Untangling Linear Referencing System-Based Network Connectivity: Strategies for Optimizing Network Performance

Presented by

Jawad Mahmud Hoque

Senior Data Scientist, WSP USA

On Behalf of

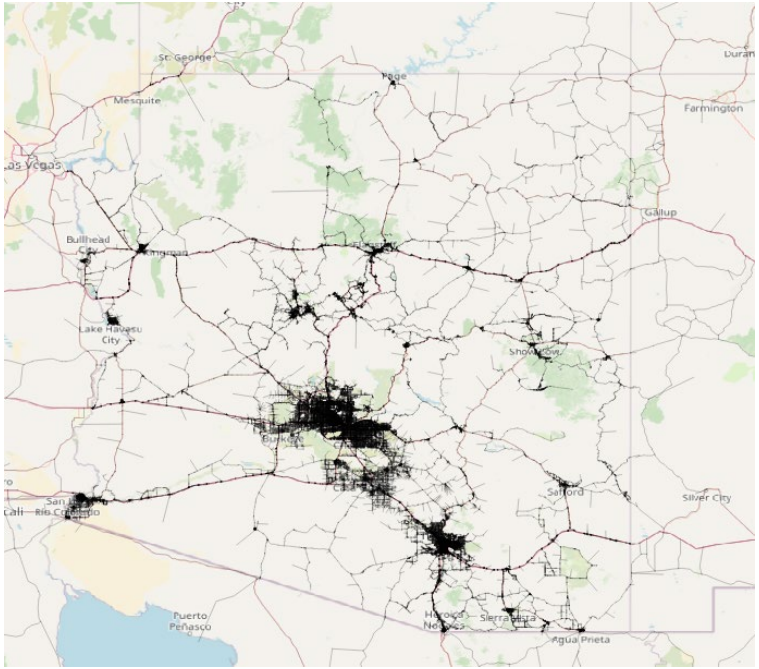
Arizona Department of Transportation- Modeling and Forecasting Team

momo2025 BY ZEPHYR

Arizona Statewide Model Network

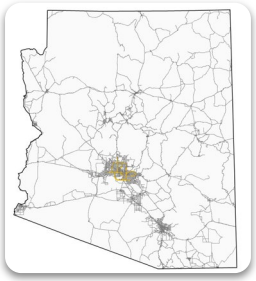
- Created from the Arizona Transportation Information System (ATIS)
  - Roadway centerline dataset owned and maintained by ADOT
  - Managed as a Linear Referencing System (LRS)
  - All roadway characteristics data defined through route name and measured along route
    - Cardinality
    - Type (retired, future, interstate, local etc.)
    - Median (divided, partially divided, undivided)
    - Functional class and Facility Type
    - Speed limit

Arizona Statewide Model Network



Arizona Statewide Model Network

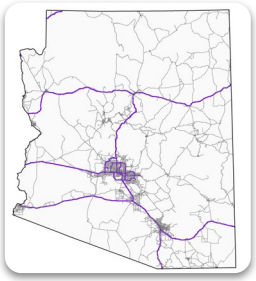
FT = 0



3,379 LINKS

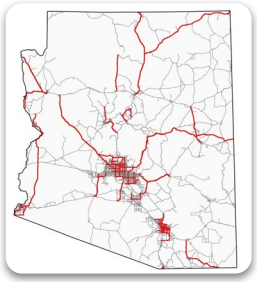
HOV

FT = 1



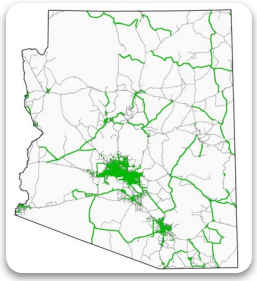
FREEWAY

FT = 2



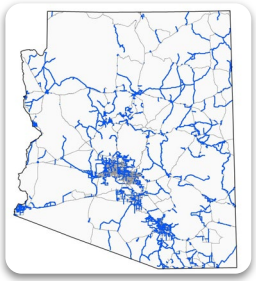
MAJOR ARTERIAL

FT = 3



MINOR ARTERIAL

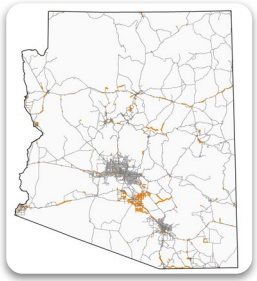
FT = 4



38,406 LINKS

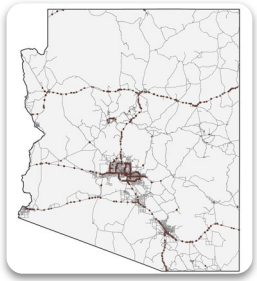
MAJOR COLLECTOR

FT = 5



MINOR COLLECTOR

FT = 7 & 8



RAMP & METERED RAMP

Common Issues in Networks Built from LRS

- Freeway dualization causing wrong directionality and incorrect number of lanes.
- Segregated lanes (HOV, express or auxiliary) not available on LRS.
- Turn prohibitors on ramps
- LRS not always having the full list of attributes needed for demand models.

Testing Model Connectivity

- Visual check
  - Too cumbersome with a network of this size
- Validate network with count
  - Not reliable at early stages of model development
- Load network and check zero volume links
  - Links may still have zero volumes due to unrelated reasons
- Stress test
  - Load network with 10X demand

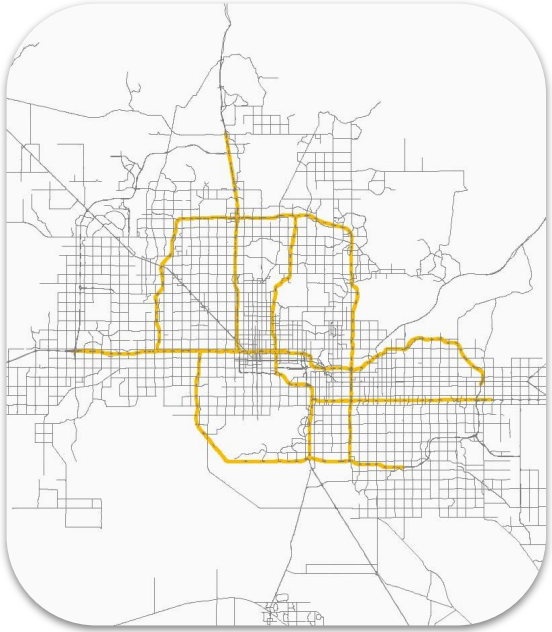
Testing Model Connectivity- Links with Zero Flow

