Appendices

Appendix 1 – Advisory Committee

An advisory committee was formed to guide the project design, oversee data completeness, and review conclusions. The advisory committee was comprised of the following members:

Principle Investigators:

- Dr. Eugene Russell, Kansas State University, Professor, Civil Engineering
- Dr. Margaret Rys, Kansas State University, Associate Professor, Industrial & Manufacturing Systems Engineer

Committee Members:

- Scott Crain, City of Manhattan, City Engineer
- Steve Hall, City of Manhattan (former Mayor)
- Greg Luttrell, Graduate Research Assistant, Kansas State University
- Jack Messer, (former Manhattan City Engineer)
- Jerry Petty, City of Manhattan Public Works Director
- Jim Tobaben, Kansas Department of Transportation, Chief, Bureau of Planning
- Linda Voss, Kansas Department of Transportation, State Transportation Engineer
- David Woosley, City of Lawrence, City Traffic Engineer

Appendix 2 – Annotated Bibliography

This research identified six primary sources for information regarding *roundabouts (1, 2, 3, 4, 5, and 17).* These six references include major design guides from U.S. and overseas locations. Each of these six primary resources could be taken individually and would provide the reader with a single source view of modern roundabout use, design, capacity and safety. However, taken in combination, they present a broad picture of the modern roundabout, and how its use applies to locals within the United States.

Each reference cited is accompanied by a brief summary of the item.

The reader is cautioned that many of the references interuse the terminology of 'roundabout' and 'modern roundabouts' with 'traffic circle'. Typically when referring to traffic calming techniques, the reference is presenting information with regard to 'traffic circles'. In the rest of these sources, the information relates to 'roundabouts' and 'modern roundabouts'.

1. Maryland Department of Transportation, *Roundabout Design Guidelines,* State Highway Administration, Hanover, Maryland, 1995 - This State DOT manual provides design guidelines for use in Maryland. The manual includes detailed information regarding capacity calculations and geometric considerations. Chapters included in this manual are, use of roundabouts, performance of roundabouts, geometric design, landscape design, signing and pavement markings, lighting, pedestrian and bicycle considerations, and work zone traffic control. This manual has figures containing signing details.
2. Wallwork, M., *Roundabouts, Information Brief and Design Guide,* Alternate Street Design, Inc., Orange Park, Florida, undated - This technical manual was developed by Mr. Wallwork which presents methods to design and calculate the capacity at roundabouts. Chapters include traditional traffic control, modern roundabouts, features of modern roundabouts, geometry of traffic circles and roundabouts, conflicts, capacity of roundabouts and traffic signals, advantages, disadvantages, capacity analysis, geometric design, and roundabout design hints. This manual presents information relating roundabouts to the other types of intersections control, including comparison/ contrast with traffic circles. This manual is based on Mr. Wallwork's experience using Australian design techniques.
3. Troutbeck, R., *The Guide to Traffic Engineering Practice Roundabouts,* Austroads, Sidney, Australia, 1993 – This is the Australian guide to the use, design and analysis of roundabouts. The book includes chapters titled, use of roundabouts, performance of roundabouts, geometric design of roundabouts, pedestrian and cyclist considerations, line marking and signing, lighting roundabouts, landscaping and road furniture, trial installations, traffic regulations for roundabouts, analysis packages for roundabout design, and case studies. This text included detailed geometric design information for roundabouts as well as information concerning non-geometric design issues (pedestrians, bicyclists, lighting, etc.). The book also provides instructions on calculation of roundabout capacity.
4. Taekratok, T., *Modern Roundabouts for Oregon, #98-SRS-522,* Oregon Department of Transportation, Salem, Oregon, 1998 – This manual developed by the Oregon Department of Transportation is the evaluation guide for the State DOT with regards to the possible use of roundabouts. The chapters included in this text are modern roundabouts, safety of roundabouts, pedestrian and bicycle considerations, geometric design of roundabouts, capacity and delay at roundabouts, software models for roundabouts, and other related topics. As this manual was developed to help the Oregon DOT decide if roundabouts are appropriate

in their state, the manual presents much information relating to the choice to use or not use a roundabout. The chapters on delay and capacity, and software provide an in depth presentation of the two primary delay models and the software that has been developed which implements these models.

