Falls	Thompson Fls.	-	30	2030									-	-	-	-	-	-	-
36	2001	Brady St/Joslyn St - Helena	Helena	At-Risk	30	2030									-	-	-	-	-	-	-
37	2001	Paving - Wolf Point	Wolf Point	-	30	2030									-	-	-	-	-	-	-
39	2001	Citywide Signals - Bozeman	Bozeman	At-Risk	10	2010									21	21	21	21	21	21	21
54	2001	Main St - Billings Heights	Billings	Non-Attainment	10	2010									15	15	15	15	15	15	15
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Non-Attainment	10	2010									293	293	293	293	293	293	293
61	2001	Arthur Ave - Missoula	Missoula	Non-Attainment	20	2020									120,504	120,504	120,504	120,504	120,504	120,504	120,504
62	2001	Missoula/Ravalli TMA	Missoula	Non-Attainment	1	2001									28						
23	2002	Annual Sidewalk Prog.	Great Falls	Non-Attainment	10	2011										44	44	44	44	44	44
30	2002	Off System Paving - Lame Deer	Lame Deer	-	30	2031										-	-	-	-	-	-
41	2002	South 19th & College - Bozeman	Bozeman	At-Risk	20	2021										9	9	9	9	9	9
42	2002	Dewey Blvd Extension - Butte	Butte	At-Risk	20	2021										228	228	228	228	228	228
43	2002	Signal Upgrade - Helena	Helena	At-Risk	10	2011										10	10	10	10	10	10
46	2002	Sidewalks - Great Falls	Great Falls	Non-Attainment	10	2011										115	115	115	115	115	115
47	2002	Bike/Ped Path - Whitefish	Whitefish	-	10	2011										-	-	-	-	-	-
48	2002	Swords Park Path - Billings	Billings	Non-Attainment	10	2011										128	128	128	128	128	128
49	2002	2002 Air Quality Equipment	Statewide	-	10	2011										-	-	-	-	-	-
50	2002	I-90 Interchange Study - Billings	Billings	Non-Attainment	0	2001															
20	2003	Kelley Island Walkway	Missoula	Non-Attainment	10	2012											23	23	23	23	23
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Non-Attainment	10	2012											26	26	26	26	26
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	At-Risk	30	2032											5	5	5	5	5
44	2003	North Meridian Rd - Kalispell	Kalispell	At-Risk	30	2032											10	10	10	10	10
			TOTALS				$528	$528	$572	$572	$572	$909	$956	$2,270	$126,396	$123,059	$122,610	$122,610	$122,566	$122,566	$122,566

Cost Effectiveness - CO ($/kg)																								
2008	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***	***2029***	***2030***	***2031***	***2032***	***2033***
14	14	14	14	14																					
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
8																									
38																									
30	30																								
-	-																								
27	27	27	27	27	27	27	27	27	27	27	27														
33	33																								
9	9	9	9	9	9	9	9	9	9	9	9														
2	2	2																							
287	287	287																							
183	183	183	183	183	183	183	183	183	183	183	183	183													
167	167	167																							
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
21	21	21																							
15	15	15																							
293	293	293																							
120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504	120,504													
44	44	44	44																						
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
9	9	9	9	9	9	9	9	9	9	9	9	9	9												
228	228	228	228	228	228	228	228	228	228	228	228	228	228												
10	10	10	10																						
115	115	115	115																						
-	-	-	-																						
128	128	128	128																						
-	-	-	-																						
23	23	23	23	23																					
26	26	26	26	26																					
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
$122,228	$122,182	$122,119	$121,334	$121,037	$120,974	$120,974	$120,974	$120,974	$120,974	$120,974	$120,974	$120,939	$252	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$0