FT	Links	Links w/o Flow	% of Links w/o Flow
0	1,609	91	1.59%
1	3,379	29	0.86 %
2	13,718	227	1.66%
3	34,365	884	2.55 %
4	38,406	7,981	20.71%
5	3,209	1,571	49.08 %
7	7,450	1,083	14.33%
8	7	1	14.29%
Total	102,143	11,867	11.6%

HOV Links with Zero Flow

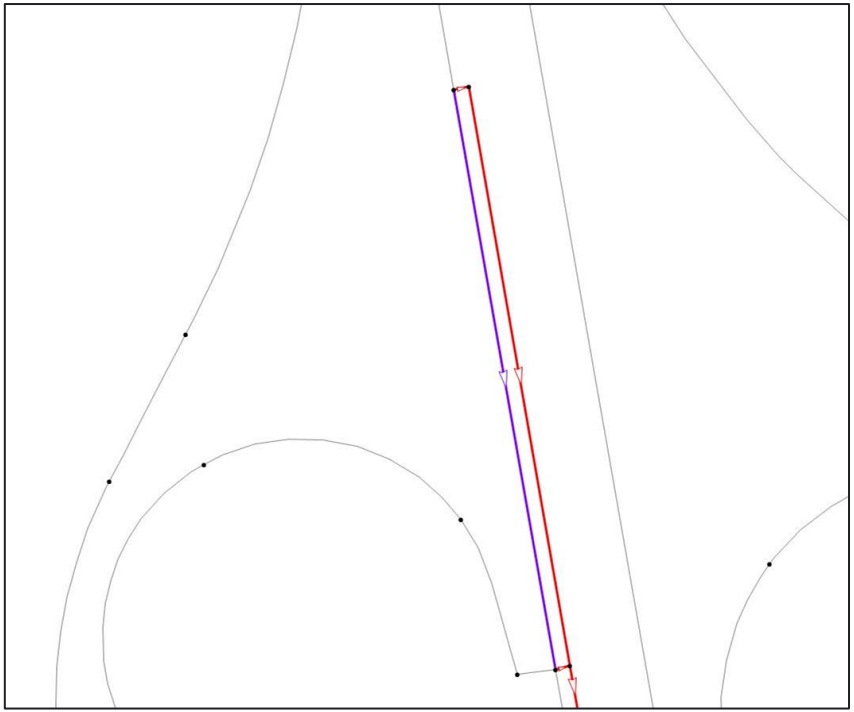
HOV Links
(n = 1,609)

HOV Links with no flow (n = 91)