5. Jacquemart, G., *Modern Roundabout Practice in the United States, Synthesis of Highway Practice 264*, Washington, D.C., Transportation Research Board, National Research Council, 1998 – This document summarizes the current state of roundabouts in the U.S. Chapters include history and evolution of roundabouts, use of roundabouts in the United States: survey results, design guidelines used in the Unites States, design guidelines used in other countries, safety of roundabouts, capacity and delays, issues relating to pedestrians, bicyclists and the visually impaired, and location criteria for roundabouts. This synthesis provides many facts relating to where and under what conditions various types of roundabouts are being used by those states that responded to the document survey.
6. List, G., and Waldenmaier, E., *Omnidirectional Video Instrumentation for Unsignalized Intersections and Roundabouts*, Third International Symposium on Intersections Without Traffic Signals, Portland, OR, 1997 – This paper discusses the advantages and methods of using an omnidirectinal video camera for traffic data collection at intersections.
7. Glauz, W., and Migletz, D., *Application of Traffic Conflict Analysis at Intersections*, National Cooperative Highway Research Program Report 219, Washington, D.C., Transportation Research Board, National Research Council, 1980 – This manual provides definitions of traffic conflicts and methods of collecting and analyzing them.
8. Highway Capacity Manual, Special Report 209, National Research Council, Transportation Research Board, Washington, D.C., 1994.
9. Kansas Department of Transportation, Roundabouts, Topeka, Kansas, undated – This informational brochure summarizes what roundabouts are, advantages of roundabouts and instructions on how to drive them.
10. Ourston, L., *Comparative Safety of Modern Roundabouts and Signalized Cross Intersections*, http://www.west.net/~owendee/safety.html, Ourston & Doctors, Santa Barbara, CA, 1996 – This paper presents crash rates for STOP and signalized intersections and compares these rates with those found at roundabouts. Roundabouts were found to be safer than the STOP and signalized intersections.
11. Ourston, L., and Bared, J., *Roundabouts: A Direct Way to Safer Highways*, Public Roads, Autumn 1995 – The safety to roundabouts in the U.S. is compared to the safety record of roundabouts in Western European countries. While relatively new, the safety record of the U.S. roundabouts parallels that found in Europe, where roundabouts have been in use longer. Pedestrian and bicyclists safety is enhanced at roundabouts.
12. Savage, W., and Al-Sahili, K., *Traffic Circles – A Viable Form of Intersection Control?* ITE Journal, Washington, D.C., Institute of Transportation Engineers, September 1994 – This article discusses the success of roundabout installations in Lansing, Michigan. The authors conclude that roundabouts are safer, more efficient, and offer better aesthetic opportunities than typical STOP intersection control.
13. Todd, K., *Modern Rotaries*, ITE Journal, July 1979, Institute of Transportation Engineers – This article presents findings with regard to the function, design and safety of roundabouts in Britain. Examples are provided of different roundabout configurations. Roundabouts were found to operate more efficiently and safer than previous intersection controls. A list of advantages of roundabouts over conventional intersection control is provided.

14. Russell, E., and Mulinazzi, T., Identification, Analysis an Correction of High-Accident Locations, CTRT Report TASK-94-002, Kansas Department of Transportation, revised second edition, 1994 – This manual outlines techniques for identifying and addressing high accident locations. Specifically used in this study was the section dealing with statistical analysis of accident reductions.
15. Mendenhall, W., Statistics for Engineering and the Sciences, 4th ed., Prentice Hall, Upper Saddle River, NJ, 1995
16. Ott, L., An Introduction to Statistical Methods, 4th ed., Duxbury Press, Belmont, CA, 1993
17. Ourston, L., and Doctors, P., *Roundabout Design Guidelines*, Ourston & Doctors, Santa Barbara, CA, 1995 - This technical design manual presents information relating to the physical design of modern roundabouts. Chapters include types of roundabouts, the siting of roundabouts, safety, road users' specific requirements, landscaping, and geometric design features. The design techniques used in this manual are based on the British roundabout design methods and have been adapted for use in the United States with permission by the authors.

