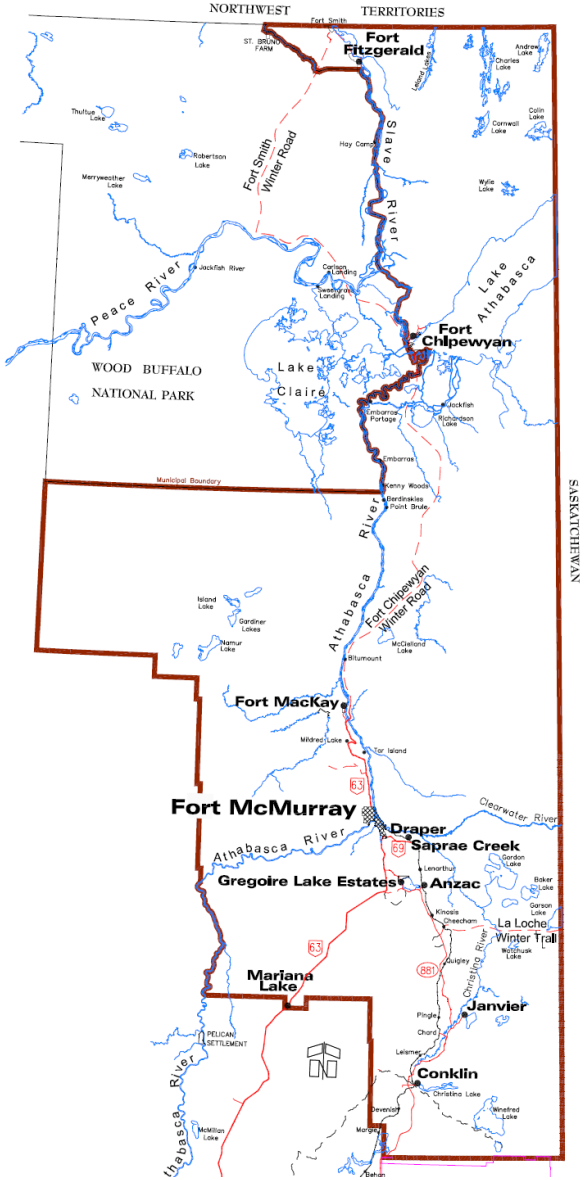
An Atypical TDM - Development of the RM of Wood Buffalo Regional Travel Model

Outline

- What makes the RMWB region unique?
- How does the model work?
- What challenges arose from data sparsity?
- What distinctive results did we obtain?

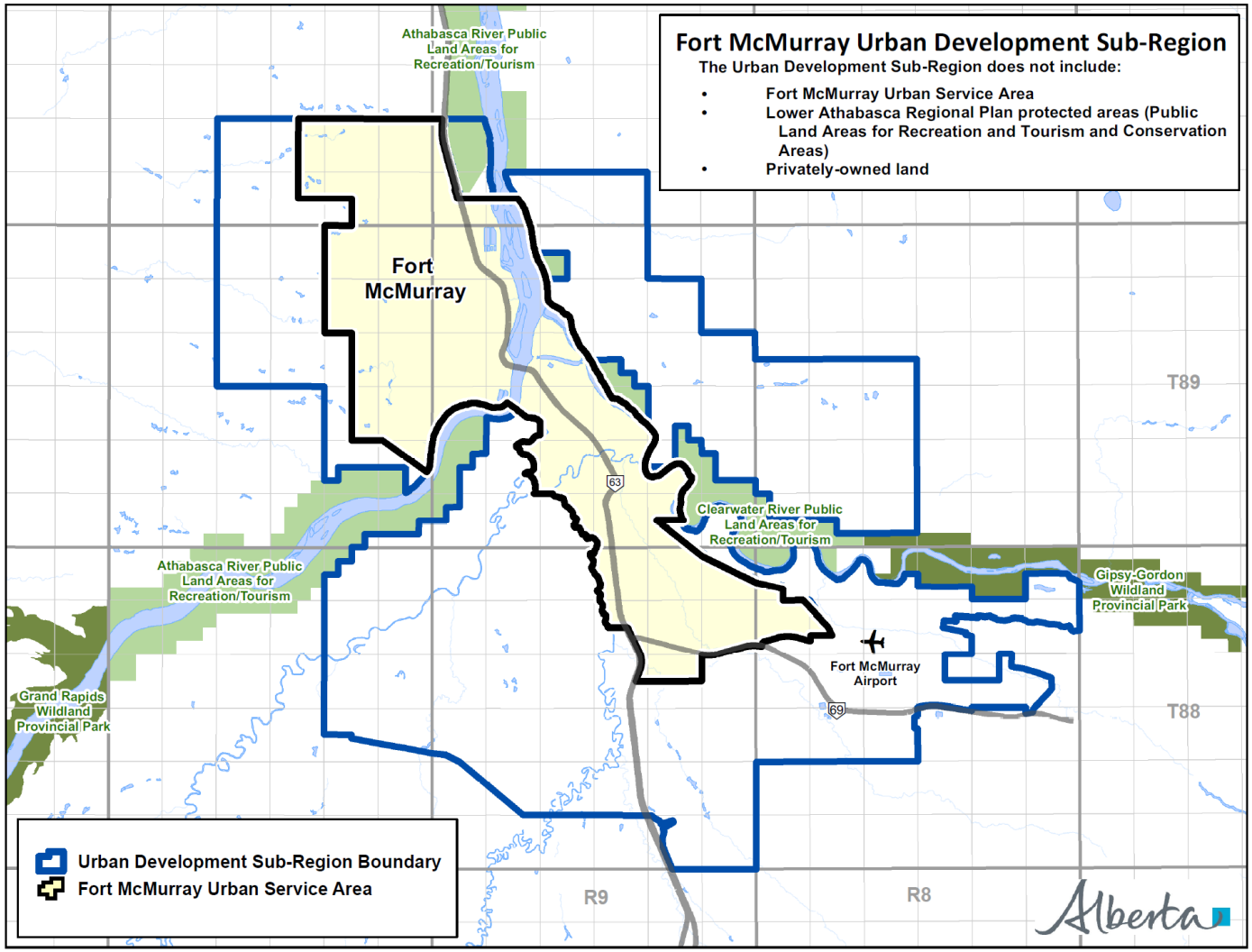
Study Area: Overall



360 km
(15 hours drive in summer)

130 km
(2½ hours drive)

Study Area: UDSR



Specific Model Uses for RMWB

Alternatives Analysis in Support of Identified Planning Goals

R.2.1: Develop Rapid Transit – to encourage permanent residency in the region by reducing commuting time from communities to oil sands operations throughout the region

R.2.2: Expand Regional Road Transportation Systems – to facilitate the efficient movement of people and goods throughout the region and to connect to outside markets

R.2.3: Explore Expansion of Rail Transportation – to potentially provide alternative land transportation options for both shipping and passenger travel use

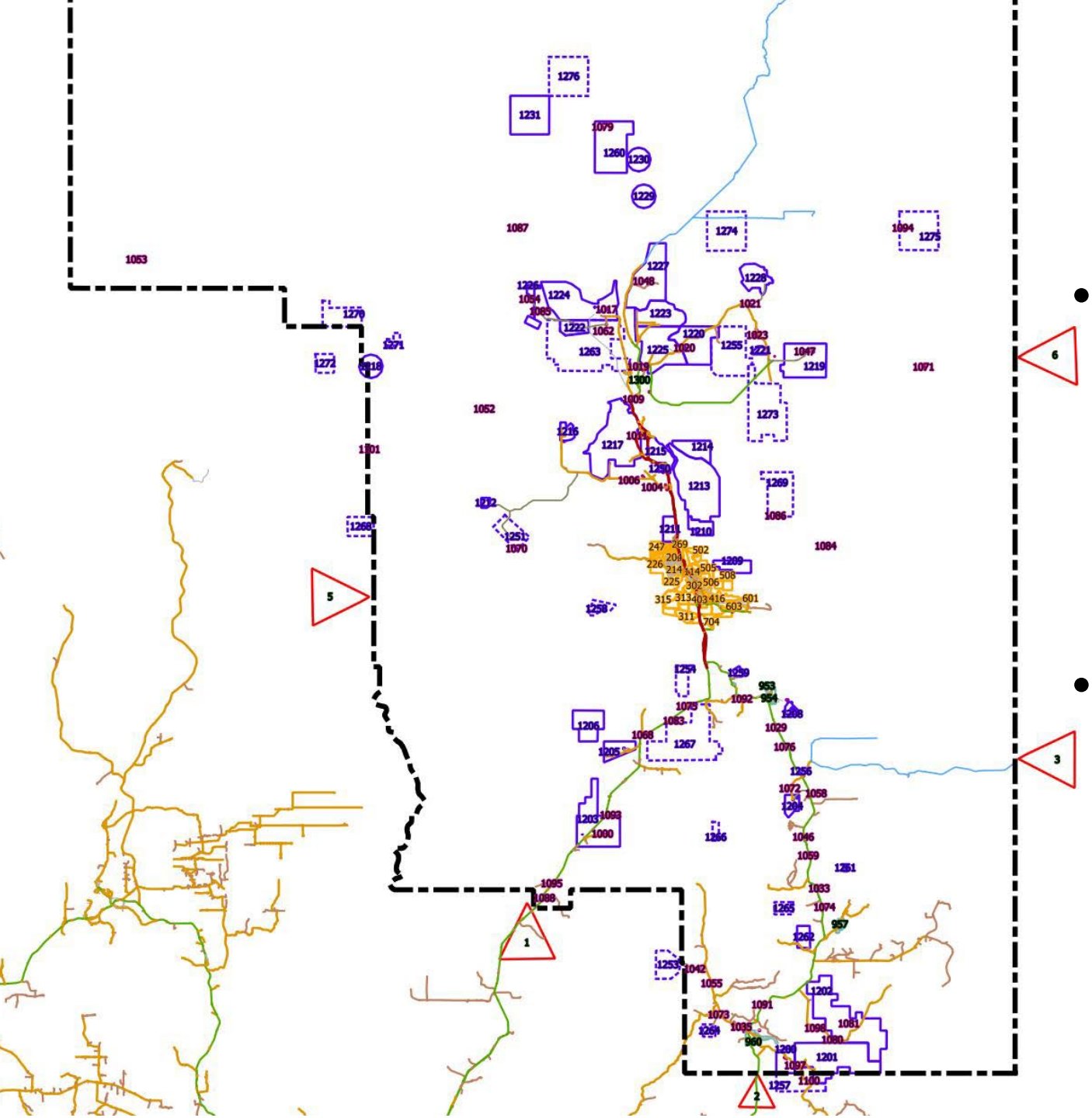
R.2.4: Support Aerodromes to Facilitate Remote Access – to help promote safe and efficient use of air transport

R.2.5: Support the Development of Multi-Use Corridors – to develop integrated mobility solutions for people, goods and services

Specific Model Uses for RMWB

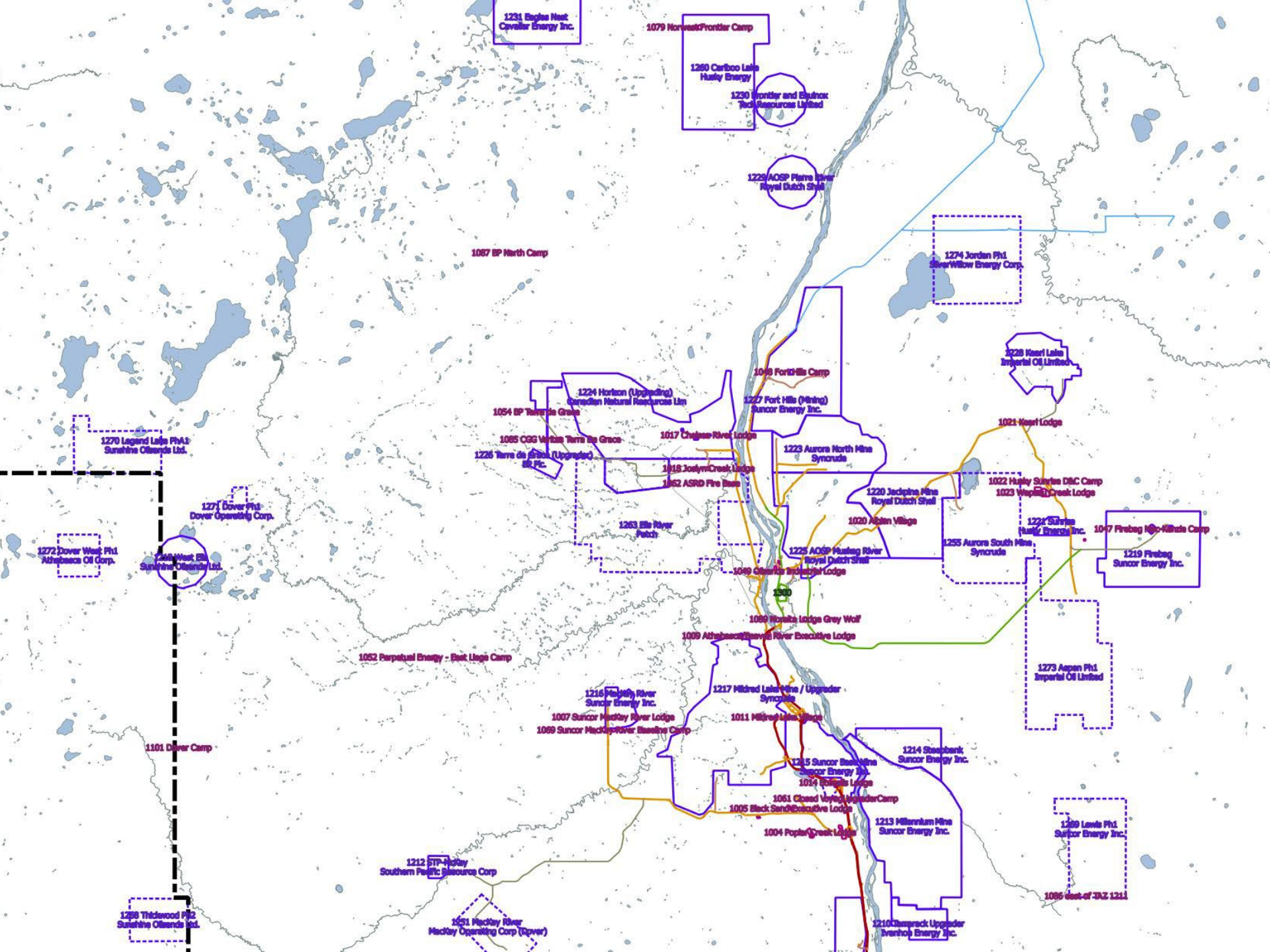
To support a number of transportation planning activities, including:

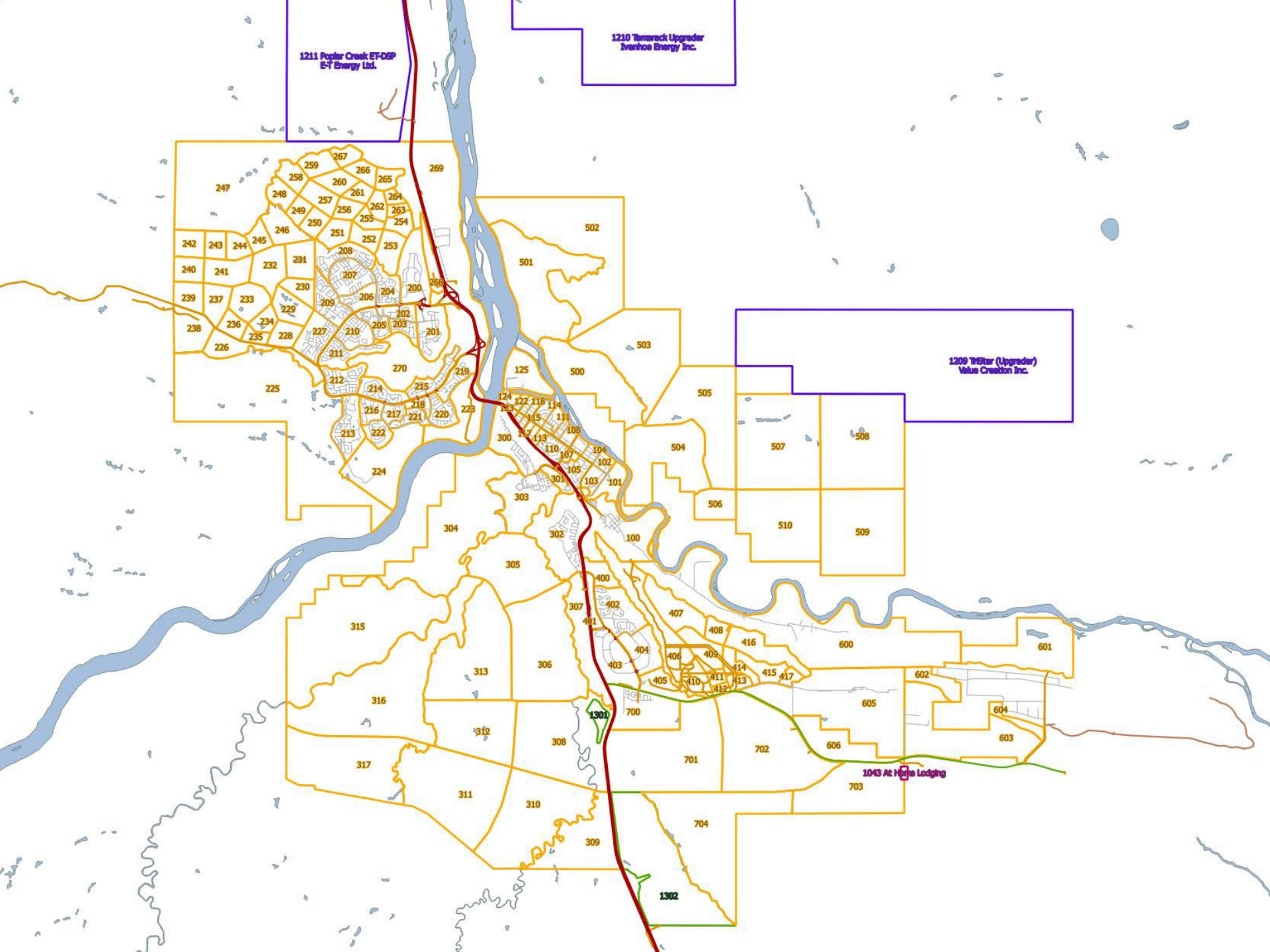
- Traffic forecasting (private, transit and truck)
- Future volumes and flows for road design
- Corridor analysis
- Investment studies
- Interchange evaluations
- External and through trip analysis
- Pavement Management System
- Safety analysis
- Transit network planning