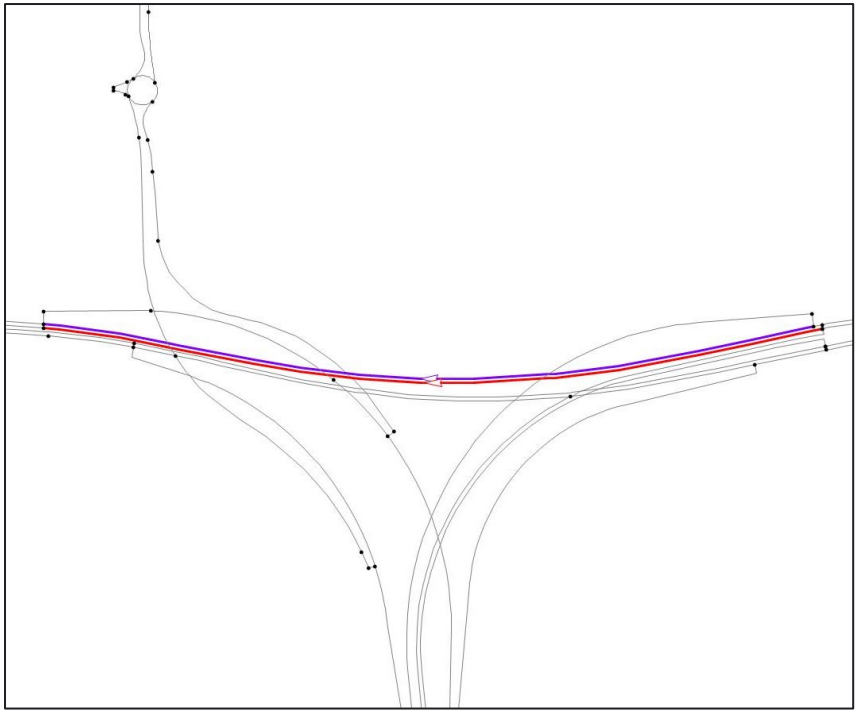


HOV Links with Zero Flow

EXAMPLE 1: CODING ISSUE



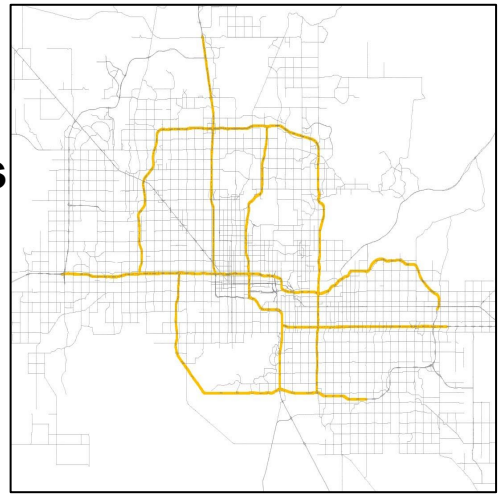
EXAMPLE 2 : CODING ISSUE

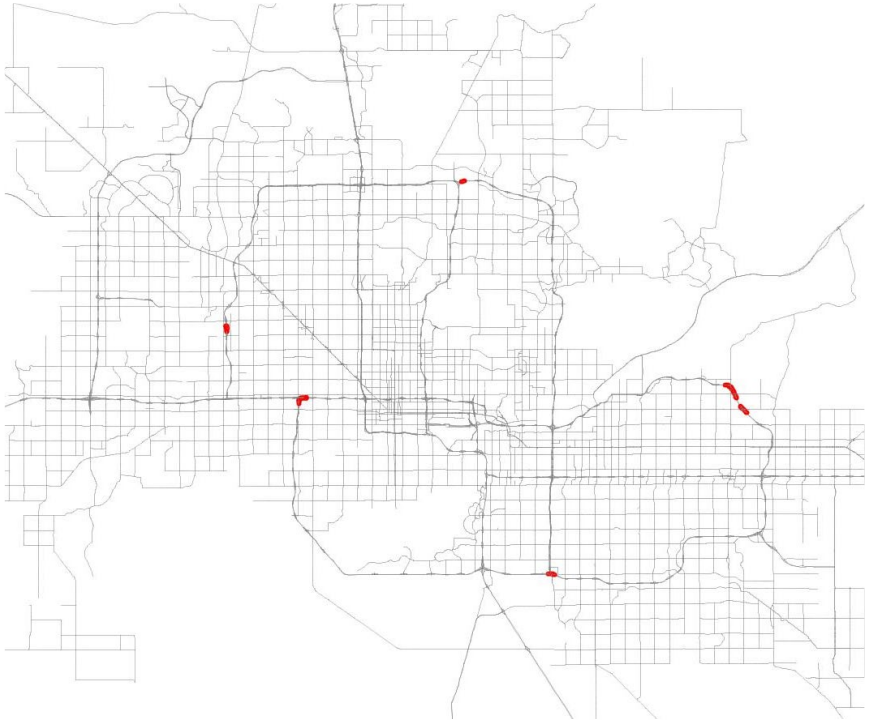


Freeway Links with Zero Flow

Freeway Links
(n = 3,377)

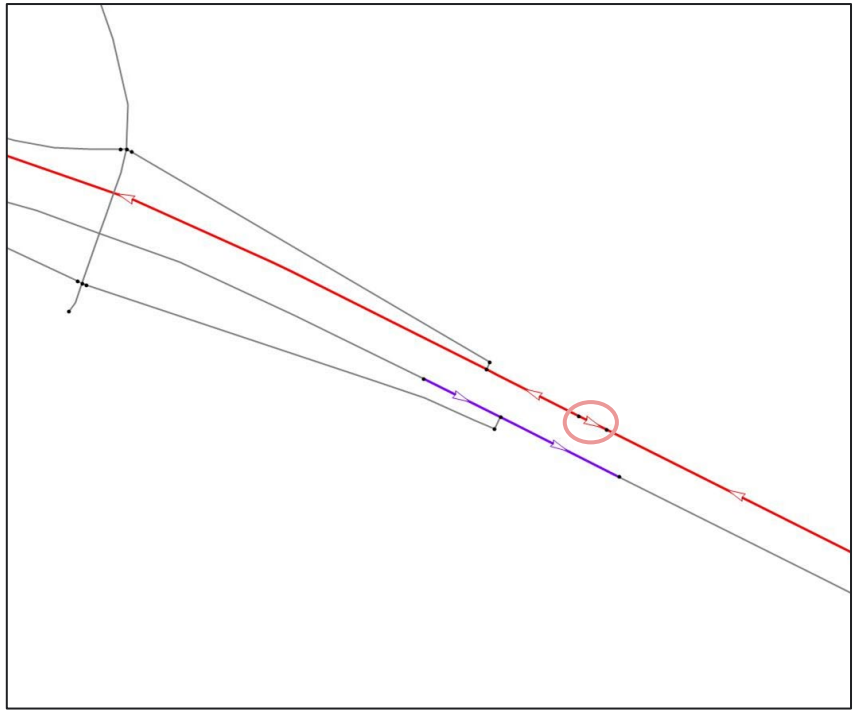
Freeway Links With zero flow
(n = 11)



