City of Bellevue, Washington

Americans with Disabilities Act (ADA) Sidewalk & Curb Ramp Inventory

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NOTICE

The following report on the City of Bellevue's ADA Sidewalk & Curb Ramp Inventory system is a case study found in:

National Cooperative Highway Research Program (NCHRP), *Asset Management Approaches to ADA Compliance*, NCHRP 20-07 Task 249.

For more information on the Bellevue ADA inventory program, contact the project manager, Franz Loewenherz at floewenherz_bellevuewa.gov or by calling 425-452-4077

CITY OF BELLEVUE, WASHINGTON

Asset Data Inventory and Condition Assessment Practices

Before commencing work on its Americans with Disabilities Act (ADA) Transition Plan Update effort, Bellevue staff considered a number of options for gathering data on its 336 miles of sidewalks, including traditional survey and light detection and ranging (LIDAR). For the survey option, the city conducted a trial experiment and concluded the cost could be more than $1 million. After evaluating several technologies, the city decided to test a modified ultra-light, slow-speed inertial profiler (ULIP) mounted on a Segway Human Transporter. Testing of this technology is the result of a research partnership agreement with the Federal Highway Administration (FHWA). Based on the results of an initial test during the summer of 2007, Bellevue staff decided to use the technology to develop a comprehensive inventory of sidewalks and curb ramps throughout the city. 2008 is the second year of operations.

Bellevue's existing GIS inventory on the location of the city's 336 sidewalk miles was used to organize the work management approach. The field inventory is approached with two staff, one operating the ULIP (responsible for the sidewalk inventory) and one on a bicycle using a Top-Con GMS-2 hand-held Global Positioning System (responsible for the curb ramp inventory).

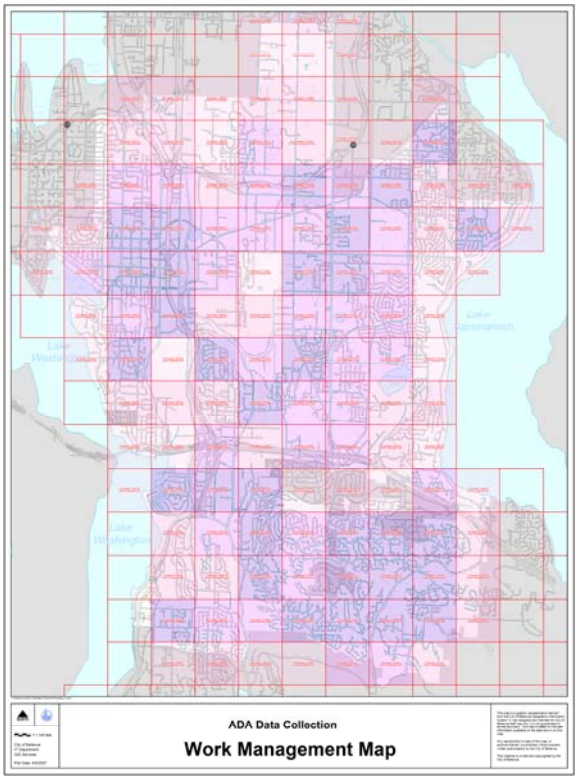
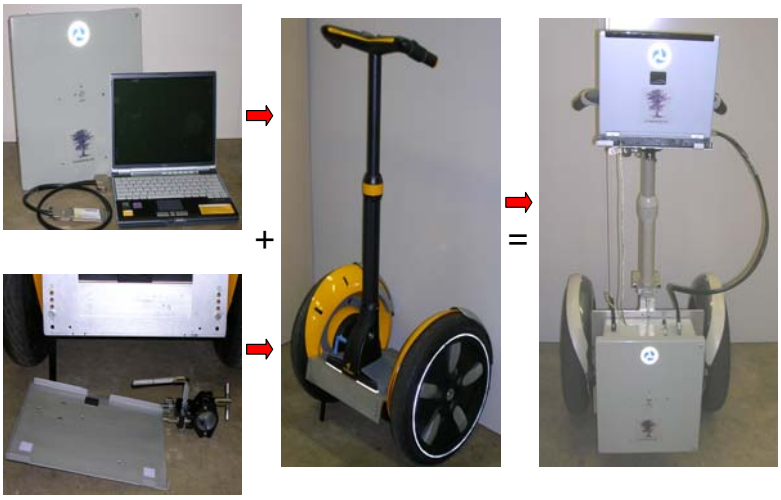


Figure 1. City of Bellevue's Work Management Map

<u>Sidewalk Inventory</u>

The Ultra-Light Inertial Profiler (ULIP) is a specially-equipped scooter that houses an extensive set of sensors performing measurements of sidewalk pavement surfaces at 6 mph; an attached computer collects the data.