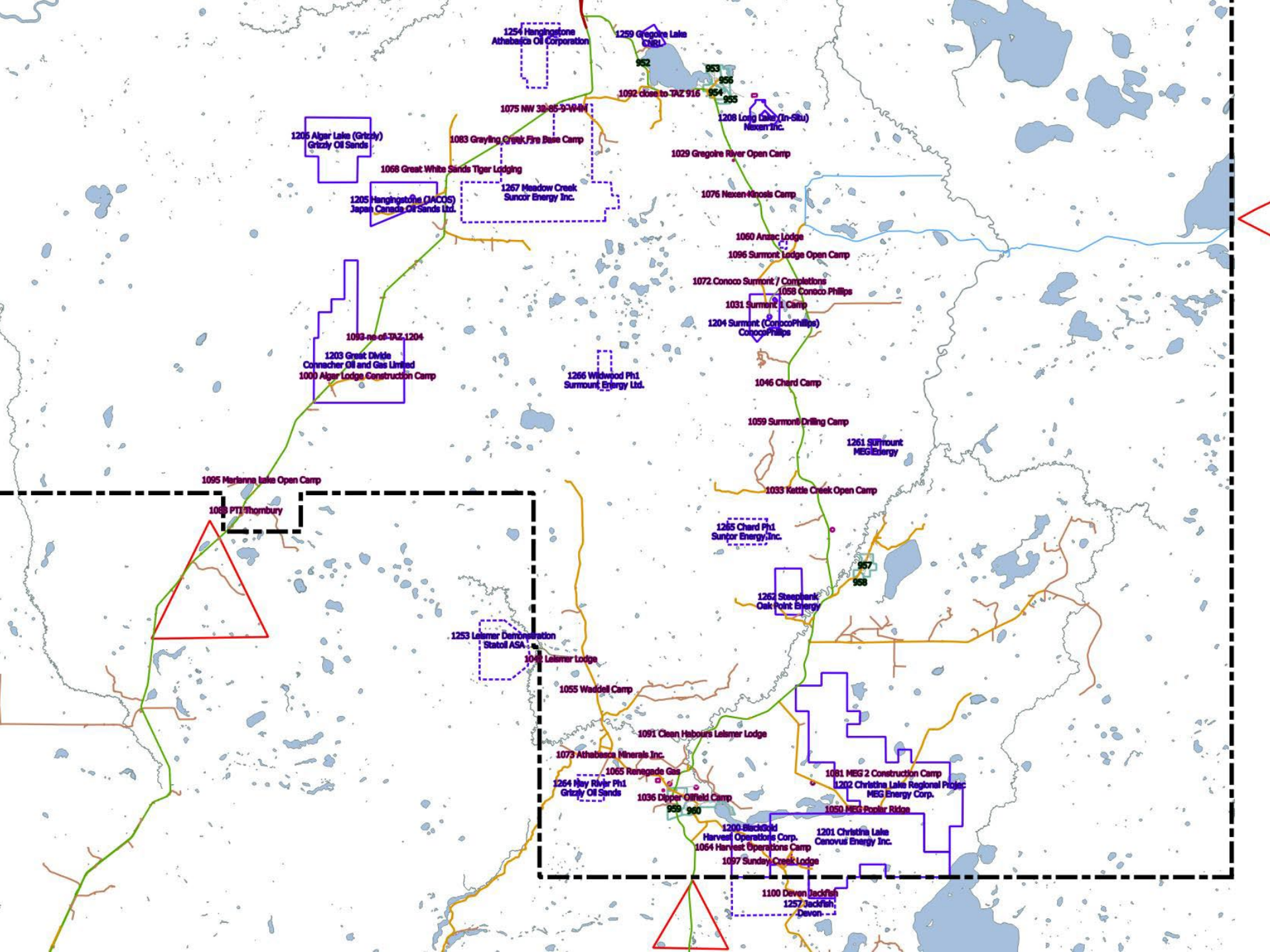


Zones

- Study area divided into “zones” for analysis purposes
- Special zones:
  - Plants
  - Camps
  - External


1231 Eagles Nest
Cavalier Energy Inc.
1079 NorwestFrontier Camp
1260 Caribou Lake
Husky Energy
1230 Frontier and Equinox
Teck Resources Limited
1229 AOSP Pierre River
Royal Dutch Shell
1087 BP North Camp
1274 Jordan Ph1
SilverWillow Energy Corp.
1228 Kearl Lake
Imperial Oil Limited
1048 FortHills Camp
1224 Horizon (Upgrading)
Canadian Natural Resources Ltd
1227 Fort Hills (Mining)
Suncor Energy Inc.
1054 BP Terre de Grace
1085 CGG Veritas Terre de Grace
1226 Terre de Grace (Upgrader)
BP Plc.
1017 Chipewe River Lodge
1018 JoslynCreek Lodge
1052 ASRD Fire Base
1223 Aurora North Mine
Syncrude
1021 Kearl Lodge
1270 Legend Lake PhA1
Sunshine Oilsands Ltd.
1220 Jackpine Mine
Royal Dutch Shell
1022 Husky Sunrise DBC Camp
1023 Wapisiw Creek Lodge
1221 Sunrise
Husky Energy Inc.
1047 Firebag Kno-Kihnde Camp
1219 Firebag
Suncor Energy Inc.
1020 Aiken Village
1255 Aurora South Mine
Syncrude
1225 AOSP Mustang River
Royal Dutch Shell
1049 Cheecha Industrial Lodge
1271 Dover Ph1
Dover Operating Corp.
1263 Ells River
Patch
1272 Dover West Ph1
Athabasca Oil Corp.
1268 West Ells
Sunshine Oilsands Ltd.
1300
1089 Horizon Lodge Grey Wolf
1009 Athabasca/Beaver River Executive Lodge
1052 Perpetual Energy - East Liege Camp
1273 Aspen Ph1
Imperial Oil Limited
1216 Mackay River
Suncor Energy Inc.
1217 Mildred Lake Mine / Upgrader
Syncrude
1007 Suncor Mackay River Lodge
1011 Mildred Lake Village
1069 Suncor Mackay River Baseline Camp
1214 Steepbank
Suncor Energy Inc.
1101 Dover Camp
1215 Suncor Baseline
Suncor Energy Inc.
1014 Borealis Lodge
1061 Closed Voyageur UpgraderCamp
1005 Black Sand Executive Lodge
1213 Millennium Mine
Suncor Energy Inc.
1004 Poplar Creek Lodge
1269 Lewis Ph1
Suncor Energy Inc.
1212 STP-Hickey
Southern Pacific Resource Corp
1086 east of TAZ 1211
1268 Thickwood Ph2
Sunshine Oilsands Ltd.
1231 Mackay River
Mackay Operating Corp (Dover)
1210 Shenzack Upgrader
Ivanhoe Energy Inc.


1211 Poplar Creek EF-DSP
E-T Energy Ltd.
1210 Tamarack Upgrader
Ivanhoe Energy Inc.
1209 TriStar (Upgrader)
Value Creation Inc.
1043 At Home Lodging
1301
1302


1254 Hangingstone Athabasca Oil Corporation
1259 Gregoire Lake (ISR)
952
953
956
954
955
1092 close to TAZ 916
1075 NW 32-85-9-W4M
1208 Long Lake (In-Situ) Nexen Inc.
1205 Algar Lake (Grizzly) Grizzly Oil Sands
1083 Graying Creek Fire Base Camp
1029 Gregoire River Open Camp
1068 Great White Sands Tiger Lodging
1267 Meadow Creek Suncor Energy Inc.
1205 Hangingstone (JACOS) Japan Canada Oil Sands Ltd.
1076 Nexen Hinols Camp
1060 Anzac Lodge
1096 Surmont Lodge Open Camp
1072 Conoco Surmont 2 Completions
1058 Conoco Phillips
1031 Surmont 1 Camp
1204 Surmont (ConocoPhillips) ConocoPhillips
1093 re-of TAZ 1204
1203 Great Divide Connacher Oil and Gas Limited
1000 Algar Lodge Construction Camp
1266 Widwood Ph1 Surmount Energy Ltd.
1046 Chard Camp
1059 Surmont Drilling Camp
1261 Surmount MEG Energy
1095 Marianna Lake Open Camp
1033 Kettle Creek Open Camp
1265 Chard Ph1 Suncor Energy Inc.
957
958
1262 Steepbank Oak Point Energy
1253 Leismer Demonstration Statoil ASA
1042 Leismer Lodge
1055 Waddell Camp
1091 Clean Harbours Leismer Lodge
1073 Athabasca Minerals Inc.
1065 Renegade Gas
1264 Hay River Ph1 Grizzly Oil Sands
1036 Dipper Oilfield Camp
959
960
1081 MEG 2 Construction Camp
1202 Christina Lake Regional Project MEG Energy Corp.
1050 MEG Poplar Ridge
1200 BlackGold Harvest Operations Corp.
1064 Harvest Operations Camp
1201 Christina Lake Cenovus Energy Inc.
1097 Sunday Creek Lodge
1100 Devon Jackfish
1257 Jackfish Devon

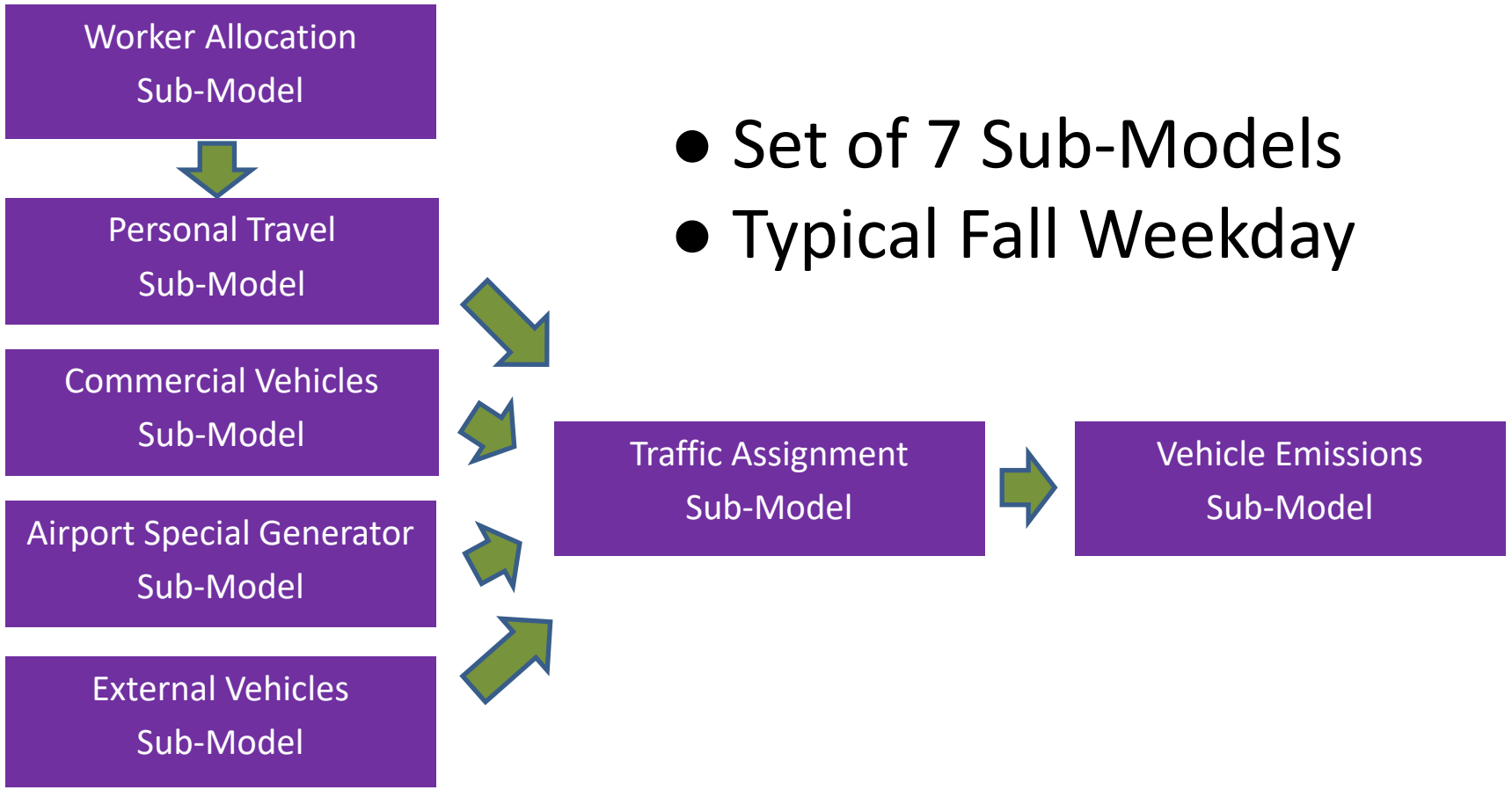
Modes

- Auto:
  - Single Occupant Vehicle
  - HOV (2 person and 3+)
- Transit:
  - Public transit
  - Work bus
  - Park and ride (future)
- Active:
  - Walk
  - Bike
- Light commercial vehicles
- Medium commercial vehicles (single unit trucks)
- Heavy commercial vehicles (tractor-trailer)

11 Time Periods

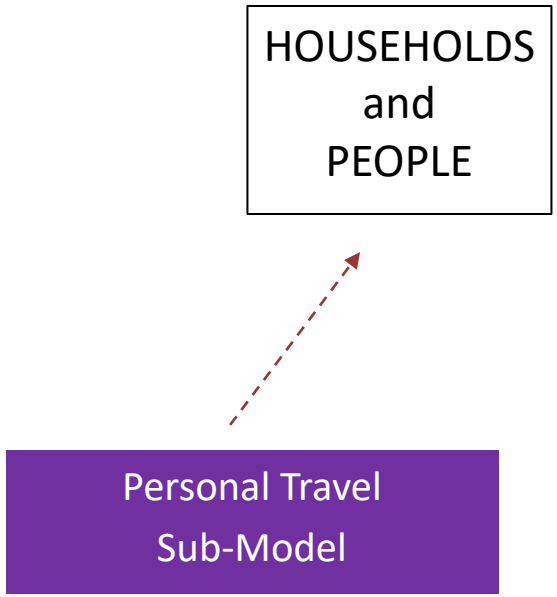
- Off-peak:
  - Midnight to 5 AM
- AM Peak:
  - 5 to 6 AM
  - 6 to 7 AM
  - 7 to 8 AM
  - 8 to 9 AM
- Midday:
  - 9 AM to 4 PM
- PM Peak:
  - 4 to 5 PM
  - 5 to 6 PM
  - 6 to 7 PM
  - 7 to 8 PM
- Off-Peak:
  - 8 PM to midnight

How Does The Model Work?