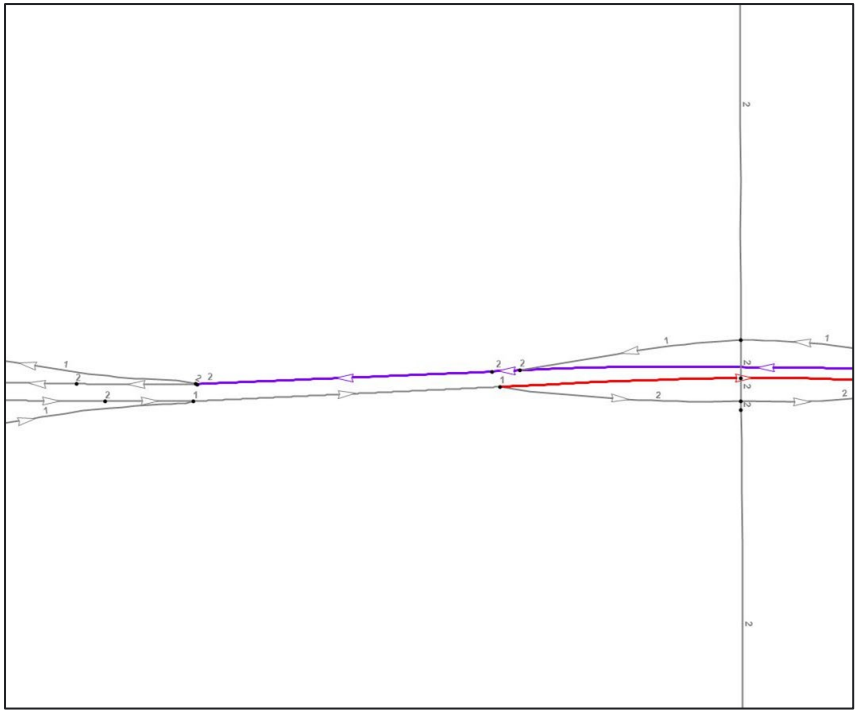


Freeway Links with Zero Flow

EXAMPLE 3 : WRONG DIRECTIONALITY



EXAMPLE 4 : WRONG NUMBER OF LANES



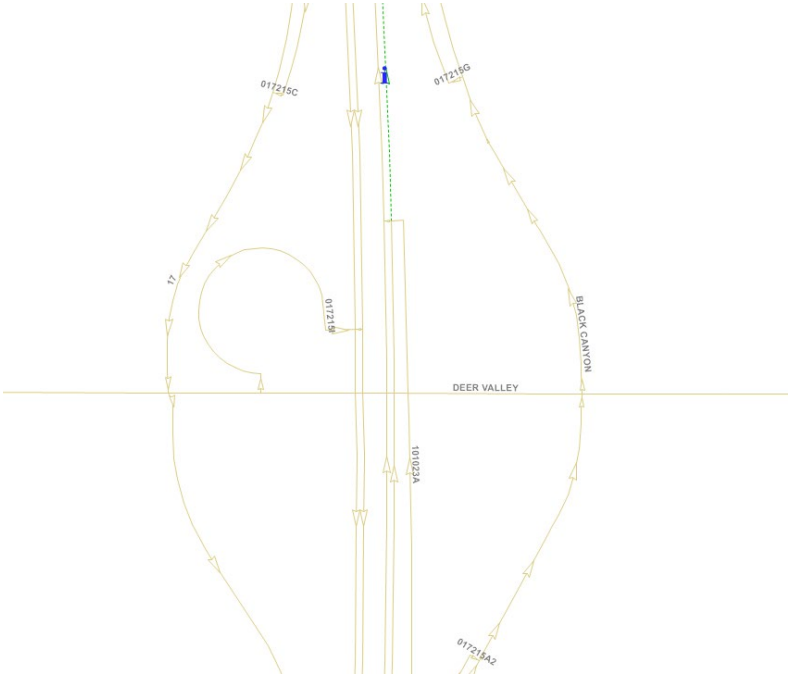
Freeway Links with Zero Flow

EXAMPLE 1: WRONG DIRECTIONALITY

EXAMPLE 2 : WRONG NUMBER OF LANES

Turn Prohibitors on Ramps

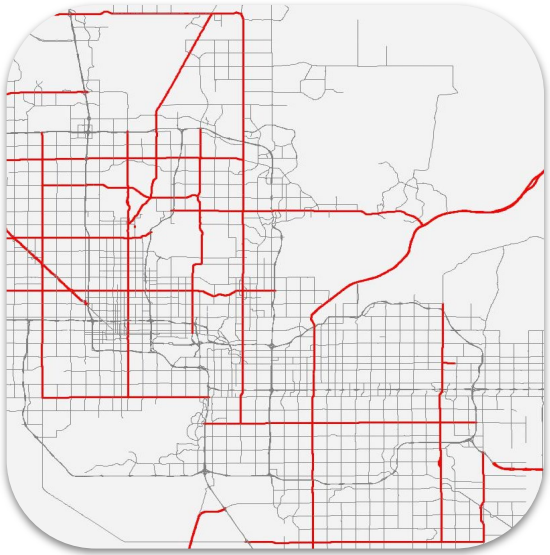
EXAMPLE 1: Loop ramp accessbile to East Deer Valley



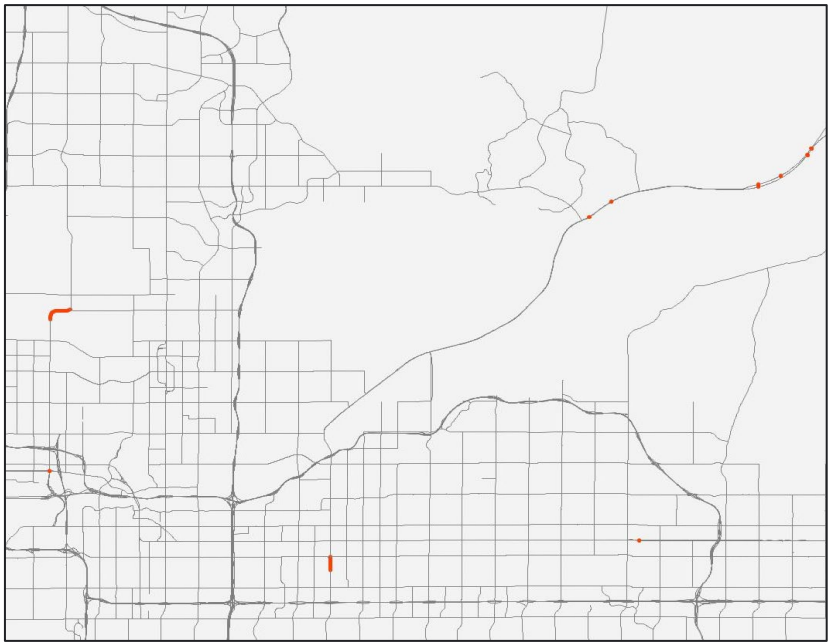
EXAMPLE 1 : Aerial Image Showing Otherwise

Major Arterial Links with Zero Flow

Major Arterial Links
(n = 13,718)

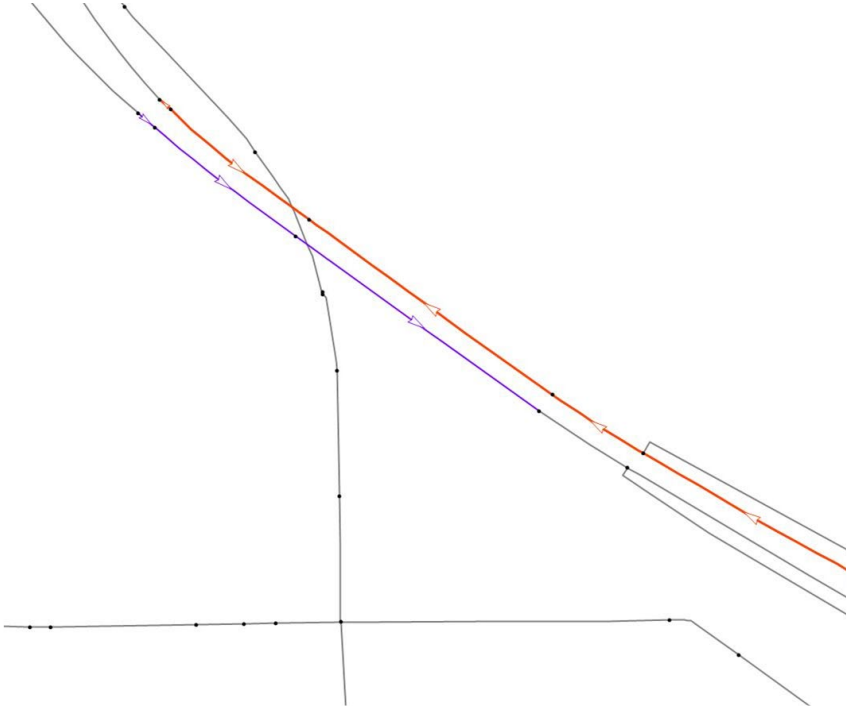


Major Arterial Links
(n = 227)

