Accuracy vs. Consistency
A Dilemma in Stormwater Master Planning

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Matthew Wilkinson, *Atkins*

2018 Floodplain Management Association Annual Conference, Reno, Nevada
Overview

- Stormwater Master Planning in Clark County
- Challenges in Long Term Planning
- Consistency vs Accuracy
- Hydrologic Verification Study
- Conclusions
Stormwater Master Planning
Flood Control Master Planning

- Data Collection
- Hydrology
- Facility Planning
- Cost Estimate
- Reports and Maps
Challenges in Long Term Planning
Master Plan Challenges – 5 year cycle…

- Data Collection
- Technology Advances
- New or Changing Data: Soils, Land Use, Rainfall
- National /Federal Issues (Design Storms, Climate Change)
- Environmental Regulations
- Flooding Events or Observations
- Rapid and Varying Development
Ongoing Development
SNWA Turf Conversion
Change in Percent Imperviousness

- Natural Ground Cover:
  - 40% evaporation and water from plants
  - 10% runoff
  - 50% soaks into ground

- 75% or More Impervious Surface:
  - 30% evaporation and water from plants
  - 55% runoff
  - 15% soaks into ground

Map showing change in % Imperviousness:
- -90% - -71%
- -70% - -52%
- -50% - -31%
- -30% - -11%
- -10% - 0%
- 0% - 6%
- 6% - 10%
- 11% - 30%
- 31% - 50%
- 51% - 70%
- 71% - 90%

SNC-LAVALIN
ATKINS
REGIONAL FLOOD CONTROL DISTRICT
Change in Curve Number using latest soil data
Soils Data

West Airport Hydrograph Comparison

Original Peak Flow = 115.7 cfs
Boulder Peak Flow = 856 cfs

Soil Group

A
B
C
D

SNC-LAVALIN
ATKINS
REGIONAL FLOOD CONTROL DISTRICT
Example Impacts of Data Changing / Updates

<table>
<thead>
<tr>
<th>Results at the Beltway Detention Basin</th>
<th>2014 NRCS Soils Data</th>
<th>1985 Soils Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Inflow (CFS)</td>
<td>899</td>
<td>1992</td>
</tr>
<tr>
<td>Peak Outflow (CFS)</td>
<td>49</td>
<td>69</td>
</tr>
<tr>
<td>Peak Storage (AC-FT)</td>
<td>97</td>
<td>193</td>
</tr>
</tbody>
</table>

![Graph showing peak flow over time](image-url)
Consistency vs. Accuracy
A Dilemma…
### Accuracy vs Consistency

<table>
<thead>
<tr>
<th>ACCURACY</th>
<th>CONSISTENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving target</td>
<td>Not representative of actual condition</td>
</tr>
<tr>
<td>Expensive and time consuming</td>
<td>Relies on assumptions in lieu of latest data</td>
</tr>
<tr>
<td>Hard to verify</td>
<td>Based on management decisions</td>
</tr>
<tr>
<td>Numerous variables</td>
<td>Standards may be outdated</td>
</tr>
<tr>
<td>Site specific, not regional</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>THE NOT SO GOOD:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>THE GOOD:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflects actual flows</td>
<td>Cost effective</td>
</tr>
<tr>
<td>Facilities sized appropriately</td>
<td>Globally manage assumptions/models</td>
</tr>
<tr>
<td>Defendable</td>
<td>Builds upon previous plan</td>
</tr>
<tr>
<td>Model fidelity can be very good</td>
<td>Continuity over long term</td>
</tr>
<tr>
<td>Useful for actual events or flood response</td>
<td>Works at a regional level</td>
</tr>
</tbody>
</table>
Hydrologic Verification Study
Ongoing Efforts at the District

- Use latest data
- GIS technology
- Research projects (DRI, UNLV, University of Illinois)
- Physical Testing / Field Observations
- Historical Observations
- FTRS and Gage Data
- Hydrologic Verification
DRI Soil Group

The 2007 DRI study confirmed that the hydrologic soil groups generated from NRCS was correct.
National Land Cover Database (NLCD) 2011

<table>
<thead>
<tr>
<th>Land Use Description</th>
<th>Land Use Index</th>
<th>MPU IMP Pct (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undeveloped Land, Open Desert</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Parks, Golf Courses</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Rural, 0.5-1 units per acre (uses 1 unit/acre)</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Low-Density Residential, 1-2 units per acre (uses 2 units/acre)</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Medium-Density Residential, 2-4 units per acre (uses 3 units/acre)</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>High-Density Residential, 4-8 units per acre (uses 6 units/acre)</td>
<td>6</td>
<td>62</td>
</tr>
<tr>
<td>Public Facility and Residential, 8-12 units/acre (including ROW)</td>
<td>7</td>
<td>72</td>
</tr>
<tr>
<td>Very High-Density Residential, 12 units/acre or more</td>
<td>8</td>
<td>85</td>
</tr>
<tr>
<td>Commercial, Retail, Casino, High Rise Condominiums</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Light Industrial</td>
<td>10</td>
<td>70</td>
</tr>
<tr>
<td>Heavy Industrial</td>
<td>11</td>
<td>85</td>
</tr>
<tr>
<td>Schools</td>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>Lakes</td>
<td>13</td>
<td>0</td>
</tr>
</tbody>
</table>
Manual Total Imperviousness Percentages Check Examples
Gages / Flood Threat Recognition System

