

Synthesis of Countermeasure Cost User Guide



FHWA Safety Program



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Synthesis of Countermeasure Costs User Guide

Background

Crash modification factors/ (CMFs) are a valuable tool that can help identify the most effective countermeasures to improve roadway infrastructure safety. Transportation professionals need CMFs, countermeasure service life, countermeasure costs, and crash severity costs to conduct an economic appraisal or crash based cost benefit analysis of potential countermeasures for implementation. Crash based cost benefit analyses provide users with a quantitative measure to assist in determining which safety areas or countermeasures would be most cost effective for addressing safety concerns and helping to reduce the number and severity of crashes in a particular area.

The CMF Clearinghouse provides an online database of all available CMFs as well as the recently published “Synthesis of Countermeasure Service Life and Crash Severity Costs User Guide.” However, synthesized information on countermeasure costs is lacking. Therefore, FHWA conducted a synthesis to identify information used by the states for countermeasure costs. The results of the synthesis are included in this user guide.

The availability of roadway infrastructure countermeasure cost information and the way in which transportation agencies report costs vary considerably from jurisdiction to jurisdiction. Various factors influence cost, including but not limited to the types of material used, project scale, existing infrastructure, local climate conditions, and local economic conditions. This user guide includes the most up-to-date countermeasure cost information found nationwide and can be used for project prioritization and estimating purposes when local countermeasure cost information is not available. This information should not be used for determining actual prices for specific infrastructure projects.

Literature Review

The research team conducted a literature review of each state to identify sources of publicly available roadway infrastructure countermeasure cost information. In order to include costs for as many countermeasures as possible, the research team explored State DOT and city websites for resources and conducted targeted keyword searches for specific countermeasures and countermeasure categories using conventional search engines. Drawing from city plans and other sources, these targeted searches provided information that was otherwise unavailable from other sources.

Many resources provided detailed descriptions and information but provided limited or categorical cost information (“low”, “high”, or “varies”). The research team found the majority of the information collected for this effort in general countermeasure or traffic calming fact sheets and information pages, municipality master plans, and contractor bid sheets for specific infrastructure projects. The research team also collected cost information from other sources such as average unit price sheets (AUPs) but did not include the cost information in the database. In particular, many of the AUPs were difficult to interpret and in most cases included redundant cost information that did not enhance the cost information already collected for a particular countermeasure. Also, the level of detail provided in the

AUPs was far greater than the detail provided in all other resources. The research team concluded that this level of detail did not align with the scope of this project and what would be useful to most researchers and practitioners using this synthesis.

Appendix A includes the results of the literature review. Some states have multiple resources and report costs for numerous countermeasures whereas other states lack publicly available cost information or report costs for only a small number of countermeasures. The research team did not include any cost information for Delaware, Illinois, Kansas, Pennsylvania, Rhode Island, or Vermont.

Synthesis Results

The countermeasure cost database synthesizes the information identified through the literature review. Appendix B includes a brief description of the data variables. In total, the research team obtained countermeasure cost information for 44 states plus the District of Columbia and national resources. The database summarizes countermeasure cost information for 308 countermeasures across 18 countermeasure categories. The countermeasure categories are consistent with those in the CMF Clearinghouse. The database includes the source data and the respective hyperlink for most of the cost entries in the database. All provided costs are in the source year dollars. Thus, anyone using this information will need to adjust the dollar amount to the current year using the United States Consumer Price Index published by the Bureau of Labor Statistics.

The countermeasure cost database includes the most up-to-date cost figures that were available. Approximately 59 percent of resources reported costs within the last five years (2011-2015) with 22 percent from 2010 or later and 19 percent undetermined. Outdated resources still provide useful information for project planning for states where current cost information is not available. For example, the most comprehensive resource from Missouri is a Missouri DOT publication (1999) reporting 1998 costs.

Some resources specify whether additional costs are associated with a countermeasure such as material, installation, design, or maintenance costs. The database includes these details as comments for each respective countermeasure entry. Some resources, however, report costs as “implementation costs” (installation costs) but do not specify what is included in the implementation.

For all cases, the research team categorized costs as either “material cost only” or “implementation cost” based on details reported in the original figures and the language in the document. This process was straightforward for resources that specified whether additional costs (i.e., material, installation, design, maintenance costs) were associated with a countermeasure. Some resources, however, reported costs as “implementation costs” without specifying what was included in the implementation. This generated some degree of uncertainty as to the meaning of the reported cost. For these countermeasures, the research team assessed all available information and applied the category that seemed most appropriate. For this reason, the research team intends for this document and the associated database to be used as a general guideline for estimating future project implementation costs.

The research team produced summary tables from the countermeasure cost database to present the results of the synthesis. Below is a description of the summary tables. They can also be accessed at the CMF Clearinghouse website.