The inertial profiling hardware sensor box includes a displacement measurement laser

(height measurement), three accelerometers, an optical trigger, and a distance measurement instrument. The addition of a gyroscope removes remaining errors due to pitch and roll.

Together, these devices enable the city to capture highly accurate location-specific information about sidewalk slope and small surface variations that can make a sidewalk difficult to navigate. The equation shell software provides an interactive graphical environment with real-time display of data collection.

The ULIP monitors cross-slope and running-slopes exceeding ADA requirements. Cross-slope is estimated using the gyroscope roll for cross slope measurement. Grade, or running slope, is estimated using the gyroscope pitch angle, the mechanical layout of the ULIP and the sensor box, the position and calibration of the laser, and the measured distance from the laser to the pavement. An output report and an ASCII text file suitable for inclusion in the city's GIS system are produced by the equation shell software.

Travel Dist_Ft	Marker Dist_Ft	Time(s)	Grade%	Xslope%
95.8	0.0	5.87	4.52	1.57
96.8	1.0	5.93	4.22	1.46
97.8	2.0	5.99	4.21	1.45
98.8	3.0	6.04	4.28	1.66
99.8	4.0	6.10	4.18	1.54
100.8	5.0	6.16	4.00	1.28
101.8	6.0	6.22	4.12	1.40

Figure 2. City of Bellevue's ULIP Output Report on Running Slope & Cross-Slope

Sidewalk faults (heaving) exceeding ADA requirements are identified using an inertial profile based on laser, accelerometer, and DMI measurements. An output report and an ASCII text file suitable for inclusion in the city's GIS system are produced by the equation shell software. The first few lines of such a file is shown at right. Fields are: distance in feet, time in seconds, bump category (1: >=1/4" and <1/2", 2:>=1/2"), bump height, casename.

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 7.05,   1.58,  1,  0.27, II3
 7.15,   1.61,  1,  0.26, II3
 7.23,   1.63,  1,  0.28, II3
 7.32,   1.64,  1,  0.25, II3
11.75,   2.65,  2,  0.90, II3
12.57,   2.84, -1, -0.28, II3
13.17,   2.98, -1 ,-0.29, II3
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Figure 3. City of Bellevue's ULIP Output Report on Sidewalk Heaving

Operators of the ULIP are also able to record geospatial information and verbalized descriptions of obstructions that might affect accessibility (e.g., "branch," "utility pole," or "mail box"). This functionality is provided by direct to disk videologging supported by a Sony HDR-SR1 30 GB hard disk drive (room for 10 hours of SD video) linked to a Red Hen Systems VMS 300 unit, a GPS encoder hardware device. Although the unit uses a GPS receiver, it is not uncommon to lose the signal, making it necessary to rely on orthophotos and field observations to determine the location where data collection occurred.

