- 1 Understanding Everyday Travel Experiences and Transportation
- 2 Infrastructure Challenges of People with Disabilities in Denver, CO
- 3 4

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### 1 ABSTRACT

- 2 A common perception is that the transportation experiences of people with disabilities have
- 3 improved dramatically since the passing of the Americans with Disabilities Act (ADA) in 1990.
- Though much progress has been made, many aspects of the current transportation system still limit
   people with disabilities from traveling safely and efficiently. Moreover, transportation planning and
- 6 design efforts consistently lack representation of people with disabilities.
- 7 Our research seeks to address this disconnect via semi-structured interviews with (i) twenty-8 eight stakeholders who self-identify as having a disability; and (ii) nine government officials whose
- 8 eight stakeholders who self-identify as having a disability; and (ii) nine government officials whose
  9 work intersects with the supply of infrastructure regulated under the ADA. All interviewees reside or
- 10 work in the Denver region in Colorado. One objective is to understand how attributes of
- 11 transportation infrastructure impact the daily mobility of people with disabilities. A second is to
- 12 comprehend how the programming and management of transportation assets impacts navigation for 13 people with disabilities.
- 14 Through a thematic and content analysis of the interview corpus, we reveal the challenges 15 faced by people with disabilities through hard infrastructure issues and the
- 16 programming/management of transportation facilities. Together, these act to diminish the quality of
- 17 mobility options for people with disabilities. When working to create a transportation network that
- 18 is universally accessible, it is critical for planners and engineers to work with people with disabilities
- 19 when attempting to consider the design needs of individuals with different types of disabilities.
- 20
- 21 Keywords: accessible transportation and mobility, Americans with Disabilities Act, design,
- 22 infrastructure, lived experience, transportation equity, Universal Design
- 23

#### 1 INTRODUCTION: Limits in Implementing ADA for Mobility of Persons with Disability

2 3

Transportation is a lifeline to accessing education, work, healthcare, food, and other opportunities

4 (1-4). When the transportation system fails to provide for the travel needs of individuals,

5 consequences can include reduced access to opportunities in the short term and diminished

6 economic and well-being outcomes in the medium- to long-term. This is particularly true for people

with disabilities, who typically rely more on multi-modal transportation systems than those who donot identify as having a disability (5).

There is a common perception that, since the passing of the Americans with Disabilities Act (ADA) in 1990, the transportation needs of people with disabilities are now routinely considered and realized (6). Yet, transportation planning and design efforts constantly lack representation of people with disabilities (7,8). This paper seeks to address this disconnect by relying on semi-structured interviews with (i) twenty-eight stakeholders who self-identify as having a disability; and (ii) nine

14 government officials whose work intersects with the supply of infrastructure regulated under the

ADA. Using the Denver region as a case study, our intent is to shed light on the reality of transportation challenges faced by people with disabilities, by planners whose work operationalizes

ADA, and the importance of involving individuals with disabilities in planning and design processes.

- 18 Like other North American metropolitan regions, the Denver region contains the City and County
- 19 of Denver at the primary hub, surrounded by urban and suburban cities that make up the region (9).

20 In the United States, the ratio of the population not having disabilities to those having at 21 least one disability is 8:1, although this ratio shifts to 3:1 for those 65 years and older (10). 22 Additionally, the United States' population is aging, which may increase the prevalence of those 65 23 years and older with age-related disabilities with direct implications for daily travel (11-14). The lack 24 of voices for those living with disabilities is exemplified by the uneven representation of people with 25 disabilities in the workforce. For example, people without disabilities outnumber people with 26 disabilities working in architecture and engineering, construction and extraction, and transportation 27 and material moving occupations by approximately 24:1 (15).

28 There have been improvements to ground transportation systems across the United States 29 since the initial passing of the ADA, such as the addition of lifts on public transit vehicles (16). 30 However, significant barriers remain regarding how transportation infrastructure is prohibitive or 31 dangerous for people with disabilities. Much of this is evidenced by recent lawsuits against local 32 governments, on issues including curb ramps and sidewalk accessibility, failure to install elevators at 33 transit stations, and failure to provide audible feedback for blind and low-vision passengers (17-19). 34 The National Council on Disability even stated that "...lawsuits and forced settlement agreements may be essential tools for ensuring compliance" (20). 35

36 In a review of forty national surveys that asked questions about people with disabilities' daily 37 lives, information on travel and transportation was among the least asked-about topics (21). 38 Moreover, there remains an overall lag in developing infrastructure asset inventories that seem 39 critical for mobility of people with disabilities. Gibson and Marshall, for instance, discuss how local 40 governments have limited knowledge of sidewalk presence, condition, and existing obstructions (22). 41 A combination of limited survey data on people with disabilities' experiences and a lack of data on 42 infrastructure may lead to inaccuracies in evaluating infrastructure to accurately reflect the needs of 43 multiple groups, including people with disabilities, older adults, and children. 44

Planners and engineers design systems to help populations such as people with disabilities as
required by the ADA. As such, lived experiences of people with disabilities should be an essential
learning tool to help increase a community's knowledge of infrastructure design, policies, and

learning tool to help increase a community's knowledge of infrastructure design, policies, and
practices (23-25). Following in the tradition of learning from local knowledge and community

48 experts (26), this research relies on twenty-eight semi-structured interviews, twenty-six of which are

1 individuals who self-identify as having a disability (two are caregivers or advocates), to answer two

- 2 primary research questions:3 1. Given disability
  - 1. Given disability type, how do attributes of the transportation infrastructure impact the daily mobility of people with disabilities?
    - 2. How does the programming and management of transportation assets impact navigation for people with disabilities?

7 We also interviewed nine government officials about their challenges in planning for people with 8 disabilities and the implementation of the ADA. While it is important to recognize that no two

9 persons' experiences are the same, we use these interviews to inform current practice by identifying

10 common themes from stakeholder interviews about their everyday travel experiences.

- 12 LITERATURE REVIEW
- 13

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6

14 In this review of the literature, we initially focus on studies dealing with the infrastructure challenges

15 faced in the daily lives of persons with disabilities as well as the resulting opportunity restrictions.

16 We then consider research about how expert knowledge (of designers, planners, and engineers) can

improve by learning from the lived experiences of marginalized groups such as individuals withdisabilities.