Countermeasure Cost by Countermeasure

The CMF Clearinghouse uses 18 countermeasure categories, and the research team produced a summary table for each category. Various costs for countermeasures populate the cells. Table 1 provides a description of each field in the countermeasure cost summary tables.

It is important to note that the research team studied each countermeasure closely due to the variation in reported costs and cost units for each resource found. The research team used their expertise to convert varying cost units for a given countermeasure into one common unit. For example, the research team converted all distance units (km, linear foot, mile, etc.) and all object units (location, intersection, island, approach) to the unit that made most sense for a given countermeasure. Additionally, some resources noted that the reported cost for a given countermeasure was for 8 locations or 25 miles of roadway. In these instances, the research team divided costs by the number of locations (or reported distance) in order to be able to combine multiple resources for a single countermeasure. Table 1 provides the average, low end, and high end costs for unit cost, total installed cost, and annual maintenance cost as described below.

Table 1. Variables for countermeasure cost summary tables

Variable	Definition	Example/Notes
Countermeasure Category	Countermeasure category used by the CMF Clearinghouse.	
Countermeasure Name	Name of countermeasure cleaned for uniformity by the research team.	“Install rumble strips on shoulders”, “Install shoulder rumble strips”, and “Shoulder rumble strips” were all renamed to “Install shoulder rumble strips”.
Cost Per Unit or Average Cost Per Unit	The unit cost or average unit cost reported for a particular countermeasure.	If a single cost entry exists, the value shown is the cost per unit. If multiple cost entries exist, the value shown is the average cost per unit.
Low End of Cost Per Unit	The lowest value of the range of cost per unit.	
High End of Cost Per Unit	The highest value of the range of cost per unit.	
Cost Unit	The unit of cost indicated by the resource or research team.	Per mile, per intersection, per foot, etc. In some cases, the “Cost Per Unit” and the “Installed Costs” have different units. Example: “Install shared lane markings” has a cost unit of “per sharrow/per mile” indicating the unit costs are per sharrow and the installed costs are per mile.

Variable	Definition	Example/Notes
Estimated or Average Total Installed Treatment Cost	The estimated or average total installed treatment cost reported for a particular countermeasure.	Costs may include material, labor, equipment, etc. If a single cost entry exists, the value shown is the estimated installed treatment cost. If multiple cost entries exist, the value shown is the average installed treatment cost.
Low End of Estimated Total Installed Treatment Cost	The lowest value of the range of the total installed treatment cost.	
High End of Estimated Total Installed Treatment Cost	The highest value of the range of the total installed treatment cost.	
Average Annual (Maintenance) Cost	The average annual maintenance cost reported for a particular countermeasure.	
Low End of Average Annual (Maintenance) Cost	The lowest value of the range of the average annual maintenance cost.	
High End of Average Annual (Maintenance) Cost	The highest value of the range of the average annual maintenance cost.	
State	Abbreviation of state name.	If more than one entry exists, multiple states are listed.
Number of Records	The number of records used to summarize cost information.	
Year Range	The range of years cost information is reported from.	All costs are provided in the source year dollars.

Additional National Resources

While searching for resources for this effort, the research team found two national sources that could also be of use to researchers and practitioners. The research team did not include the information contained in these two documents in the database developed for this effort because they include different cost sources. Provided below is a brief summary of each resource.

NCHRP Project 17-48: Highway Infrastructure and Operations Safety Research Needs (Appendix R)¹

The objectives of NCHRP 17-48 were to:

- Develop a detailed methodology for identifying and evaluating research needs in the area of highway infrastructure and operations safety.

¹NCHRP Project 17-48: Highway Infrastructure and Operations Safety Research Needs. Final Report: Appendix R “Countermeasure Cost Compilations”. April 2013

- Implement the methodology to identify and evaluate research needs in the areas of highway infrastructure and operations safety.
- Develop a detailed plan that can be implemented by other entities within the transportation community to transform the identified research needs into a formal national research agenda.

As part of this effort, the research team assembled a countermeasure cost database using bid letting information or price indices from state and local agencies. The cost information contained in this report should be used only for estimating purposes and research prioritization.

“Costs for Pedestrian and Bicyclist Infrastructure Improvements”²

This report is intended to provide meaningful estimates of infrastructure costs by collecting up-to-date cost information for pedestrian and bicycle treatments from states and cities across the country.

Researchers, engineers, planners, and the general public can use this information to better understand the cost of pedestrian and bicycle treatments in their communities and make informed decisions about which infrastructure enhancements are best suited for implementation.

Summary

It is important for researchers and practitioners to have as much information as possible when selecting which countermeasures to use to improve roadway infrastructure safety and reduce the number and severity of crashes. Crash based cost benefit analyses are a great tool for states to use to determine which countermeasures would be most cost effective in improving safety for roadway users.

Countermeasure cost information is a necessary piece needed to conduct these analyses. The results of this synthesis will provide researchers and practitioners with additional information to conduct economic appraisals of potential countermeasures.

