November 8, 2016

Members, Technical Committee on Geometric Design

Dear Members,

The annual meeting of the AASHTO Subcommittee on Design, Technical Committee on Geometric Design was held in Woods Hole, MA during the period July 11 through July 15, 2016. Mr. Jeff Jones, Chair, called the meeting to order at 8:00 a.m. on July 11.

Attendance

The following members were present:

Kent R. Belleque, Oregon Department of Transportation
Patricia Bush, AASHTO Program Manager for Engineering
Ray Derr, Transportation Research Board
R. Marshall Elizer, American Public Works Association
Chad Frisinger, North Dakota Department of Transportation
Aaron Frits, Kansas Department of Transportation
Mike Fugett, Arkansas State Highway and Transportation Department
Kevin M. Herritt, California Department of Transportation
Elizabeth Hilton, Federal Highway Administration
Jeff C. Jones, Tennessee Department of Transportation (Chair)
Deanna L. Maifield, Iowa Department of Transportation
Eric E. Marabello, Maryland Department of Transportation
James A. Rosenow, Minnesota Department of Transportation (Vice Chair)
Joe W. Ruffer, National Association of County Engineers
Brent Story, Georgia Department of Transportation
Barton Thrasher, Virginia Department of Transportation
Ryan VanKirk, Pennsylvania Department of Transportation
Richard D. Wilder, New York State Department of Transportation
Robert Wunderlich, National League of Cities
The following members were not in attendance:

Mark A. Leiferman, South Dakota Department of Transportation  
Reza Maleki, Port Authority of New York and New Jersey  
Amutha Vijayakumar, New Jersey Department of Transportation  
Paul Ki-Bun Chan, North Carolina Department of Transportation

Also in attendance were:

Doug Harwood, MRI Global  
Clayton Chen, Federal Highway Administration  
Ricky Mitchell, National Association of County Engineers  
James O. Brewer, retired committee member

Monday, July 11
The committee meeting began with welcoming remarks by the Chair and an overview of the agenda. New members were recognized and introduced; they are:

- Ryan VanKirk representing Pennsylvania Department of Transportation (Region 1)  
- Aaron Frits representing Kansas Department of Transportation (Region 3)  
- Amutha Vijayakumar (not present) representing New Jersey Department of Transportation (Region 1)

Jeff will assign new members to chapter teams for the Green Book update effort.

The effort to update the Green Book was discussed in general terms. A winter meeting will likely be necessary to continue editing the Green Book with a goal of having a ballot-ready copy available in 2017. Regarding units of measure, we will switch to English [metric]. TDOT will make changes to the figures and the Technical Editor will handle the text and tables. It was noted that a more robust Index is desired. Notes from authors would be helpful in this regard.

Review of Guidelines for Geometric Design of Low-Volume Roads
The draft Guidelines for Geometric Design of Low-Volume Roads (2016) was reviewed in detail, with the NCHRP contractor Doug Harwood. Doug gave an overview presentation, noting that the updated guide will raise the ADT threshold from 400 to 2000 and be applicable to roads classified as local or minor collector. There will be much more emphasis on looking at crash history and evidence of problems (guardrail hits, etc.) rather than always upgrading to meet specific values. The philosophy will be that improvements on existing roads should be justified by crash evidence and that systemic improvements are generally not appropriate on low-volume roads. Committee discussion included the following points:

- Weave in more multimodal discussion  
- Term “functional subclass” may be confused with “functional classification”  
- Consider changing title of Chapter 3 as it doesn’t present a design philosophy  
- Clarify provisions applicable to urban streets  
- Re-look at side friction factors in Table 4 compared to Table 3, at low speeds  
- Whether the discussion on stopping sight distance is consistent with the findings in NCHRP Report 783  
- Recommendation to number the examples listed at the beginning of Chapter 5.
Multiple detailed edits were suggested

**Review of Green Book, Chapter 2**
The committee started discussion of redlines of the Green Book with Chapter 2. Bart Thrasher presented an overview of recommended edits. The committee voted (8 in favor, 4 against) to reorganize the chapter to add an introduction as section 2.1 and move existing section 2.1 to follow section 2.7. Elizabeth Hilton agreed to help with language for the introduction. Detailed edits were suggested by committee members.