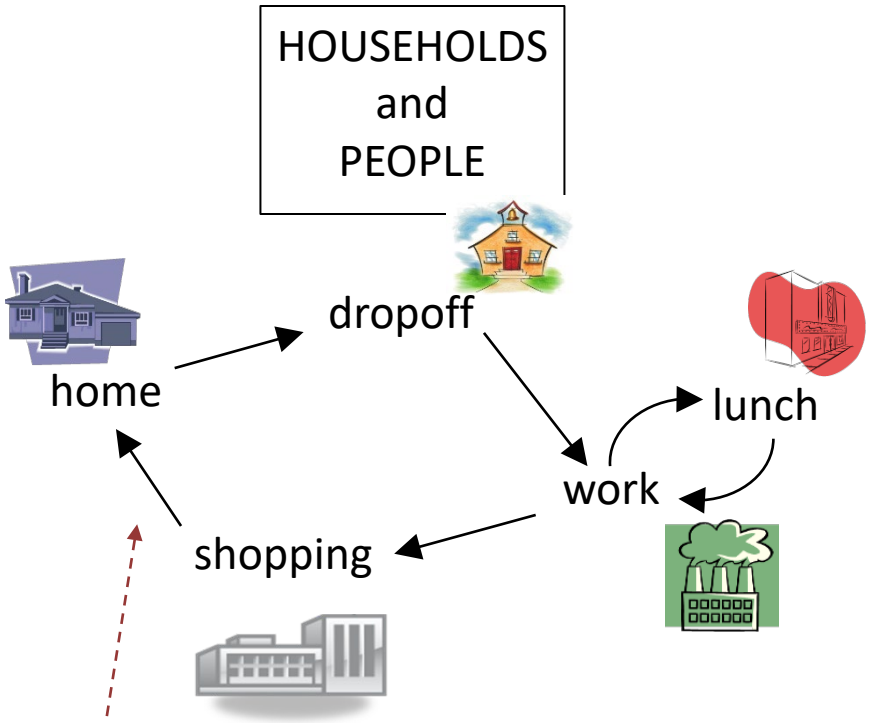


- Set of 7 Sub-Models
- Typical Fall Weekday

- Represent different aspects of transportation demand and the impacts of transportation


HOUSEHOLDS
and
PEOPLE
Personal Travel
Sub-Model


HOUSEHOLDS and PEOPLE
EMPLOYEES at WORKPLACES
Personal Travel Sub-Model
Commercial Vehicles Sub-Model



trips
- start time
- end time
- mode

HOUSEHOLDS and PEOPLE

dropoff

home

lunch

work

shopping

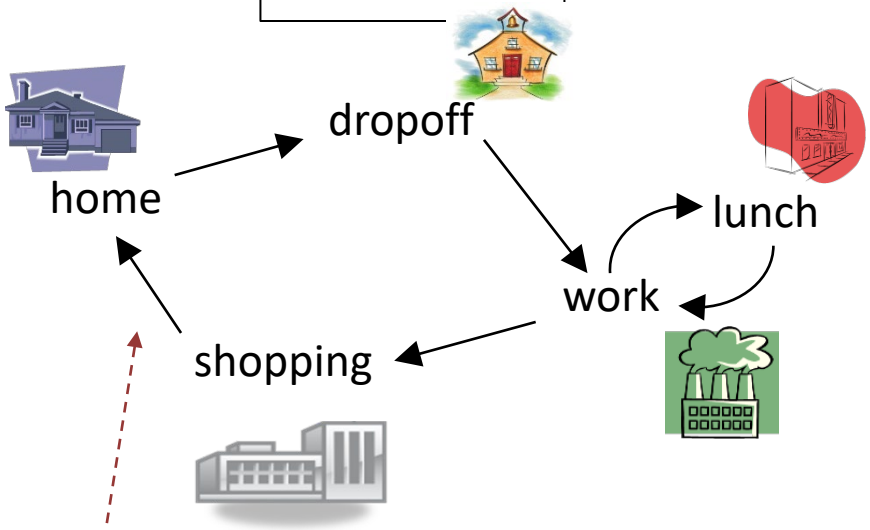
trips
- start time
- end time
- mode

EMPLOYEES at WORKPLACES

Commercial Vehicles Sub-Model

HOUSEHOLDS and PEOPLE

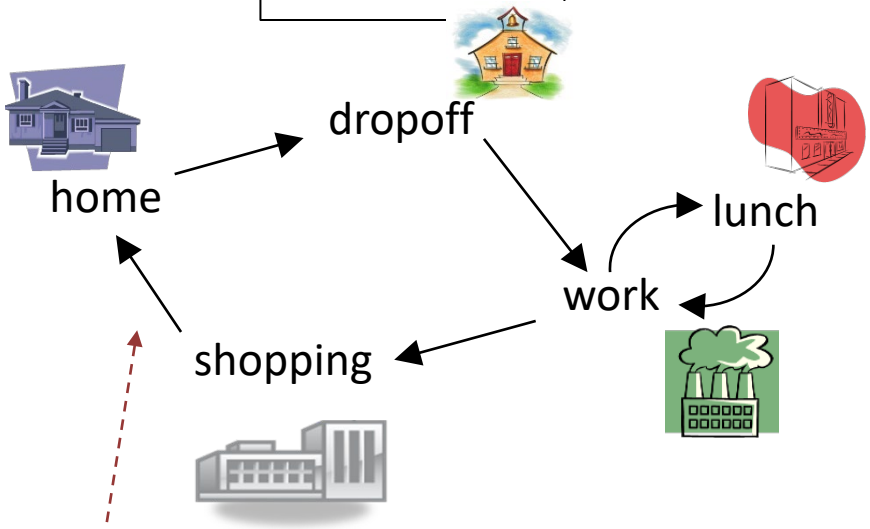
EMPLOYEES at WORKPLACES



trips
- start time
- end time
- mode

HOUSEHOLDS and PEOPLE

EMPLOYEES at WORKPLACES



establishment

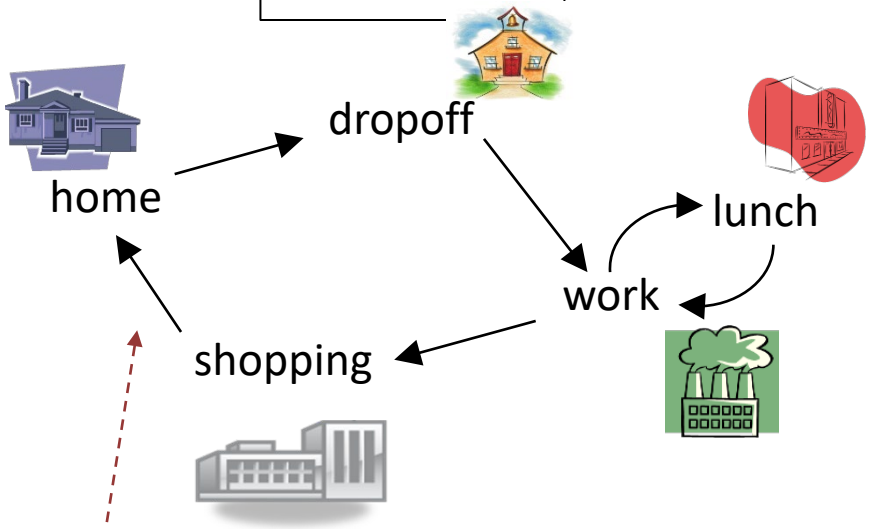
trips
- start time
- end time
- mode

Establishments

- Oil Sands Plants
- Other Industrial
- Manufacturing
- Retail
- Services
- Transportation and Handling
- Government
- Airport

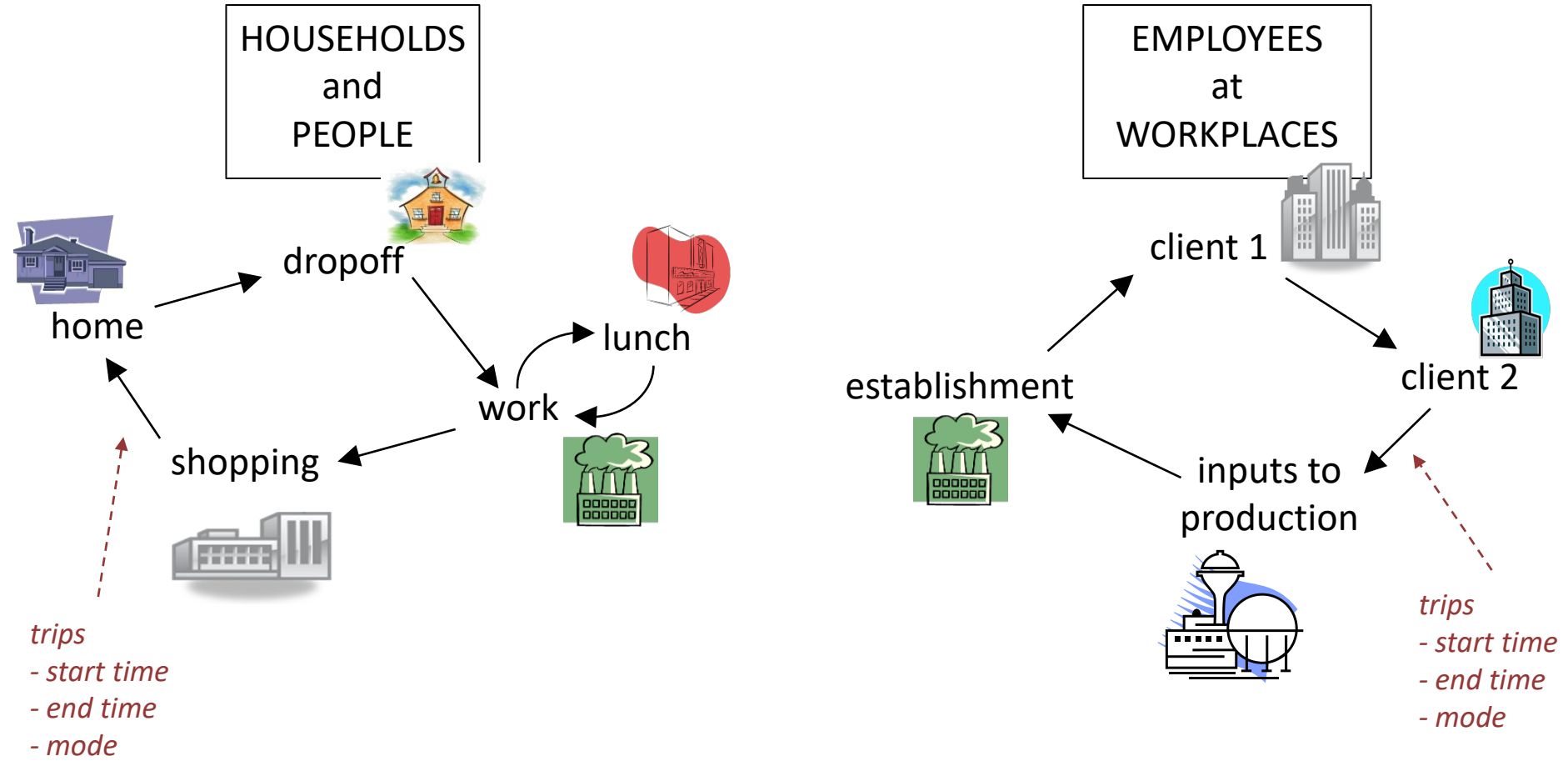
HOUSEHOLDS and PEOPLE

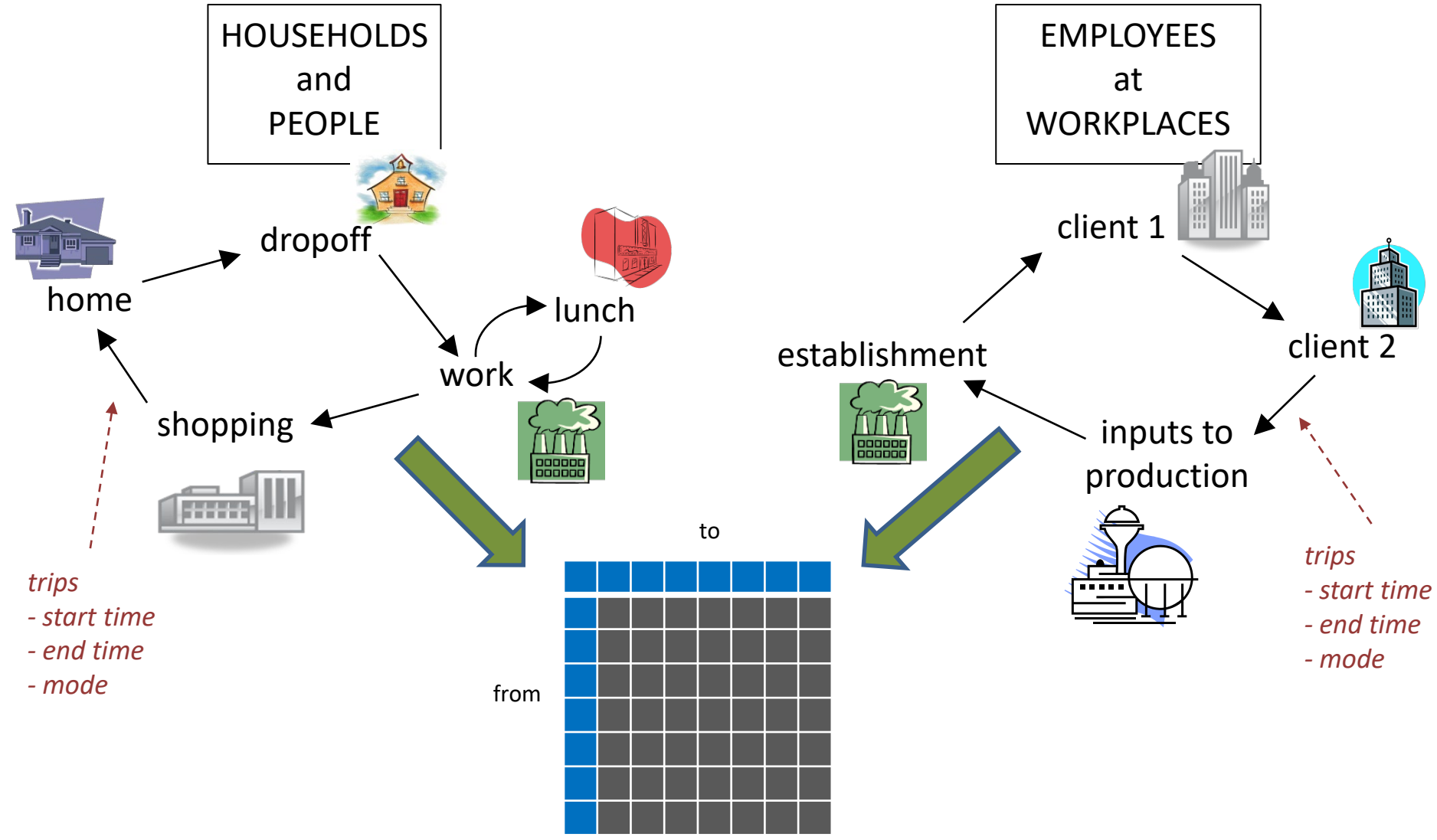
EMPLOYEES at WORKPLACES

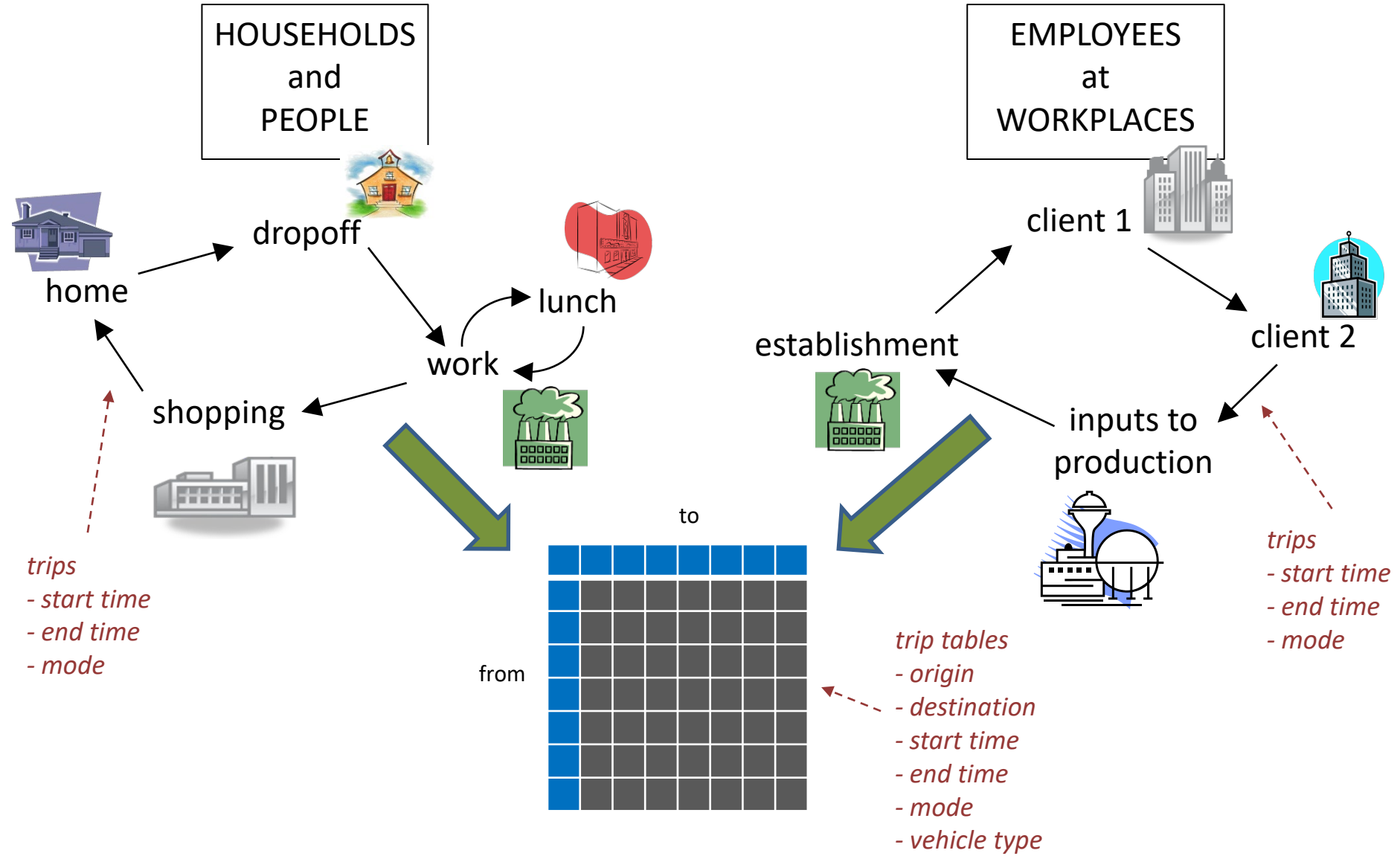


establishment

trips
- start time
- end time
- mode


HOUSEHOLDS
and
PEOPLE
dropoff
home
lunch
work
shopping
trips
- start time
- end time
- mode
EMPLOYEES
at
WORKPLACES
client 1
client 2
establishment
inputs to
production
trips
- start time
- end time
- mode