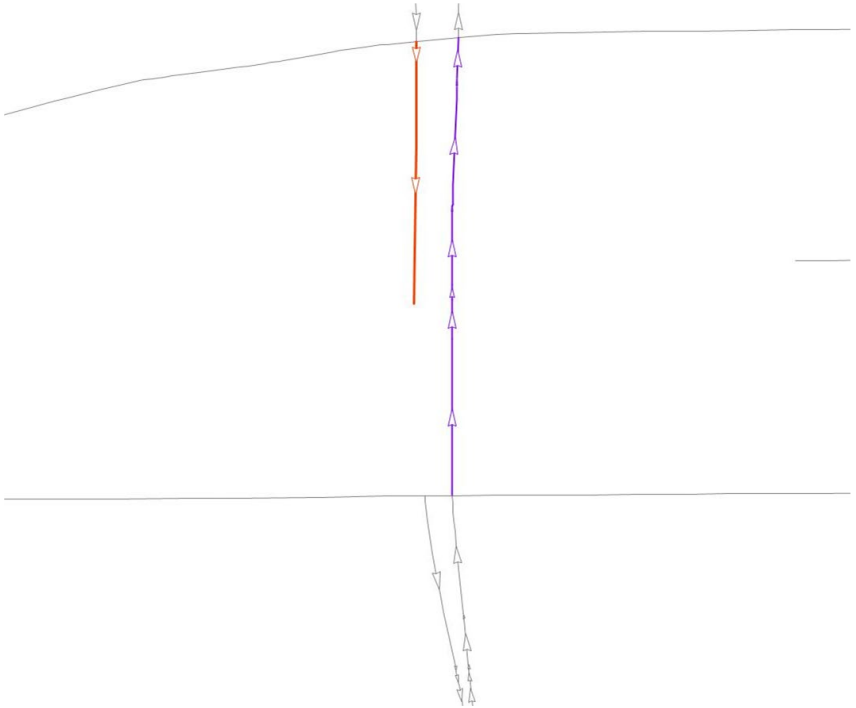


Major Arterial Links with Zero Flow

EXAMPLE 5 : WRONG DIRECTIONALITY



EXAMPLE 6 : Missing Links

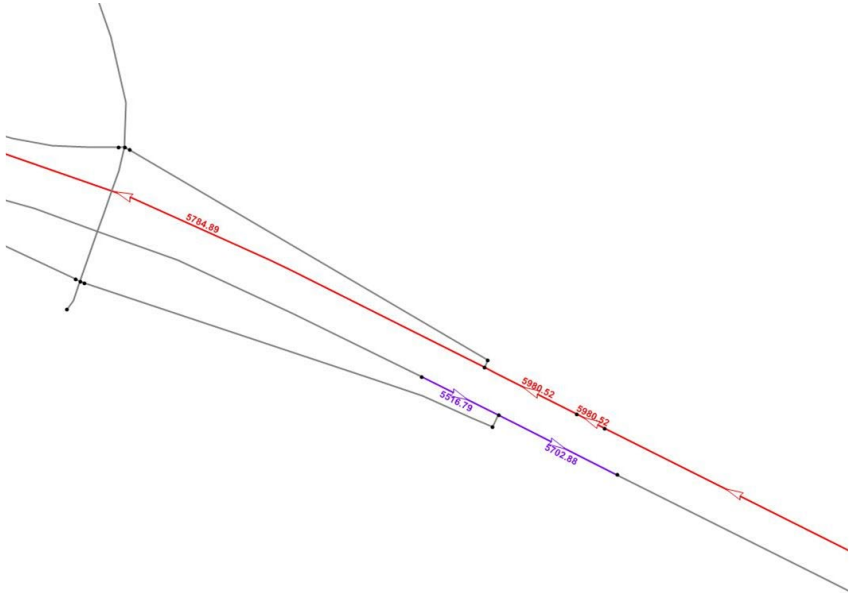


Major Arterial Links with Zero Flow

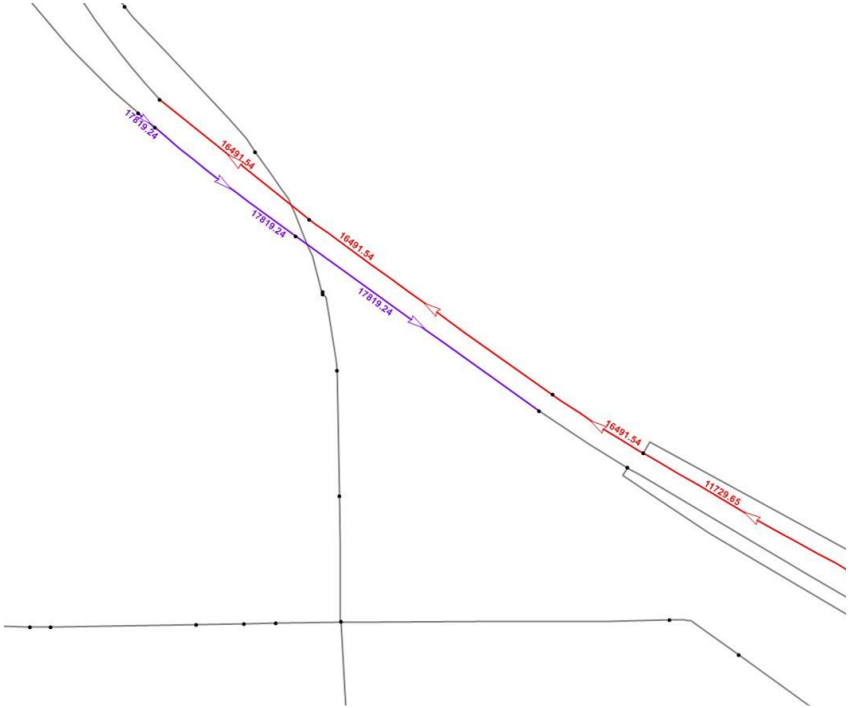
EXAMPLE 5 : WRONG DIRECTIONALITY

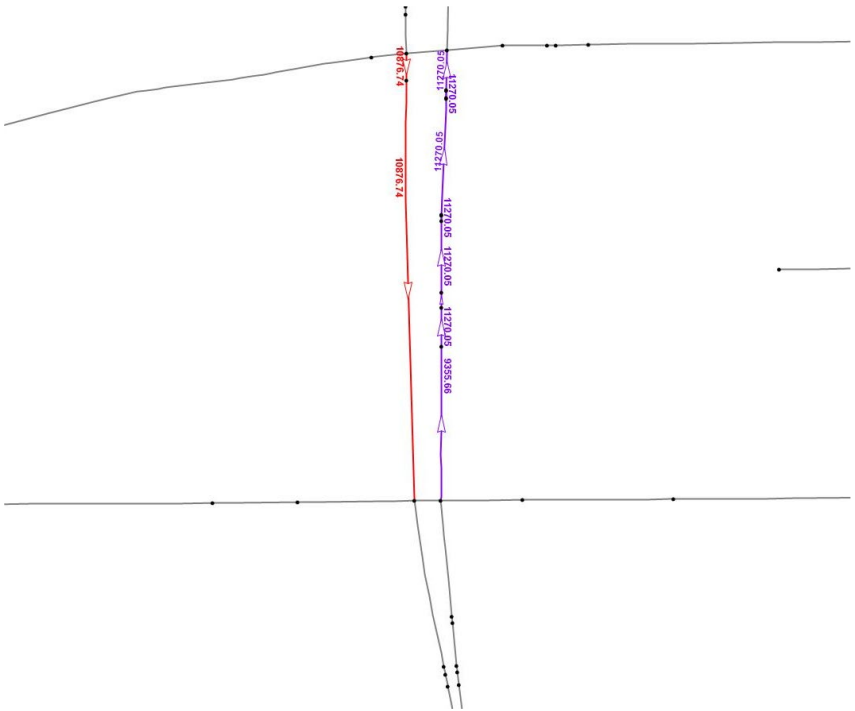