10

# 20 Infrastructure Challenges and Constraints to Opportunity

21

22 Bjerkan and Øvstedal conducted a detailed literature review on the intersection of disability and

23 transportation (27). They identified eight functional requirements: accessible, centralized

information; flexibility; safety and security; physically accessible design; reliability; economic

25 predictability; reduced administration; and short, predicted travel times. Each of these can be viewed

as a challenge that people with disabilities face for daily travel.

27

## 28 Infrastructure failures and limitations

29 The literature suggests that public agencies have a limited focus on improvements that would also

30 help individuals with disabilities. In a survey of ten regional and local governments plus transit

- 31 agencies across the United States, professionals indicated that their agency leadership showed high
- 32 levels of support for pedestrian planning and first-/last-mile initiatives, but support for projects such

33 as pedestrian access to transit was not viewed as important (28). In another survey, researchers

- 34 found that public transportation agencies did not provide efficient services nor transit operator
- training to assist people with disabilities in getting where or when they needed to travel (29). A study of sixteen cities across the U.S. identified that many cities rarely go beyond ADA requirements.
- of sixteen cities across the U.S. identified that many cities rarely go beyond ADA requirements,
   approaching sidewalk maintenance and inventory management from a legal risk reduction
- approaching sidewalk maintenance and inventory management from a legal risk reduction
   perspective rather than prioritizing a fully accessible pedestrian network (22). A study conducted in
- perspective rather than phonuzing a rully accessible pedestrian network (22). A study conducted if
   Cambridge, Massachusetts, for example, evaluated ADA conditions of sidewalks and found that
- 40 nearly half of all sidewalks within the city did not meet the minimum 36-inch width ADA standard
- 41 *(30)*.
- 42

## 43 Challenges with navigating the city for people with disabilities

- 44 The built environment, along with personal capabilities—such as access to vehicles, attitudes, and
- 45 health—influence the type of trips people make. As adults age, social interactions become
- 46 increasingly important (12). High vehicle speeds may reduce social activities for older adults, who are
- 47 more risk averse than younger cohorts (31). Poor street conditions and unstable surfaces exacerbate
- 48 mobility disparities when traveling even short distances in urban settings (32,33). A person's type of

1 disability may also influence the kinds of trips taken (34).

2 In a qualitative analysis of public transit users in London who use a wheelchair, where the 3 United Kingdom's Disability Discrimination act 1995 applies, Velho identified both physical and

4 social challenges (*35*). The challenges resulted in added anxiety and risk of physical and emotional

5 safety (25). Another UK-based study found that wheelchair users encountered barriers to shopping

6 centers such as inaccessible or crowded pedestrian environments, poor labeling of handicap parking,

and limited information about accessible services (23). In the United States, Cochran found that
 negative interactions with transit operators and other customers limited the willingness to use these

- 9 systems, while Shirgaokar et al. found that the open-streets policies during COVID-19 radically
- 10 changed the navigability of sidewalks, streets, and parking spaces (24,36).
- 11

### 12 Limited access to opportunity for people with disabilities

13 People with limited physical capacities, including young children and older adults, generally have

14 access to fewer opportunities for education, work, and entertainment. People with disabilities are

also twice as likely to live in poverty, and only 32% of the working-age people with disabilities are

16 employed (37). The U.S. Bureau of Labor Statistics estimated that half of all unemployed people

17 with disabilities experience workforce barriers, including transportation access *(3)*. In the City of

18 Toronto, Canada, which is subject to the Accessible Canada Act, wheelchair users had access to

19 three-quarters of non-wheelchair users' jobs because of accessibility barriers at public transit facilities

(38,39). In a thorough literature review of costs associated with disabilities, Mitra et al. found that
 households with persons with disabilities experienced higher cost burdens for healthcare and

22 transportation (40).

In the New York metropolitan region, people with disabilities earned up to 17.1% less, were more likely to use public transit, and experienced longer commutes than workers without disabilities (41). In the Greater Toronto and Hamilton Area in Canada, a qualitative study examined school site design with parents of children who had disabilities (42). The study concluded that even with schools meeting minimum disability parking requirements, parents still had to alter arrival and departure schedules resulting in reduced access to education (43).

29

# 30 Expert Knowledge Versus Lived Experiences

31

To the best of our knowledge, there is limited research on how planning/design decisions and priorities affect people with disabilities. A literature review of five planning journals found only 36

34 published papers on disability-related topics *(8)*. Gebresselassie reviewed 53 graduate-level

transportation planning courses and found that the curriculum's content on planning accessible transport for people with disabilities was limited in scope (44). Bromley et al. relied on interview

transport for people with disabilities was limited in scope (44). Bromley et al. relied on interviews
 with people with disabilities and recommended inclusive transit, Universal Design, greater inclusion

37 with people with disabilities' views in policy, raising public awareness, recognition of the need for

39 compromise between people with disabilities and service providers, and best practice analysis as

40 ways to improve mobility for people with disabilities (23).

41 Universal Design is increasingly seen as a solution to reducing access barriers in the built 42 environment (45). Imrie argues that operationalizing Universal Design in practice is problematic

43 since people with disabilities are viewed as informants of a process rather than being considered

44 experts. Decision-making authority is reserved for professionals, continuing to further the divide

between professional practice and lived experience. Costanza-Chock draws similar comparisons
 across various professional industries, including architecture, urban planning, product design, and

across various professional industries, including architecture, urban planning, product design, and
 medical technology (46). An under-representation of people with disabilities and other marginalized

48 groups in decision-making leads to erasure and ableism in project execution. Corburn argues that

1 incorporating local knowledge from the most at-risk community members should be as crucial as 2 standard professional practices for more inclusive and effective planning outcomes (26).

3 This discrepancy between expert knowledge and lived experience is also being recognized in 4 other aspects of transportation. For example, a qualitative study comparing cyclists' and planning 5 professionals' perceptions of bicycling showed differences in perspectives between professionals and

6 cyclists (47). Marquart et al. found that professionals viewed the effectiveness of bicycling

7 infrastructure from a network level, whereas individual bicyclists consider their own human

8 experience along routes. A network may be well connected from a bird's eve view, yet individual 9

factors and the experience while riding impact a person's positive and negative associations with 10 infrastructure. In a similar vein, the present study seeks to learn from the everyday lived experiences

11 that impact people with disabilities' decisions about how, where, and when to travel.