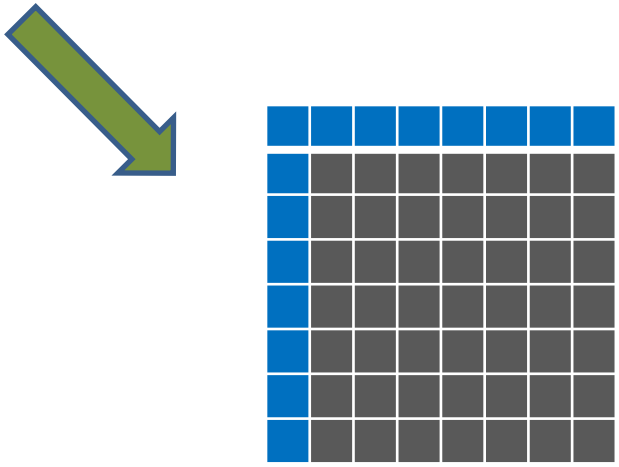

HOUSEHOLDS and PEOPLE
EMPLOYEES at WORKPLACES
home
dropoff
lunch
work
shopping
client 1
client 2
establishment
inputs to production
to
from
trips
- start time
- end time
- mode
trips
- start time
- end time
- mode


HOUSEHOLDS and PEOPLE
EMPLOYEES at WORKPLACES
home
dropoff
lunch
work
shopping
client 1
client 2
establishment
inputs to production
to
from
trips
- start time
- end time
- mode
trip tables
- origin
- destination
- start time
- end time
- mode
- vehicle type
trips
- start time
- end time
- mode

Airport Sub-Model

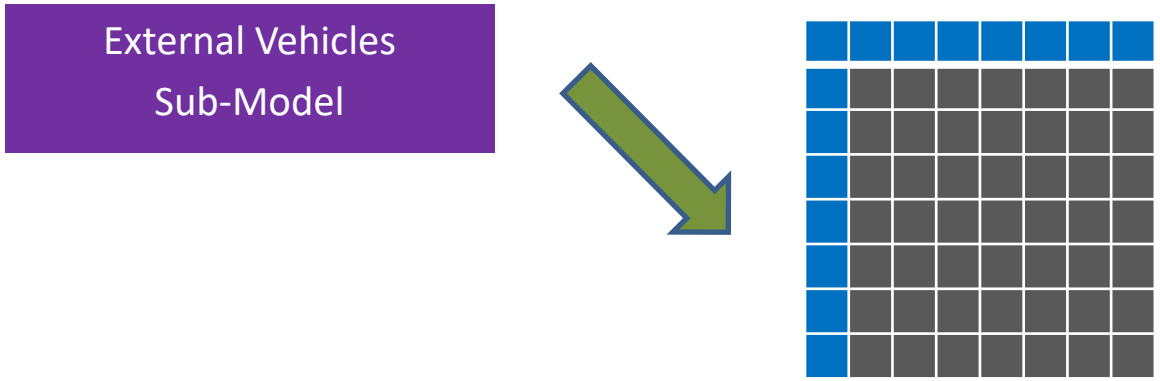
- Air Side Impacts on Surface Transportation
- Air Passenger Volumes given exogenously

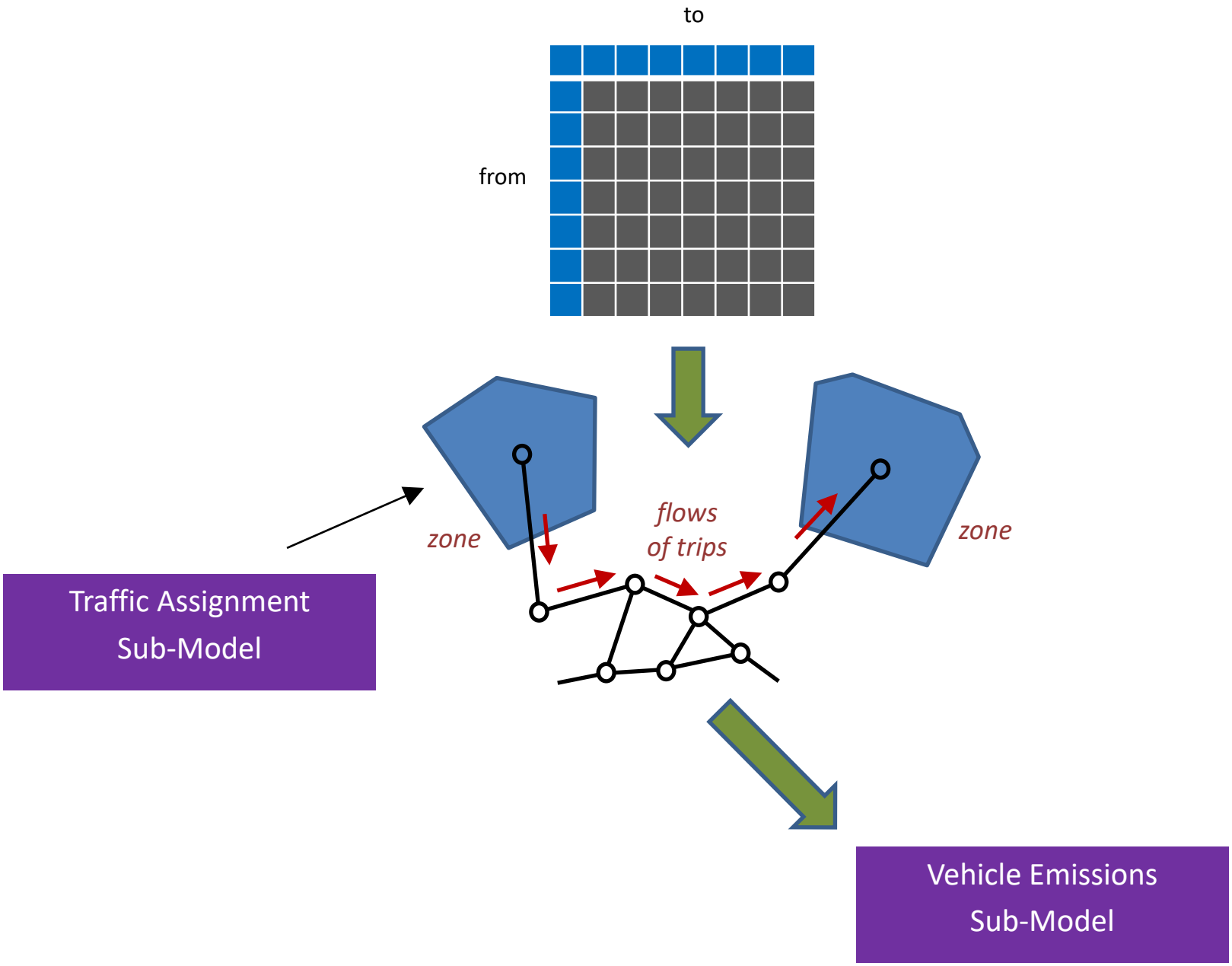
Airport Special Generator Sub-Model



External Vehicle Sub-Model

- Internal ends of external vehicle flows allocated based on distance and zone attractiveness
- Mobile worker flows given exogenously
  - camps, modes, and aerodromes




to
from
zone
flows
of trips
zone
Traffic Assignment
Sub-Model
Vehicle Emissions
Sub-Model

Worker Allocation Sub-Model

- Workers working in plants:
  - Living in camps
  - Living outside camps
- Connects workers to home and work location
- Incorporates plant-specific shift patterns

Model inputs

- Population
- Employment
- Networks
- Plant operation details

Model inputs

- Population
  - Households and persons at home end
  - Camp residences
- Employment
- Networks
- Plant operation details

Model inputs

- Population
- Employment
  - Employment by industry
  - School enrolment by level
- Networks
- Plant operation details

Model inputs

- Population
- Employment
- Networks
  - Road
  - Transit
- Plant operation details

Model inputs

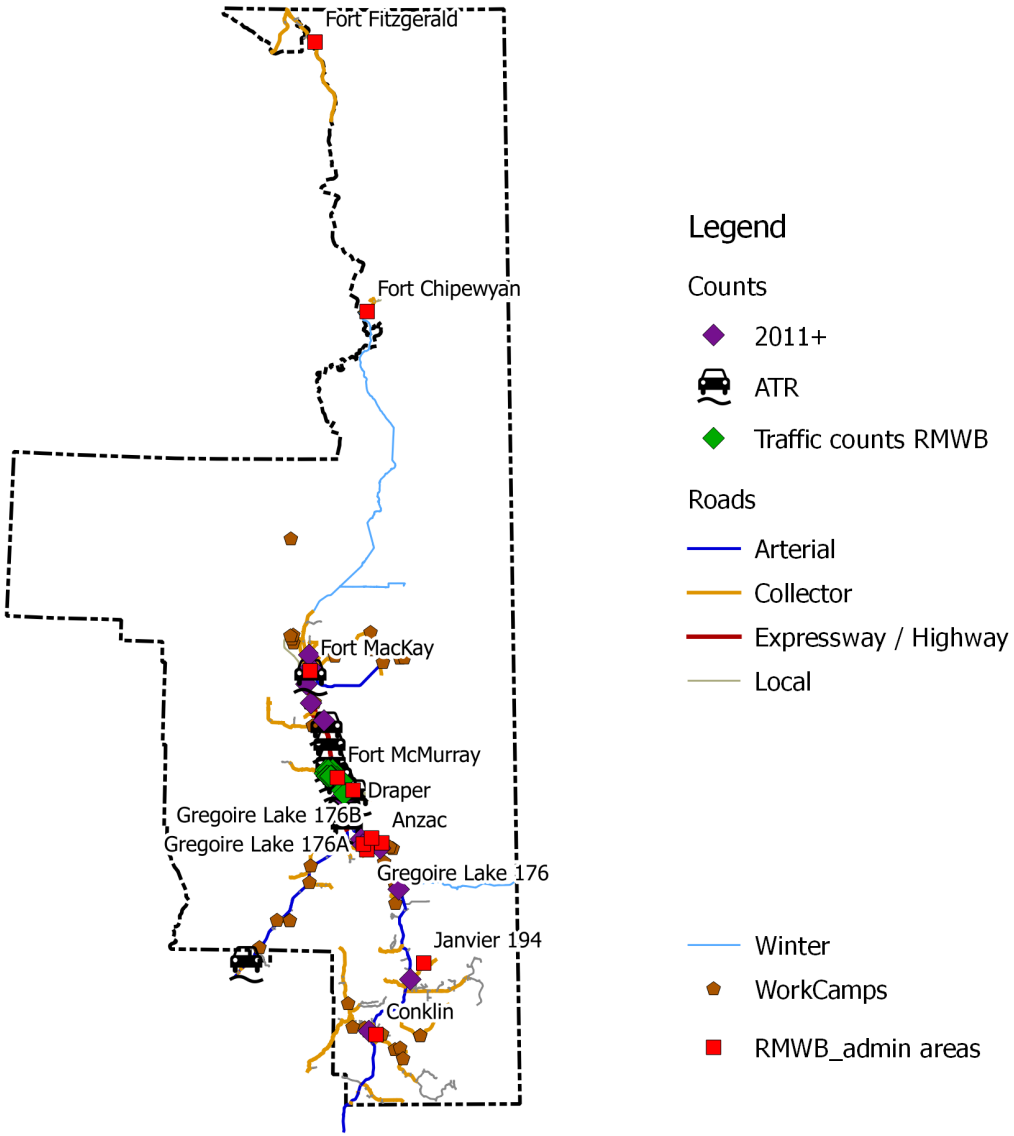
- Population
- Employment
- Networks
- Plant operation details
  - Plant employment
  - Shift time periods

Model inputs

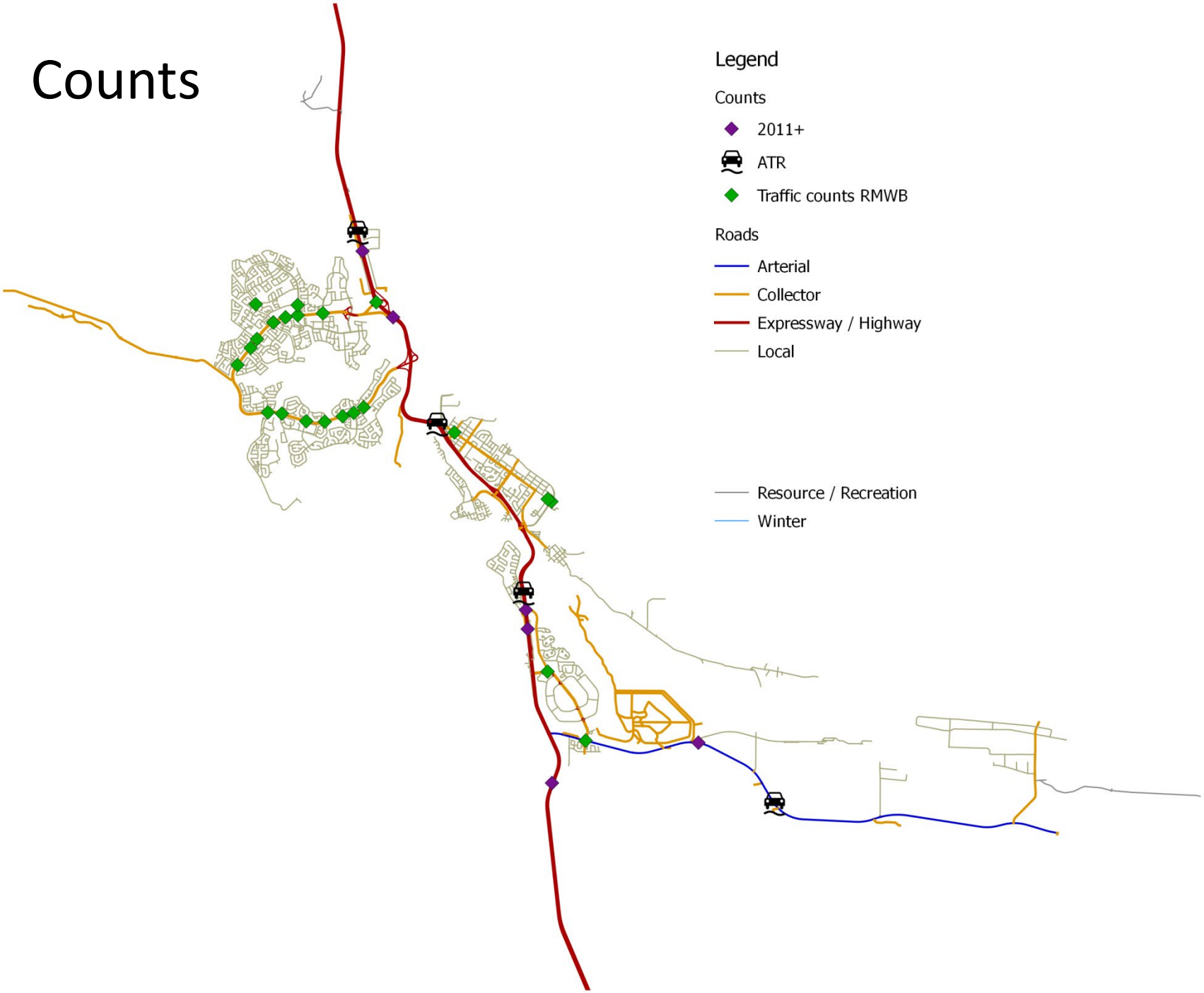
- Population
- Employment
- Networks
- Plant operation details

- Need above for present “base” year and future scenarios
  - RSAS report key source for future scenarios
  - AT for strategic roadway improvements

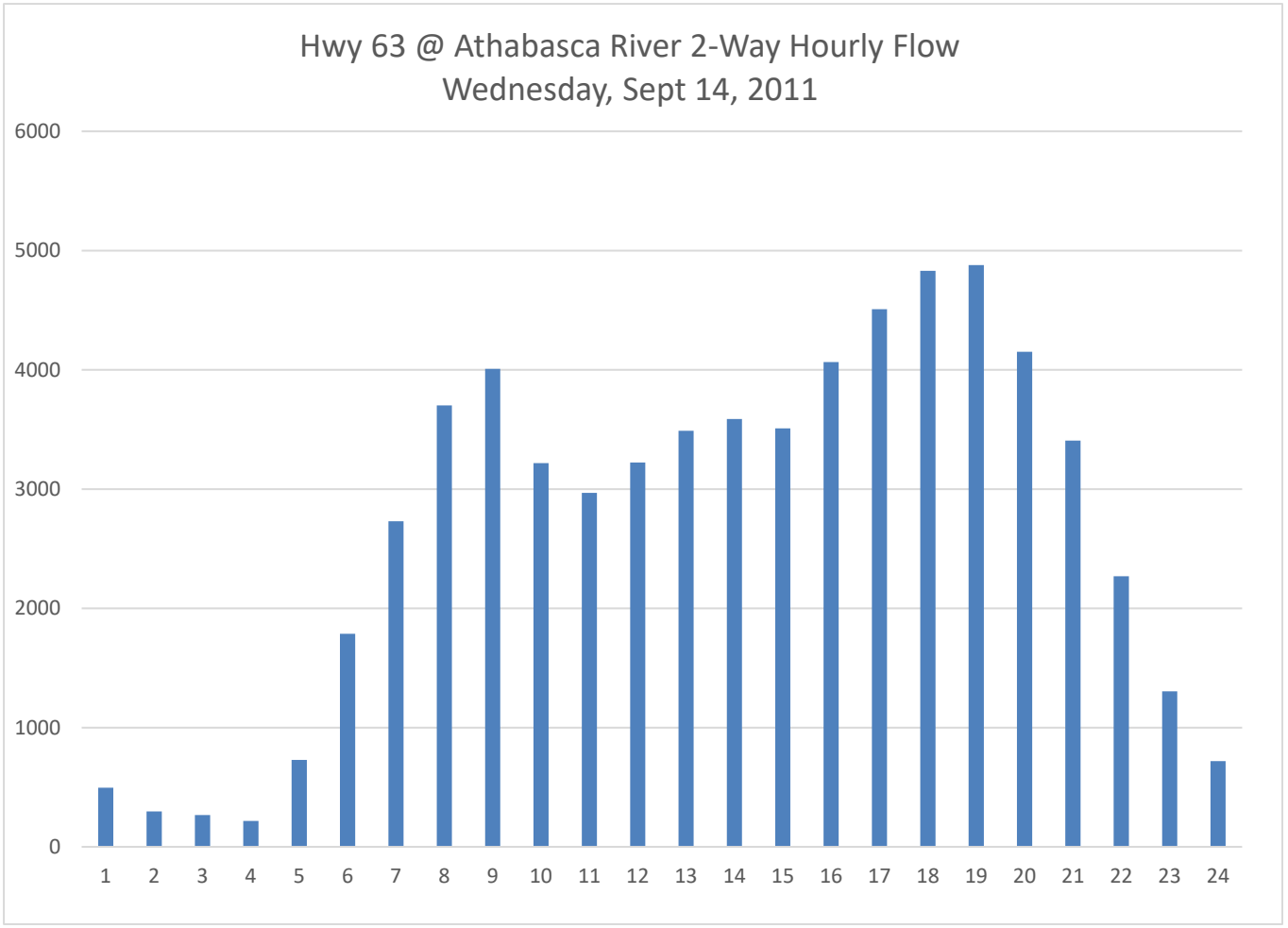
Counts


Fort Fitzgerald
Fort Chipewyan
Fort MacKay
Fort McMurray
Draper
Gregoire Lake 176B
Anzac
Gregoire Lake 176A
Gregoire Lake 176
Janvier 194
Conklin
Legend
Counts
2011+
ATR
Traffic counts RMWB
Roads
Arterial
Collector
Expressway / Highway
Local
Winter
WorkCamps
RMWB_admin areas

