Using ESRI’s ModelBuilder to Track Developments and Initiate Infrastructure Projects

Wendy Smith P.E., Orange County Sanitation District
Andy Baldwin, Woodard & Curran

July 2017
ESRI 2017 User Conference

Infrastructure Project Tracker - Agenda

1. Background and Key Goals
2. Business Use Cases
3. Making Decisions
4. Tool Design:
   a. Development Tracker
   b. Data Validation
   c. Project Tracker
5. Tool Implementation
6. Tool Demo
• Evaluate sewer infrastructure based on changing land use and growth:
  • Future flow projections are less reliable
  • Changing flows resulting from conservation
  • Oversized facilities based on old projections

• Upgrade sewer infrastructure ‘as-needed’:
  • Tracking on-going developments
  • On-going verification of CIP needs
  • Predict timing of CIP projects
  • Allocating capacity fees

• Use ModelBuilder to streamline the process:
  • Simple tools built into ArcGIS
  • Custom database to store data and results
  • Integrate with hydraulic model
Key Issues

Using the Hydraulic Modeling

• **Update previous hydraulic model to include:**
  - Changes in base flows
  - Revised flow projections
  - Latest development projects
  - Recent sewer improvements
  - OCSD trunk network

• **Conduct flow monitoring:**
  - Verify latest base flows
  - Assess changes in I&I

• **Use model to update and prioritize CIP:**
  - Revise capacity improvements
  - Optimize diversion settings
  - Develop CIP budget
Making Decisions

• **General decision process for evaluating CIP projects**
  - Receive request
  - Get data
  - Conduct analysis
  - Prepare report
  - Conduct internal review
  - Make decision – to build, defer or cancel project

• **Issues with current practice:**
  - CIP projects are only re-evaluated when master plans are updated
  - No policy / procedure for interim CIP updates
  - Difficult to track developments within member agencies
  - Difficult to associate CIP with flows generated from multiple developments
  - Difficult allocating CIP costs to developers / agencies
Making Decisions
What’s the Problem? – Tracking Growth

![Graph showing flow projection and capacity over years]

- **Existing Capacity**
- **Original Flow Projection**
- **Original Trigger Year**
- **Updated Flow Projection**
- **Updated Design Capacity**
- **Design Capacity**

Year:
- 2020
- 2025
- 2030
- 2035
- 2040

Flow Projection (mgd):
- 0
- 10
Model Building

Population data provided by Center of Demographic Research (CDR)

Population projections:
- Residential – 2015
- Residential – 2040
- Employment – 2015
- Employment – 2040
- Other years included: 2020, 2025, 2030, 2035
**Model Building**

### Step 1: Obtained Developments from Agencies

**Agency** | **Data Requested** | **Points of Contact**
--- | --- | ---
City of Orange | Sewer System GIS | Neil Millward (GIS Analyst)
 | Sewer Master Plan | George Liang (Eng. PW)
 | Land Use - Major developments | Jennifer Lee (Planning)
City of Garden Grove | Sewer System GIS | Joseph Schwartz (GIS Analyst)
 | Sewer Master Plan | Myung Chun & Scott Lo (Eng. PW)
 | Land Use - Major developments | Alana Chang & Maira Parra (Planning)
City of Fountain Valley | Sewer System GIS | Patrick Mullin (Private GIS Consultant)
 | Sewer Master Plan | Cal Youngberg (City Sewer Dept.)
 | Land Use - Major developments | n/a
City of Anaheim | Sewer System GIS | Keith Linker (Eng. PW)
 | Sewer Master Plan | Khanh Chu (PW)
 | n/a | Jonathan Hefferman (PW)
City of Fullerton | Sewer System GIS | ----
 | Sewer Master Plan | ----
 | Land Use - Major developments | Susan Kim (Planning)
City of Westminster / Midway SAN District | Sewer System GIS | Ken Robbins (Eng. PW)
 | Sewer Master Plan | n/a
 | Land Use - Major developments | Chris Wong (Planner)
Yorba Linda WD / City of Yorba Linda | Sewer System GIS | Alfredo Vargas (GIS Analyst)
 | Sewer Master Plan | Anthony Manzano (Eng.)
 | Land Use - Major developments | Greg Rehmer (Planner)
OCSD | Class 1 & 2 Permitted SIU Database | Roya Sohanakl (Env. Compliance Div.)
 | Project 2-72B & 2-72C (on-going) | Raul Cuellar (CIP Manager)
 | n/a | Vicki Francis (Sr. Eng.)
Center for Demographic Research (CDR) | Current OCP TAZ Population Projections; Follow-up development research. | Deborah Diep (Director)
 | n/a | Steven Ayers (Asst. Director)
## Tracking Development Growth