²Bushell, M.A., B.W. Poole, C.V. Zegeer, and D.A. Rodriguez. “Costs for Pedestrian and Bicyclist Infrastructure Improvements: A resource for engineers, planners, and the general public”. FHWA. October 2013

Appendix A: Literature Review Sources

Results of literature review for countermeasure costs only include resources used to compile summary tables.

State	Information Source	Source Year	Page Number	Link to Source
AK	Alaska Department of Transportation and Public Facilities	2014	A-19, A 20	http://dot.alaska.gov/stwddes/dcs/traffic/pop_hsip.shtml
AL	Alabama Highway 59 Adaptive Traffic Signal System by Skipper Consulting March 2014	2014	4	http://www.gulfshoresal.gov/AgendaCenter/ViewFile/Item/448?fileID=917
AL	Eastern Shore MPO Traffic Signal Technology by Sain Associates January 2015	2015	2	http://easternshorempo.org/wp-content/uploads/2015/02/ESMPO-Executive-Summary-CONOPS-Traffic-Signal-Technology-2015-01-09.pdf
AR	Bentonville Bicycle and Pedestrian Master Plan 2012	2012	3.8	http://www.bentonvillear.com/assets/site_files/proposed_bicycle_and_pedestrian_master.pdf
AR	Estimated costs per mile	2014	1	http://www.arkansashighways.com/roadway_design_division/Cost%20per%20Mile%20%28JULY%202014%29.pdf
AZ	FHWA Pedsafe Safety Guide and Countermeasure Selection System	2013	1-47	http://www.pedbikeinfo.org/pdf/Webinar_PBIC_FHWA_090413.pdf
CA	Roadway Striping as a Traffic Calming Option	2010	19-21	
CA	City of La Mesa Traffic Calming Toolbox	unknown	TB-22	http://www.cityoflamesa.com/DocumentView.aspx?DID=1954
CA	Converting Napa Downtown Streets from One-Way to Two-Way	unknown	3	
CA	Metropolitan Transportation Commission Safety Toolbox: Engineering - Raised Crosswalks	unknown	N/A	
CA	Pedestrian and Bicycle Information Center Case Study - Bicycle Boulevards	unknown	4	http://www.sustainablecitiesinstitute.org/Documents/SCI/Case_Study/Case_Study_Bicycle_Boulevards%20SF.pdf
CO	I-70 Reversible Lane Georgetown to Floyd Hill: Phase II Feasibility Study	2010	15	http://www.coloradodot.info/projects/i70reversiblelanephaseii

State	Information Source	Source Year	Page Number	Link to Source
CT	South Central Regional Council of Governments Traffic Calming Resource Guide	2008	5	
CT	Connecticut Department of Transportation Cost Estimating Guidelines - 2015	2015	7	http://www.ct.gov/dot/lib/dot/documents/aec/cost_estimating_guidelines.pdf
DC	Sunkari, Srinivasan. (2004, April). The Benefits of Retiming Traffic Signals. ITE Journal.	2004	28	http://www.spcregion.org/downloads/ops/Other%20Studies/BenefitsofRetimingTrafficSignals.pdf
FL	USDOT Miami-Dade Pedestrian Safety Project Phase II	2013	1	http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_scdproj/miami/ch1.cfm
FL	Florida Department of Transportation Bridge Costs	2014	1-2	
FL	Florida Department of Transportation District 3 Annual Roadway Construction Costs	2014	entire document	
FL	Florida Department of Transportation District 7 Annual Roadway Construction Costs	2014	3	
GA	USDOT Federal Highway Administration Safety Evaluation of the Safety Edge Treatment	2011	N/A	http://www.fhwa.dot.gov/publications/research/safety/11024/005.cfm#toc288222439
HI	Hawaii.gov Contracts for Goods, Services, and Construction	2012	N/A	http://hawaii.gov/spo2/source/search_results.php?sourcethodID=1
IA	BIKESAFE: Bicycle Countermeasure Selection System	2004	74	http://nacto.org/wp-content/uploads/2011/03/Bikesafe-Bicycle-Countermeasure-Selection-System-ch5.pdf
IA	IA DOT Traffic Safety Improvement Program Applications for Traffic Control Devices 2015	2012-2015	82	http://www.iowadot.gov/traffic/pdfs/2015%20TCD%20Applications.pdf
ID	ID DOT Enhancement of ITD District 6 Safety Project Prioritization and Implementation Capabilities	2012	25	
IN	IN DOT SRTS Pedestrian and Bicycle Facility Costs 2011	2011	1	http://www.in.gov/indot/files/SRTS_BikePedFacilityCosts_0311.pdf
IN	Indianapolis SustainIndy Illinois Street and Capitol Avenue Bike Lane Project	2011	1	