Project	Year	Project Name	Location	Designation	Lifespan	Horizon	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	*2004*	*2005*	*2006*	*2007*
1	1993	Street Sweepers	Missoula	Non-Attainment	10	2002	9	9	9	9	9	9	9	9	9	9					
2	1993	Areawide Signal	Missoula	Non-Attainment	10	2002	-	-	-	-	-	-	-	-	-	-					
8	1993	$ Transfers - Transit (1993-2003)	Missoula	Non-Attainment	10	2002	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632					
9	incl. In # 8	City Bike Shelter	Missoula	Non-Attainment	10	N/A															
14	1993	Brooks/South/Russell	Missoula	Non-Attainment	20	2012	196	196	196	196	196	196	196	196	196	196	196	196	196	196	196
10	1994	Missoula County Paving	Missoula	Non-Attainment	30	2023		1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	incl. in # 10	County Paving	Missoula	Non-Attainment	30	N/A															
13	1994	Missoula City Paving	Missoula	Non-Attainment	30	2023		4	4	4	4	4	4	4	4	4	4	4	4	4	4
15	1994	Bike/Ped Coordinator	Missoula	Non-Attainment	0	1993															
4	1995	California Street Bridge	Missoula	Non-Attainment	10	2004															
5	1995	Northside Access	Missoula	Non-Attainment	10	2004															
6	1995	Bicycle Commuter Network	Missoula	Non-Attainment	10	2004															
11	1995	Primary Sidewalk Network	Missoula	Non-Attainment	10	2004															
45	incl. In # 11	*39th St/SW Higgins/S Higgins Ave	Missoula	Non-Attainment	10	N/A			23	23	23	23	23	23	23	23	23	23			
12	1995	Bicycle Lane Network	Missoula	Non-Attainment	10	2004															
16	1995	Reserve Street Landscaping	Missoula	Non-Attainment	10	2004															
18	1995	South Avenue Bike/Ped Path	Missoula	Non-Attainment	10	2004															
3	1997	North Reserve Street	Missoula	Non-Attainment	10	2006													0	0	
7	1998	Clark Fork-Orange Street Bridge	Missoula	Non-Attainment	10	2007						18,280	18,280	18,280	18,280	18,280	18,280	18,280	18,280	18,280	18,280
60	incl. In # 7	**Clark Fork - Missoula	Missoula	Non-Attainment	10	N/A															
17	1998	Missoula TDM	Missoula	Non-Attainment	10	2007						329	329	329	329	329	329	329	329	329	329
28	1998	1998 Air Quality Equipment	Statewide	-	10	2007						1	1	1	1	1	1	1	1	1	1
52	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Non-Attainment	10	2008							-	-	-	-	-	-	-	-	-
53	1999	North 93 Signals - Kalispell	Kalispell	Non-Attainment	10	2008															
58	1999	Custer Ave - Signal Synch - Helena	Helena	At-Risk	10	2008							-	-	-	-	-	-	-	-	-
57	2000	Custer & McHugh - Helena	Helena	At-Risk	10	2009															
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	-	10	2009								-	-	-	-	-	-	-	-
27	2000	FTA Transfer - Great Falls	Great Falls	-	1	2000								3,125							
38	2000	2000 Air Quality Equipment	Statewide	-	10	2009								0	0	0	0	0	0	0	0
51	2000	Kalispell-Main St	Kalispell	Non-Attainment	20	2019								-	-	-	-	-	-	-	-
