Asset Management for ADA Compliance
Using Advanced Technologies

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Presentation Outline

1. ADA Culture of Compliance
2. ADA Sidewalk & Curb Ramp Self Evaluation
3. Data Collection
4. Quality Assurance/Quality Control
5. Roadway Grade Analysis
6. Driveway Cross Slope Analysis
7. ADA Viewer Interface
8. Barrier Ranking Analysis
9. Programming of Asset Improvements
ADA Culture of Compliance

Americans with Disabilities Act (ADA)

Title II – Government Services: Must ensure that individuals with disabilities are not excluded from programs, services, and activities (pedestrian facilities are an example of a program).
Title II Elements

28 CFR 35.105

Self-Evaluation Report
- Data Collection
- Database Analysis
- Barrier Ranking

28 CFR § 35.150(d)(3)

ADA Transition Plan
- Corrective Measures
- Implementation Schedule
- Financing Plan

Disability Community Participation

City of Bellevue (WA)

Approximately 15 percent of residents live with developmental, physical, and mental disabilities.

The City of Bellevue is a diverse community of 120,000 residents.
As the population continues to age, the number of people with mobility disabilities is expected to increase.

ADA Title II Compliance Flowchart
Policy Commitment

Policy TR-26: Address the special needs of physically challenged and disabled citizens in planning, designing, implementing, and maintaining transportation improvements, particularly non-motorized improvements, and other transportation facilities, and in delivering transportation services and programs, in accordance with the Americans with Disabilities Act (ADA).

Bellevue ADA Sidewalk & Curb Ramp Self Evaluation
Sidewalk & Curb Ramp Inventory Overview

Absence of level landing

No Ramp

Ramp cross slope

Ramp Transition

Heaving

Guidance for Conducting an ADA Inventory

Curb Ramp Measurements:

<table>
<thead>
<tr>
<th>Off Distance (m)</th>
<th>Number of Ramps</th>
<th>Type</th>
<th>Approach Slope (%)</th>
<th>Ramp Slope (%)</th>
<th>Length of Approach (cm)</th>
<th>Landing Length (cm)</th>
<th>Threshold Slope (%)</th>
</tr>
</thead>
</table>
Numerous Methodologies

Summer 2006. Bellevue conducted 2 week assessment with professional staff using equipment for land surveys. Estimated cost in excess of $1M.

Project Approach

1. Data Collection  
2. Database Analysis  
3. Barrier Ranking

Disability Community Participation
Data Collection

Inertial Profilers

Profiling systems originally developed by GM Labs in the 1970s.

Used in both the aerospace and roadway construction industries
Technology Development Partnership

Summer 2007. Research partnership agreement with FHWA led to 2 month assessment with student interns using a modified ultra-light, slow-speed inertial profiler (ULIP) mounted on a Segway HT.

Coordinated staffing & funding commitment from three agencies from three levels of government.

ULIP Technology

Starodub, Inc. developed R&D prototype ULIP

Sensor box includes:
1. a displacement laser (texture/profile/height),
2. three accelerometers (inertial profiling),
3. a gyroscope (pitch, roll, yaw),
4. optical trigger (reference),
5. GPS (general location), and
6. a DMI (travel distance system).

Computer and data acquisition card are used for data capture.
Distance Measurement Instrument (DMI) Calibration: Requires rider and tire pressure specific calibration.

Together, these devices enable the City to measure the sidewalk surface at a rate of 10,000 records per second capturing highly accurate information about slope and small surface variations that can make a sidewalk difficult to navigate.

**ULIP Relative to Surface**

**ADA Sidewalk Compliance Criteria**

1:50 (2%) max
ADAAG 4.3.7

1:20 (5%) max
ADAAG 4.8

1/4 inch max
ADDAG 4.5.2
Movable Obstructions/Driveways/Protrusions

Key-press events: Time/distance coding of user defined features.