State	Information Source	Source Year	Page Number	Link to Source
IN	IN DOT 2012 Design Manual	2012	49-51	http://www.in.gov/indot/design_manual/files/Ch78_2012.pdf
IN	IN DOT Cost Estimation for I-69 Evansville to Indianapolis Alternatives		10	http://www.in.gov/indot/projects/files/I69/Tier1/FEIS/Vol2-Appendixes/Appendix_HH.pdf
KY	KY Transportation Cabinet Congestion Mitigation and Air Quality Improvement Program June 30 2010	2010	1	http://transportation.ky.gov/Program-Management/STIP%20Book/Exhibit%20A-8.pdf
KY	Lexington-Fayette Urban County Government Division of Traffic Engineering Facts & Information 2014	2014	1	http://www.lexingtonky.gov/Modules/ShowDocument.aspx?documentid=21225
KY	Residential Traffic Calming Program City of Alexandria KY	unknown	12	http://www.alexandriaky.org/wp-content/uploads/Alexandria-RESIDENTIAL-TRAFFIC-CALMING-PROGRAM.pdf
LA	LA Dept. of Transportation and Development Traffic Engineering 101 The Basics	2010	76	https://www.ltrc.lsu.edu/ltap/pdf/te101_module456.pdf
LA	LA Dept. of Transportation and Development Traffic Signal Controller Certification	2013	4	http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Traffic_Engineering/Traffic%20Control/Bolinger_-_Traffic_Signal_Controller_Certification.pdf
LA	LA Dept. of Transportation and Development: Roundabouts	2014	4-10	http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Traffic_Engineering/Roundabouts/Roundabout%20Info%20and%20Instructions.pdf
LA	New Orleans Urbanized Area Transportation Improvement Program FY 2015-2018	2014	63	http://www.norpc.org/assets/pdf-documents/NO_TIP_15_18.pdf
LA	Houma Thibodaux Metropolitan Planning Organization 2015 Transportation Improvement Program	2015	10	http://www.htmppo.org/docs/2014-10-23_TIP_v1.1.pdf
MA	MA Highway Traffic Engineering - Pavement Markings	2008	3	
MD	FHA Roundabouts: Maryland Experience PDF	unknown	4	http://safety.fhwa.dot.gov/intersection/resources/casestudies/fhwas09018/fhwas09018ppt.pdf

State	Information Source	Source Year	Page Number	Link to Source
MD	MD DOT Traffic Signals Brochure	unknown	N/A	http://www.roads.maryland.gov/index.aspx?PagelId=278
ME	Maine DOT Using LED's in Traffic Signals	2013	N/A	http://www.maine.gov/mdot/csd/mlrc/technical/ti/ledtrafficsignals.htm
MI	MI DOT Crash Countermeasure and Mobility Effects	2012	8	https://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1572_Part3_387426_7.pdf
MI	MI DOT Evaluating Pedstrian Safety Improvements Final Report 2012	2012	26	https://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC-1585_408249_7.pdf
MN	Safety Effects of Centerline Rumble Strips in Minnesota (Briese, 2006)	2006	2-4	http://www.lrrb.org/PDF/200844.pdf
MN	American Traffic Safety Services Association Low Cost Local Road Safety Solutions	2008	25	
MN	City of Mankato Neighborhood Traffic Calming Program January 2007	2009	11	
MN	Northeast/Southeast Minneapolis Bike Boulevard Costs	2010	1	http://www.ci.minneapolis.mn.us/www/groups/public/@publicworks/documents/webcontent/convert_267688.pdf
MN	Kansa LTAP Fact Sheet: The When, Where and How of Mid-block Crosswalks	2011	4	http://www2.ku.edu/~kutc/pdf/files/LTAPFS11-Mid-Block.pdf
MN	MN DOT Local Road Research Board 46th Street Pilot Street Lighting Project	2013	7	http://www.lrrb.org/media/reports/201304.pdf
MN	City of Minneapolis Protected Bikeway Feasibility Analysis	2015	6	http://www.ci.minneapolis.mn.us/www/groups/public/@publicworks/documents/webcontent/wcms1p-139020.pdf
MN	Crossroads MN Transportation Research Blog How Better Sign Management Could Save Minnesota Millions	2015	N/A	http://mntransportationresearch.org/2015/01/20/how-better-sign-management-could-save-minnesota-millions/
MN	HAWK Pedestrian System Presentation	unknown	18	http://ceam.org/vertical/Sites/%7BD96B0887-4D81-47D5-AA86-9D2FB8BC0796%7D/uploads/%7BC83BB08D-26B1-4C13-9C96-E9D82DBADF47%7D.PDF