**Tuesday, July 12**

The committee met jointly with the TRB Committee on Geometric Design (AFB10) and the TRB Operational Effects of Geometrics Committee (AHB65) for the full day. Eric Donnell welcomed attendees on behalf of the TRB committees.

Jeff Jones gave an overview of technical committee efforts, including the recent publication of revised Interstate standards and the work underway to update the Low-Volume Road guide and the Green Book. Jeff discussed the recent resolution on flexible design standards approved unanimously by the AASHTO Standing Committee on Highways (SCOH). Joyce Taylor, Vice Chair of the AASHTO Subcommittee on Design (SCOD), was present and participated in the discussion. Several ongoing NCHRP projects, including 15-47 and 15-52, will help the technical committee address the resolution, but likely not in time for the 2017 edition. Chapter 1 will be rewritten in light of the resolution as part of the 2017 update and other changes will be made to the extent possible. Full implementation of the resolution will need to be addressed in the subsequent update. Attendees discussed issues with State adoption of tables from the AASHTO Green Book without the accompanying text that discusses the flexibility in the application of those tables. Training needs were also discussed at the SCOD meeting held in June. Among the educational needs is increasing understanding of how to integrate use of the various AASHTO publications as well as non-AASHTO publications (e.g. NACTO Urban Street Design Guide).

Adam Kirk (Nelson/Nygaard) gave an overview of the NCHRP 15-52 project to develop a context sensitive functional classification system. The current system lacks land use recognition, balance of modal needs, recognition of suburban context, and recognition of rural community (i.e. small town) main streets. Five context zones are proposed: rural, rural town, suburban, urban and urban core, which are themselves defined by density, land use and building setbacks. These will be an overlay to existing roadway types of arterial, collector or local. Adam showed a matrix that suggested an appropriate balance of modal accommodation based on the context and roadway type. They propose to handle freight and transit as additional overlays. Attendees discussed the idea that all routes can’t be all things to all modes. Sometimes one or more modes need to be accommodated on a parallel route. There was also discussion of the definition of “mobility” and how that differs from “speed”, and whether “mobility” was inclusive of all modes. Implementation funds have been requested to fund state pilot projects.

Rich Coakley (CH2M) and Tim Neuman gave an overview of the NCHRP 15-47 project to develop an improved highway geometric design process. The process must be consistently executable and be problem oriented, primarily problems concerning infrastructure condition, mobility and safety. They utilized land use/context zones from the ITE Walkable Urban Thoroughfares publication. The report will make a major distinction between new construction, reconstruction and 3R. Performance measures include travel time, reliability and cost of travel. Report will discuss target speed and that, in urban
areas, increased speeds do not equal increased quality of road. This project may influence a major update to the Green Book after the 2017 edition.

Marcus Brewer and R.J. Porter sought feedback on their work with FHWA on performance based practical design (PBPD) and the evolution of the geometric design process such that decisions are informed by a performance analysis of the existing facility. Five performance categories were discussed: accessibility (access to destinations by various modes, not in the ADA sense), mobility, quality of service over time, reliability and safety. PBPD is a system-wide approach, while value engineering is a project-level approach. They sought input on future trends and the roles various stakeholders play with regard to trends in practice, performance prediction tools, multimodal performance, benefit-cost analysis, and linking intended project outcomes and performance measures. Discussion focused on the following:

- Disconnect between planning and design – geometric designers tend to get too detailed too early. Level of detail should vary with the stage of project development
- Could a new contextual functional class be adopted under some kind of interim publication prior to a post-2017 Green Book?
- More knowledge about, and acceptance of, the Highway Safety Manual (HSM) is needed
- NCHRP 15-48 on accommodating all users on low/medium speed roadways will be a transitional document that will outline research that needs to be done over next 10-15 years
- Tools are needed that are appropriate at each stage of project development. Use of the HSM and Highway Capacity Manual (HCM) early in project development is too complex. Simplified, high level tools are needed for planning level analyses.
- Ped/bike considerations must be an integral component of early project development, not an afterthought.
- Designers need to better incorporate Strategic Highway Safety Plan (SHSP) goals into project development. Perhaps a case study document would be helpful for awareness.
- Whether a fundamental change can be realized absent a legal mandate