ULIP Data Transfer

Data Capture  Data Acquisition  GIS Integration  Data Processing
ADA Curb Ramp Compliance Criteria

Curb Ramp Inventory Toolkit
Curb Ramp Documentation

Topcon GMS-2 handheld GPS receiver:

- Equipped with a digital camera, graphic interface, & data entry form.
- Positional accuracy of GPS receiver is 1-3 meters.
- Receiver can load and display ortho-photos enabling field staff to zoom in and create points on specific curb ramps.
- Spatial resolution of ortho-photos is 1 foot per pixel.
GMS-2 Curb Ramp Data Dictionary

- **Ramp type**: Directional; Perpendicular; Diagonal; Construction; None (indicates no ramp where ramp is needed)
- **Gutter running slope**: Standard (≤5%); Non-standard (>5%)
- **Gutter cross-slope**: Standard (≤2%); Non-standard (>2%)
- **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**: 2' x 4' yellow panel of truncated domes adjacent to gutter transition (yes/no)
- **Marked crossings**: Curb ramp wholly contained within crosswalk markings (yes/no)
- **Landing slope**: Landing slope does not exceed 2% in any direction (yes/no)

- **Landing panel**: None (non-standard); ≥ 48 in. (best practices); 36-47 in. (standard); < 36 in. (non-standard)
- **Ramp width**: ≥48 in. (best practices); 36-47 in. (standard); < 36 in. (non-standard)
- **Ramp slope**: <8.3% (standard); 8.3% - 10% (non-standard); >10% (non-standard)
- **Ramp cross-slope**: <2% (standard); 2% - 4% (non-standard); >4% (non-standard)
- **Ramp flares**: None; ≤10% (standard); 10.1% - 12% (non-standard); >12% (non-standard)
- **Returned curbs**: None (if no ramp flares); Standard (ramp is situated such that pedestrians will not walk across returned curbs); Non-standard (returned curbs may present tripping hazard)

GMS-2 Sidewalk Data Dictionary

- **Fixed Obstructions**
- **Narrow Sidewalks**
Quality Assurance/Quality Control

Nationally Recognized Best Practice

“Efforts such as those at the City of Bellevue, Washington, that rely on the collection of large datasets at extremely fine spatial and temporal disaggregation levels have the potential to significantly automate the identification of non-compliant locations in the field.”

- Texas Transportation Institute
Attribute Accuracy of Data

Field technicians check the slope and grade of sidewalk segment with smart level for QAQC validation of ULIP data.

Validation Report: Smart Level/ULIP

- ULIP data consistently follows with the Smart Level’s peaks and troughs at test sites.
- Rise versus Running Distance compared to ADAAG.
ULIP Path Repeatability for Grade

Site was a sidewalk with two successive driveway crossings.

ULIP Path Repeatability for Cross Slope
**Change in Level Output Reports**

Field Validation Mode → ASCII text file → Data in City's GIS

- **QA/QC**

**Positional Accuracy of Data**

Streaming GPS → Sensor-based inertial navigation

- Bellevue testing with global navigation satellite system (GPS) found the accuracy of latitude/longitude data degraded in areas with tall buildings or thick tree canopies.

- Start/end points for each data collection run entered on an ortho-photo image on the ULIP's notebook computer screen. The gyroscope and distance measurement instrument were used to compute path of travel.
Roadway Grade Analysis

Measurement of Grade

Maximum grade is defined as a limited section of path that exceeds the typical running grade.
Raw Data Allows for Infinite Re-analysis

Grade and Cross Slope Averaging Window Size:
• In the ULIP Geometry Equation, the user specifies the grade and cross slope window size in feet to be applied in a moving average computation.
• The graph illustrates the effect of moving average window size. The larger the value, the more dampened out the features.

User-Specified Window Size

FHWA guidance on grade and cross-slope: “should be measured over 2 ft intervals, the approximate length of a wheelchair wheelbase, or a single walking pace.”
Grade Compliance Criteria

An accessible route with a running slope greater than 1:20 (5%) is a ramp and shall comply with ADAAG 4.8. (ADAAG 4.3.7)

- Maximum slope 8.33%
- Maximum rise for any run shall be 30”
- Minimum clear width shall be 36”
- Level landings at bottom and top of each ramp

<table>
<thead>
<tr>
<th>Slope</th>
<th>Maximum Rise (inches)</th>
<th>Construction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:20 to 1:16 (5% to 6.3%)</td>
<td>30</td>
<td>New const. &amp; modifications</td>
</tr>
<tr>
<td>1:16 to 1:12 (6.3% to 8.3%)</td>
<td>30</td>
<td>New const. &amp; modifications</td>
</tr>
<tr>
<td>1:12 to 1:10 (8.3% to 10%)</td>
<td>6</td>
<td>Modifications only</td>
</tr>
<tr>
<td>1:10 to 1:8 (10% to 12.5%)</td>
<td>3</td>
<td>Modifications only</td>
</tr>
</tbody>
</table>

Grade (Ramp Type) Classification

Ramp type 1 meets the definition of a ramp (>= 5%) but is not regarded as having a non-standard grade.