State	Information Source	Source Year	Page Number	Link to Source
MN	Minneapolis Bicycle Master Plan Chapter 8- Funding and Implementation Strategies	unknown	190	http://www.minneapolismn.gov/www/groups/public/@publicworks/documents/webcontent/convert_253725.pdf
MN	MN DOT Horizontal Curves Delineation Policy	unknown	1	http://www.dot.state.mn.us/stateaid/trafficsafety/safety/horizontal-curves-delineation.pdf
MO	Manual on Identification, Analysis and Correction of High Crash Locations (HAL manual)	1999	E-1	http://www.modot.org/safety/Safety_Engineering/documents/Hal%20Manual.pdf
MO	Light Emitting Diode (LED) Signal Installation - MoDOT Final Report	2000	5	http://library.modot.mo.gov/RDT/reports/RI96023/RDT99010.pdf
MO	City of Kansas City, MO Main Street Corridor Streetscape Master Plan	2008	45	http://kcmo.gov/wp-content/uploads/2013/07/018165.pdf
MO	Comprehensive Bicycle Infrastructure and Promotion in a Small City Columbia, MO	2012	N/A	http://pedbikesafe.org/BIKESAFE/casestudies_detail.cfm?CM_NUM=48&CS_NUM=718
MO	MODOT Long-range Transportation Plan A VISION FOR MISSOURI'S TRANSPORTATION FUTURE	2013	53	http://missourionthemove.org/wp-content/uploads/Final-Draft-Full-Tech-Report-11-5-13-final.pdf
MO	Jefferson Co., Missouri Roadway Master Plan 2014	2014	127	https://www.jeffcomo.org/Uploads/Public%20Works/Additional%20Information/Roadway%20Master%20Plan%20Final%20as%20Amended.pdf
MO	Meet MODOT 2015	2015	2	
MS	MS DOT Traffic Signal Parts and Equipment Agency Contract 2014	2014	8	
MT	MTDT Bicyclist Signing Guide 2007	2007	6	http://www.mdt.mt.gov/travinfo/docs/bicyclist_signing_guide.pdf
National	USDOT Policy Considerations for Roundabouts	1998	36	http://www.fhwa.dot.gov/publications/research/safety/00067/000672.pdf
National	PEDSAFE: Raised Pedestrian Crosswalks	2004	1	http://guide.saferoutesinfo.org/engineering/slowing_down_traffic.cfm

State	Information Source	Source Year	Page Number	Link to Source
National	FHWA Office of Safety	2009	1	http://safety.fhwa.dot.gov/intersection/resources/fhwasa09020/chap_6.cfm
National	SRTS Guide Marking and Signing Crosswalks	2013	1	http://guide.saferoutesinfo.org/engineering/marked_crosswalks.cfm
National	FHWA Rumble Strips and Rumble Stripes	2014	1	http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/faqs.cfm
National	Safe Routes to School Guide - Traffic Signals	unknown	1	http://guide.saferoutesinfo.org/engineering/traffic_signals.cfm
NC	Spot Safety Project Evaluation	2005	2	https://connect.ncdot.gov/resources/safety/Safety%20Evaluation%20Completed%20Projects/SS1398002.pdf
NC	John Locke Foundation - Livable Streets, Dangerous Roads 2006	2006	5	http://www.johnlocke.org/acrobat/policyReports/trafficcalming-brief.pdf
NC	Murphy, B. & Hummer, J. (2007). Development of Crash Reduction Factors for Overhead Flashing Beacons at Rural Intersections in North Carolina. Transportation Research Record, 2030, 15-21. DOI: 10.3141/2030-03.	2007	12	https://connect.ncdot.gov/resources/safety/Safety%20Evaluation%20Projects/Flasher%20Crash%20Reduction%20Factors%20Final%20Report.pdf
NC	FHA Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections 2008	2008	Near Bottom	http://www.fhwa.dot.gov/publications/research/safety/08044/index.cfm#Toc193873726
NC	Evaluation of the Conversion from Two-Way Stop Sign Control to All-Way Stop Sign Control at 53 Locations in North Carolina, (Simpson & Hummer, 2010)	2010	24	https://connect.ncdot.gov/resources/safety/Safety%20Evaluation%20Projects/All%20Way%20Presentation%20with%20Notes.pdf
NC	NCDOT Spot Safety Evaluation	2010	7	https://connect.ncdot.gov/resources/safety/Safety%20Evaluation%20Completed%20Projects/SS07-05-249.pdf
NC	NCDOT Board of Transportation Meeting Minutes Nov. 2014	2014	1896	http://www.ncdot.gov/download/about/board/bot/meetingminutes/2014/201411_minutes.pdf