Counts

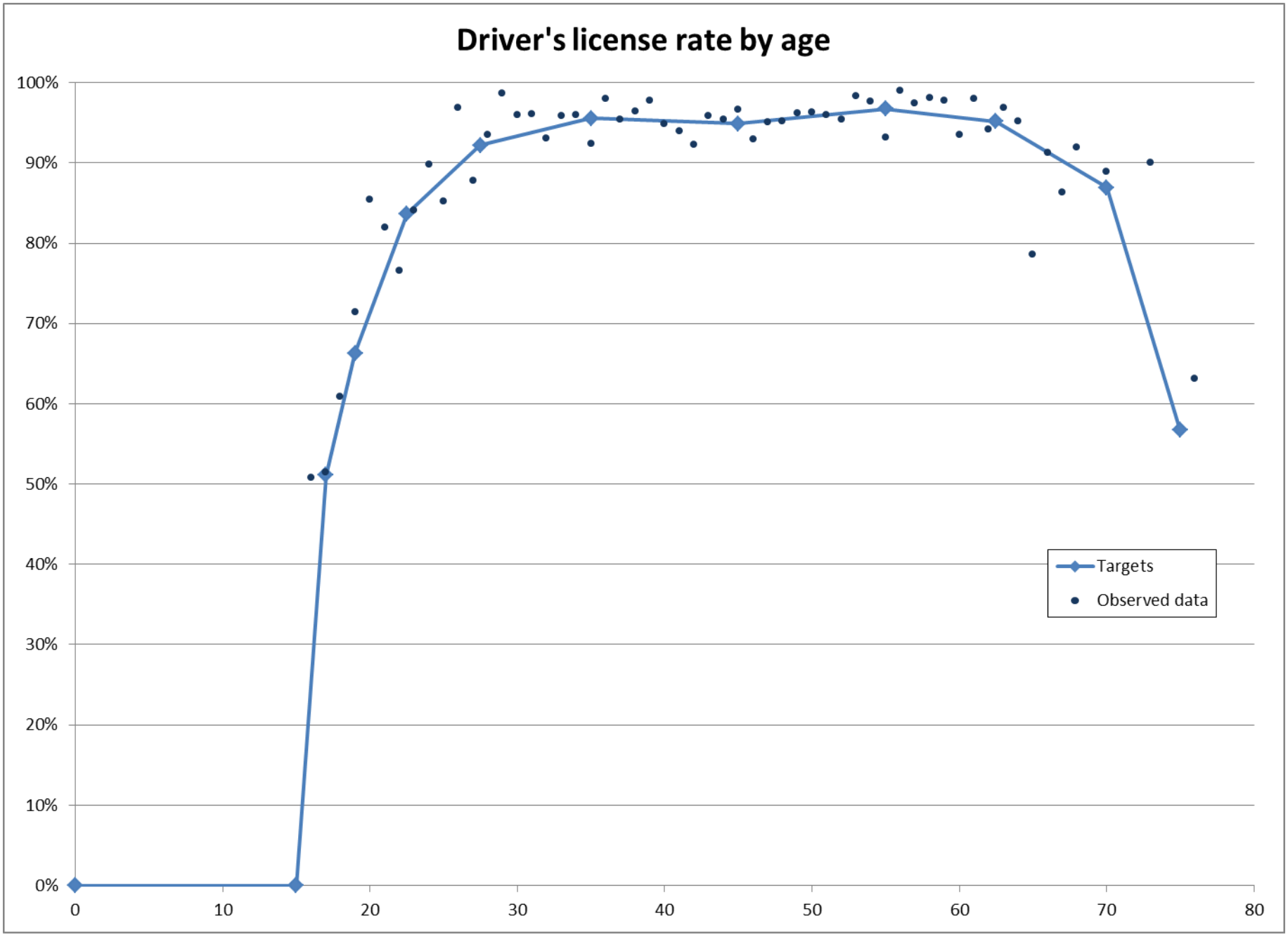

Legend
Counts
2011+
ATR
Traffic counts RMWB
Roads
Arterial
Collector
Expressway / Highway
Local
Resource / Recreation
Winter