56	2000	1999 Signal Upgrade - Butte	Butte	Non-Attainment	10	2009								-	-	-	-	-	-	-	-
59	2000	19th & Main Bozeman	Bozeman	At-Risk	20	2019								-	-	-	-	-	-	-	-
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	-	10	2010									-	-	-	-	-	-	-
25	2001	West Bank Trail Connection	Great Falls	-	10	2010									-	-	-	-	-	-	-
26	2001	South Arterial Study	Great Falls	-	0	2000															
27A	2001	6th Ave N to Bench Blvd	Billings	-	20	2020									-	-	-	-	-	-	-
29	2001	Sidewalks - Kalispell	Kalispell	Non-Attainment	10	2010									31,926	31,926	31,926	31,926	31,926	31,926	31,926
31	2001	Off System Paving - Butte	Butte	Non-Attainment	30	2030									0	0	0	0	0	0	0
32	2001	FTA Transfer - Butte	Butte	Non-Attainment	1	2001									139,933						
33	2001	Division/5th St - Polson	Polson	Non-Attainment	30	2030									3	3	3	3	3	3	3
34	2001	FoxField Ave - Hamilton	Hamilton	At-Risk	30	2030									11	11	11	11	11	11	11
35	2001	Paving - Thompson Falls	Thompson Fls.	Non-Attainment	30	2030									4	4	4	4	4	4	4
36	2001	Brady St/Joslyn St - Helena	Helena	At-Risk	30	2030									0	0	0	0	0	0	0
37	2001	Paving - Wolf Point	Wolf Point	At-Risk	30	2030									3	3	3	3	3	3	3
39	2001	Citywide Signals - Bozeman	Bozeman	At-Risk	10	2010									-	-	-	-	-	-	-
54	2001	Main St - Billings Heights	Billings	-	10	2010									-	-	-	-	-	-	-
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	-	10	2010									-	-	-	-	-	-	-
61	2001	Arthur Ave - Missoula	Missoula	Non-Attainment	20	2020									-	-	-	-	-	-	-
62	2001	Missoula/Ravalli TMA	Missoula	Non-Attainment	1	2001									179						
23	2002	Annual Sidewalk Prog.	Great Falls	-	10	2011										-	-	-	-	-	-
30	2002	Off System Paving - Lame Deer	Lame Deer	Non-Attainment	30	2031										9	9	9	9	9	9
41	2002	South 19th & College - Bozeman	Bozeman	At-Risk	20	2021										-	-	-	-	-	-
42	2002	Dewey Blvd Extension - Butte	Butte	Non-Attainment	20	2021										-	-	-	-	-	-
43	2002	Signal Upgrade - Helena	Helena	At-Risk	10	2011										-	-	-	-	-	-
46	2002	Sidewalks - Great Falls	Great Falls	-	10	2011										-	-	-	-	-	-
47	2002	Bike/Ped Path - Whitefish	Whitefish	Non-Attainment	10	2011										9,338	9,338	9,338	9,338	9,338	9,338
48	2002	Swords Park Path - Billings	Billings	-	10	2011										-	-	-	-	-	-
49	2002	2002 Air Quality Equipment	Statewide	-	10	2011										1	1	1	1	1	1
50	2002	I-90 Interchange Study - Billings	Billings	-	0	2001															
20	2003	Kelley Island Walkway	Missoula	Non-Attainment	10	2012											41	41	41	41	41
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	-	10	2012											827	827	827	827	827
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	-	30	2032											-	-	-	-	-
44	2003	North Meridian Rd - Kalispell	Kalispell	Non-Attainment	30	2032											1,212	1,212	1,212	1,212	1,212
			TOTALS				$2,838	$2,843	$2,866	$2,866	$2,866	$21,476	$21,476	$24,601	$193,535	$62,770	$62,208	$62,208	$62,185	$62,185	$62,185