State	Information Source	Source Year	Page Number	Link to Source
NC	Town of Cary, NC TF15-019 Traffic Signal Installation - Morrisville Pkwy and Green Level Church Rd	2014	1	
NC	Albemarle Comprehensive Pedestrian Plan	unknown	E5	
NC	DurhamWalks Pedestrian Plan - Standards and Guidelines	unknown	6-7	
NC	NCDOT Share the Road Signing Program	unknown	1	
ND	Local Road Safety Program Cavalier Co., ND	2013	25	https://www.dot.nd.gov/divisions/safety/docs/LSRP/LSRP_Cavalier_County.pdf
ND	Local Road Safety Program Cass Co., ND	2014	3-13	https://www.dot.nd.gov/divisions/safety/docs/LSRP/LSRP_CassRegion_Fargo_WestFargo.pdf
ND	NDOT Local Road Safety Program Phase 3 November 2014	2014	3-16	https://www.dot.nd.gov/divisions/safety/docs/LSRP/VIEW_WesternRegion_Agency_SlopeCounty.pdf
NE	City of Omaha Traffic Signal System Master Plan Ver. 2 Oct. 2013	2013	vi	http://www.cityofomaha.org/pw/images/stories/Traffic/City%20of%20Omaha%20-%20Traffic%20Signal%20System%20Master%20Plan%20Part%201.pdf
NE	City of Omaha Traffic Signal System Master Plan Ver. 3 Oct. 2013	2013	101	http://www.cityofomaha.org/pw/images/stories/Traffic/City%20of%20Omaha%20-%20Traffic%20Signal%20System%20Master%20Plan%20Part%204.pdf
NE	Lincoln MPO Bicycle and Pedestrian Capital Plan May 2013	2013	48	http://lincoln.ne.gov/city/plan/mpo/mporpts/bikeped/FinalReport.pdf
NH	NHDOT Town of Lee Board of Selectmen Meeting 2013	2013	24	http://www.leenh.org/Pages/LeeNH_News/2013-05-28%20Rumble%20Strips%20%28NH%20125%29%20Presentation.pdf

State	Information Source	Source Year	Page Number	Link to Source
NH	NHDOT Milling Rumble Strips Bids February 2014	2014	1	http://www.nh.gov/dot/org/administration/finance/bids/bidresults/2014/documents/Statewide26842.pdf
NH	NHDOT Replacement of Outdated Pedestrian Signal Heads October 2014	2014	1	http://www.nh.gov/dot/org/administration/finance/bids/bidresults/2014/documents/Statewide27592.pdf
NH	NHDOT Signalizing an Intersection Bids December 2014	2014	1	http://www.nh.gov/dot/org/administration/finance/bids/bidresults/2014/documents/Loudon24941.pdf
NH	NHDOT Single Lane Roundabout Bids March 2015	2015	1	http://www.nh.gov/dot/org/administration/finance/bids/bidresults/2015/documents/Swanzey15697.pdf
NJ	Design and Evaluation of Effective Crosswalk Illumination	2009	37	http://www.utrc2.org/research/assets/152/FHWA-NJ-2009-0031.pdf
NJ	Municipality of Princeton, NJ Crosswalk Design Standards	2013	5	http://www.princetonnj.gov/council/ag-min/2013/102813/Crosswalks%20Design%20Standards.pdf
NJ	NJDOT NJ School Zone Design Guide	2014	70	http://www.saferoutesnj.org/wp-content/uploads/2014/11/schoolzonedesignguide2014.pdf
NJ	City of Hoboken, NJ Traffic Calming Toolkit	est. 2010	12	http://www.hobokennj.org/docs/transportation/Hoboken-Traffic-Calming-Toolkit.pdf
NJ	NJ Safe Routes to School Implementation Costs	unknown	8	http://www.saferoutesnj.org/wp-content/uploads/2013/07/srts_costs_NEW-FORMAT_FINAL.pdf
NM	Daily Times Four Corners News Sept. 2013 'New crosswalk signs are welcome but concerns over safety linger'	2013	1	
NM	City of Albuquerque Street Lighting Operation and Maintenance Dec. 2014	2014	2	http://www.cabq.gov/municipaldevelopment/documents/copy_of_ALBUQUERQUESTREETLIGHTING.pdf
NM	KOB.com October 2014 BernCo. installs pedestrian-controlled crosswalk at Isleta and McEwen Ct.	2014	1	