Curb Ramp Inventory

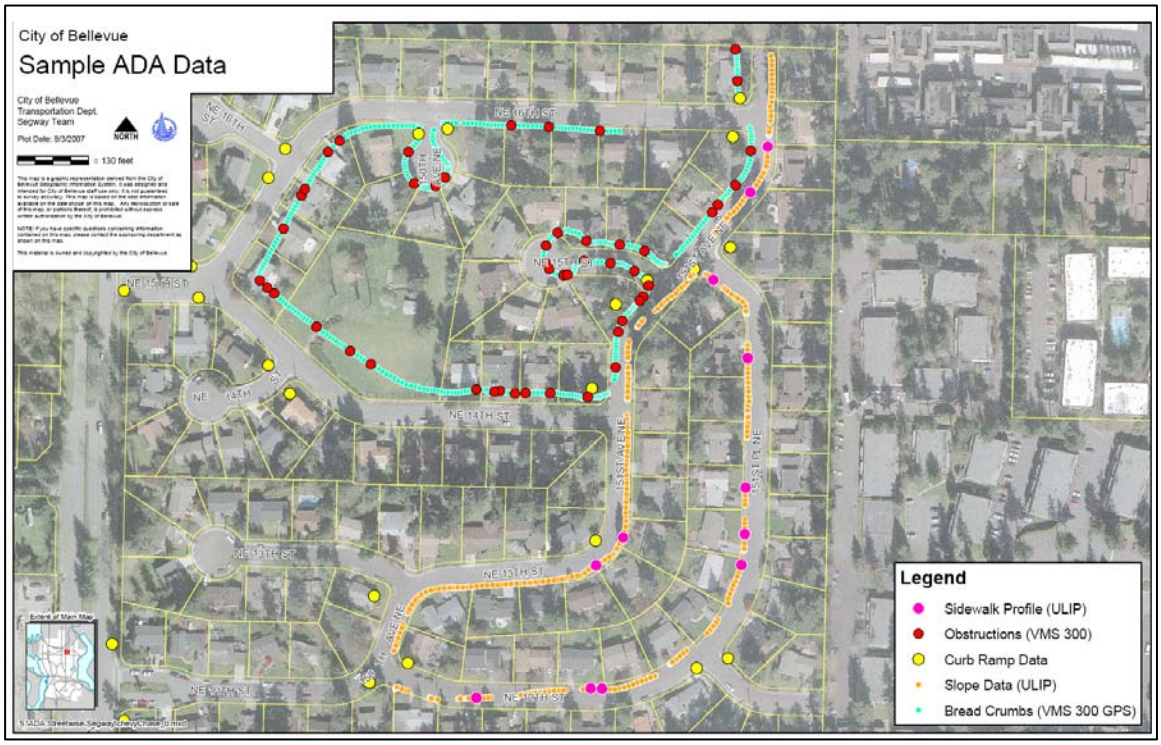
The bicycle operator carries a Topcon handheld GPS receiver, which is equipped with a digital camera and a graphic interface with a data entry form. The positional accuracy of the GPS receiver is 1-3 meters. However, because the receiver can also load and display orthophotos, the operator can easily zoom in and create points associated with specific curb ramps. The spatial resolution of the orthophotos loaded on the GPS receiver is 1 foot per pixel.

Table 4 shows the data dictionary loaded on the GPS receiver.

Table 4. City of Bellevue's Data Dictionary for Curb Ramps.

Element	Options
Ramp type	Directional Perpendicular Parallel Diagonal Construction None (indicates no ramp where ramp is needed)
Gutter running slope	Compliant (< 5%) Non-compliant (> 5%)
Gutter cross-slope	Compliant (< 5%) Non-compliant (> 5%)
Transition	Free of heaves, gaps, and obstructions (yes/no)
Clear space at bottom	4' x 4' of clear space at the bottom of a diagonal ramp, within marked crosswalk (yes/no)
Detectable warnings	A 2' x 4' yellow (or other high- contrast color) panel of truncated domes located adjacent to gutter transition (yes/no)
Marked crossings	Curb ramp is wholly contained within crosswalk markings (yes/no)
Landing slope	Landing slope does not exceed 2% in any direction (yes/no)
Landing panel	None (non-compliant) >= 48 in. (best practices) 36 – 47 in. (compliant) < 36 in. (non-compliant)
Ramp width	>= 48 in. (best practices) 36 – 47 in. (compliant) < 36 in. (non-compliant)
Ramp slope	< 8.3% (compliant) 8.3% - 10% (non-compliant) > 10% (non-compliant)
Ramp cross-slope	< 2% (compliant) 2% - 4% (non-compliant) > 4% (non-compliant)
Ramp flares	None <= 10% (compliant) 10.1% – 12% (non-compliant) > 12% (non-compliant)
Returned curbs	None (if no ramp flares) Compliant (ramp is situated such that pedestrians will not walk across returned curbs) Non-compliant (returned curbs may present tripping hazard)

The three data-sets generated in this survey effort will be integrated into the city's mapping system to facilitate the evaluation and prioritization of locations requiring ADA-related mitigation. A representative sample of the maps that the City of Bellevue will produce as an output of this inventory effort is reflected below. The map reflects the merging of data from the ULIP, VMS-300, and GMS-2 data collection units.