Cost Effectiveness - PM10 ($/kg)																									
2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
196	196	196	196	196																					
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4										
-																									
-	0	0	0	0	0	0	0	0	0	0	0														
-	-																								
0	0																								
-	-	-	-	-	-	-	-	-	-	-	-														
-	-																								
-	-	-	-	-	-	-	-	-	-	-	-														
-	-	-																							
-	-	-																							
-	-	-	-	-	-	-	-	-	-	-	-	-													
31,926	31,926	31,926	31,926																						
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11		
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
-	-	-																							
-	-	-																							
-	-	-																							
-	-	-	-	-	-	-	-	-	-	-	-	-													
-	-	-	-																						
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9		
-	-	-	-	-	-	-	-	-	-	-	-	-	-												
-	-	-	-	-	-	-	-	-	-	-	-	-	-												
-	-	-	-																						
-	-	-	-																						
9,338	9,338	9,338	9,338																						
-	-	-	-																						
1	1	1	1																						
41	41	41	41	41																					
827	827	827	827	827																					
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	1,212	
$43,576	$43,576	$43,576	$43,576	$2,312	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,247	$1,242	$1,242	$1,242	$1,242	$1,242	$1,242	$1,242	$1,241	$1,212	$0

Project(s)	Year	Project Name	Location	MDT Project Type	NRC Class	NRC Subcategory	NRC Lifespan (years)	Assumed Lifespan (years)
1	1993	Street Sweepers	Missoula	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10
2	1993	Areawide Signal	Missoula	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
8, 9	1993	$ Transfers - Transit (1993-2003)	Missoula	Transit (bus purch.)	Transit	New or AFV Buses	10 to 12	10
14	1993	Brooks/South/Russell	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
10, 19	1994	Missoula County Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
13	1994	Missoula City Paving	Missoula	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
15	1994	Bike/Ped Coordinator	Missoula	Bike/Ped		?	?	?
4, 5, 6, 11, 45, 12, 16, 18, 3	1995	**Grouped Bike/Ped Projects**	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
7, 60	1998	Clark Fork-Orange Street Bridge	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
17	1998	Missoula TDM	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
28	1998	1998 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10
52, 53	1999	Idaho-Lasalle Signals - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
58, 57	1999	Custer Ave - Signal Synch - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
24	2000	Annual Bike/Ped Facil. Impvts	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
27	2000	FTA Transfer - Great Falls	Great Falls	Transit (bus facilities)	Transit	Transit Service Improve	1 to 2	1
38	2000	2000 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	?	?
51	2000	Kalispell-Main St	Kalispell	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
56	2000	1999 Signal Upgrade - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
59	2000	19th & Main Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
21	2001	Traffic Signals-Telemetry-Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
25	2001	West Bank Trail Connection	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
26	2001	South Arterial Study	Great Falls	Traffic Flow (study)		?	?	?
27A	2001	6th Ave N to Bench Blvd	Billings	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
29	2001	Sidewalks - Kalispell	Kalispell	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
31	2001	Off System Paving - Butte	Butte	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
32	2001	FTA Transfer - Butte	Butte	Transit (bus facilities)	Transit	Transit Service Improve	1 to 2	1
33	2001	Division/5th St - Polson	Polson	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
34	2001	FoxField Ave - Hamilton	Hamilton	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
35	2001	Paving - Thompson Falls	Thompson Fls.	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
36	2001	Brady St/Joslyn St - Helena	Helena	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
37	2001	Paving - Wolf Point	Wolf Point	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
39	2001	Citywide Signals - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
54	2001	Main St - Billings Heights	Billings	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
55	2001	2nd Ave N - Signals - Great Falls	Great Falls	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
61	2001	Arthur Ave - Missoula	Missoula	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
62	2001	Missoula/Ravalli TMA	Missoula	Transit	Transit	Travel Demand Mgmt	1 to 2	1
23	2002	Annual Sidewalk Prog.	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
30	2002	Off System Paving - Lame Deer	Lame Deer	PM-10 Reduction	Other	Paving and Sweeping	30 to 35	30
41	2002	South 19th & College - Bozeman	Bozeman	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
42	2002	Dewey Blvd Extension - Butte	Butte	Traffic Flow	Traffic Flow	Roadway Improvements	20	20
43	2002	Signal Upgrade - Helena	Helena	Traffic Flow	Traffic Flow	Roadway Signal Systems	10 to 12	10
46	2002	Sidewalks - Great Falls	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
47	2002	Bike/Ped Path - Whitefish	Whitefish	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
48	2002	Swords Park Path - Billings	Billings	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
49	2002	2002 Air Quality Equipment	Statewide	PM-10 Reduction	Other	Paving and Sweeping	10 to 12	10
50	2002	I-90 Interchange Study - Billings	Billings	Traffic Flow (study)		?	?	?
20	2003	Kelley Island Walkway	Missoula	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
22	2003	13th St S/13th Ave S Sidewalk	Great Falls	Bike/Ped	Pedestrian/Bicycle	Pedestrian/Bicycle	10 to 12	10
40	2003	VIS/Entrance - W Yellowstone	W. Yellowstone	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30
44	2003	North Meridian Rd - Kalispell	Kalispell	Traffic Flow	Traffic Flow	Pavements and Bridges	30 to 35	30