### Step 2: Compared Developments with CDR

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned: Development</td>
<td></td>
<td>Planned: Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DU Conversion (Persons/DU)</td>
<td></td>
<td>SqFt Conversion (employees/TSP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planned: Development</td>
<td></td>
<td>Planned: Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DU2015</td>
<td>DU2040</td>
<td>RPOP15</td>
<td>RPOP40</td>
<td>EMP2015</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.66</td>
<td>28</td>
<td>NA</td>
<td>28</td>
<td>724</td>
</tr>
<tr>
<td>3.37</td>
<td>1958</td>
<td>156</td>
<td>1162</td>
<td>1158</td>
<td>61</td>
</tr>
<tr>
<td>3.68</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.75</td>
<td>1169</td>
</tr>
<tr>
<td>21</td>
<td>0</td>
<td>423000</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>423000</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>153766</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>220</td>
<td>0</td>
<td>4.25</td>
<td>935</td>
<td>3.5</td>
<td>1090</td>
</tr>
<tr>
<td></td>
<td>2.53</td>
<td>66</td>
<td>18000</td>
<td>0</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>4.61</td>
<td>600</td>
<td></td>
<td>0</td>
<td>546</td>
</tr>
<tr>
<td></td>
<td>4.50</td>
<td>587</td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td></td>
<td>5.28</td>
<td>412</td>
<td></td>
<td>0</td>
<td>1538</td>
</tr>
<tr>
<td></td>
<td>3.20</td>
<td>167</td>
<td></td>
<td>0</td>
<td>1092</td>
</tr>
<tr>
<td></td>
<td>3.27</td>
<td>170</td>
<td></td>
<td>0</td>
<td>1092</td>
</tr>
<tr>
<td></td>
<td>2.73</td>
<td>142</td>
<td></td>
<td>0</td>
<td>1092</td>
</tr>
<tr>
<td></td>
<td>4.48</td>
<td>817</td>
<td></td>
<td>0</td>
<td>3822</td>
</tr>
<tr>
<td>0.00</td>
<td>391</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td>1.50</td>
<td>391</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td>2.94</td>
<td>383</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td>0.00</td>
<td>383</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td>2.43</td>
<td>570</td>
<td></td>
<td></td>
<td>0</td>
<td>4914</td>
</tr>
<tr>
<td>4.00</td>
<td>521</td>
<td></td>
<td></td>
<td>0</td>
<td>4914</td>
</tr>
<tr>
<td>1.88</td>
<td>440</td>
<td></td>
<td></td>
<td>0</td>
<td>4914</td>
</tr>
<tr>
<td>0.00</td>
<td>NA</td>
<td></td>
<td></td>
<td>0</td>
<td>4914</td>
</tr>
<tr>
<td>2.96</td>
<td>386</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
<tr>
<td>2.29</td>
<td>298</td>
<td></td>
<td></td>
<td>0</td>
<td>2730</td>
</tr>
</tbody>
</table>
Tracking Development Growth

Step 3: Add Missing Developments to Model
Focused Business Decisions

- **Key business decisions for managing capital improvements:**
  - Determine **size** of capacity improvements to convey development flows
  - Determine **when** to build capacity improvements
  - Proportion **cost** of capacity improvements to developers / agencies

- **Secondary needs:**
  - Track development requests – location, flows and status
  - Integrate hydraulic model with development analysis process
  - Dynamically update CIP listing based on growth
Verify Existing Capacity Improvements