Other Resources On Roundaobuts:

- Blankson, C., *Roundabout Used Successfully as a Traffic Calming Technique*, The Urban Transportation Monitor, Burke, VA, Lawly Publications, March 15, 1996 – This letter to the editor provides the authors viewpoint of roundabout operation from his experience in Ghana. He points out two negatives from his experience: poor operation for pedestrians, erratic operating conditions.
- Brilon, W., and Vandehey, M., *Roundabouts – The State of the Art in Germany*, ITE Journal, Washington, D.C., Institute of Transportation Engineers, November 1998 – The authors find that roundabout capacity is greatly affected by driver abilities and actions and that multi-lane roundabouts do not provide increases in capacity equal to the number of additional lanes. Roundabouts provide safety benefits due to reduced intersection speeds. Safety for all users is highly dependent on using good design. Environmental benefits include the provision of less pavement and a reduction of noise at the intersection.
- Brilon, W., and Stuwe, B., *Capacity and Design of Traffic Circles in Germany*, Transportation Research Record 1398, Washington, D.C., Transportation Research Board, National Research Council, 1993 – This is a paper summarizing the German research with regards to capacity and safety of roundabouts. The German researchers found that German roundabouts have actual capacities 70 –80% of that found at British sites and comparable to French sites. The number of crashes at roundabouts was found to be similar after installation, but the severity decreased greatly.
- Burden, D., *Bicycle and Pedestrian Facilities Planning and Design Workshop*, Manual assembled for Mid-America Regional Council, APA - Greater Kansas City Section, Missouri Department of Transportation and Kansas Department of Transportation, High Springs, FL, Walkable Communities, Inc. 1998 – This workshop manual presents findings with respect to bicyclists activities and safety at roundabouts and traffic circles. Photos and data are presented which find that roundabouts are beneficial to bicyclists.
- California Department of Transportation, *Design Information Bulletin Number 80*, Roundabouts, http://www.dot.ca.gov/hq/oppd/dib/db80.htm, 1998 – This is the California Department of Transportation design guide for roundabouts constructed with in California. It provides explanations of all roundabout geometric features and provides either numeric

values of reach, or direction on how to determine the value for each.