Annual Cost ($)	Annual CO Benefit (kg)*	Annual PM Benefit (kg)*	CO Cost-Eff Ratio ($/kg)**	PM10 Cost-Eff Ratio ($/kg)**
$154,704	0	33,216	-	9.3
$637,163	7,277	0	175.1	-
$748,673	4,421	569	338.7	2,632.5
$150,901	21,314	1,538	14.2	196.2
$70,871	0	104,160	-	1.4
$139,900	0	70,560	-	4.0
	0	0	-	-
$1,724,710	78,531	149,165	43.9	23.1
$1,212,506	7,432	133	326.3	18,279.6
$81,613	14,484	497	11.3	328.6
$572,942	0	482,483	-	1.2
$86,936	10,608	0	8.2	-
$70,222	1,853	0	37.9	-
$25,901	1,707	DNC	30.3	-
$525,000	864	168	1,215.3	3,125.0
$73,570	0	569,758	-	0.1
$126,323	4,713	0	26.8	-
$294,557	8,944	0	32.9	-
$71,799	8,299	0	8.7	-
$27,196	24,580	0	2.2	-
$71,797	500	DNC	287.2	-
	0	0	-	-
$554,877	6,077	0	182.6	-
$78,697	472	5	166.9	31,926.0
$32,978	0	177,617	-	0.4
$363,825	95	5	3,842.7	139,932.7
$15,581	0	9,435	-	3.3
$8,229	0	765	-	10.8
$27,241	0	14,983	-	3.6
$24,946	0	94,436	-	0.3
$40,845	0	15,980	-	2.6
$165,118	7,986	0	20.7	-
$71,458	9,567	0	14.9	-
$31,643	216	0	293.0	-
$48,146	1	0	120,503.8	-
$336,000	24,270	3,746	27.7	179.4
$299,327	13,761	DNC	43.5	-
$39,031	0	8,953	-	8.7
$63,552	6,745	0	9.4	-
$111,432	489	0	227.9	-
$141,751	14,185	0	10.0	-
$142,455	2,479	DNC	114.9	-
$93,891	DNC	20	-	9,337.7
$99,719	1,557	DNC	128.1	-
$369,756	0	672,821	-	0.5
	0	0	-	-
$25,901	2,217	1,269	23.4	40.8
$14,893	1,154	18	25.8	827.4
$21,012	4,198	0	5.0	-
$72,733	7,279	120	10.0	1,212.2

DNC = Did Not Calculate
* - Does not include emission area weighting factor
** - Includes emission area weighting factor

#7 - Clark Fork-Orange Street Bridge

Mode	Total Vehicle ADT	Percent Vehicle Trip Decrease	Avoided Veh Trips = Bike/Ped Trip Increase	Average Bike/Ped Trip Distance (mi)	Daily Avoided VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	Applicable Days Per Year (days/yr)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Pedestrian	21,261	2.0%	425	0.7	298	14.88	0.143	0.138	0.52	240	1,084	37
Bicycle	21,261	2.0%	425	1.8	765	14.88	0.143	0.138	0.52	240	2,784	95
									MOBILE6	TOTALS (kg/yr)	3,868	133

Mode	Total Vehicle ADT	Percent Vehicle Trip Decrease	Avoided Veh Trips = Bike/Ped Trip Increase (trips)	Average Bike/Ped Trip Distance (mi)	Daily Avoided VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	Applicable Days Per Year (days/yr)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Pedestrian	21,261	2.0%	425	0.7	298	32.79	2.91	0.52	240	3,553	37
Bicycle	21,261	2.0%	425	1.8	765	32.79	2.91	0.52	240	3,879	95
								MOBILE5	TOTALS (kg/yr)	7,432	133

#17 - Missoula TDM

2002	Avoided VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Way to Go Club	955,362	14.88	0.143	0.138	0.52	14,484	497
				MOBILE6	TOTALS (kg/yr)	14,484	497

"Way to Go Club" is a community-wide incentive CTR program to reward bicyclists, peds, as well as transit and HOVs.