Ramp type 30 has a rise of 30 in and run between 30 to 50 ft. (5% >= x <= 8.33%)

Ramp type 6 has a rise of 6 in and run between 6 & 5 ft. (8.33% >= x <= 10%)

Ramp type 3 has a rise of 3 in and run between 2 & 2.5 ft. (10% >= x <= 12.5 %)

Ramp type 99 has a rise greater than 1.5 over 1 ft. (> 12.5 %)

<table>
<thead>
<tr>
<th>Slope</th>
<th>Max Rise (in.)</th>
<th>Max Run (ft.)</th>
<th>Grade Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;= 5.0%</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&gt;= 5.0%</td>
<td>30</td>
<td>50</td>
<td>1:20 30</td>
</tr>
<tr>
<td>5.5%</td>
<td>30</td>
<td>45.5</td>
<td></td>
</tr>
<tr>
<td>6.0%</td>
<td>30</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>6.5%</td>
<td>30</td>
<td>38.5</td>
<td></td>
</tr>
<tr>
<td>7.0%</td>
<td>30</td>
<td>35.7</td>
<td></td>
</tr>
<tr>
<td>7.5%</td>
<td>30</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>8.0%</td>
<td>30</td>
<td>31.3</td>
<td></td>
</tr>
<tr>
<td>&lt; 8.33%</td>
<td>30</td>
<td>30.0</td>
<td>1:12 6</td>
</tr>
<tr>
<td>8.33%</td>
<td>6</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>8.5%</td>
<td>6</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>9.0%</td>
<td>6</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>9.5%</td>
<td>6</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>&lt; 10.0%</td>
<td>6</td>
<td>5.0</td>
<td>1:16 3</td>
</tr>
<tr>
<td>&gt; 10.0%</td>
<td>3</td>
<td>2.5</td>
<td>1:16 3</td>
</tr>
<tr>
<td>10.5%</td>
<td>3</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>11.0%</td>
<td>3</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>11.5%</td>
<td>3</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>12.0%</td>
<td>3</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>12.5%</td>
<td>3</td>
<td>2.0</td>
<td>1.8 99</td>
</tr>
<tr>
<td>&gt; 12.5%</td>
<td>&gt;=1.5</td>
<td>1.0</td>
<td>99</td>
</tr>
</tbody>
</table>
Determination of “Technical Infeasibility”

“Because of the constraints imposed by right-of-way width, the pedestrian access route (PAR) is relieved of the slope limits that would apply to an accessible route on a site provided it matches the general grade of the adjacent roadway.”

- Revised Draft Guidelines for Accessible Public Rights-of-Way; R301.4
Digital Elevation Model

- DEM (Digital Elevation Model) data in GIS used to determine grade of streets for this analysis.
- A DEM is a grid in which each cell represents an elevation. The City contracts with private vendors for updated DEM information approximately every 2 years.
- For a given section of road, grade is calculated as Rise/Run. In this equation the length of the road section provides the Run. The DEM provides the Rise.

GIS Script

The GIS script loops through all non-standard sidewalk grade cases. For each location, the sidewalk grade is compared with the grade of the adjacent street (DEM), allowing for identification of sidewalks where high grade values are due to topographic factors. Once this information is recorded for each location, criteria can be defined to filter out locations which are considered “technically infeasible”.

- **Roadway:** 1%
  - **Sidewalk:** 10%
    - Non-Standard Running Slope Location

- **Roadway:** 10%
  - **Sidewalk:** 10%
    - Compliant due to technical infeasibility
Digital Elevation Model Calculation

134 miles

Digital Elevation Model Calculation

134 miles
95 miles
Digital Elevation Model Calculation

134 miles

95 miles

39 miles

NE 8th Street Example

The sidewalk slope does not conform to the roadway slope. The sidewalk is classified as a Ramp Type 30, which has a running slope between 5 and 8 percent over a distance of 30 feet or greater. The road adjacent to it, has a slope of 5 percent.
The road slope where it is greater than 5 percent (red) is deemed technically infeasible according to ADDAG documentation. Sidewalks with adjacent road slopes that are less than 5 percent are identified as non-standard.
Driveway Standards

- Certain grades and slopes must be maintained.
- 2% cross-slope,
- 8.33% max ramp slopes if used.