- Network of 200+ gauges
- Share information
  - Entities
  - NWS
  - USGS
  - Local Media
  - Public
Verification Study

- Obtain and use actual rainfall data in models
  - Point rainfall data at Rain Gages
  - Radar Rainfall (NEXRAD)
- Compare model results with measured results at gages
- Verify if model over- or under-predicts flow rates/volumes

- Credit to: Clark Barlow, Hongyu Deng, & OneRain
McCullough DB & Anthem DB Watersheds
Pioneer DB Watershed
Gowan South DB & Lakes Detention DB Watersheds
DB Gages

Station 4359
Lakes Detention Basin
Installed: February 21, 2001
August 13, 2009

Station 4259
Gowan South DB
Installed: June 20, 1995
March 02, 2011

Station 4769
Pioneer DB
Installed: May 05, 2002
July 31, 2009

Station 4729
McCullough Hills
Installed: July 31, 2002
August 07, 2009

Station 4724
Anthem DB
Installed: June 27, 2001
October 04, 2012
### Total Precipitation by Storm Event

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Gowan South DB</th>
<th>Lakes DB</th>
<th>McCullough DB</th>
<th>Anthem DB</th>
<th>Pioneer DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/19/2003</td>
<td>1.5 in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/22/2010</td>
<td>2.7 in</td>
<td>2.2 in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/22/2012</td>
<td></td>
<td></td>
<td>1.7 in</td>
<td>1.8 in</td>
<td>1.1 in</td>
</tr>
<tr>
<td>9/11/2012</td>
<td></td>
<td></td>
<td></td>
<td>1.1 in</td>
<td></td>
</tr>
<tr>
<td>10/11/2012</td>
<td></td>
<td>1.7 in</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sept 11, 2012 Storm

12:04pm
Sept 11, 2012 Storm

12:21pm
Sept 11, 2012 Storm

12:30pm
Sept 11, 2012 Storm

12:47pm
Sept 11, 2012 Storm

1:05pm
Sept 11, 2012 Storm

1:30pm
Sept 11, 2012 Storm

1:52pm
Sept 11, 2012 Storm

2:14pm
Radar storm total for the Gowan South Watershed
## Radar storm total for the Gowan South Watershed

<table>
<thead>
<tr>
<th>Gage</th>
<th>Gage Total</th>
<th>Adj Radar Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4259</td>
<td>1.52”</td>
<td>1.35”</td>
</tr>
<tr>
<td>4234</td>
<td>1.64”</td>
<td>1.45”</td>
</tr>
<tr>
<td>4214</td>
<td>1.48”</td>
<td>1.49”</td>
</tr>
<tr>
<td>4224</td>
<td>2.12”</td>
<td>2.06”</td>
</tr>
<tr>
<td>4229</td>
<td>1.80”</td>
<td>1.51”</td>
</tr>
<tr>
<td>4204</td>
<td>1.96”</td>
<td>1.46”</td>
</tr>
<tr>
<td>4209</td>
<td>1.92”</td>
<td>1.84”</td>
</tr>
<tr>
<td>4329</td>
<td>2.72”</td>
<td>1.75”</td>
</tr>
<tr>
<td>4269</td>
<td>2.12”</td>
<td>1.97”</td>
</tr>
</tbody>
</table>
### Sources of Results for Comparison

<table>
<thead>
<tr>
<th></th>
<th>Gauge Data</th>
<th>HEC-1 model Point Gauge Rainfall Data</th>
<th>HEC-1 model GARR Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Water Depth (ft)</strong></td>
<td>Highest Record – Gauge Datum</td>
<td>Peak Stage – DB Bottom elevation (from SE record)</td>
<td>Peak Stage – DB Bottom elevation (from SE record)</td>
</tr>
<tr>
<td><strong>Peak Water Volume</strong></td>
<td>Peak water elevation is calculated from peak water depth. The peak water volume is interpolated based on SSD curve. This assumes gauge datum is equivalent to DB bottom elevation from SSD curve.</td>
<td>HEC-1 output</td>
<td>HEC-1 output</td>
</tr>
<tr>
<td><strong>Total Inflow Volume</strong></td>
<td>Back-calculated using time series water depth data. This assumes gauge datum is equivalent to DB bottom elevation from SSD curve.</td>
<td>HEC-1 output</td>
<td>HEC-1 output</td>
</tr>
<tr>
<td><strong>Water Depth Time Series</strong></td>
<td>Gauge Record – Gauge Datum</td>
<td>HEC-1 output</td>
<td>HEC-1 output</td>
</tr>
</tbody>
</table>
Verification Conclusions

- Models generally exhibit higher peak water depth and total inflow volume than the observed data
  - Suggesting MPU hydrologic methodology is conservative in predicting rainfall runoff
- Models are better at predicting runoff volumes for developed areas
- Inconclusive whether GARR or point rainfall is more accurate
Takeaways…

- Remember the purpose
- Take advantage of available data and technology
- Engineering judgment is key
- Find balance between consistency and accuracy
- Sustainable over a long-period of time, incremental
- Regional framework and foundation
Questions?

IF YOU HAVE QUESTIONS
Please ask an Engineer
THEY WILL BE HAPPY
TO EXPLAIN EVERYTHING

Rey Giese
@engineering_memes