12

#### 13 **STUDY CONTEXT**

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15 This study focuses on the transportation experiences of people with disabilities living within the

16 Denver region in Colorado, which consists of nine counties: Adams, Arapahoe, Boulder,

17 Broomfield, Clear Creek, Denver, Douglas, Gilpin, and Jefferson Counties (48). The Denver region

18 has an estimated population of 3.1 million (10). Nine percent of the population identifies as having

19 one or more disabilities (Table 1), while thirty percent of those 65 years and older have one or more

- 20 disabilities.
- 21

#### 22 Table 1 Population with One or More Disabilities

|                               | All population |              |              | Older adults (65+ years) |            |              |
|-------------------------------|----------------|--------------|--------------|--------------------------|------------|--------------|
|                               |                |              |              | Population               |            |              |
| County                        | Total          | Population   | Percent      | Total                    | w/         | Percent      |
| -                             | Population     | w/disability | w/disability | Population               | Disability | w/disability |
| Adams                         | 500,418        | 52,006       | 10.4%        | 50,041                   | 18,049     | 36.1%        |
| Arapahoe                      | 637,690        | 57,415       | 9.0%         | 80,198                   | 23,555     | 29.4%        |
| Boulder                       | 320,329        | 26,043       | 8.1%         | 43,080                   | 11,010     | 25.6%        |
| Broomfield                    | 67,545         | 5,479        | 8.1%         | 8,876                    | 2,579      | 29.1%        |
| Clear Creek                   | 9,382          | 928          | 9.9%         | 1,842                    | 418        | 22.7%        |
| Denver                        | 699,351        | 67,073       | 9.6%         | 79,750                   | 26,730     | 33.5%        |
| Douglas                       | 334,814        | 22,459       | 6.7%         | 38,204                   | 9,612      | 25.2%        |
| Gilpin                        | 5,960          | 572          | 9.6%         | 1,079                    | 264        | 24.5%        |
| Jefferson                     | 568,063        | 57,029       | 10.0%        | 90,245                   | 26,893     | 29.8%        |
| Denver Region                 | 3,143,552      | 289,004      | 9.2%         | 393,315                  | 119,110    | 30.3%        |
| United States                 | 319,706,872    | 40,335,099   | 12.6%        | 49,488,873               | 17,063,045 | 34.5%        |
| Source: US Census Bureau (10) |                |              |              |                          |            |              |

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24

25 Within the Denver region, ambulatory disabilities constitute the highest recorded disability 26 (Table 2) across the population of people with disabilities and those 65 years and older. One in four 27 people with disabilities has a condition that limits their ambulatory capacity-this figure increases to 28 29% for those 65 years and older. Table 2 highlights the variation in disability in the Denver region's 29 population. Broadly, we find that the transportation literature has largely been quiet on how 30 individuals with *different* disabilities interact with infrastructure.

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| 1 | Table 2 Disability | Type* | by | County | and Ag | e |
|---|--------------------|-------|----|--------|--------|---|
|---|--------------------|-------|----|--------|--------|---|

|                       |         |        |           |            |           | Independent |
|-----------------------|---------|--------|-----------|------------|-----------|-------------|
| County                | Hearing | Vision | Cognitive | Ambulatory | Self-Care | Living      |
| Adams                 |         |        |           |            |           |             |
| All Ages              | 14,784  | 9,627  | 19,124    | 24,886     | 8,555     | 15,410      |
| 65 and Older          | 8,042   | 3,364  | 3,999     | 10,845     | 3,449     | 6,702       |
| Arapahoe              |         |        |           |            |           |             |
| All Ages              | 17,145  | 10,649 | 21,073    | 26,879     | 10,277    | 20,660      |
| 65 and Older          | 10,236  | 3,995  | 5,615     | 13,639     | 4,468     | 9,708       |
| Boulder               |         |        |           |            |           |             |
| All Ages              | 9,029   | 4,350  | 9,996     | 10,527     | 3,701     | 7,858       |
| 65 and Older          | 5,601   | 2,107  | 2,234     | 5,828      | 1,720     | 3,839       |
| Broomfield            |         |        |           |            |           |             |
| All Ages              | 1,955   | 1,014  | 1,957     | 2,237      | 607       | 1,364       |
| 65 and Older          | 1,451   | 441    | 517       | 1,326      | 335       | 816         |
| Clear Creek           |         |        |           |            |           |             |
| All Ages              | 339     | 170    | 138       | 362        | 172       | 258         |
| 65 and Older          | 179     | 72     | 58        | 209        | 65        | 172         |
| Denver                |         |        |           |            |           |             |
| All Ages              | 18,827  | 13,724 | 25,797    | 30,617     | 12,038    | 22,769      |
| 65 and Older          | 10,791  | 4,813  | 6,792     | 16,267     | 5,984     | 11,406      |
| Douglas               |         |        |           |            |           |             |
| All Ages              | 7,990   | 3,406  | 7,556     | 8,161      | 2,856     | 6,098       |
| 65 and Older          | 4,690   | 1,130  | 2,028     | 4,753      | 1,364     | 3,331       |
| Gilpin                |         |        |           |            |           |             |
| All Ages              | 279     | 36     | 228       | 270        | 53        | 193         |
| 65 and Older          | 200     | 0      | 77        | 155        | 10        | 39          |
| Jefferson             |         |        |           |            |           |             |
| All Ages              | 20,603  | 10,093 | 19,210    | 25,250     | 8,877     | 18,002      |
| 65 and Older          | 12,925  | 4,610  | 5,968     | 15,169     | 4,860     | 9,943       |
| Total                 |         |        |           |            |           |             |
| All Ages              | 90,951  | 53,069 | 105,079   | 129,189    | 47,136    | 92,612      |
| 65 and Older          | 54,115  | 20,532 | 27,288    | 68,191     | 22,255    | 45,956      |
| Percentage (of Total) |         |        |           |            |           |             |
| All Ages              | 17.6%   | 10.2%  | 20.3%     | 24.9%      | 9.1%      | 17.9%       |
| 65 and Older          | 22.7%   | 8.6%   | 11.4%     | 28.6%      | 9.3%      | 19.3%       |

Source: US Census Bureau (10)

\*Persons may identify as having one or more disability

The Regional Transportation District services six counties in the Denver region with commuter rail, demand responsive, light rail, and bus services (49,50). Other transportation options include various transportation network companies such as Uber, Lyft, Via Mobility Services, and Via paratransit. Figure 1 shows the extent of RTD's service area. RTD is obligated to provide paratransit services only within three-fourths of a mile of any existing and operating transit route (shown in blue for bus, and purple for light rail). Thus, a large portion of the region does not have any supply of public transportation for people with disabilities, especially for those who live farther away from the 12 more urban areas.