- Flannery, A., Elefteriadou, L., and McFadden, J., *Safety, Delay and Capacity of Single-Lane Roundabouts in the United States*, Transportation Research Record 1646, Washington, D.C., Transportation Research Board, National Research Council, 1998 – This paper evaluates the use of roundabouts as replacements for STOP and signal control. Capacity calculations from SIDRA and the Highway Capacity manual were compared to field observations. Findings indicate that additional research is needed to fine tune the gap acceptance parameters to U.S. operations as the current parameters may lead to an over estimate of available capacity.
- Florida Department of Transportation, *The Florida Roundabout Guide*, http://www-uftrc.ce.ufl.edu/wwwround/guide.htm, downloaded 1999 – Portions of the Florida Roundabout Guide are available for downloading on this web site. Most information given is general in nature with regard to roundabouts, alternative intersection controls and roundabout justification.
- Jadaan, K., *An Application of Traffic Conflict Techniques for Safety Evaluation of Roundabouts*, Australian Road Research, 21(3), September 1991 – This article presents the results of a traffic conflict study of six roundabouts in Kuwait. Traffic conflicts were found to relate directly to the traffic volume, the width of the exit, and angle of exit. A regression model is presented.
- Kansas Department of Transportation, *Are Traffic Signals Really A Cure-all?* Topeka, Kansas, undated – This informational brochure presents an overview of traffic signals, the advantages and disadvantages, and the costs associated with signalization.
- Kreis, D., *The Emergence of Roundabouts as an Effective Form of Traffic Control in the United States*, Compendium: Graduate Student Papers on Advanced Surface Transportation Systems, 1998, College Station, TX, Texas Transportation Institute, 1998 – This research discusses the modern roundabout, compares it to other forms of intersection traffic control, presents when roundabouts should be used, and makes implementation recommendations. The research also examines eight existing roundabouts in Loveland and Vail, Colorado, Lisbon and Towson, Maryland, Jackson, Mississippi, Hilton Head Island, South Carolina, Montpelier, Vermont, and University Park, Washington.
- Maryland Department of Transportation, *Modern Roundabouts* (video), State Highway Administration, 1992 – This video explains the modern roundabout, where it can be used, and the benefits of roundabouts. The benefits are: safest type of intersection control, high capacity, economical, provides lower environmental impacts, and has the ability to be beautified.
- Myers, E., *Modern Roundabouts for Maryland*, ITE Journal, Institute of Transportation Engineers, Washington, D.C., October, 1994 – This article discusses the difference between modern roundabouts and older traffic circles. The history of the design for a roundabout interchange at I-95/ Ritchie – Marlboro Road is presented. A table compares the operation of the roundabout with the alternative traffic signal. The roundabout was found to operate better with regard to v/c ratio, delays, and injury accidents.
- Ourston & Doctors, *I-70/ Vail Road* (video), Santa Barbara, CA, undated – This video follows the change of four STOP controlled intersections, including an Interstate interchange, in Vail, Colorado to roundabout control. Increases in capacity of 50%, elimination of delays and long queues and a decrease of injury crashes were all benefits of the change to roundabout control.
- Ourston & Doctors, *Roundabout Valley: America's Future*,

http://www.roundabouts.com/valley.html, Santa Barbara, CA, 1997 – This web site summarizes the roundabout installation at three Interstate interchanges and one connecting arterial in Vail and Avon, Colorado. There were nine roundabouts installed and three signals removed under this project. The result was alleviation of congestion and provision of safer intersections.

- Ourston & Doctors - Willdan Associates, *Nonconforming Traffic Circle Becomes Modern Roundabout* (video), Santa Barbara, CA, undated – Shows the change at the Pacific Coast Highway/ Lakewood Boulevard intersection in Long Beach, California to a modern roundabout. This roundabout carries 800 – 1800 peak hour vehicles per approach and 5,000 peak hour vehicles total and operates at Level of Service A.
- Ourston & Doctors - Willdan Associates, *Snow at Roundabouts* (video), Santa Barbara, CA, undated – Shows operation of roundabouts in Norway under snow conditions. Video also shows snow removal operations at the roundabouts.
- Ourston, L., *British Interchanges, Intersections, and Traffic Circles*, Westernite, District 6, Institute of Transportation Engineers, September – October 1992 – This article compares the use of intersection traffic control in Great Britain versus the United States. The British favor roundabouts first for their better functionality and signals only as a last resort. This contrasts with the U.S. use of signals primarily.
- Ourston, L., *Wire Nodes and Narrow Roads*, Transportation Research Board 72nd Annual Meeting, Washington, D.C., 1993 – This article discusses the advantages of a roundabout based street network system. Use of roundabouts at intersections allows narrower streets to be used between the intersections, as storage/ turn lanes are not needed. This represents a savings related to all costs associated with the additional pavement needed to support a signalized intersection system. Roundabouts also provide better capacity than signalized intersections.
- Parker, M., and Zegeer, C., *Traffic Conflict Techniques for Safety and Operations – Observation Manual*, Publication no, FHWA-IP-88-027, Federal Highway Administration, McLean, Virginia, 1989 – This manual presents field methods for training personnel and collecting traffic conflict data.
- Reddington, T., *Emergence Of The Modern Roundabout As A Reality In Vermont And Its Relation To Vermont Urban Design And Development*, Paper number 35, 32nd Annual conference of the Canadian transportation research forum, 1997, http://www-mctrans.ce.ufl/wwwround/emergence.htm, downloaded 1999 – This paper presents findings relating to the operation of the roundabout in Montpelier, Vermont and discusses plans for other roundabout throughout Vermont. Also presented is a discussion as to the role a roundabout may play in urban design.
- Redington, T., *Montpelier's Modern Roundabout at Keck Circle Neighborhood Opinion Survey: January 1997*, http://www-uftrc.ce.ufl.edu/wwwround/montpeli.htm, Montpelier, VT, downloaded 1999 – This web site provides a paper on the history and reaction to the roundabout installed in Montpelier, Vermont in 1995. Keck Circle as it is called carries 11,000 ADT and is in the downtown area of Montpelier. Actual respondent comments are provided with regard to use, likes and dislikes of the roundabout. Overall, citizens provided a positive response tot he roundabout installation.
- Savage, J., and MacDonald, R., *A Toolbox Approach to Residential Traffic Management*, ITE Journal, Washington, D.C., Institute of Transportation Engineers, June, 1996 – This article discusses the highlights of the text written by the authors for the Washington State DOT