State	Information Source	Source Year	Page Number	Link to Source
NM	City of Albuquerque Rio Grande/Candelaria Roundabout Project	2015	1	http://rgc-roundabout.com/cost.php
NV	Clark Co. NV Information on Traffic Signals 2012	2012	1	
NV	NDOT Kietzke Lane Safety Management Plan August 2013	2013	104	
NY	NYS DOT Lighting and Vegetation for Energy Efficient and Safe Roadway Travel	2009	5-3	https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/LightingVegetation-C-08-03-10628.pdf
NY	NYS DOT Green Light - Sustainable Street Lighting for NYC	est. 2010	12	http://www.nyc.gov/html/dot/downloads/pdf/sustainablestreetlighting.pdf
NY	NYS DOT Centerline Rumble Strips	unknown	1	https://www.dot.ny.gov/programs/rumblestrips/centerrumblestrips
NY	NYS DOT Shoulder Rumble Strips	unknown	1	https://www.dot.ny.gov/programs/rumblestrips
OH	NOACA Traffic Signal Improvements on Mayfield Road in Cleveland Heights	2014	1	http://www.noaca.org/index.aspx?page=207
OH	OH DOT State Rt. 53 Corridor Study Meeting Handout 2014	2014	4	http://www.dot.state.oh.us/districts/D02/StateRoute53CorridorDocLib/Meeting%20Handout.pdf
OK	City of Norman, OK Traffic Control Division: Street Signs and Traffic Signals	unknown	1	http://www.ci.norman.ok.us/sites/default/files/WebFM/Norman/Public%20Works/Stop%20Signs%20and%20Signals.pdf
OR	ODOT Pedestrian and Bicycle Safety Implementation Plan 2014	2014	21-23	ftp://ftp.odot.state.or.us/OTCDC_SHARED/OTCDCMeetingRefDocs/May_16_2014_OTCDC_Handouts/PBSIP%204-3-14.pdf
OR	ODOT Tabulation of Bids Burns Signal Improvements 3-26-2015	2015	1	http://www.oregon.gov/ODOT/CS/CONSTRUCTION/docs/BT/2015/14796.pdf
OR	ODOT Tabulation of Bids District 8 Rumble Strips and Warning Signs 3-26-2015	2015	1	http://www.oregon.gov/ODOT/CS/CONSTRUCTION/docs/BT/2015/14795.pdf

State	Information Source	Source Year	Page Number	Link to Source
OR	ODOT Tabulation of Bids Region 2 Rumble Strips 4-9-2015	2015	1	http://www.oregon.gov/ODOT/CS/CONSTRUCTION/docs/BT/2015/14799.pdf
OR	ODOT Updated Curve Warning Signs Fact Sheet	2010?	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/UpdatedCurveWarningSigns.pdf
OR	ODOT Basic Intersection Upgrades Fact Sheet	unknown	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/Int_Upgrades.pdf
OR	ODOT Basic Signal Upgrades Fact Sheet	unknown	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/Signal_Upgrades.pdf
OR	ODOT Bicycle Enhancements Fact Sheet	unknown	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/BikeEnhancements.pdf
OR	ODOT Pedestrian Enhancements Fact Sheet	unknown	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/PedEnhancements.pdf
OR	ODOT Rumble Strips Fact Sheet	unknown	1	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/RumbleStripsFactSheet.pdf
OR	PennDOT Frequently Asked Questions - Traffic Signal Costs	unknown	N/A	
OR	Portland Bureau of Transportation Traffic Calming Devices and Photos	unknown	1	http://www.portlandoregon.gov/transportation/article/83341
OR	Oregon DOT Tabulation of Bids	2015	1	http://www.oregon.gov/ODOT/CS/CONSTRUCTION/docs/BT/2015/14778.pdf
SC	TRB Paper: Revisiting the Use of Drone Radar to Reduce Speed in Work Zones: South Carolina's Experience	2007	15	http://www.workzonesafety.org/files/documents/database_documents/07-2908.pdf
SC	Greenville County, SC Traffic Calming Program 2008	2008	A-9	

State	Information Source	Source Year	Page Number	Link to Source
SC	City of Greenville, SC Bicycle Master Plan	2011	8-20	http://sc-greenville.civicplus.com/DocumentCenter/View/1481
SC	2014 SC Highway Safety Improvement Program	2014	18	http://safety.fhwa.dot.gov/hsip/reports/pdf/2014/sc.pdf
SD	2011 Rapid City SD Bicycle and Pedestrian Master Plan	2011	69	
SD	Downtown BID Board Special Meeting City of Rapid City, SD February 2013	2013	2	
SD	2015 SD Highway Safety Plan	2015	58	https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/sd_fy15hsp.pdf
TN	Memphis TN Regional Bicycle and Pedestrian Plan	2011	293	http://memphismpo.org/sites/default/files/public/documents/bike-ped-plan/regional-bicycle-and-pedestrian-plan-full.pdf
TN	TN Transportation Improvement Program 2014-2017	2014	53	
TX	TTI Research Recommendations for Uniform Rumble Strip Applications in Texas	2005	2	http://tti.tamu.edu/documents/0-4472-S.pdf
TX	Texas DOT HSIP Work Codes Table	2013	entire document	http://ftp.dot.state.tx.us/pub/txdot-info/trf/hsipworkcodetable.pdf
UT	UT Highway Safety Improvement Program 2014	2014	16	http://safety.fhwa.dot.gov/hsip/reports/pdf/2014/ut.pdf
UT	Salt Lake City UT Bicycle & Pedestrian Master Plan 2015	2015	123	
VA	VDOT Traffic Calming Guide for Local Residential Streets 2002	2001	9	http://www.virginiadot.org/business/resources/TrafficCalmingGuideOct2002.pdf
VA	VDOT Traffic Calming Measures at a Glance	2005	1	http://www.virginiadot.org/info/resources/TrafficCalming.pdf
VA	VDOT Planning level cost estimate for bicycle accommodations 2011	2011	1	http://www.virginiadot.org/programs/resources/bic_planning_cost_estimates.pdf
VA	Gloucester Transportation Planning Study	2012	24	