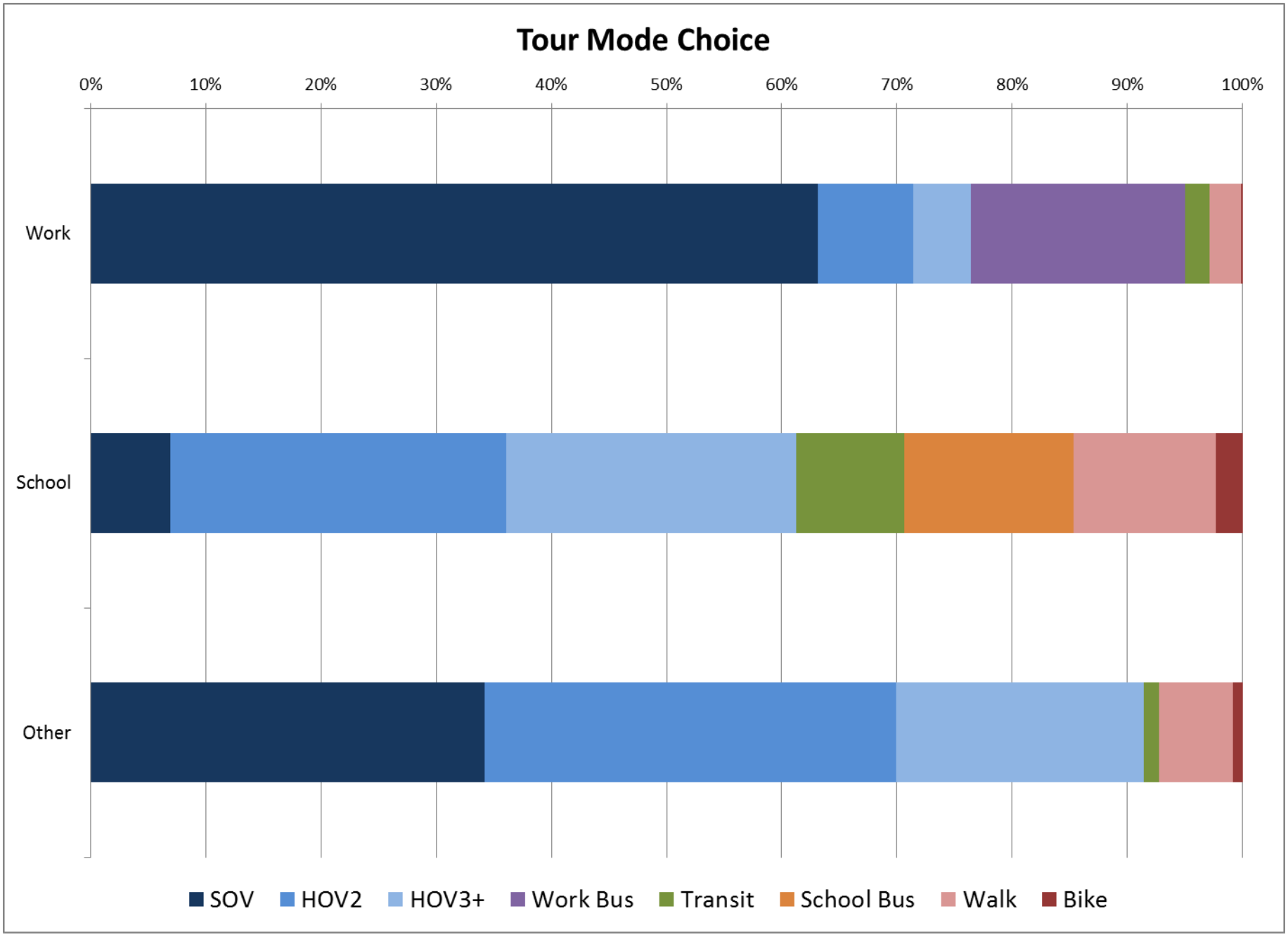
Traffic Flow by Time of Day

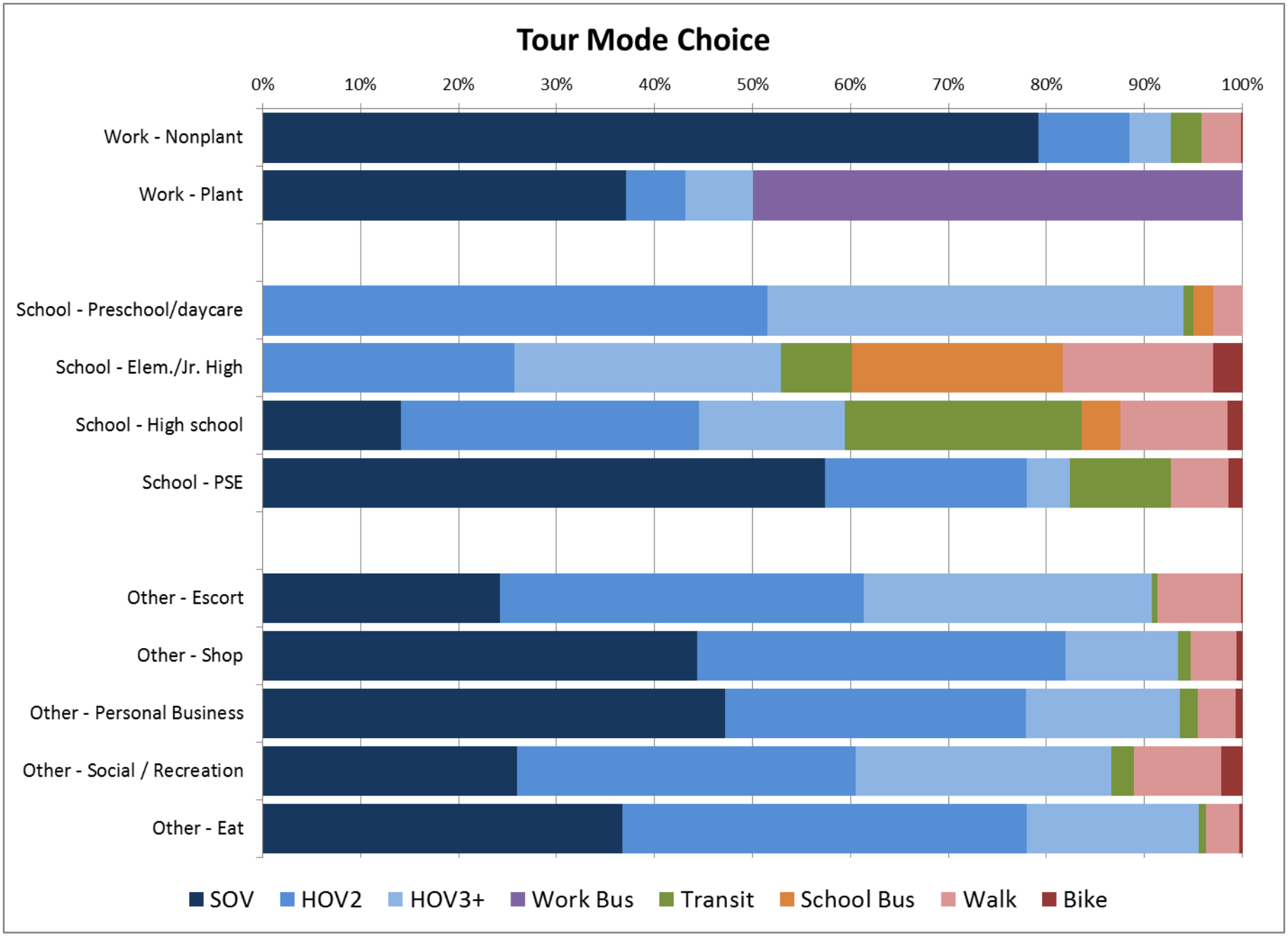


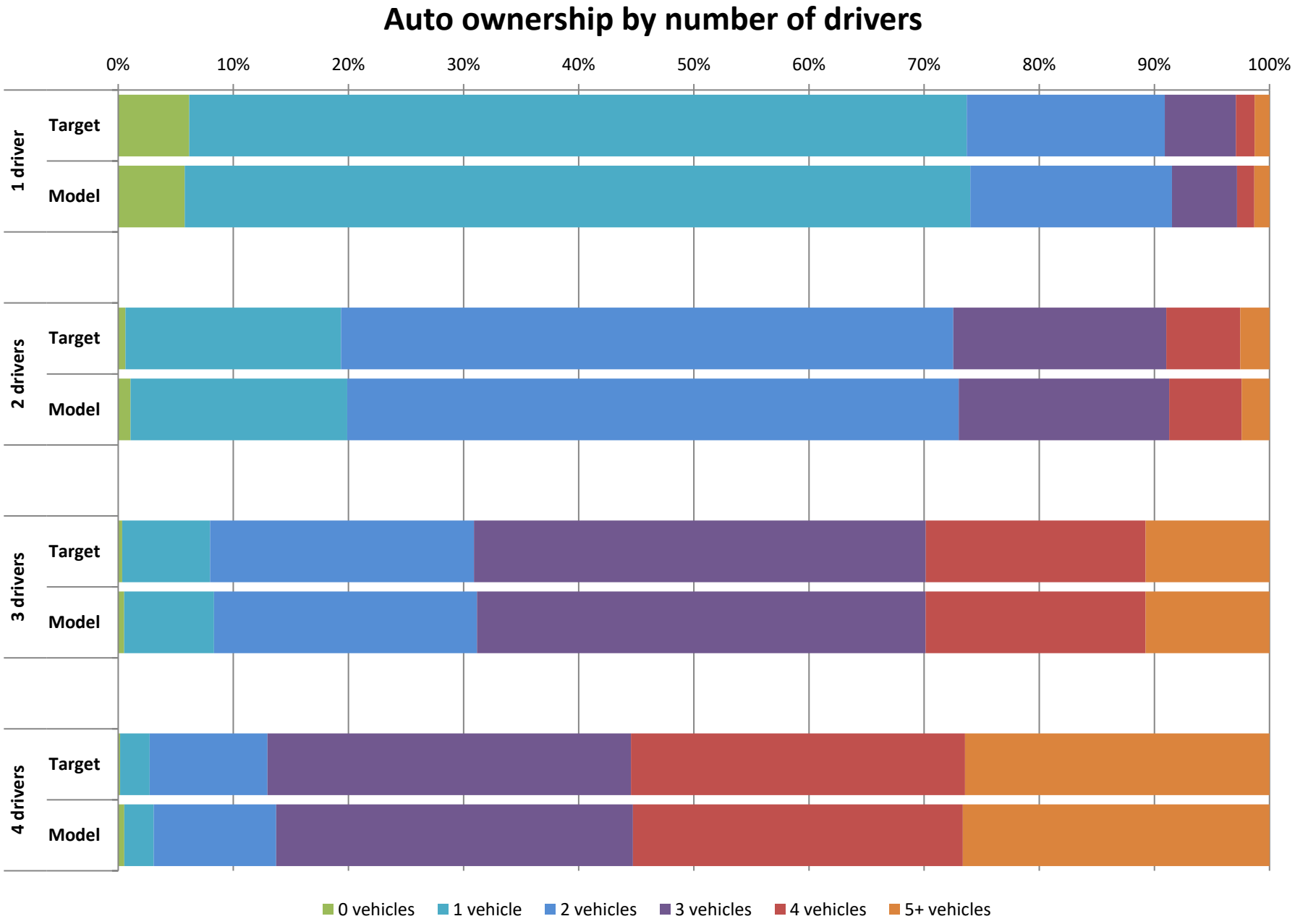
Calibration

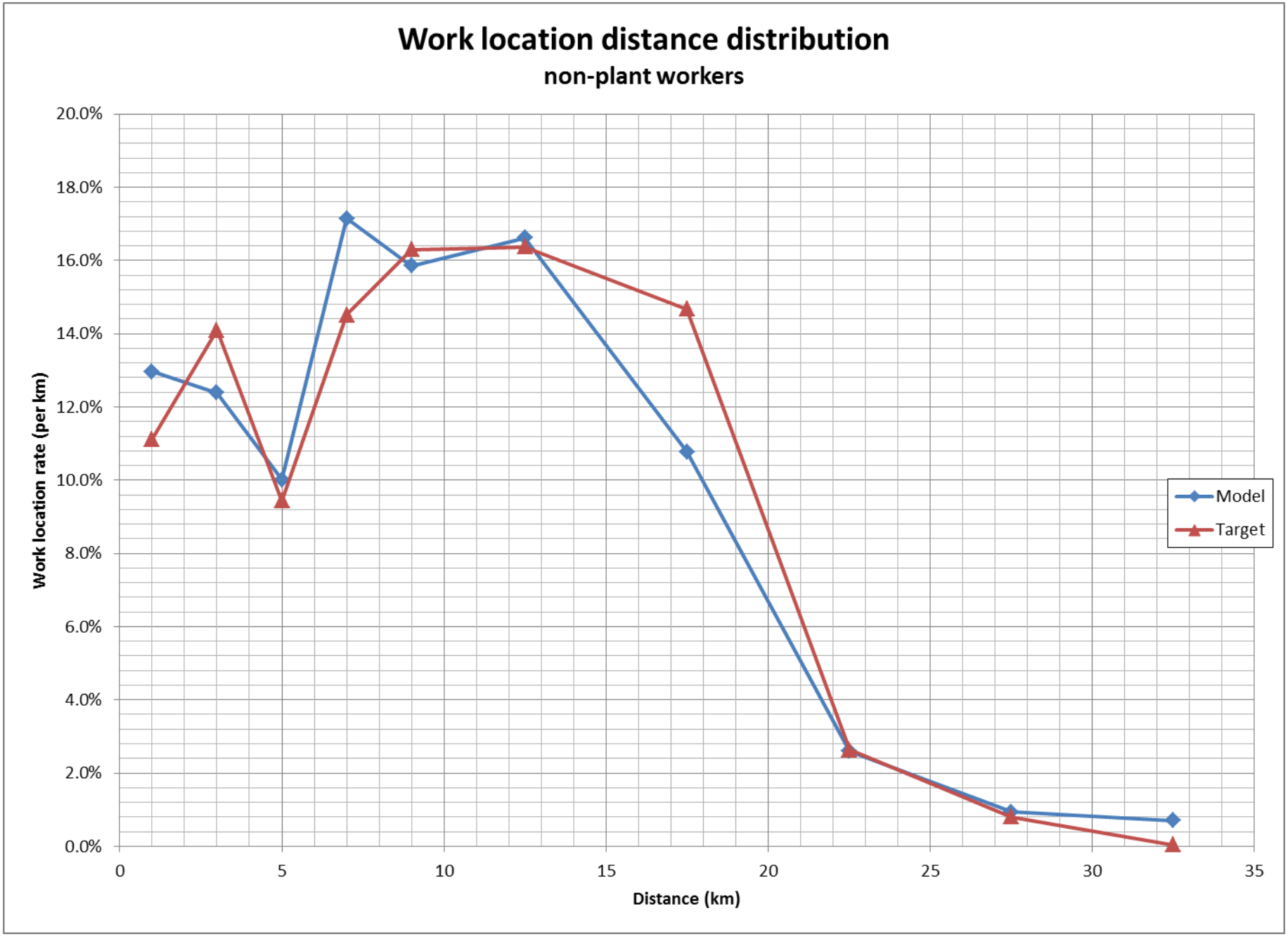
- Use “targets” developed from RM of Wood Buffalo household survey data
- Adjust model parameters to match distributions seen in household survey targets


Driver's license rate by age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
70
80
Targets
Observed data

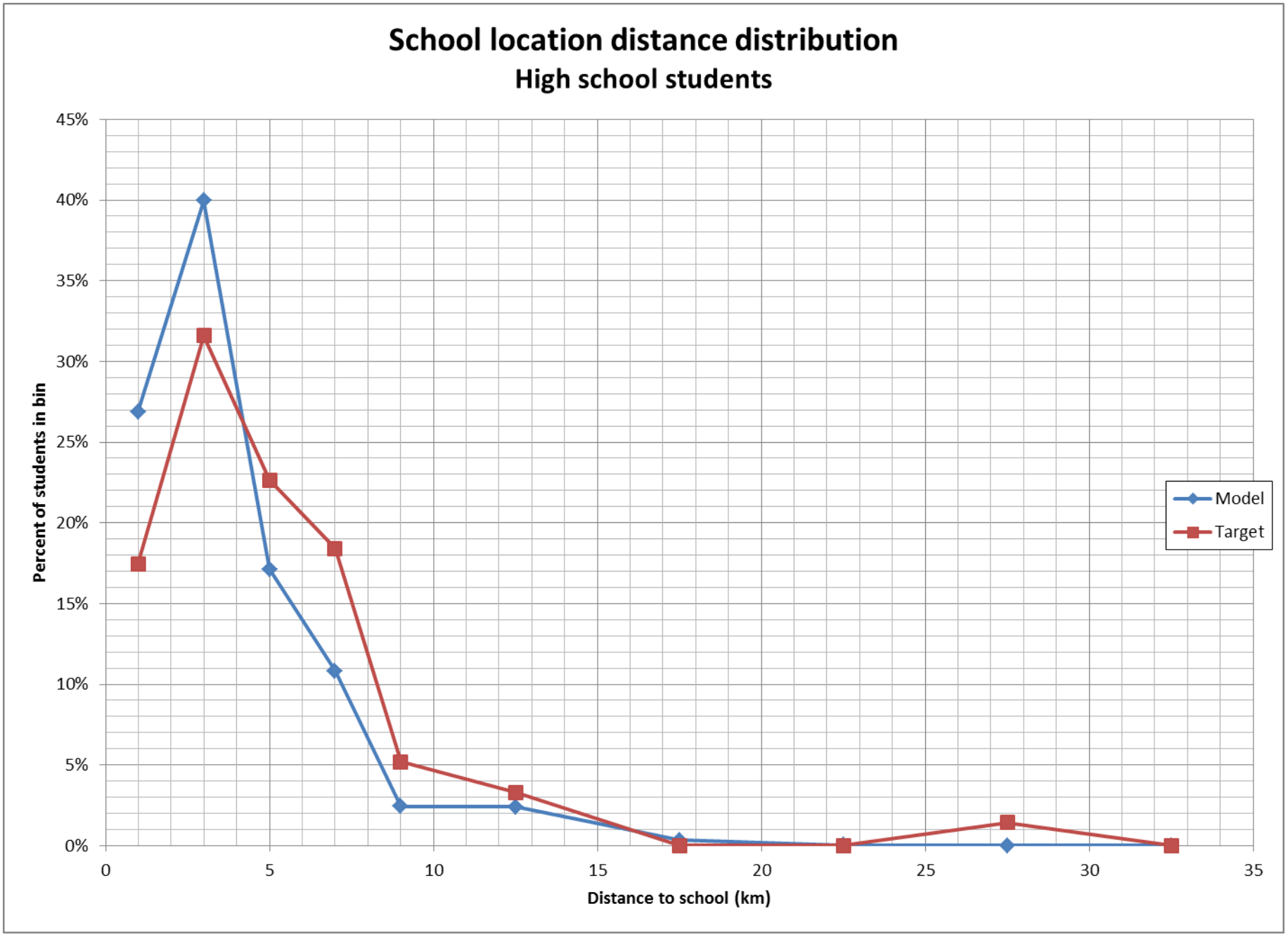

Tour Mode Choice
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Work
School
Other
SOV
HOV2
HOV3+
Work Bus
Transit
School Bus
Walk
Bike

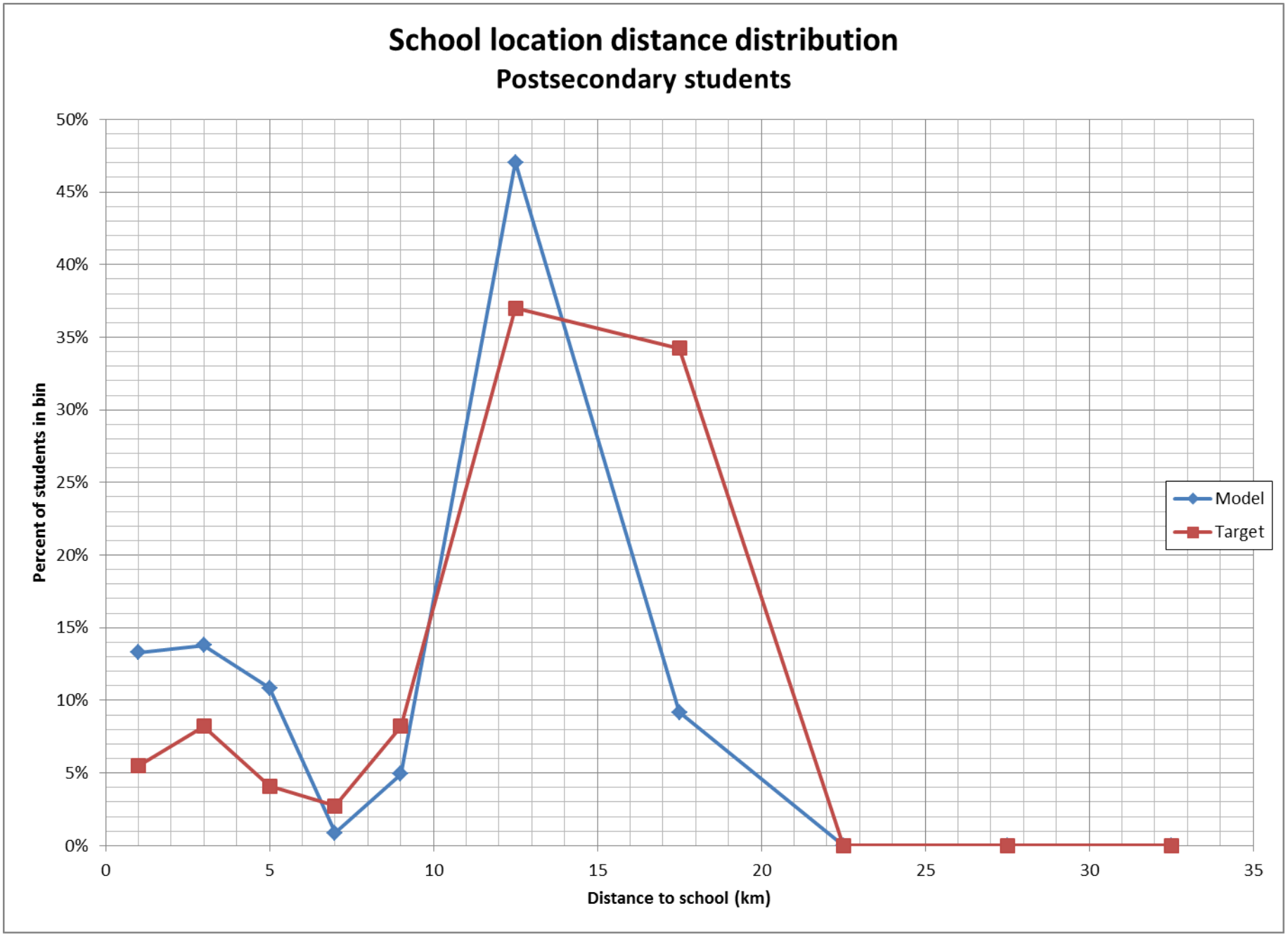

Tour Mode Choice
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Work - Nonplant
Work - Plant
School - Preschool/daycare
School - Elem./Jr. High
School - High school
School - PSE
Other - Escort
Other - Shop
Other - Personal Business
Other - Social / Recreation
Other - Eat
SOV
HOV2
HOV3+
Work Bus
Transit
School Bus
Walk
Bike

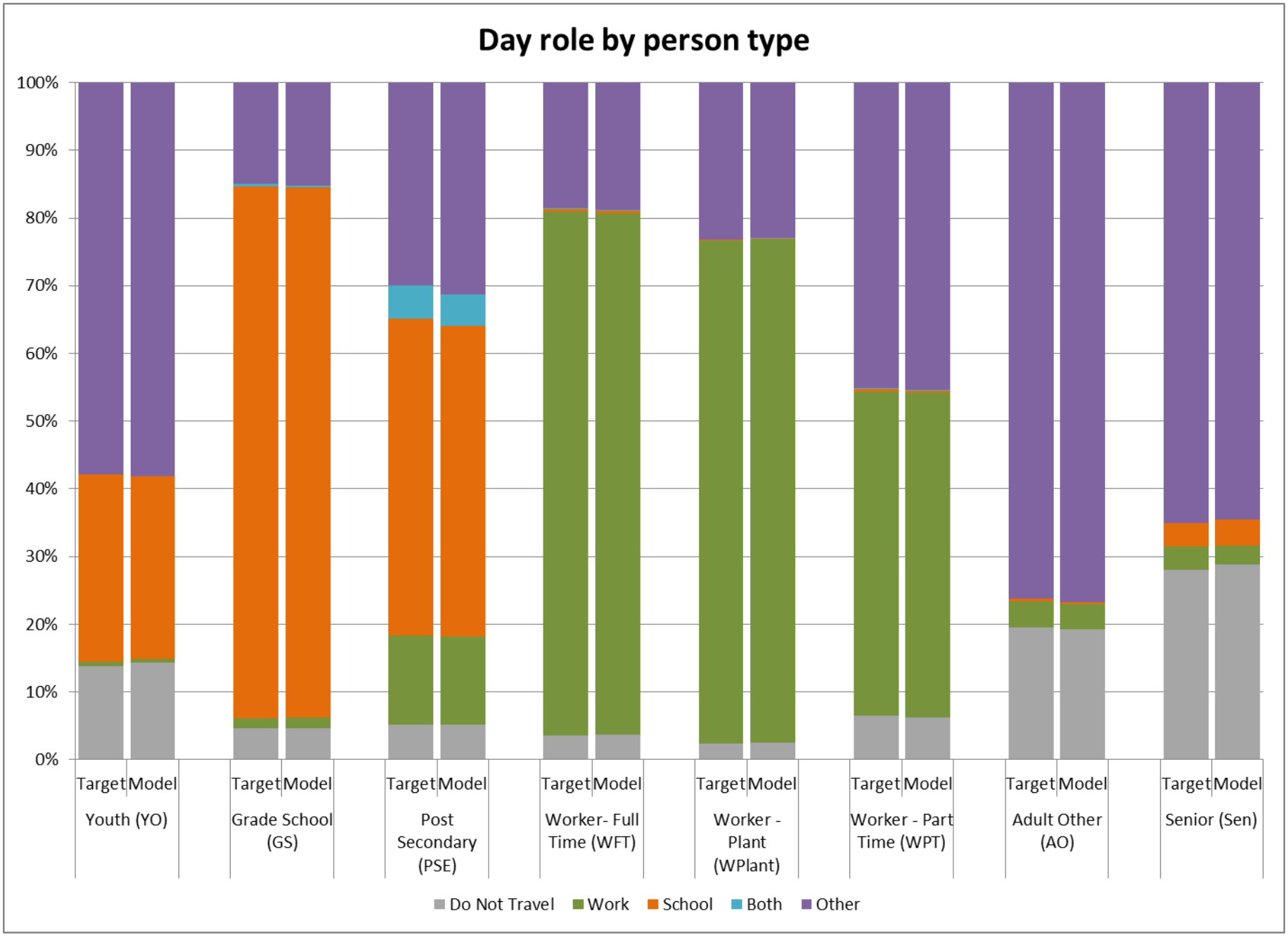

Auto ownership by number of drivers
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1 driver
Target
Model
2 drivers
Target
Model
3 drivers
Target
Model
4 drivers
Target
Model
0 vehicles
1 vehicle
2 vehicles
3 vehicles
4 vehicles
5+ vehicles


Work location distance distribution
non-plant workers
20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Work location rate (per km)
0
5
10
15
20
25
30
35
Distance (km)
Model
Target