Figure 1 RTD service area (Denver region)

1 Similar to national trends, people with disabilities in the Denver region are also more likely 2 to rely on modes of transportation where they are the passenger, using public transport, or walk 3 compared to people who do not have a disability (Table 3). Fewer people with disabilities drive 4 alone compared to people who do not have a disability, making it critical for planners and engineers to focus on infrastructure that intersects with multi-modal travel.

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## Table 3 Travel Mode Share for Commuting to Work in the Denver Region\*

|   | Total Civilian<br>Non-<br>institutionalized<br>Population | Percent splits | With a<br>disability | Percent splits |
|---|---|----------------|----------------------|----------------|
| Workers aged 16 and Over                  | 1,569,915   | 100.0%         | 74,877               | 100.0%         |
| Car, truck, or van – drove alone          | 1,170,620   | 74.6%          | 50,408               | 67.3%          |
| Car, truck, or van – carpooled            | 132,095   | 8.4%           | 7,690                | 10.3%          |
| Public transportation (excluding taxicab) | 69,774  | 4.4%           | 5,522                | 7.4%           |
| Walked                                    | 38,650  | 2.5%           | 2,390                | 3.2%           |
| Taxicab, motorcycle, bicycle, or other    |   |                |                      |                |
| means                                     | 34,558  | 2.2%           | 1,866                | 2.5%           |
| Worked at home                            | 123,894   | 7.9%           | 6,865                | 9.2%           |

Source: US Census Bureau (51)

8 9 \*Commute Data for Broomfield, Clear Creek, and Gilpin Counties are unavailable.

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#### 11 DATA AND ANALYTICAL APPROACH 12

#### 13 **Research Approach**

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#### 15 Stage 1 Interviews with People with Disabilities

16 We conducted hour-long, semi-structured, online interviews from February 2021 to March 2022

17 with 28 people to understand what infrastructure limits mobility, when, and how. Twenty-six

18 interviewees self-identified as having a disability, and two interviewees were educators at a local

19 school for children and adults with disabilities. Twenty-seven were located within the Denver region.

20 The interview group was relatively diverse based on disability status, use of mobility devices, and

21 gender (see Table 4). We developed eight open-ended interview questions about general daily travel, 22 barriers experienced, and variations in travel behavior due to inclement weather or COVID-19. The

23 research team stopped interviews once there was internal consistency and thematic saturation of

24 responses as suggested by Bowen and Creswell et al. (52,53).

25

26 Stage 2 Interviews with experts (planners/engineers)

27 We spoke with nine transportation professionals working at municipalities or nonprofits throughout

28 the Denver region (Table 5). We conducted thirty-minute, semi-structured, online interviews during

29 April and May 2022 with nine such planners and engineers. Our agenda was to explore the 30 challenges public sector organizations face in complying with ADA. One interview was with two

31 transportation planners working at the same agency. We asked six open-ended questions about how

32 infrastructure is planned and implemented in each agency, how each person interacts with

33 accessibility projects, challenges in planning and implementation of projects, and how the ADA

34 interacts with planning, implementation, and maintenance of projects.

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#### 1 **Procedures in the Field**

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#### 3 Stage 1 Interviews with People with Disabilities

4 Participants for stage 1 were recruited via a digital flyer shared with transportation advocacy groups 5 and disability rights groups throughout the Denver region. Groups shared information about the 6 study through social media, newsletters, and one blog post; hence, we relied on online recruitment 7 and snowball sampling. Interested participants completed an online survey hosted on the Qualtrics 8 platform to ensure eligibility for an interview. Survey questions included photographs with alt text 9 descriptions of missing sidewalks or barriers, such as an electric scooter, asking respondents to share 10 how they would navigate each situation, thus priming the sample for a deeper discussion. Survey 11 respondents were then invited to schedule an hour-long online interview. Each interview participant 12 was provided with information on confidentiality with consent obtained per IRB requirements. 13 Upon completion of the interview, participants were sent a \$25 gift card. 14 The interviews were facilitated over Zoom's online meeting platform and recorded for

14 The interviews were facilitated over Zoom's online meeting platform and recorded for 15 subsequent notetaking. The researchers noted key talking points during each interview. Upon

16 interview completion, researchers used the audio recordings to take in-depth notes and add critical

17 insights to a digital whiteboard (54). We then attempted to identify related themes across participant

18 responses. Audio recordings were also used to collect quotes from the participants, which were

19 marginally edited for grammar and content for inclusion in this paper. Table 4 shows key

- 20 characteristics for the sample.
- 21

#### 22 Table 4 Sample Characteristics of People with Disabilities interviewees

|                      | Interviewees<br>(n = 28) | Percentage |
|----------------------|--------------------------|------------|
| Gender               |                          |            |
| Male                 | 15                       | 54%        |
| Female               | 13                       | 46%        |
| Non-binary           | 0                        | 0%         |
| Disability*          |                          |            |
| Ambulatory           | 16                       |            |
| Hearing              | 3                        |            |
| Cognitive            | 2                        |            |
| Visual               | 9                        |            |
| Self-Care            | 3                        |            |
| Independent Living   | 2                        |            |
| Multiple             | 7                        |            |
| Use of Mobility Aids |                          |            |
| Yes                  | 19                       | 68%        |
| No                   | 9                        | 32%        |
| Drives Independently |                          |            |
| Yes                  | 13                       | 46%        |
| No                   | 15                       | 54%        |

23 \*Percentage not presented since interviewees identified as having one or more disability 24

25 Stage 2 Interviews with experts (planners/engineers)

- 26 Professionals in stage 2 were contacted via publicly available emails and professional connections.
- 27 Researchers emailed professionals requesting a 30-minute conversation. Conversations were
- 28 conducted over Zoom but were not recorded due to privacy concerns of public employees.
- 29 Researchers documented the responses to six questions using Microsoft Word. Responses were then
- 30 migrated to a separate digital whiteboard to identify themes (54). Professionals were not

- 1 compensated via electronic gift cards or by any other means. Table 5 lists the expertise cohorts for
- 2 the professional interviewees.