The TRB committees led a discussion of possible research needs to get AASHTO input and feedback regarding priorities, providing an overview of the topics presented in a white paper distributed at the meeting. Feedback included the following:

- Design Methodology
  - The horizontal curve model should be sensitive to context
  - SSD model needs to be sensitive to traffic volume and context in urban areas
  - Long term maintenance costs should be considered
  - Sketch planning tools are needed to look at capacity and safety performance of all modes
- Freeways and Interchanges
  - Buffer guidance between the managed and general purpose lanes
- Intersections
  - Level of Stress application for early planning – how do we measure the sense of safety, livability and public health impacts?
  - Bicycle and pedestrian treatments for different interchange forms
  - Design guidance for selection of vehicle types based on new context zone and road types
- Highways
  - Driver/pedestrian behavior characteristics
  - Which geometric design features will be most impacted by automated/connected vehicles
Attendees talked about the “call to action” that resulted in the CSS conference in Maryland many years ago. How do we affect change? We need an action plan. What do we need to get from where we are now to where SCOH wants us to be and what does the end product look like? TRB can find some funds to support a national meeting to collect input if desired.

**Wednesday, July 13**
The Chair asked members to hold detailed comments on the chapters and *submit all comments to chapter authors by August 3* for their consideration.

**Review of Green Book, Chapter 3**
The committee continued reviewing Green Book redlines with Chapter 3. Rick Wilder led the discussion. He incorporated information from multiple NCHRP reports, including 774, 439, 730, Syntheses 432, 783, and web documents 151 and 198. Discussion included:
- Committee discussed applicability of the Green Book to new construction, rather than reconstruction and moving toward performance based design in the 8th edition (with some limited shift in that direction in the upcoming 7th edition).
- Whether to reduce SSD as in TRB Special Report 214 since the values are overly conservative, and problematic on reconstruction projects. Doug noted that a NCHRP project is nearly complete that will replace SR 214. Also discussed reducing the reaction time by 2 seconds but there is a lack of research to support this change. Adoption of lesser, fixed criteria at odds with using performance based criteria. Consensus to reconsider discussion in subsequent edition of the Green Book. More research into SSD criteria is needed.
- Horizontal curve formulas and comfort side friction factors date to the 1940s. Rick proposed adding 0.1 to the friction factors. Consensus not to modify at this time. General language about design exceptions and flexibility will be included in Chapter 1.
- Discussed adding high-speed criteria for curvature. Chapter 10 needs to look at TTI report for language on accel/decel design. Committee decided to stop at 85 mph.
- Discussed dropping Superelevation methods 1, 3, 4 – most agencies using 2 and 5 only but they want to keep all of them. Methods 3 & 4 help explain how we got to Method 5. Consensus to retain all 5 methods.
- Table 3-29: Change to ‘traveled way’ and continue referencing from Chapter 10. Relook at interplay to make clear this is just ramp terminals, not entire ramp length.
- The chapter team was reminded of the apparent errors in Section 3.4.2.

**Review of Green Book, Chapter 6**
Mike Fugett walked through proposed edits that incorporate comments received at our meeting last year. Members discussed the minimum lane and shoulder widths in Table 6-5 and whether the minimum shoulder width should be reduced with a footnote stating that wider shoulders may be warranted based on expected safety performance. Also discussed changing lane widths to 11’ even at higher ADTs. Section 6.3.2 provides ranges for key dimensions, while Table 6-5 is more specific. A small group of Rosenow, VanKirk and Mitchell (& Wilder?) will work with Fugett to propose an approach for modifying this table. Their recommendation should address similar tables in other functional chapters.