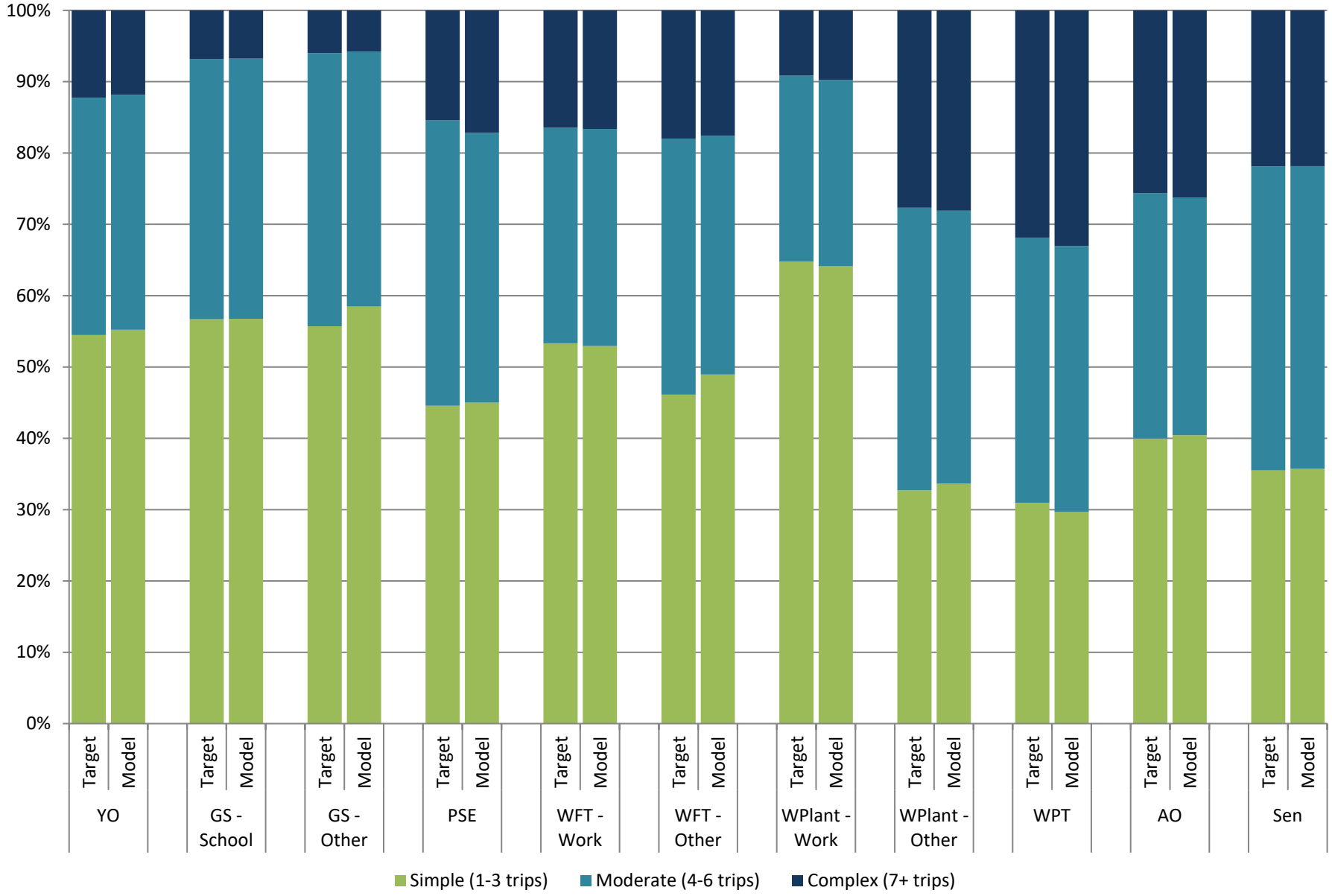

School location distance distribution
Elementary / Jr. High students
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of students in bin
0
5
10
15
20
25
30
35
Distance to school (km)
Model
Target

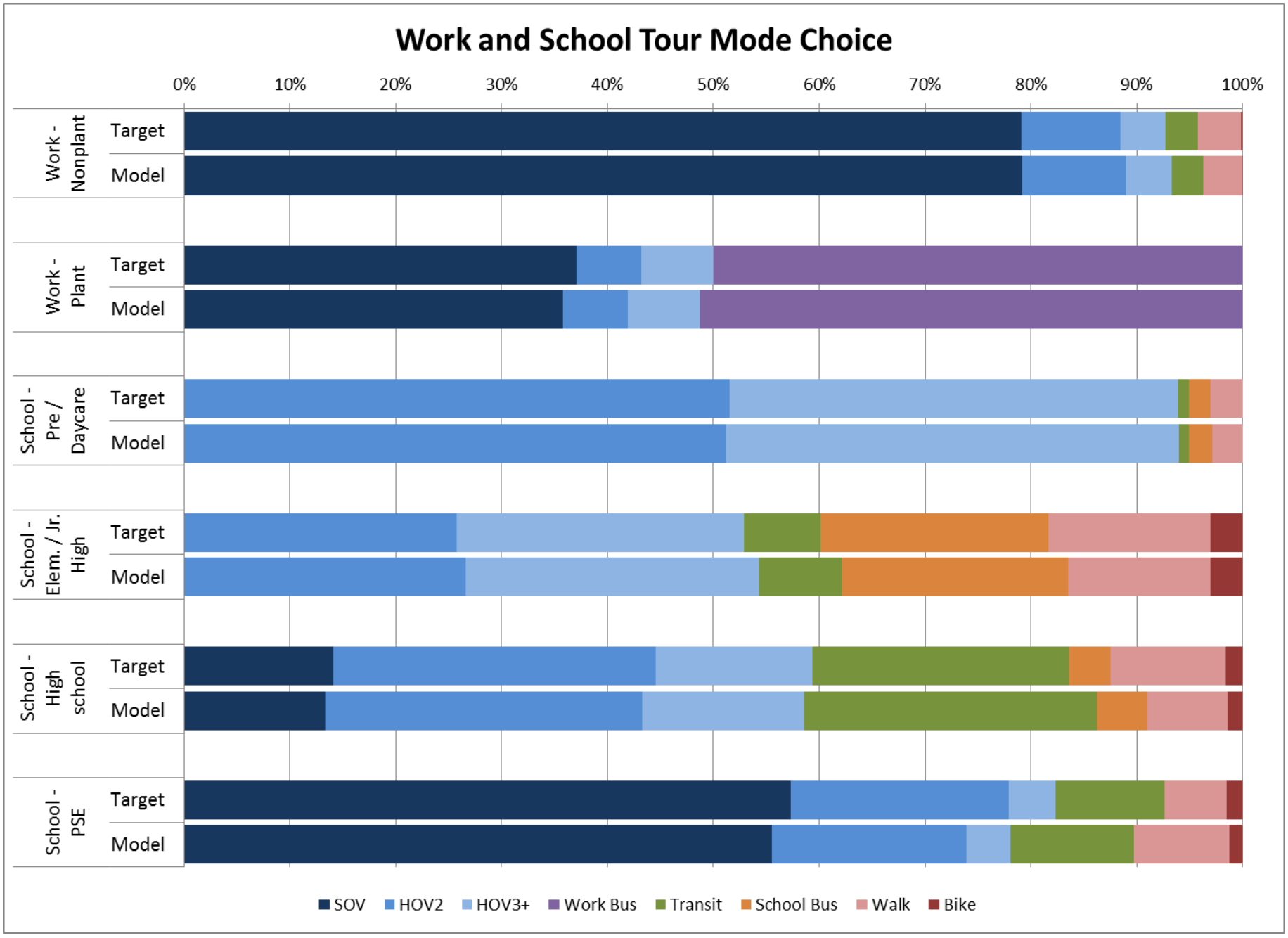

School location distance distribution
High school students
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of students in bin
0
5
10
15
20
25
30
35
Distance to school (km)
Model
Target

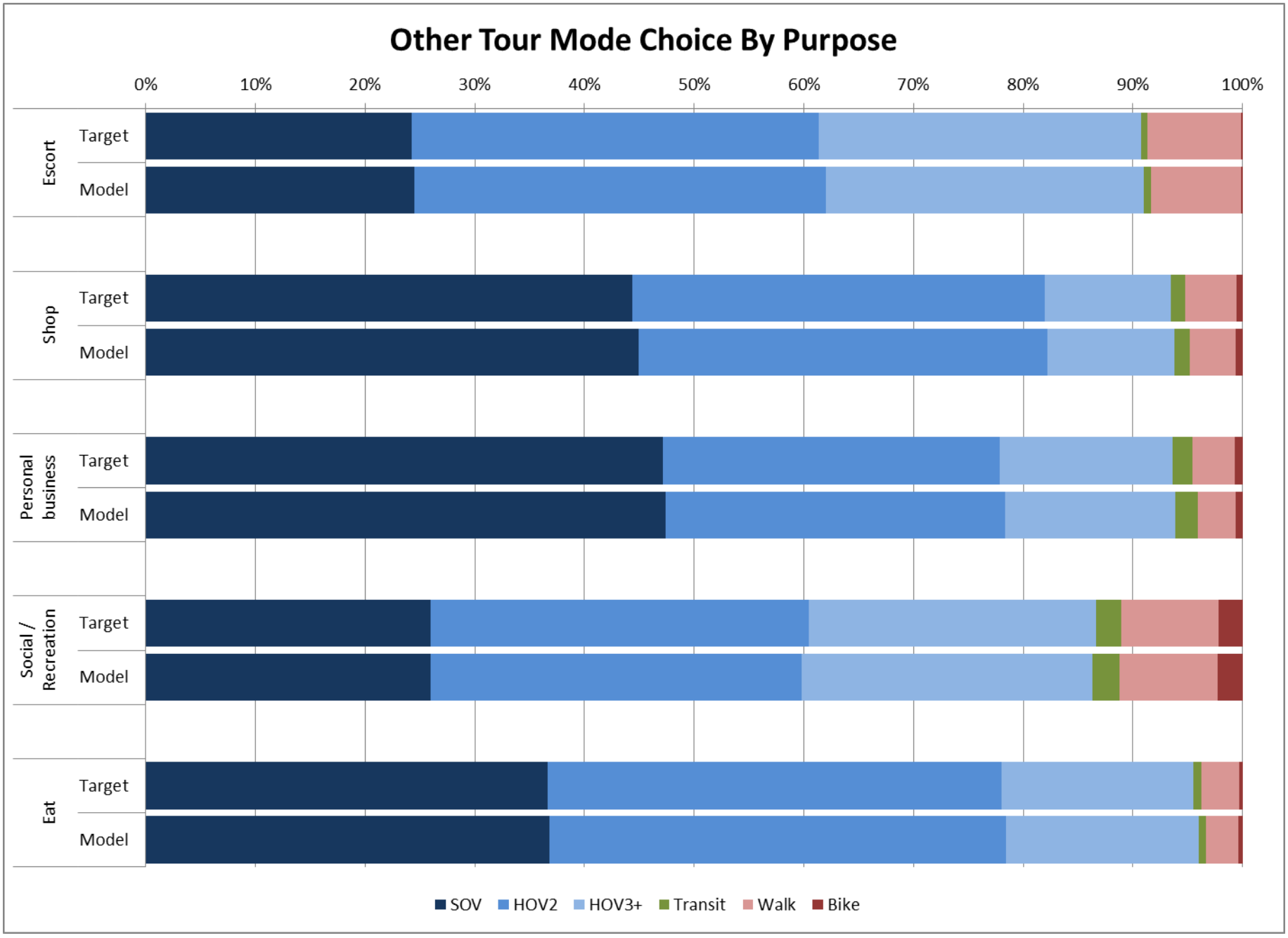

School location distance distribution
Postsecondary students
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of students in bin
0
5
10
15
20
25
30
35
Distance to school (km)
Model
Target


Day role by person type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Target
Model
Youth (YO)
Grade School (GS)
Post Secondary (PSE)
Worker- Full Time (WFT)
Worker - Plant (WPlant)
Worker - Part Time (WPT)
Adult Other (AO)
Senior (Sen)
Do Not Travel
Work
School
Both
Other

Pattern Group Complexity by Person Type and Day Role




Work and School Tour Mode Choice
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Work - Nonplant
Target
Model
Work - Plant
Target
Model
School - Pre / Daycare
Target
Model
School - Elem. / Jr. High
Target
Model
School - High school
Target
Model
School - PSE
Target
Model
SOV
HOV2
HOV3+
Work Bus
Transit
School Bus
Walk
Bike


Other Tour Mode Choice By Purpose
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Escort
Target
Model
Shop
Target
Model
Personal business
Target
Model
Social / Recreation
Target
Model
Eat
Target
Model
SOV
HOV2
HOV3+
Transit
Walk
Bike

Challenges in Worker Allocation Model Development

- Lack of data for calibration, so forced to perform validation with few adjustment 'levers'
- Explicit mode shifts built into PTM to shift trips toward bus (i.e. fewer vehicle trips per worker trip) for more distant plants
- Atypical land use pattern with roughly 70 km separation b/w residential home locations and industrial work locations

Validation

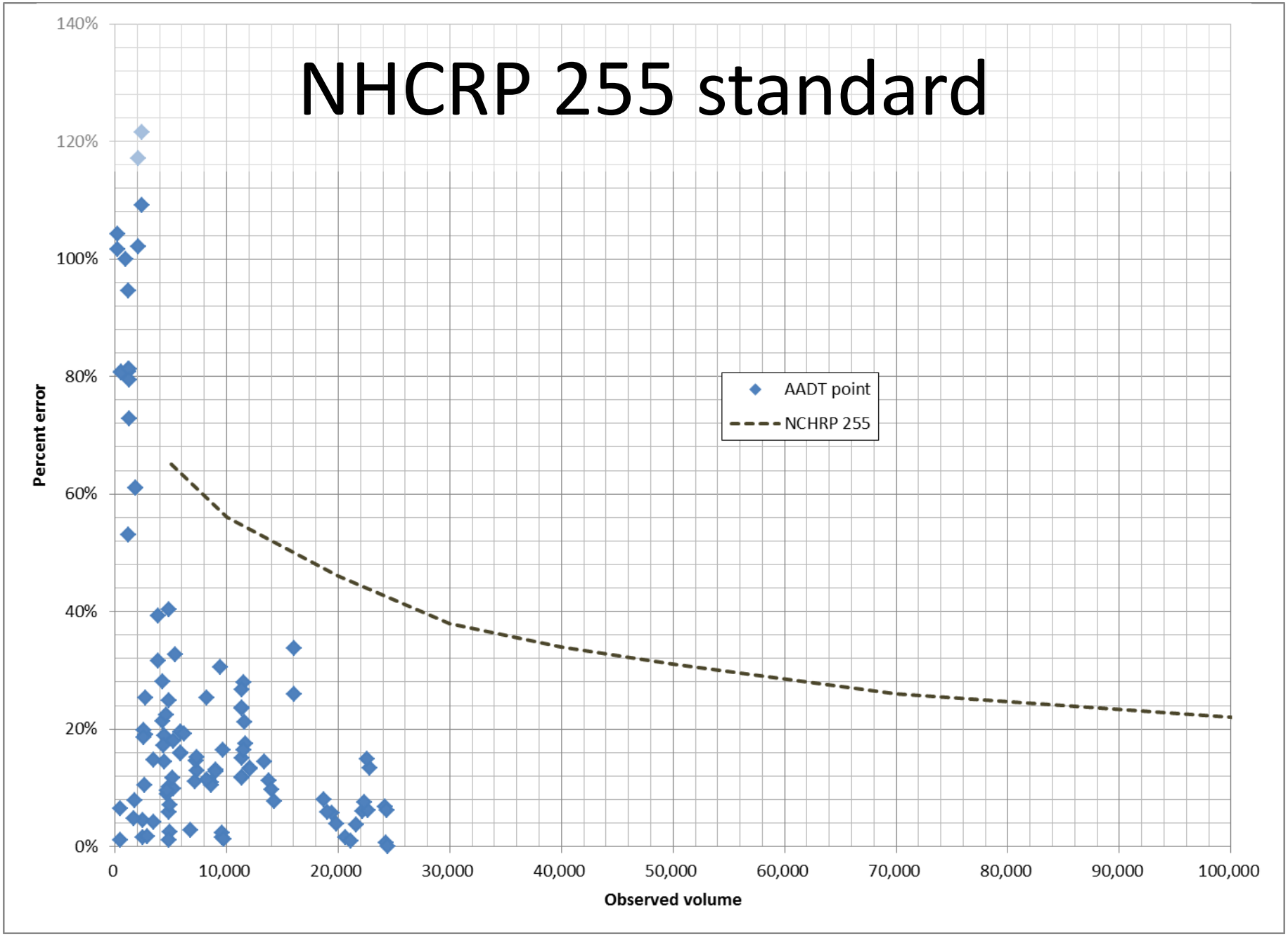
- Compare model performance versus “external” sources of data
- Traffic count comparison
- Challenge: rapid changes in RMWB area
  - Counts predating major infrastructure projects
  - Uncertainty about levels of oilsands activity and shadow population
  - Variability in oilsands activity

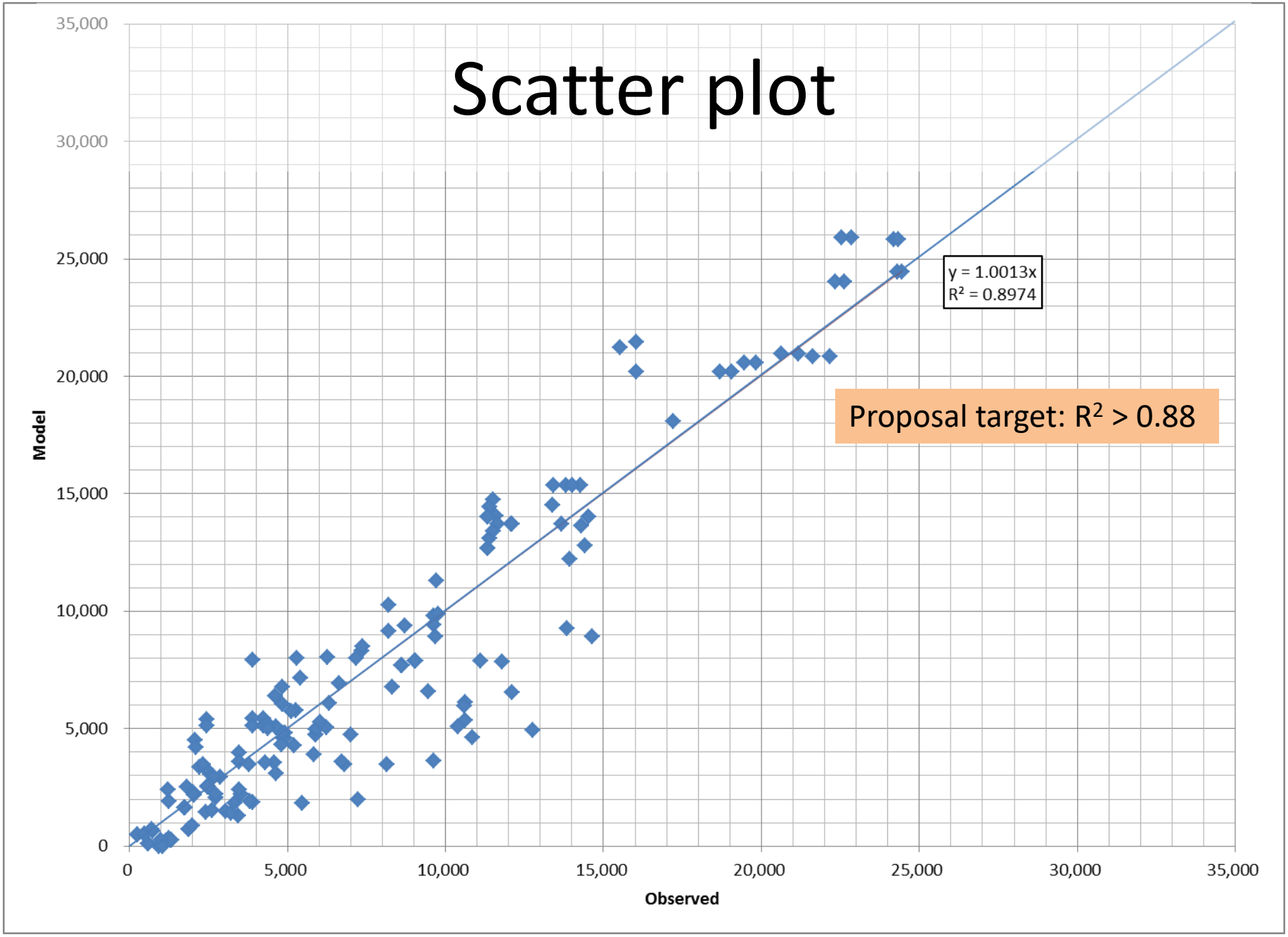
Root Mean Squared Error (RMSE)