#### 4 Table 5 Sample Characteristics of Professional interviewees

|                       | Interviewees<br>(n = 9) | Percentage |
|-----------------------|-------------------------|------------|
| Agency Type           |                         |            |
| Regional              | 2                       | 22%        |
| City                  | 5                       | 56%        |
| Public Transit Agency | 1                       | 11%        |
| Nonprofit             | 1                       | 11%        |
| Position              |                         |            |
| Engineer              | 1                       | 11%        |
| Project Manager       | 2                       | 22%        |
| Planner               | 4                       | 44%        |
| Executive Leadership  | 1                       | 11%        |
| Other                 | 1                       | 11%        |

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#### **FINDINGS** 7

8 Interviews with people with disabilities revealed several themes regarding how infrastructure affects 9 their transportation experiences and mode choice.

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#### 11 Failures with Sidewalks

12 13 A combination of sidewalk gaps, uneven sidewalks, and inconsistent curb cuts created physical and 14 safety barriers to travel for all participants. Inadequate sidewalk conditions caused some participants 15 to abandon their route or find alternate routes and other travel options, increasing burdens across 16 time, money, and stress. Participants revealed several experiences along specific routes that still do 17 not meet ADA requirements, particularly in neighborhoods that predate ADA's enactment.

When you go to Globeville or Eylria-Swansea (or) over in South Denver, there's spots where there's literally no sidewalk, and you're right next to a busy street ... there's no way you can do that in a chair, because there's a huge ditch.

- #12-I, Man with ambulatory disability

We were walking, it starts off with paved sidewalks, and then you cross this one street, and it all stops. There's no paved sidewalks; the potholes are huge, and you literally have to walk out into the street to get across. There's railroad tracks that you have to cross and get over. It feels very dangerous. - #1-I, Blind woman

28 29 There is also a lack of sidewalk inventory programs cataloging the presence of sidewalks, 30 conditions, and barriers within local governments in the Denver region. Some professionals 31 indicated that these data programs are in the infant planning stages. Slow progress on these 32 programs was linked to manual labor hours, fear of liability risk, and an overall heavier emphasis on 33 auto-oriented projects compared to transit and pedestrian projects.

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# Failures with Intersection Design 2

Curb ramps, tactile paving, and a preference for perpendicular curb ramps aligned with crosswalks
remain essential for all participants. For blind participants, perpendicular curb ramps at intersections
indicate where a crosswalk is located to help align with the crosswalk. When asked about blended
curb ramps, many said it was more challenging to identify where the crosswalk was located,
increasing the fear of unknowingly crossing outside the designated area.

8 Pedestrian auditory signals can provide supporting information to determine when it is safe 9 to cross the street, particularly in more urbanized areas. Many participants said they do not rely on 10 auditory signals because they are inconsistent in design or only beep, which does not provide helpful 11 information. Roundabouts also present significant challenges to navigate, particularly for blind 12 persons, because the direction and flow of traffic are more complex to identify by sound than a 13 controlled stop intersection.

A lot of people don't know that for a lot of these audible signals you can't just press the button and expect to get that information. You have to hold it for 2 seconds to trip the smart logic, which then says that the walk signal is on and might or might not tell you the intersection that you're about to cross. There's no consistency across different municipalities, nor even within the same municipality, as to how a signal of this type should behave. - #17-I, Blind man

There's an area in my own neighborhood where I've been hit multiple times. I've spoken to the City about

this, and I say, could you at least put a sign that's got "Guide Dog crossing"? I have an email from the City guy saying signs are ineffective. – #21-I, Blind man with guide dog

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27 Regardless of disability, the lack of safe crossings can require people with disabilities to travel
28 long distances to reach a safe crossing. The distance required to travel can be time intensive,
29 physically demanding, or preventative altogether.
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## 31 Maintenance Failures

Participants shared that the lack of maintenance for existing pedestrian facilities was frustrating,
particularly in residential areas where property owners are responsible for maintaining and repairing
sidewalks. Where sidewalks exist, they may contain cracks or gaps and may not be up to current
ADA standards, increasing risk of injury or forcing people with disabilities to travel in the street.
During the winter, snow and ice often result in individuals with disabilities becoming homebound
for an unpredictable time until sidewalks and transit stops are cleared.

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Snow is terrible. A lot of times the bus stops aren't going to be shoveled. I end up having to walk on the street because the streets are plowed.

– #5-I, Woman with multiple disabilities

44 Multiple challenges were identified with the building and maintenance of projects, including

45 funding, staffing shortages, and challenges in developing equitable approaches to sidewalk

- 46 maintenance programs. One professional said, "In America...we love building but do not maintain (existing
- 47 *infrastructure*)", noting that maintenance budgets are not given the same weight as new projects.