EXAMPLE 6 : Missing Links

Freeway with proper flow



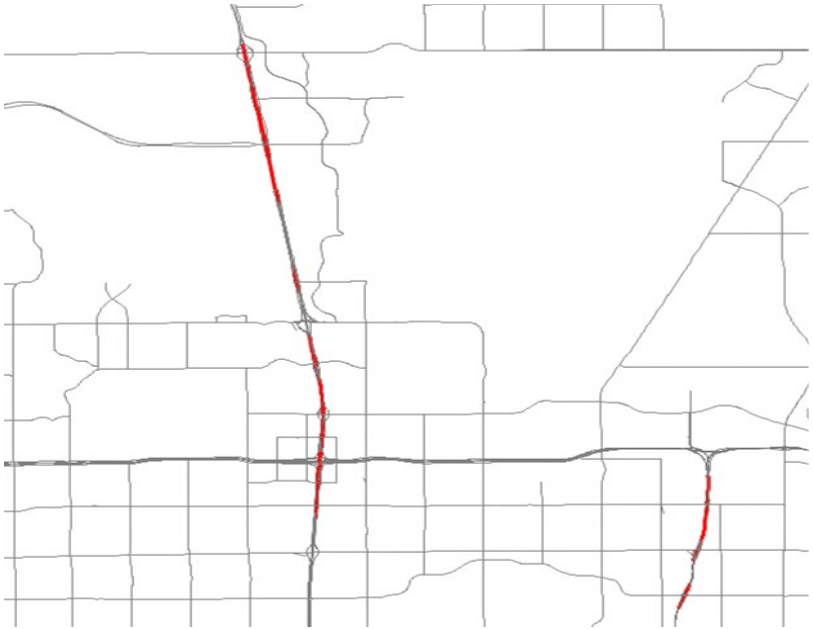
Major Arterial with proper flow



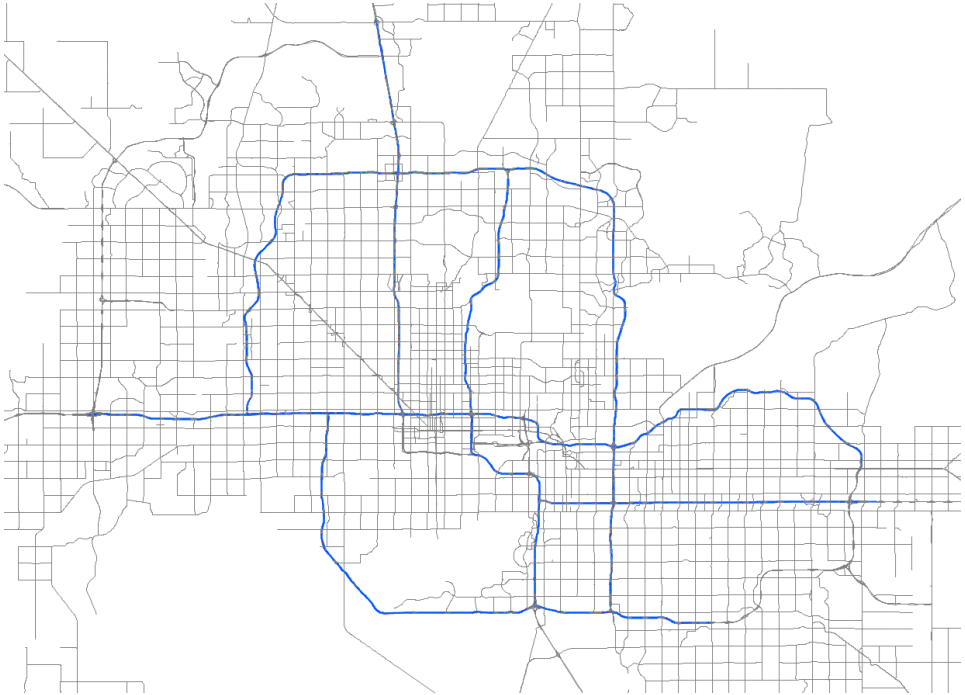


HOV Connectivity- Persisting Issue

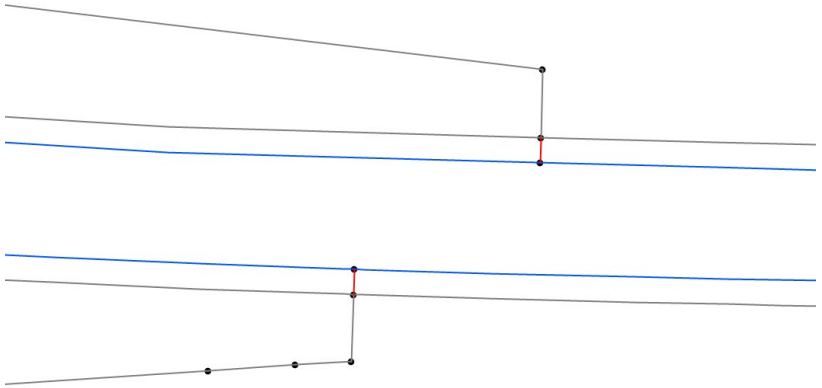
- No Flow in some HOV Lanes
- Certain links with FT = 0 produced no Flow values.