- **Step 1 - Update hydraulic model:**
  - Obtain latest flow projections from CDR
  - Combine development flows with flow projections
  - Add flow projections to model

- **Step 2 – Evaluate existing and future flow scenarios**
  - Run model to determine capacity issues for dry and wet weather conditions
  - Run model for existing and future flow scenarios
  - Determine if previously identified capacity issues are still triggered (per d/D and surcharge criteria)

- **Step 3 - Evaluate proposed CIP solutions**
  - Run model with proposed CIP solutions (from master plan)
  - Determine if proposed solutions still meet future flows (2040) needs
Making Decisions
When to Build Capacity Improvements

- **Step 1 – Update Development Tracking Database:**
  - Collect latest development data (location, flows, dates, status)
  - Update periodically or per development application

- **Step 2 – Update Flow Projections**
  - Adjust base flow projections derived from capacity study

- **Step 3 – Compare Existing Capacities with Updated Flow Projections**
  - Extract capacities from hydraulic model and compare with new flows

- **Step 4 – Evaluate Improvement Trigger Year**
  - Interpolate trigger year

- **Step 5 – Verify Improvement Design Capacity**
  - Compare adjusted 2040 flow projections with existing design capacity
Hydraulic Modeling
Evaluate Capacity using Hydraulic Models

Legend
- Surcharged - Throttle
- Surcharged - Backwater
- Non-surcharge
- Flow Meter

See Figure 3-10
See Figure 5-11
See Figure 3-12
See Figure 3-13

Data Sources
Hydraulic Modeling
Finding Capacity Deficiencies

Wright Street - Hydraulic Profile of Existing Sewer (2040 / Peak Wet Weather)
Hydraulic Modeling
Designing Capacity Improvements

Wright Street - Hydraulic Profile with Capacity Improvement (2040 / Peak Wet)
Tool Development

Designing Tools – Tool Architecture

• **Tool 1: Development Tracker:**
  - Development Specs

• **Tool 2: Data Importing and Validation:**
  - Base Flows
  - Development Flows
  - Project Specs
  - Project Basins

• **Tool 3: Flow Projection Update:**
  - Adjusted Flow Projections (per Project site)

• **Tool 4: Capacity Analysis:**
  - Capacity Analysis:
    - Exceedance Year
    - Revised Design Capacity
Tool Development

Designing Tools – Data Architecture

```
CapacityTracker.gdb
- BaseFlows
- Basins
- DevelopmentSpecs
- ProjectBasins
- ProjectFlows
- ProjectSpecs
```

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJECTID</td>
<td>Object ID</td>
</tr>
<tr>
<td>ProjectID</td>
<td>Text</td>
</tr>
<tr>
<td>PWWF2015</td>
<td>Double</td>
</tr>
<tr>
<td>PWWF2020</td>
<td>Double</td>
</tr>
<tr>
<td>PWWF2025</td>
<td>Double</td>
</tr>
<tr>
<td>PWWF2030</td>
<td>Double</td>
</tr>
<tr>
<td>PWWF2035</td>
<td>Double</td>
</tr>
<tr>
<td>PWWF2040</td>
<td>Double</td>
</tr>
<tr>
<td>TriggerYear</td>
<td>Text</td>
</tr>
<tr>
<td>TargetCapacity</td>
<td>Double</td>
</tr>
</tbody>
</table>
Tool Development

Tool 1: Development Tracker

**Tool inputs:**
- Development specs and flows obtained from developers and/or member agencies

**Processing steps:**
- Create a new Development Flow (point) feature class:
- Manually collate and add new development flows:
  - Locate point matching development address
  - Add residential and commercial units
  - Calculate flows
  - Determine key dates (constructed, occupied)
  - Determine if development is included in CDR flow projection