1 request maintenance, but this is only for areas maintained by the city. Most professionals shared 2 frustration around sidewalk maintenance programs, which often put the onus on the homeowner, 3 indicating that this is an ongoing challenge with few answers or funding. 4 5 Failure with Transit Communications and Services 6 7 Participants expressed the need for improving transit communications across multiple areas, 8 including improving real-time arrival and departure data and communicating route changes and 9 cancellations. Persons who are deaf or blind indicated that clear audio and ASL communication at 10 stops, stations, and onboard vehicles is needed. The lack of communication led to distrust with 11 transit, especially after some interviewees missed essential appointments due to transit failures. 12 Persons who are deaf found it exceedingly challenging to communicate with transit operators or 13 access ASL interpretation support. People with disabilities shared the desire for increased efforts to 14 notify and involve people with disabilities in decisions regarding service changes. 15 16 Any time announcements happen, hearing people can hear drivers speaking over the intercom, but deaf people 17 don't have access to that. 18 – #15-I, Deaf woman 19 20 Since the onset of the COVID-19 pandemic, transportation operators have cut back on 21 service and experienced critical staffing shortages. Particularly in Denver, RTD has made significant 22 cuts to bus routes. Participants expressed frustration about needing to relearn new routes, no longer 23 having access to transit due to changes, and sometimes not learning a route is canceled until they 24 were waiting for the bus. 25 The bus route that comes by our place got canceled. So now I have to have a whole binder of all the different 26 27 local mobility services transportation services that I could access, whether they're free, eight-five, medical only, 28 after hours. So, it's multiple options. 29 – #10-I, Blind man 30 31 Failure with Paratransit 32 33 Participants across all disabilities shared frustrations about paratransit logistics and scheduling. 34 Particularly, they noted the requirement to book rides a day in advance and the reality that a 20-35 minute trip often turned into a multiple-hour event, requiring riders to miss appointments or work. For many, paratransit is a last-ditch transportation option. 36 37 38 We really have to be smart about where we're going because we don't have the option for impromptu trips. It 39 takes six hours just to get to an appointment and back because you're waiting for two-hour windows before 40 and after the trip, and the trip takes twice as long because they're shared with multiple stops. It prevents a lot 41 of people from even wanting to utilize them because who has time to spend your entire day...? 42 – #17-I, Man using a wheelchair 43 44 I do not own my own vehicle. I gave up my car about four or five years ago. Mostly, because I knew that I 45 would have transportation to medical appointments provided by Colorado Medicaid, and that has been a good 46 thing, but it's also been a difficult thing. 47 - #5-1, Woman with multiple disabilities

| 1<br>2               | One participant described the approval process for paratransit as humiliating:                                    |
|----------------------|---|
| 3                    | The process to me is very humiliating and it's dumb because the government has declared me permanently            |
| 4                    | disabled. I have to go every four years and walk myself embarrassingly with somebody, so they can certify that    |
| 5                    | I still can't get everywhere I want to go all by myself at all times.   |
| 6                    | – #23-I, Blind woman with a cane  |
| 7                    |   |
| 8                    | Failure with Public Transit Facility Designs  |
| 9                    |   |
| 10                   | Participants found the design of public transit facilities and connections to facilities inconsistent,            |
| 11                   | often leading to frustration. The placement of transit stops, and the surrounding conditions of                   |
| 12                   | sidewalks and crosswalks influenced participants' decision to take transit or how far out of their way            |
| 13                   | they would travel on transit to find a safe route. One blind participant expressed the need for                   |
| 14                   | improved strategies to identify bus stop locations, such as the consistent design of poles, RFID                  |
| 15                   | technology, and other tactile materials at bus stops. Other concerns affecting the health, safety, and            |
| 16                   | comfort of riders at stops included the lack of seating, protection from the weather, and poor                    |
| 17                   | placement of bus loading areas.   |
| 18                   |   |
| 19                   | I spend a lot of time poking around. If I could see, I would know the bus stops right there, but the bus stops    |
| 20                   | everywhere are different. They don't even have the same pole, they re not constantly the same distance from the   |
| 21                   | corner, they re not even on the same side of the sidewalk, or some of them are in concrete, some of them are just |
| 22                   | th grass. I rying to make sure 1 m at the bus stop is very difficult.<br>#23 I. Blind momen with a same           |
| 23<br>24             | $ \pm 2$ J-1, Duna woman will a tane  |
| 2 <del>4</del><br>25 | The bus stop will have the ramp that comes down for the bus but that's right where they put the bus stop sign     |
| 26                   | So, they'd have to stop the bus either before or after it where there wasn't pavement and that would force me to  |
| 27                   | bush through grass or dirt to use the ramp.   |
| 28                   | - #17-1. Man using a wheelchair   |
| 29                   | Ý 0   |
| 30                   | Getting dropped off at a (bus) stop, it's like, I'm never quite sure of sidewalks. I have fallen going to and     |
| 31                   | from the bus. I know that sidewalks can be dangerous because they're not eye level. You know there's not          |
| 32                   | always a ramp to go up and down.  |
| 33                   | – #5-I, Woman with multiple disabilities  |
| 34                   |   |
| 35                   | Transportation professionals shared that addressing first/last-mile connections to transit is a                   |
| 36                   | barrier when the transit stop property (or adjacent property) is owned and managed by a                           |
| 37                   | combination of public and private owners, requiring additional coordination, funds, and time.                     |
| 38                   |   |
| 39                   | Failures around Street Furniture, Emerging Technology, and Temporary Route Closures                               |
| 40                   |   |
| 41                   | With the onset of COVID-19, many local governments acted quickly to allow outdoor dining in the                   |
| 42                   | public realm on sidewalks and in parking spaces. Participants shared support for outdoor dining and               |
| 45<br>11             | street furniture that enhances the public realm. However, the additional demands on sidewalk space                |
| 44<br>15             | created participants for persons with disabilities. Dining tables and other street furniture forced               |
| 43<br>16             | participants to alternate between the sidewalk and the street on the same block, which was not                    |
| +0<br>17             | always leasible for people with disabilities. More generally, e-scoolers and e-bikes parked on the                |
| - <b>T</b> /         | SIGE WAIKS WELE AISO A DATHET AND POINT OF MUSUAUON TOF MANY.   |