along with other sources with regard to residential traffic calming.

- Savage, J., MacDonald, R., and Ewell, J., *A Guidebook for Residential Traffic Management*, WA-RD 368.1, Olympia, WA, Washington State Department of Transportation, 1994 – This manual outlines all aspects of the Washington State Department of Transportation residential traffic management program. There is a section in this manual that describes the use and characteristics of traffic circles.
- *Traffic Devices the Experts Like*, Better Roads, October 1998 – This article presents information from the Institute for Highway Safety with regards to roundabouts. Roundabouts were found to be less expensive than traffic signals and operate better then four-way STOP control. The first modern roundabout was installed in Las Vegas in 1990 and "the public response to this and subsequent roundabouts is enthusiastic."
- Troutbeck, R., *Background for HCM Section on Analysis of Performance of Roundabouts*, Transportation Research Record 1646, Washington, D.C., Transportation Research Board, National Research Council, 1998 – The author presents a discussion of the two methods of capacity calculations at roundabouts: gap acceptance theory and empirical model. The two models are compared and recommendations made. The gap acceptance theory method is recommended for use at uncongested sites, while congested sites should be examined using the empirical model. The gap acceptance theory method is the one adopted for use in the Highway Capacity Manual chapter which examines roundabouts.
- Troutbeck, R., *Capacity and Design of Traffic Circles in Australia*, Transportation Research Record 1398, Washington, D.C., Transportation Research Board, National Research Council, 1993 – This article explains the process used in to modify the British design techniques to fit Australian circumstances. Location parameters, geometric designs, and evaluation of roundabouts are presented. Conclusions include that roundabouts are safe and efficient.
- Troutbeck, R., *Effect of Heavy Vehicles at Australian Traffic circles and Unsignalized Intersections*, Transportation Research Record 1398, Washington, D.C., Transportation Research Board, National Research Council, 1993 – The author presents new equations for calculating passenger car equivalents for trucks. The new method addresses the effect trucks have on the gap acceptance theory used to calculate roundabout capacity when the percentage of trucks is large (>5%).
- Yagar, S., Use of Roundabouts, ITE Journal, Institute of Transportation Engineers, Washington, D.C., February, 1992 – This article presents a summary of the findings of an ITE technical council with regard to current (1992) impressions of the usefulness of roundabouts.

Appendix 3 – Sample SIDRA Results – Candlewood Drive/ Gary Avenue

Appendix 4 – Sample SIDRA Results – Dickens Avenue/ Wreath Avenue

Appendix 5 – Sample SIDRA Results – Juliette Avenue/ Pierre Street

Appendix 6 – Local News Articles