**Tool outputs:**
- Development Specs – point feature class
Tool Development

Tool 2A: Base Flow Importing

- **Tool inputs:**
  - Hydraulic model results for existing and future

- **Processing steps:**
  - Create a new Base Flow feature class:
    - Feature type: Polygon (subcatchments)
    - Import model basins (subcatchments)
  - Run model for 2020, 2025, 2030, 2035 and 2040 peak wet flow scenarios
  - For each model run:
    - Export model result file (SHP format)
    - Import model results into Base Flow
  - For each Project Basin:
    - Calculate dry and wet-weather peaking factors

- **Tool outputs:**
  - Base Flows - polygon feature class
Tool Development

Tool 2B: Development Basin Allocator

- **Tool inputs:**
  - Development Specs feature class

- **Processing steps:**
  - Create a new Subcatchment ID column in Development Specs
  - For each development site:
    - Identify basin (subcatchment) polygon
    - Assign basin ID to development site

- **Tool outputs:**
  - Development Specs (with basin ID’s) – point feature class
Tool Development

Tool 2C: Project Specs

- **Tool inputs:**
  - Capital improvement list or master plan

- **Processing steps:**
  - Create a new Project Specs point feature class
  - Manually enter project spec data including:
    - Name and description
    - Project ID and model ID (link ID)
    - Type (pipe, pump or other)
    - Existing capacity
    - Design capacity
  - Calculate flow factors for each project:
    - Dry weather peaking factor = DW peak flow / average dry weather flow
    - Wet weather peaking factor = WW peak flow / average dry weather flow

- **Tool outputs:**
  - Project Specs – point feature class
Tool Development

Tool 2D: Project Basins

- **Tool inputs:**
  - Project basins defined from model network

- **Processing steps:**
  - Create a new Project Basins - polygon feature class
  - For each Project Site:
    - Manually select upstream basins draining to project site
    - For each basin, assign a flow factor (0 – 1) that represents how much flow contributes to the ‘project network’. Normally, flow factor = 1 unless basin is split due to flow diversions
    - Use model trace tool to define upstream network and associated basins

- **Tool outputs:**
  - Project Basins – polygon feature class
Tool Development
Tool 3: Flow Projection Update

• Tool inputs:
  • Base Flows, Development Flows, Project Specs and Project Basins

• Processing steps:
  • For each Project Site > Year > Basin:
    • Existing Base Flow = model base flow x flow factor
    • Total Development Flow = sum development flows per basin
    • Adjusted Base Flow = Existing Base Flow + Development Flow
  • For each Project Site > Year:
    • Total Adjusted Base Flow = Sum of Adjusted Base Flows
  • For each Project Site:
    • Dry Weather Peak Flow = Total Adjusted Base Flow x DW Peaking Factor
    • Wet Weather Peak Flow = Total Adjusted Base Flow x WW Peaking Factor

• Tool outputs:
  • Project Flows – contains adjusted flow projections
Tool Development
Model Building and GIS Analysis

- **ModelBuilder Approach**
  - Utilized existing InfoWorks model
  - Verified diversion settings

- **Population and Future Developments**
  - OCSD obtained and compiled development populations
  - Updated CDR 2040 projections

- **GIS Processing and ModelBuilder**
  - Applied model procedures
  - Procedures automate the modeling process
  - Utilized ArcGIS ModelBuilder to distribute populations
Tool Development

Tool 4: Capacity Analysis

- **Tool inputs:**
  - Project Specs and Adjusted Flow Projections

- **Processing steps:**
  - Add new columns to Adjusted Flow Projection feature class:
    - Updated Trigger Year
    - Updated Target Capacity
  - For each Project Site > Year:
    - Compare existing capacity with adjusted flow projections
    - Select projection year when flow exceeds capacity
    - Interpolate between 5-year projections to estimate trigger year
    - Compare 2040 adjusted flow projection with target (design) capacity
    - Update target capacity if adjusted 2040 flow exceeds current target capacity

- **Tool outputs:**
  - Capacity Analysis
Tool Development
ModelBuilder and Tool Demo

- OCSD Capacity Tracker
  - A. Development Tracking
    - A1 Development Specs
  - B. Data Management
    - B1 Base Flow Importer
    - B2 Development Allocator
  - C. Capacity Analysis
    - C1 Flow Projector
    - C2 Project Reviewer