Mode	Annual Avoided VMT (mi)	Annual Avoided Veh Trips	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Way to Go Club	955,362	79,614	32.79	2.91	0.52	5,391	497
				MOBILE5	TOTALS (kg/yr)	5,391	497

Projects #28 & #49 - Air Quality Equipment

	1998	2000	2002
Deicer (gal)	1,700,000	2,007,510	*2,370,645*
Benefits (kg/yr)	*482,483*	569,758	672,821

It is assumed that AQ benefits are proportional to amount of deicer applied.
Amount of deicer found on-line: http://www.mdt.state.mt.us/departments/maintenance/
Underlined values were estimated.

#32 - Butte Transit Center

Transit Improvements	Total Annual System Trips	Percent Transit Trip Increase	Transit Trip Increase	Average Transit Trip Distance (mi)	Annual Avoided VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)	
Riders	100,000	2.0%	2,000	5	10,000	14.88	0.143	0.138	0.52	152	5	
									TOTALS (kg/yr)	152	5	**MOBILE6**

Ridership, trip distance, and estimated ridership increase due to transit center provided by Gary Keeler, Director Butte-Silver Bow Transit System.

Transit Improvements	Total Annual System Trips	Percent Transit Trip Increase	Avoided Veh Trips Transit Trip Increase (trips)	Average Transit Trip Distance (mi)	Annual Avoided VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)	
Riders	100,000	2.0%	2,000	5	10,000	32.79	2.91	0.52	95	5	
								TOTALS (kg/yr)	95	5	**MOBILE5**

Ridership, trip distance, and estimated ridership increase due to transit center provided by Gary Keeler, Director Butte-Silver Bow Transit System.

Project #61 - Arthur Avenue Roadway Improvements (2001)

Section	Improvement	Speed (mph)	Running CO Emission Factor (g/mi)	Roadway Section Length (mi)	ADT (veh)	VMT (veh-mi)	Applicable Days Per Year (days/yr)	CO Emissions (g/yr)	Emission Reductions (kg/yr)
1	Before	31.00	2.916	0.12	7,250	901	365	959	0.12
	After	35.65	2.551	0.12	7,250	901	365	839	
2	Before	31.00	2.916	0.09	13,155	1,226	365	1,305	0.16
	After	35.65	2.551	0.09	13,155	1,226	365	1,142	
3	Before	31.00	2.916	0.09	19,060	1,777	365	1,891	0.24
	After	35.65	2.551	0.09	19,060	1,777	365	1,654	
4	Before	31.00	2.916	0.06	20,530	1,276	365	1,358	0.17
	After	35.65	2.551	0.06	20,530	1,276	365	1,188	
5	Before	31.00	2.916	0.12	2,870	357	365	380	0.05
	After	35.65	2.551	0.12	2,870	357	365	332	
6	Before	31.00	2.916	0.06	7,430	462	365	491	0.06
	After	35.65	2.551	0.06	7,430	462	365	430	
							MOBILE5	**CO EMISSIONS REDUCTION (kg/yr)**	**0.8**

Assumptions	Speed (mph)	Running CO Emission Factor (g/mi)
Before	31.00	2.916
After	35.65	2.551

Approx. speeds obtained from MDT Project #56 report & 2000 MDT Speed Study: Princ Arterial = 31 mph. FHWA Recommendation: "after" speed = 1.15 x "before" speed
Emission Factors obtained from MDT Project #56 report
VMT = segment length * ADT
Conversions:
1 meter = 0.0006214 mi
1000 g = 1 kg

Section	Improvement	Speed (mph)	Running CO Emission Factor (g/mi)	Roadway Section Length (mi)	ADT (veh)	VMT (veh-mi)	Applicable Days Per Year (days/yr)	CO Emissions (g/yr)	Emission Reductions (kg/yr)
1	Before	31.00	9.270	0.12	7,250	901	365	3,049	-0.04
	After	35.65	9.380	0.12	7,250	901	365	3,085	
2	Before	31.00	9.270	0.09	13,155	1,226	365	4,149	-0.05
	After	35.65	9.380	0.09	13,155	1,226	365	4,198	
3	Before	31.00	9.270	0.09	19,060	1,777	365	6,011	-0.07
	After	35.65	9.380	0.09	19,060	1,777	365	6,082	
4	Before	31.00	9.270	0.06	20,530	1,276	365	4,317	-0.05
	After	35.65	9.380	0.06	20,530	1,276	365	4,368	
5	Before	31.00	9.270	0.12	2,870	357	365	1,207	-0.01
	After	35.65	9.380	0.12	2,870	357	365	1,221	
6	Before	31.00	9.270	0.06	7,430	462	365	1,562	-0.02
	After	35.65	9.380	0.06	7,430	462	365	1,581	
							MOBILE5	**CO EMISSIONS REDUCTION (kg/yr)**	**-0.2**