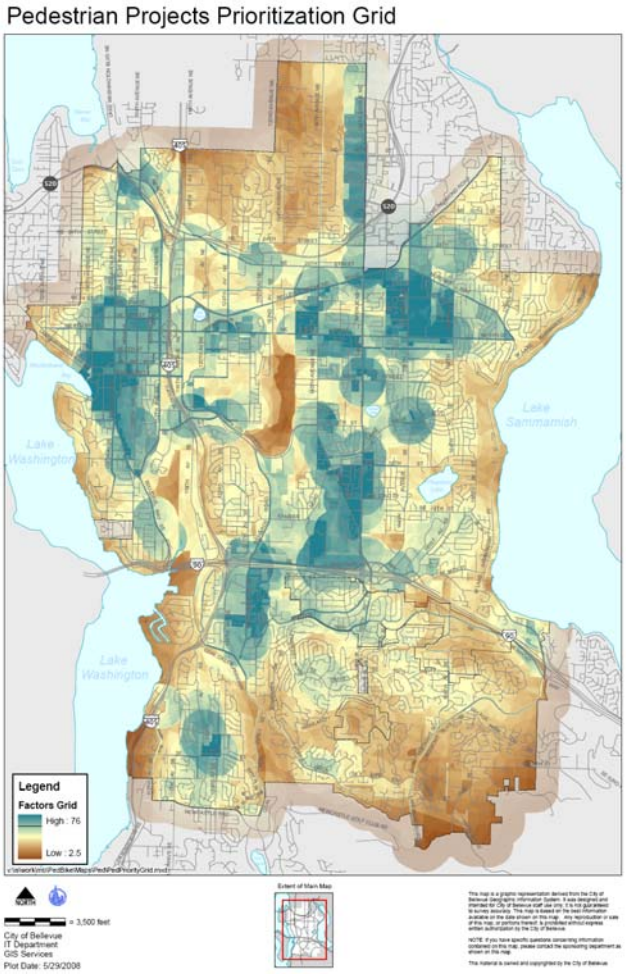
Lessons learned from the use of the equipment and the new data collection approach that city staff have identified include the need for software debugging (particularly during the first year) and identification of the range of operations of the equipment. For example, wet pavement can affect laser readings. The equipment is also sensitive to changes in tire pressure (tire pressure is an optimization parameter in the software). The Segway tends to buck back on hilly terrain, causing the laser unit to go out of range (a valid question is whether this is a serious problem given that it is difficult to find ADA compliant elements anyway on very hilly areas).

A concern for city staff is the lack of guidance in ADAAG regarding distances over which to take measures in the field. The city now has the ability to collect ground data at extremely fine spatial resolution levels, but guidelines or procedures on how to derive measures at higher aggregation levels are not available. As a result, just by looking at individual data points in the city's data collection program, many elements might appear to be non-compliant. However, if averaged over a pre-established distance, say, 5 feet, it is quite possible that those elements could meet accepted standards. City staff identified a need to develop guidelines to address the issue of how to convert fine-resolution data into aggregated measures that can enable effective

comparisons against the standard (or modify the standard so that it effectively includes elements such as distance).

Programming of Asset Improvements

After determining which facilities do not meet standards, the next phase will be to develop a prioritized list of improvement requirements in conjunction with the disability community and other stakeholders. In December 2007, the city conducted three informal focus groups with different segments of the disability community, and intends to conduct a follow-up series of conversations over the next few months.



The prioritized list of improvements will likely take into consideration factors such as proximity to transit, activity centers and social services as well as maximization of available resources by leveraging connections to other funded projects. This component of the prioritization effort will rely on Geographic Information System (GIS) software to automate the evaluation process. By overlapping a series of maps, each representing one of several characteristics, the cumulative intensity of all characteristics at a specific location can be determined.

Once the list of identified improvements is prioritized, the city will program needed implementation resources through the transition plan time horizon. The city already has a number of mechanisms in place to address needs as they arise, including Sidewalk Maintenance, Curb Ramp Retrofit, and Pavement Overlay programs. In addition, the city incorporates ADA improvements into its capital projects and as permit conditions for development. From its innovative and comprehensive barrier inventory system to its multi-level approach to addressing identified ADA-related concerns, the City of Bellevue is aggressively working to ensure its transportation facilities are accessible for all users.