Bellevue Design Manual

Bellevue employs a number of accessible driveway designs to maintain an acceptable cross slope and facilitate wheelchair movement at driveways.

As reflected in DEV-7D above, securing additional right-of-way from the adjacent property is a good strategy for improving pedestrian access on narrow sidewalks. This design allows pedestrians to maintain a level path as they cross the driveway.
Project Approach

Driveway crossings without landings confront wheelchair users with severe and rapidly changing slopes at the driveway flare.

A series of driveway apron flares with 11% cross slope measurements at 130th Avenue SE & SE 26th Street.

The driveway analysis is based on ULIP recordings taken by field staff at the center points of driveways. Using GIS, any non-standard cross slope values within buffer are attributed to the driveway aprons.

Cross Slope Findings

<table>
<thead>
<tr>
<th>Cross Slope Category</th>
<th>Total Length (Miles)</th>
<th>Cross Slope within Driveway Buffer (Miles)</th>
<th>Cross Slope without Driveways (Difference)</th>
<th>% Attributable to Driveways</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-4%</td>
<td>134</td>
<td>18</td>
<td>116</td>
<td>13%</td>
</tr>
<tr>
<td>4-6%</td>
<td>49</td>
<td>9</td>
<td>41</td>
<td>17%</td>
</tr>
<tr>
<td>6-8%</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>31%</td>
</tr>
<tr>
<td>8-10%</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>54%</td>
</tr>
<tr>
<td>10%+</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>70%</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>40</td>
<td>172</td>
<td>19%</td>
</tr>
</tbody>
</table>

1. Over 50% of Bellevue’s 8+ percent cross slope measurements are attributable to driveway aprons.
2. Number increases as cross slope values increase, with 70% of 10+ percent cross slope measurements attributable to driveway aprons.
3. Overall, 19% of all non-standard cross slope measurements are attributable to driveway aprons constructed like ramps, with steep, short side flares.
ADA Viewer Interface

ADA Viewer Window
Barrier Ranking Analysis

Compliance vs. Accessibility

ADA tells us which features are non-standard …

... But it doesn’t tell us which of these non-standard features should be replaced first.
Community Outreach Requirements

- Provide opportunity to interested persons and groups to participate in self-evaluation leading to transition plan. 28 C.F.R. § 35.105(b).

- Make self-evaluation and plan available for public inspection. Specific time frames and information required. 28 C.F.R. § 35.105(c).

Accessibility Evaluations

Bellevue Approach:

- Accessibility evaluations in the field with Bellevue residents who are Access para-transit customers.

- For each ramp, participants filled out an evaluation form.

- Assessed in a general fashion the impact of each curb ramp feature (panel size, ramp cross slope, etc) on accessibility.
Barrier Ranking Analysis

GIS-Based Prioritization Tool

Allows users to adjust the weights for each criteria and run the analysis iteratively for validation purposes.
Programming of Asset Improvements
Implementation Schedule

Self-Evaluation Report
- Data Collection
- Database Analysis
- Barrier Ranking

ADA Transition Plan
- Corrective Measures
- Implementation Schedule
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Disability Community Participation

NE 8th Street Widening Project

- Summer 2009 - A new sidewalk and curb ramps were built next to the new westbound lane.
- Project enhanced pedestrian facilities by removing fixed obstructions and improving sidewalk surface conditions (both changes in level and slope variations).
- Addressed barriers to accessibility in a downtown Bellevue location that has high volumes of pedestrian usage.
Corrective Measures

From 2007 through 2009, Bellevue will have spent more than $2 million to upgrade nearly 300 curb ramps citywide.
The ADA Sidewalk and Curb Ramp Self-Evaluation Report is located at: http://www.bellevuewa.gov/accessibility-reports.htm

The project manager, Franz Loewenherz, can be reached at 425-452-4077 or FLoewenherz@bellevuewa.gov