| 1        | All the dining in the streets is driving me nuts That cannot be ADA compliant. In the street, out of the           |
|----------|--|
| 2        | street, stuff in the way, stuff not in the way. It's a nightmare. I think they should take the street because we   |
| 3        | don't traditionally walk there anyway.   |
| 4        | – #19-I, Blind woman with a guide dog  |
| 5        |  |
| 6        | People leave them (scooters) in the middle of the sidewalk and curb cuts and it makes it impossible. They get      |
| 7        | in my way.   |
| 8        | – #27-I, Man using a wheelchair  |
| 9        |  |
| 10       | Construction and other temporary route closures remain challenging for participants. At                            |
| 11       | times, construction detours direct participants on the street but do not appropriately account for                 |
| 12       | necessary ramps or other accessibility features. Persons who are blind indicated it was not easy to                |
| 13       | cross a street and continue along a route. They must learn an entirely new route that can take time                |
| 14       | and is stressful even if it is a one block detour from their typical route   |
| 15       | and is stressing, even if it is a one block detour from their typical fourt.                                       |
| 16       | Close your eyes for a second and just imagine that you learn a route you got so used to a route and then one       |
| 17       | day the streat's closed How are you going to get to work? What do you do? What if you don't have a car and         |
| 19       | uay the street's thosed. I fow are you going to get to works? What do you do? What if you don't have a car and     |
| 10       | you don't know of any other routes 1 ou can't fust say, well, 1 m bund. 1 m going to call this work and not        |
| 19       | come lo work for the next three months cause the road is closed. I ou re not gonna have a job.                     |
| 20       | $- \mp 13$ -1, Bland woman with a cane   |
| 21       |  |
| 22       | Failure to Involve People with Disabilities in Planning, Design, and Decision Making                               |
| 23       |  |
| 24       | Many people with disabilities we interviewed shared stories of contacting local government officials               |
| 25       | about concerns and experiences traveling in the city. However, they all shared an underlying                       |
| 26       | frustration of not being heard or valued in planning processes.  |
| 27       |  |
| 28       | There's a saying, "Nothing about us without us". If we don't have people to ask the questions about                |
| 29       | accessibility, then sometimes it just doesn't happen. They (experts) want to make it pretty, not necessarily safe. |
| 30       | - #1-I, Blind woman  |
| 31       |  |
| 32       | They have been doing more bus rapid transit studies between some of our neighboring cities. I've given             |
| 33       | feedback on some of those. Sometimes they take the feedback, but I don't feel like some of these projects          |
| 34       | intentionally take the voices of people with disabilities (into consideration). Sometimes the solution seems       |
| 35       | worse I wish they would do more disability-focus sessions to understand more things about wheelchair users         |
| 36       | - #8-1 Woman using a wheelchair  |
| 37       | 110 1, w oman using a wholunan   |
| 38       | One professional called local government's community engagement efforts for planning                               |
| 30       | projects well intentioned but misguided with pedestrian and transit projects having a much heavier                 |
| 39<br>40 | projects wen-intentioned but misguided, with pedestnan and transit projects having a much neavier                  |
| 40       | emphasis on long community engagement processes than auto-oriented projects.                                       |
| 41       |  |
| 42       | DISCUSSION: Built Environment and Programmatic Considerations Showing Limited                                      |
| 45       | ADA Implementation   |
| 44       |  |
| 45       | The ADA is meant to protect people with disabilities from discrimination and ensure they have                      |
| 46       | comparable access to opportunities equal to people who do not have disabilities. However, our work                 |

47 reveals that people with disabilities do not have equal access. The results suggest that the built

# 1 environment, particularly transportation infrastructure, consistently fails people with disabilities

2 through both physical and programmatic lenses.

3 People with disabilities experience physical mobility barriers daily. Incomplete sidewalk 4 networks or sidewalks that are too narrow or in poor condition can be dangerous or limiting, 5 regardless of disability. Paratransit time and booking requirements do not allow for spontaneity or 6 ease of use. People with disabilities have lost trust in fixed-route transit based on feelings of poor 7 communication of route changes and limited access to visual and auditory information services. 8 Negative transit experiences are further emphasized in transit stops with few amenities, poor 9 sidewalk connections, and little consistency for identifying stop locations for blind and low-vision 10 individuals. Changes to public transportation services as a result of the COVID-19 pandemic further 11 exacerbated feelings of distrust and disruption to daily life.

- 12 To contextualize these issues, Figure 2 shows the nature of the problem across a variety of 13 neighborhoods in Denver. In area 1 (Denver's CBD), there is a profusion of transit services and few 14 sidewalks that are under 3 feet, which are shown in yellow. Area 2 (Northeast and North Park Hill)
- 15 are industrial and lower-income neighborhoods and present a case of a location with light-rail and
- 16 bus services but large groups of blocks with sidewalks that do not meet ADA standards. Area 3
- 17 (Montbello) showcases a mixed-income neighborhood with relatively good sidewalk coverage
- 18 located at the edge of extensive transit services. Finally, area 4 (Bear Valley) is a typical suburban
- 19 redevelopment with sidewalks greater than 3 feet wide but a weak transit supply.



- Figure 2 Transit supply and sidewalk barriers for people with disabilities across Denver
- 23 neighborhoods

2 Barriers extend beyond physical infrastructure to programmatic execution. Paratransit 3 approval processes humiliate people with disabilities, preventing some from using the service. 4 Communication and consideration for the mobility needs of those with disabilities around sidewalk 5 obstructions are not evident in planning practice. Construction detours, increasing demand for 6 sidewalk space for outdoor dining programs, and micromobility pose physical and emotional safety 7 concerns. Lack of snow clearing and confusion around who is responsible for sidewalk maintenance 8 can lead to people with disabilities becoming homebound. Poor communication and insufficient 9 services also lead many participants to express frustration and anger toward decision-making that 10 results in barriers. People with disabilities express a desire to be more involved in planning decisions 11 to improve accessibility policy, plans, designs, and implementation. A word cloud analysis of the 12 interview corpus (Figure 3) focuses on frequency of keywords used by stakeholders. The results 13 suggest common discussion topic themes around infrastructure and services such as "sidewalks" 14 (mentioned 296 times) and "bus/buses" (mentioned 616 times). Themes of feelings and experiences 15 while traveling are also common. These include "hard" (mentioned 54 times), "frustrating"

16 (mentioned 82 times), and "safe/safety" (mentioned 100 times).

17

access (168) ada (21) avoid (20) bad (52) barriers (31) bike (69) blind (115) block (78) buss (151) busses (102) button (21) cane (37) Car (164) challenge (26) City (127) construction (35) cost (22) Cross (100) curb (48) dangerous (22) dark (22) design (38) difficult (51) distance (35) drive (95) drivers (26) experience (45) far (68) feel (148) friends (22) frustrating (82) hard (54) hear (46) help (140) hour (104) ice (22) independent (24) intersection (37) issue (100) light (114) lyft (29) mile (71) minutes (96) mobility (31) options (46) parking (198) pay (54) pedestrian (34) planning (87) problem (71) public (75) rail (91) ramp (49) ride (52) road (52) route (143) safe (70) safety (30) schedule (55) scoters (25) seat (27) service (52) Sidewalk (296) sign (51) signals (42) sit (57) snow (76) Street (256) surface (24) town (55) traffic (74) train (156) transit (59) transportation (128) travel (167) trees (27) uber (82) wait (70) Walk (328) walker (24) weather (37) wheelchair (129) winter (24) worry (22)

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## Figure 3 Frequency of keywords used by stakeholders during interviews

21 Conversations with professionals shed light on multiple challenges within their agencies. 22 First, only one agency had a staff position focused on transportation accessibility for people with 23 disabilities. Meeting ADA compliance was left up to team members and checked off along the way. 24 The responsibility of a staff member to advocate for changes and include people with disabilities was 25 largely aspirational. Professionals also shared that ADA was important, but their ability to address 26 gaps was limited by funding, political priorities, misalignment with other transportation projects and 27 plans, and a continued priority for auto-oriented projects. Information databases on sidewalk 28 conditions, ADA compliance, connectedness, and other features are limited, partially because of 29 agency's "liability risk" concerns of having that information. These barriers, combined with the lack of people with disabilities in transportation planning positions and as respected experts, further 30 31 exacerbate discrepancies in infrastructure and programming accessibility.