State	Information Source	Source Year	Page Number	Link to Source
VA	VDOT Highway Safety Improvement Program 2012-2013	2012	C-3	http://www.virginiadot.org/business/resources/tes_hsip_2011/HSIP_Guidelines_FY12-13.pdf
VA	VA Gloucester Co. Business 17 Corridor Planning Study Appendix D: Cost Estimates	unknown	1	http://www.gloucesterva.info/Portals/0/planning/documents/Transportation/Appendix_D.pdf
VA	VDOT What is Traffic Calming?	unknown	13	http://www.rrregion.org/pdf/LT/marshall/Abecassis-%20VDOT%20Traffic%20Calming%20Program.pdf
WA	City of Kirkland, Washington Flashing Crosswalks FAQ	unknown	1	http://www.kirklandwa.gov/depart/Public_Works/Transportation_and_Traffic/Flashing_Crosswalks.htm
WA	Low-cost vs. High-cost Traffic Calming Devices in Seattle	unknown	6	http://www.seattle.gov/transportation/docs/TorontoNoel1.pdf
WA	Pedestrian Improvements: Signage and Crosswalk Changes	unknown	72	
WA	Seattle Dept. of Transportation Neighborhood Traffic Operations: Traffic Circle Program	unknown	1	http://www.seattle.gov/transportation/trafficcircles.htm
WA	WSDOT Traffic Signals	unknown	1	http://www.wsdot.wa.gov/Operations/Traffic/signals.htm
WI	Evaluation Of The Converging Chevron Pavement Marking Pattern at One Wisconsin Location	2003	9	https://www.aaafoundation.org/sites/default/files/chevrons%20%281%29.pdf
WI	City of Brookfield, WI Neighborhood Traffic Calming Guidelines 2008	2008	36	http://www.ci.brookfield.wi.us/DocumentCenter/Home/View/990
WV	Morgantown WV Pedstrian Safety Plan Aug. 2010	2010	100	http://www.morgantownwv.gov/wp-content/uploads/MPSB-Plan-8_13_2010.pdf
WY	Cheyenne, WY Metropolitan Pedestrian Plan 2011	2011	209	http://www.plancheyenne.org/Final%20Ped%20Plan%20and%20SRTS/CHEYENNE%20Ped%20plan.pdf
WY	WYDOT Quick FactsTraffic Signals	2012	9	

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WY	Town of Jackson, WY Bicycle Improvement Plan 2013	2013	81	http://www.tetonwyo.org/pathways/docs/Capital_Projects/Region1-TownofJackson/TOJ_Bike_Network/2013_Bicycle_Improvement_Plan_Full_20130513.pdf
WY	Town of Jackson, WY Bicycle Improvement Plan 2014	2013	81	http://www.tetonwyo.org/pathways/docs/Capital_Projects/Region1-TownofJackson/TOJ_Bike_Network/2013_Bicycle_Improvement_Plan_Full_20130513.pdf

Appendix B: Database Data Variables

The following variables are included in the countermeasure cost database:

- State
- Countermeasure name used by the State
- Countermeasure name cleaned for uniformity by the research team (to make summary tables easier to understand)
 - Example: “Install rumble strips on shoulders”, “Install shoulder rumble strips”, and “Shoulder rumble strips” were all renamed to “Install shoulder rumble strips”
- Countermeasure category used by the State
- Countermeasure category used by the CMF Clearinghouse (to allow for consistency between the countermeasure service life database and the CMF Clearinghouse)
 - Example: The countermeasures in the example above were categorized as “Roadway and Roadside”, “Rural Curves”, or left blank by the state and were re-categorized as “Shoulder treatments” to be consistent with the categories in the CMF Clearinghouse.
- Urban or rural
- Divided or undivided
- Number of lanes
- Cost per unit or average cost per unit
- Low end of cost per unit
- High end of cost per unit
- Cost unit (per mile, linear foot, day, etc.)
- (Typical) # units or treatment size included in total project cost
- Estimated total installed treatment cost (may include material, labor, equipment, etc.)
- Low end of estimated total installed treatment cost (may include material, labor, equipment, etc.)
- High end of estimated total installed treatment cost (may include material, labor, equipment, etc.)
- Average annual (maintenance) cost
- Low end of annual (maintenance) cost
- High end of annual (maintenance) cost
- Cost of ROW
- State or national resource
- Isolated or combined cost
- Information source
- Information source year
- Page number within document
- Link to source
- Notes

For More Information:

Visit <http://safety.fhwa.dot.gov/hsip>

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