Assumptions	Speed (mph)	Running CO Emission Factor (g/mi)
Before	31.00	9.27
After	35.65	9.38

Project #62 - Missoula/Ravalli TMA

2001	Carpool/ Vanpool VMT (mi)	Average Vehicle Occupancy	Avoided Auto VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	606,408	2.0	606,408	14.88	0.143	0.138	0.52	9,194	315
Vanpool	1,319,586	6.0	6,597,930	14.88	0.143	0.138	0.52	100,031	3,431
						MOBILE6	TOTALS (kg/yr)	109,225	3,746

2002	Total Vehicle ADT	Average Vehicle Occupancy	Avoided Auto VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	1,016,799	2.0	1,016,799	14.88	0.143	0.138	0.52	15,416	529
Vanpool	1,598,813	6.0	7,994,065	14.88	0.143	0.138	0.52	121,198	4,157
						MOBILE6	TOTALS (kg/yr)	136,614	4,686

2003*	Total Vehicle ADT	Average Vehicle Occupancy	Avoided Auto VMT (mi)	Running CO Emission Factor (g/mi)	Hot Soak CO Emission Factor (g/mi)	Resting Loss CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	1,012,080	2.0	1,012,080	14.88	0.143	0.138	0.52	15,344	526
Vanpool	1,792,962	6.0	8,964,810	14.88	0.143	0.138	0.52	135,915	4,662
						MOBILE6	TOTALS (kg/yr)	151,260	5,188

* - Projected counts based on counts through June 30, 2003.

Average vehicle occupancy modified based on personal correspondence with Missoula/Ravilli Transportation Management Assoication.
"2 to 3 people in most of our carpools, and the vanpools are each running on average 11 people." Judee Harrison, July 30, 2003

Mode	Total Vehicle Trips	Total Vehicle VMT (miles)	Average Vehicle Occupancy	Avoided SOV trips (trips)	Avoided Auto VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	4,707	606,408	2.0	4,707	606,408	32.79	2.91	0.52	1,919	315
Vanpool	19,217	1,319,586	6.0	96,085	6,597,930	32.79	2.91	0.52	22,351	3,431
							MOBILE5	TOTALS (kg/yr)	24,270	3,746

2002	Total Vehicle Trips	Total Vehicle VMT (miles)	Average Vehicle Occupancy	Avoided SOV trips (trips)	Avoided Auto VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	7,578	1,016,799	2.0	7,578	1,016,799	32.79	2.91	0.52	3,207	529
Vanpool	21,287	1,598,813	6.0	106,435	7,994,065	32.79	2.91	0.52	26,753	4,157
							MOBILE5	TOTALS (kg/yr)	29,960	4,686

2003	Total Vehicle Trips	Total Vehicle VMT (miles)	Average Vehicle Occupancy	Avoided SOV trips (trips)	Avoided Auto VMT (mi)	Trip End CO Emission Factor (g/trip)	Running CO Emission Factor (g/mi)	Auto Running PM-10 Emission Factor (g/mi)	CO Emission Reduction (kg/yr)	PM-10 Emission Reduction (kg/yr)
Carpool	8,418	1,012,080	2.0	8,418	1,012,080	32.79	2.91	0.52	3,221	526
Vanpool	23,344	1,792,962	6.0	116,720	8,964,810	32.79	2.91	0.52	29,915	4,662
							MOBILE5	TOTALS (kg/yr)	33,136	5,188

* - Projected counts based on counts through June 30, 2003.