HOV Connectivity-Existing Method



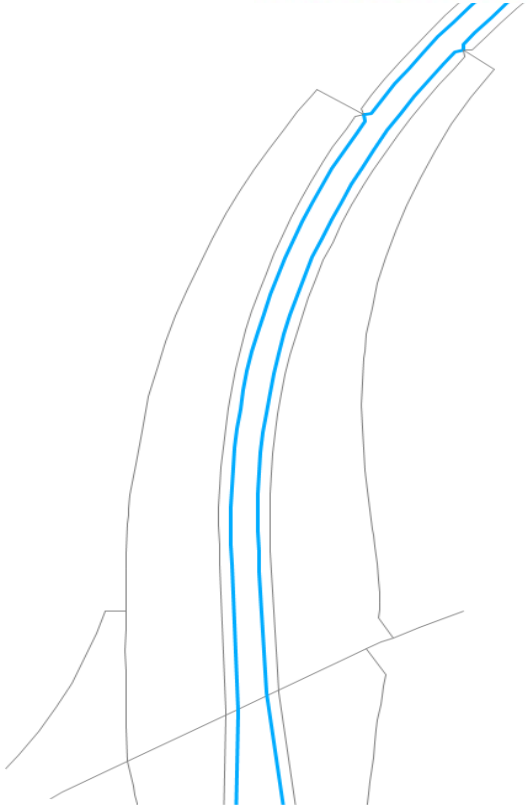
HOV Connectors at On/Off Ramps connected to HOV and General Purpose Lanes



Disparate HOV Connector lengths did not allow for free flow between GP and HOV lanes

Improving HOV Connectivity

- **Dualize HOV Links**



Benefits of Dualized HOV Lane

Fix Flow Issues in Areas

Fix volumes of vehicles passing through certain HOV Lanes resulting in less 0 values

No Need for HOV_Connectors

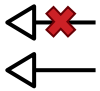
Highway Nodes now directly connect from ramp to both HOV and General Purpose Lanes

Better Visualization

Equidistant spacing between HOV and General Purpose Lanes, allowing for faster identification

Implementation

Steps taken to change current network's HOV Lanes into a dualized link of general purpose lanes with corrected field values

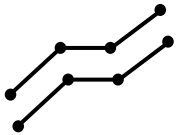


Delete Links

Delete all HOV links and HOV_Connectors

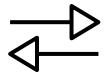
Use Dualization Tool

Use remaining general purpose links as roadways to be dualized via TransCAD



Set Dualization Length

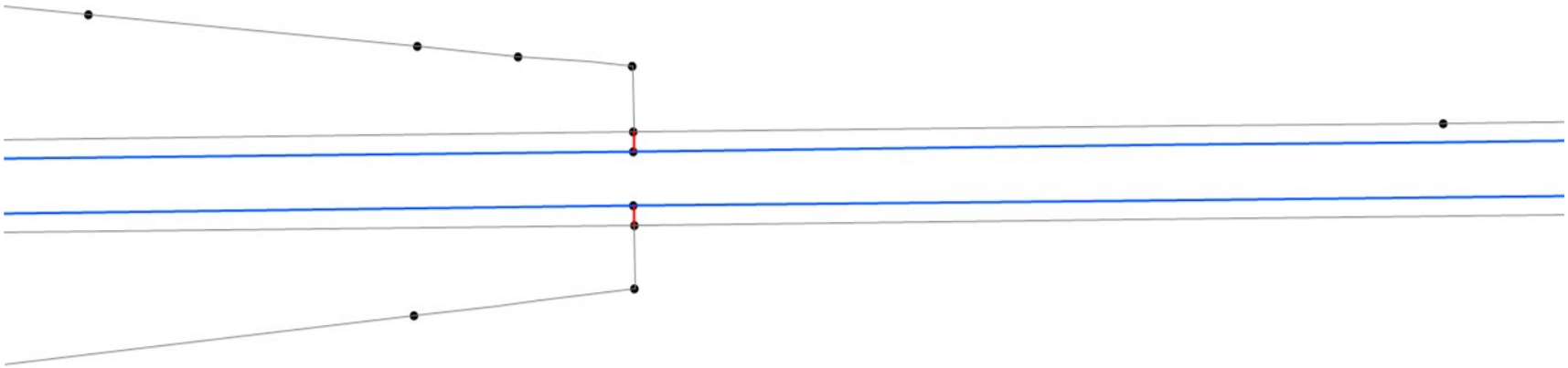
Lanes dualized to be 10 (ft) equidistant to each other.



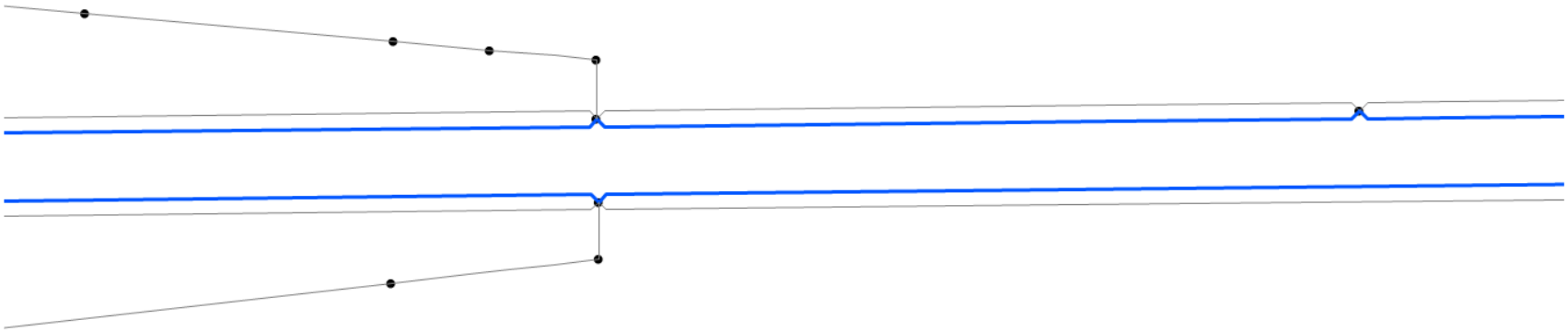
Change Directionality

Newly dualized links require change in Dir (to 0 from -1) to match general purpose.