COVID-19 disproportionately impacted the disabled community's access to transportation options and essential services, due to policies such as the cancellation of bus services (55). Other well-intentioned quick response COVID-19 efforts such as allowing outdoor dining programs on sidewalks limited or prevented navigability of sidewalks for participants. While this study is restricted to how transportation infrastructure and programming can affect a segment of the population, our findings offer a validation of how responses to public safety and public health can exclude

38 vulnerable populations who rely on public services (56). Since we interviewed during COVID-19,

- 1 our sample was reporting non-normal behaviors and experiences. We argue that even if the
- behaviors reported may have significant pandemic affects, the insights gathered are widely
   generalizable, particularly around failures of hard infrastructure and programmatic considerations.
- 4 The participants in this study identified as having at least one disability that impacted their
- 5 physical mobility on a regular basis. We focused on participants living or working within the Denver 6 region. This location may have unique qualities that influence user experience such as weather,
- topography, or resources for people with disability compared to other locations in the United States.
- 8 Our research is not intended to be a representative sample of all people with disabilities or those
- 9 living in a variety of urban, suburban, or rural settings across the United States. Nor is it a
- 10 representative sample of all professionals working in transportation fields. Both interview
- 11 participants with disabilities and professionals self-selected to participate in this research, indicating a 12 willingness to share experiences, challenges, and other information. Despite these limitations, the
- 12 willingness to share experiences, challenges, and other information. Despite these limitations, the 13 findings from this study revealed themes that can offer practical solutions for addressing
- 14 accessibility, mobility, and transportation barriers more broadly. Most notably, our research
- 15 approach highlights how incorporating local knowledge and lived experiences of people with
- 16 disabilities can help identify improvements to transportation design, programs, and policies. This
- 17 approach builds upon a widely documented movement in scholarship to use participatory research
- 18 methods to enrich scientific studies and public initiatives (57,58).
- 19

## 20 Areas for Further Thinking

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To our knowledge, no study in the U.S. has specifically looked at lived experiences of individuals with disabilities, especially focusing on how multiple facets of the transportation environment and programmatic considerations influence daily mobility. Further, there is no consistent method or policy for engaging with people with disabilities across agencies and projects.

The findings from this study call for future research in two focus areas. First, we need a deeper focus on the user experience of people with disabilities. Research is needed to understand how much time is spent planning and actively traveling, and how this additional time may result in compromises in other areas of daily life. Researchers must also examine how transportation

- infrastructure and programs may affect people with different disabilities. For example, a person who
- 31 is blind or has low vision navigates an intersection differently than someone who is deaf.
- 32 Understanding these differences can help communities tailor design solutions based on the specific
- 33 needs of residents who have a disability. This research could also inform national guidelines and best
- 34 practices for creating more inclusive transportation environments, especially with a focus on 35 formally internalizing expertise from individuals with disabilities.
- 36 Second, we need to understand better how current policies, funding limitations, perspectives,
   37 and practices for ADA within public planning agencies result in limitations in access for people with
- and practices for ADA within public planning agencies result in limitations in access for people withdisabilities. Even with ADA being in place for over 30 years, interviews with professionals revealed
- 39 significant challenges with meeting the basic requirements of the ADA. Understanding the barriers
- 40 to achieving ADA compliance, or going beyond the minimum requirements, will help researchers,
- 41 lawmakers, and practitioners address challenges and begin to remove barriers to achieving ADA
- 42 compliance.
- Practicing professionals can learn from this research and consider participatory planning and
   design efforts which include people with disabilities in decision-making by emphasizing the
- 45 importance of local expertise. For example, collaborating with people with disabilities on paratransit
- 46 approval processes, so social and emotional burdens are reduced during the disability appraisal
- 47 process. In addition to project specific-work, professionals can use this research to identify ways to
- 48 create more inclusive workplaces and protocols to diversify perspectives and experiences of

- 1 transportation professionals. Public officials can partner with local advocacy groups to gather
- 2 technical insights on designs, construction efforts, and educate staff to ensure that changes to the
- 3 built environment enhance mobility.
- 4 5

# CONCLUDING REMARKS

- For over 30 years, the ADA has intended to protect people with disabilities from discrimination and
  ensure that they have the same access to opportunities as anyone else. However, the state of
- 9 infrastructure and current planning processes fail disabled members in our communities. The daily
- 10 mobility challenges that people with disabilities face, coupled with the underrepresentation of people
- 11 with disabilities in the transportation field, risks reinforcing acts of ableism and othering in
- 12 transportation planning (59). Planners and engineers generally do not have the lived experience to
- 13 visualize how design standards, features, and programmatic considerations can leave out people with
- 14 disabilities. Our work suggests ways to learn from stakeholders who identify as being disabled, and
- 15 to rely on their expertise to improve policy and design of transportation infrastructure.
- 16 17

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- 22 23
- We sincerely thank Ryanne Ototivo for conducting the interviews during Spring and Summer 2021.

# 26 DATA ACCESSIBILITY

- Data from this study cannot be shared since it contains multiple personal identifiers as part of theinterview notes.
- 29

# 30 AUTHOR CONTRIBUTIONS

- The authors confirm contribution to the paper as follows: study conception and design: Shirgaokar,
   Marshall; data collection: Wagner; analysis and interpretation of results: Wagner, Shirgaokar; draft
- manuscript preparation: All authors. All authors reviewed the results and approved the final versionof the manuscript.
- 35

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