Mike agreed to coordinate with Marshall and Deanna on language regarding transitions between high speed and low speed sections. Also discussed removing the 50, 55 and 60 mph columns from Table 6-8 (Maximum Grades for Urban Collectors) because those speeds are too high in an urban context.
Reconvene with TRB Committees
The three groups reconvened to prioritize research needs so problem statements can be developed and submitted to NCHRP for funding consideration. The top priorities within the topic groups discussed the previous day are:

- Freeways and Interchanges
  1. Guidance for Geometric Design of Managed Lanes (put on hold for one year, and seek input from TRB Managed Lane Committee)
  2. Evaluating Trade-offs of Freeway Lane Widths and Shoulder Widths
  4. Design Guidance for Left-Side Ramps

- Intersections
  2. Freight/Large Design Vehicle Considerations by Context Zones for Intersections and Driveways
  3. Safety Effectiveness of Dual (and Triple?) Left-Turn Lanes

- Methodology and Highways
  1. Establish a framework for the multi-modal project development
  2. Methods and approaches for sight distance design by functional class and context
  3. Develop education and training for the flexibility of the Green Book
  4. Risk-based approaches in geometric design

Review of Green Book, Chapter 4
Kevin Herritt walked through proposed edits. Members discussed the definition of Roadway and Traveled Way and where bike lanes should be included. It was noted that the definition for Traveled Way in the AASHTO Roadside Design Guide excludes bike lanes. Terms need to be defined consistently, at least within the Green Book.

Members also suggested eliminating dimension ranges for lane widths here and referring to the functional chapters for specifics. Discussion about moving Fig. 4-2. Discussion about pedestrian use of shoulders and when shoulders must comply with accessibility requirements. Discussion about curb heights and shape and suggestion to review NCHRP Report 537. Authors will add some language on driveway design from NCHRP 659, perhaps including Exhibits 5-24 and 5-74.

Review of Green Book, Chapter 5
Ricky Mitchell and Joe Ruffer walked through proposed edits to Chapter 5, which were handed out at the meeting. Propose to add 35 mph column to Table 5-2 and Table 5-5. Shoulder widths will be guided by the work of the subgroup described under Chapter 6.

Review of Green Book, Chapter 7
Marshall Elizer and Deanna Maifield gave an overview of proposed edits to Chapter 7. Suggestion made to include an appropriate amount of guidance on high-speed to low-speed transitions from NCHRP 737. Discussion on whether a two-way left turn lane is considered a “median”. Suggestion to add a discussion of 3-lane sections. Revisions to the design speed language on p. 7-27 were requested. Request made to revise 7.3.3 to discuss safety of narrower lanes in urban areas with a reference to the Highway Safety Manual, along with possible language added from NCHRP 783 (p. 82). Suggestion to introduce readers to the context zones from NCHRP 15-52 as part of selecting the appropriate design criteria.
Thursday, July 14

Review of Green Book, Chapter 8
Jim Rosenow walked through proposed edits to Chapter 8. Agreement to remove “bridge piers” and “walls and piers” in 8.2.10. Members asked Jim to rewrite the last sentences under 8.4.4 (Medians) rather than deleting it entirely. A suggestion was made to add a reference to the AASHTO Guide for Development of Rest Areas on Major Arterials and Freeways.

Review of Green Book, Chapter 9
Brent Story and Robert Wunderlich walked through proposed edits to Chapter 9. Authors have nine research reports to review (NCHRP 432, 572, 650, 659, 780, 672, 707, 745, & 780). Proposal to change skew angle from 60 to 75 degrees based on research. Left turn warrants recommended by NCHRP 780 set a low threshold for installation. A lot of discussion by members about left turn deceleration lengths and whether a 10 mph speed differential in the through lane was an appropriate basis for design. Authors to draft language. Agreement to delete Table 9-16 and related diagrams, retaining only an example of a 3-centered curve design. Discussion about time gaps in ISD cases.

Review of Green Book, Chapter 10
Kent Belleque and Eric Marabello walked through proposed edits to Chapter 10. They plan to add more discussion throughout about wrong-way driving. Discussion about whether to add back in the 100’/300’ dimensions to the access control discussion. Consensus not to do so as these dimensions are usually inadequate. DDI language added but photos are needed for inclusion. SCOTÉ would like to eliminate the allowance of an inside merge, as shown in Figure 10-53-A1, but committee members want to retain it. Table 10-1 is under review as part of an ongoing NCHRP study but results won’t be available in time for this update. Auxiliary lane and reduction language will be reviewed based on discussion at last year’s meeting to better sync with MUTCD (refer to FHWA handout from last year). Look at including suggested language on ramp and interchange spacing from NCHRP web 169. Request to revisit language regarding total paved width on p. 10-102, noting it may be more important than lane and shoulder widths are individually. Request to add information from NCHRP 687 that was intended to replace Fig. 10-68 for committee review and comment. Suggestion to relook at 2-10’ range in Fig. 10-69.