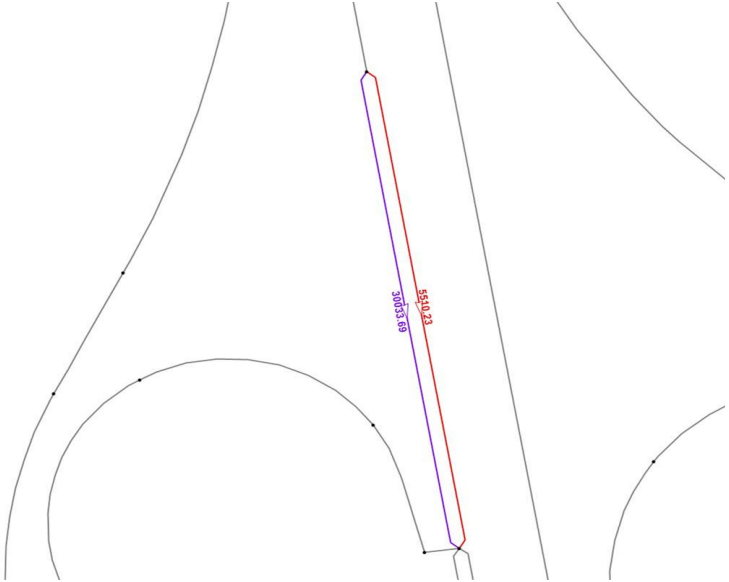
Before Update

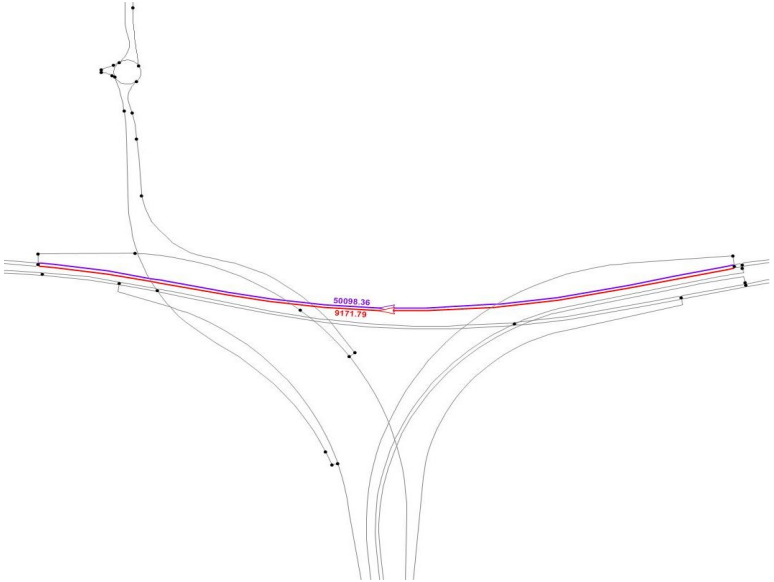


After Update

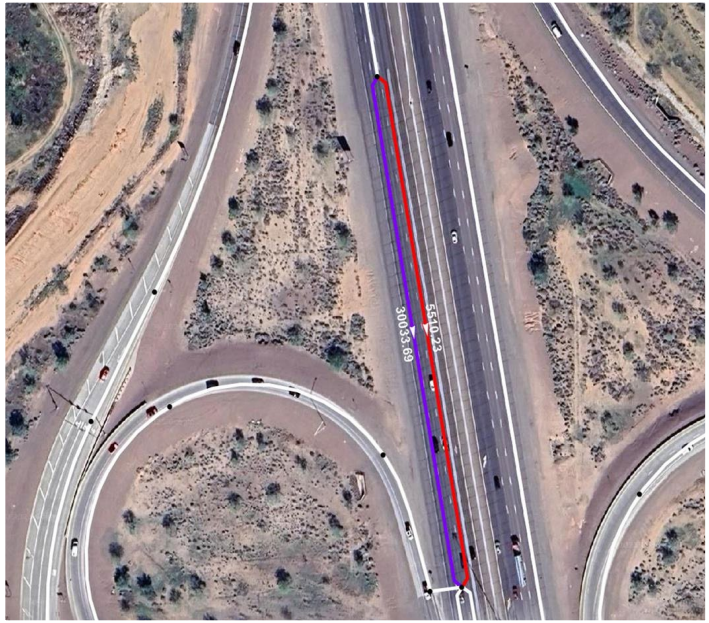


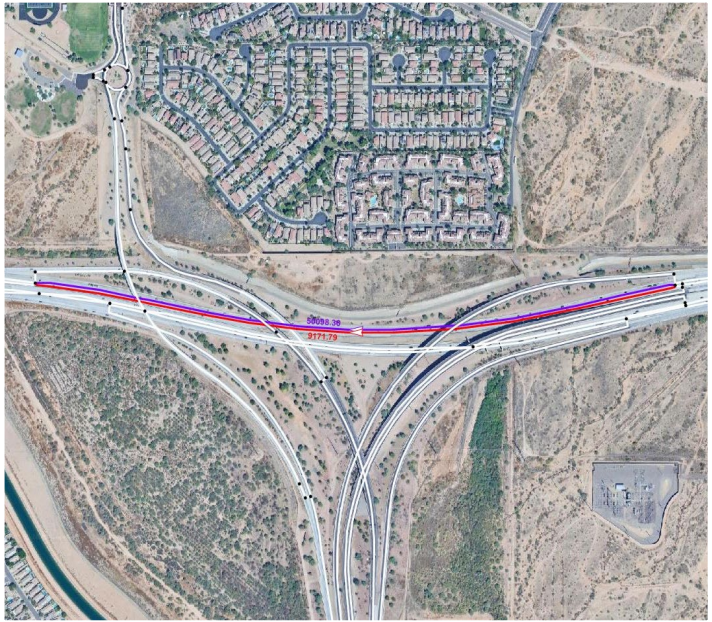
HOV with Proper Flow



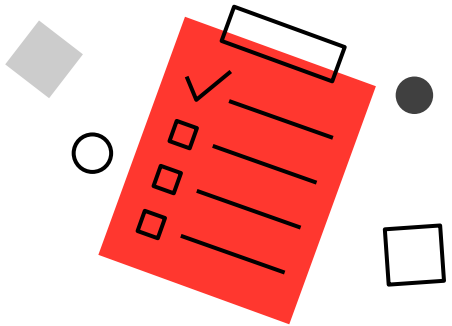


HOV with Proper Flow





Results



Feature A

Reduced amount of HOV Lanes without flow by 72.73%

Feature B

Removed need for (756) HOV_Connectors to be present within network.