Review of Green Book, Chapter 1
Doug Harwood had prepared a new Chapter 1 focused on performance based design but suggests reworking it in light of the SCOH resolution. Chapter 1 can be a bridging document to the next edition of the Green Book. Discussion points envisioned are:
- Why this Green Book looks different
- Functional class and context
- Consider all modes in reasonable balance
- Characteristics of modes – movement of people and goods
- New construction vs. projects on existing roads
- Flexibility (lots in GB) and constraints (STA manuals, design exceptions/waivers)
- Performance-based design (what’s possible now and what’s coming in future)

Further discussion of needed research
- Stopping sight Distance model (by functional class and context) – Rick Wilder
• Horizontal curve model (looking at risk, maybe new side friction models) – Rick Wilder and Tim Neuman and Ryan (PA)
• Safety implications of the geometric design of left turn (no taper, short taper, full taper) – is decel out of the through lanes really important – from chapter 9 discussion. Focus on rear-end crashes – Wunderlich, Aaron – performance based

**Discussion of Outreach and Training Needs**
• NCHRP can fund webinars to help with implementation.
• NHI course on the Green Book would cost about $600k. Marshall, Deanne will develop proposal.
• Spring symposium to tie together NCHRP 15-47 and 15-52 was discussed

**Addressing SCOH resolution**
• Suburban design criteria
• Need document to lay out a game plan
• Framework for the 8th edition of the GB

**Friday, July 15**

**Final round of further comments on GB chapters**
• Ch 7 – Discussed whether to reference the NACTO Urban Street Design Guide. Consensus to reference as needed when discussing urban core and perhaps urban context and adding language to Chapter 1 referencing the FAST Act provisions.
• Ch. 7, page 41-46 – Trim operations discussion in 7.3.12 and 7.3.13, keeping only geometric design related information.
• Ch 6-8, Discussion of foreslopes and whether to say 1:8 slopes are desirable. Kevin and Deanna coordinate with Roadside Safety committee to determine language in this regard.
• Chapter 3 (Jim, Rick bring forward) –
  o P. 3-34: new language inserted from NCHRP 774 about sharp horizontal curves will have a big impact on loop ramps. Last sentence attempts to address existing situations. Is there another solution that can mitigate the problem? Perhaps more super? Spiral help at the bottom? Doug Harwood will review research and suggest language.
  o P. 3-69, Jim Rosenow will take a shot at rewriting the language about placement of the superelevation transition to allow flexibility to put less on the tangent to improve comfort or due to constraints.
• Discussion about horizontal sight distance on directional ramps (flyovers, etc). MRI has a project underway (NCHRP 15-59) to develop risk-based model and relook at how GB says to measure sight distance.
• Maximum deflection without a curve – used to be in GB but seems to have been removed. Look at including again in Chapter 3.

**Editing guidance**
• Publications has reconverted files and posted them on SharePoint. Technical editor will use those to start from scratch. No need for chapter authors to start over because technical editor will make all markup changes in the control files.
• Need all chapter files done by Nov. 15. Earlier is better so technical editor can get started.
• TDOT will manage the images in MicroStation.
• Refer to Jeff’s 10/2/15 email on how to format track changes.
• Suggestion to trade chapters to do final proof at last stage before balloting. Decision to review your chapter plus the subsequent chapter prior to next meeting.
• Ray will work to add funds to the 20-7 contract to revise Chapter 1 to better reflect the SCOH resolution.
• Patricia sending guidance on photos, but not many new photos are anticipated.
• Aaron Frits assigned to Chapter 9, Ryan VanKirk to Chapter 2
• Need non-freeway photos on next cover. Send good photos to group/AASHTO for consideration

Closing

A timeline for getting to ballot with the Green Book in 2017 was discussed. The next meeting of the committee is not yet scheduled but will probably be in February or March. Jeff will work with Patricia to schedule it and details will be announced as soon as they are available.

The annual meeting of the Technical Committee was adjourned at approximately 9:30 a.m. on July 15.