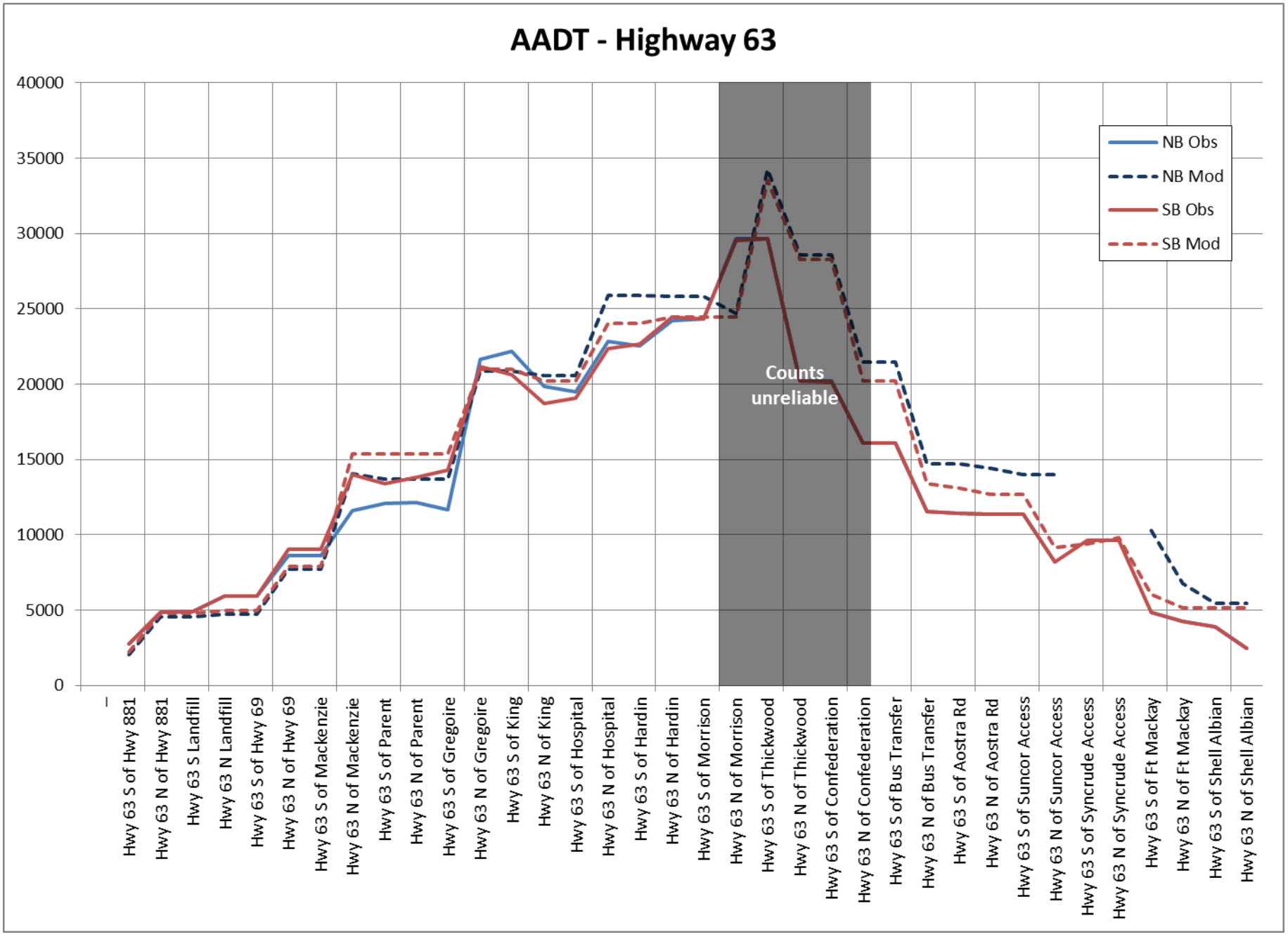
Count category	Model	Objective
All counts	27%	39%
Lower volume (<2500 veh/day)	67%	100%
Medium low volume (2500-5000 veh/day)	36%	54%
Medium high volume (5000-10000 veh/day)	26%	42%
Higher volume (10000-15000 veh/day)	28%	34%
High volume (>15000 veh/day)	12%	28%

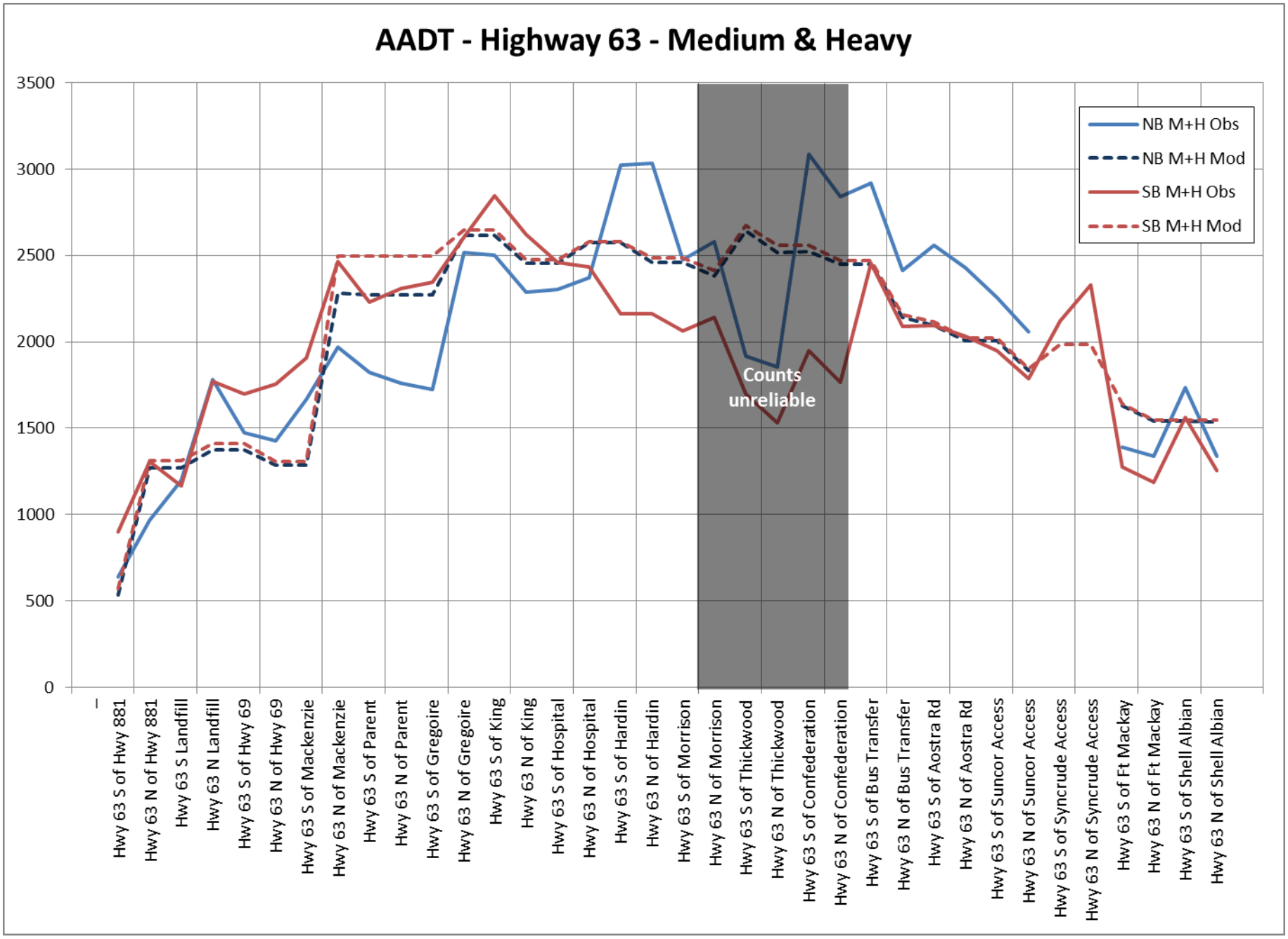
Lower RMSE indicates better performance;
objective values from 2002 Ohio DOT manual

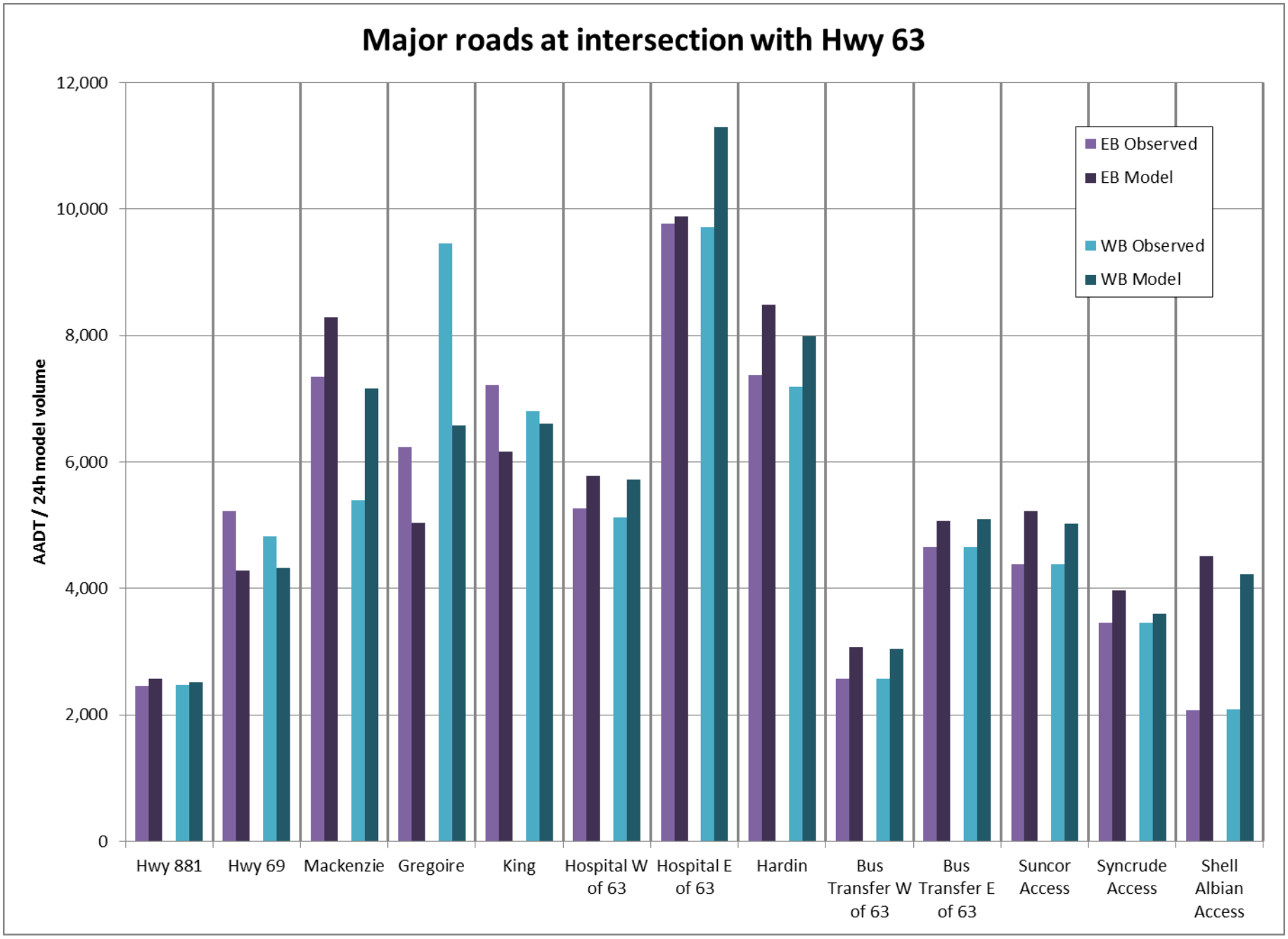
$$RMSE = \frac{\sqrt{\frac{\sum error^2}{num_{counts} - 1}}}{average\ volume}$$

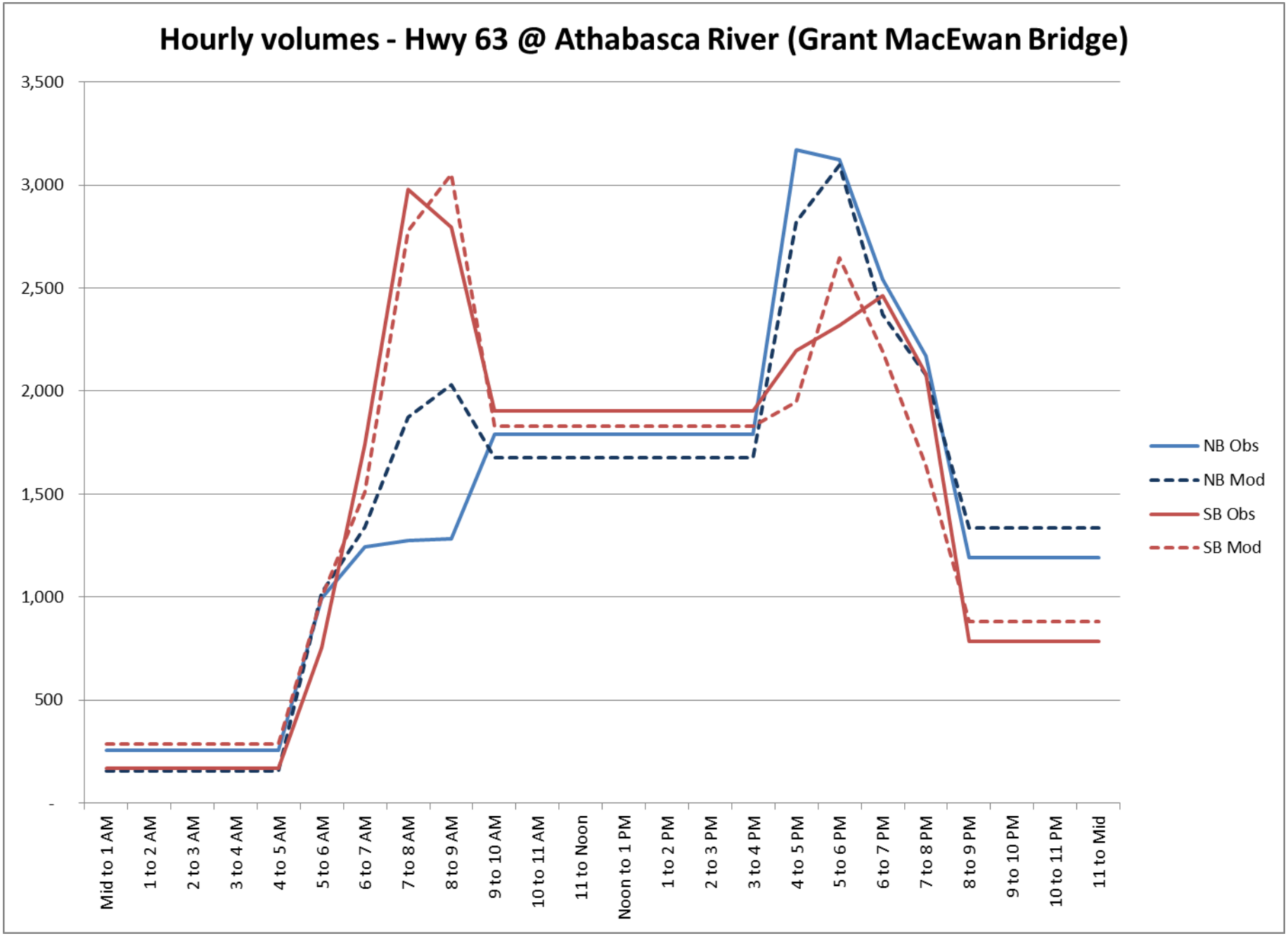

NHCRP 255 standard
140%
120%
100%
80%
60%
40%
20%
0%
Percent error
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
Observed volume
AADT point
NCHRP 255

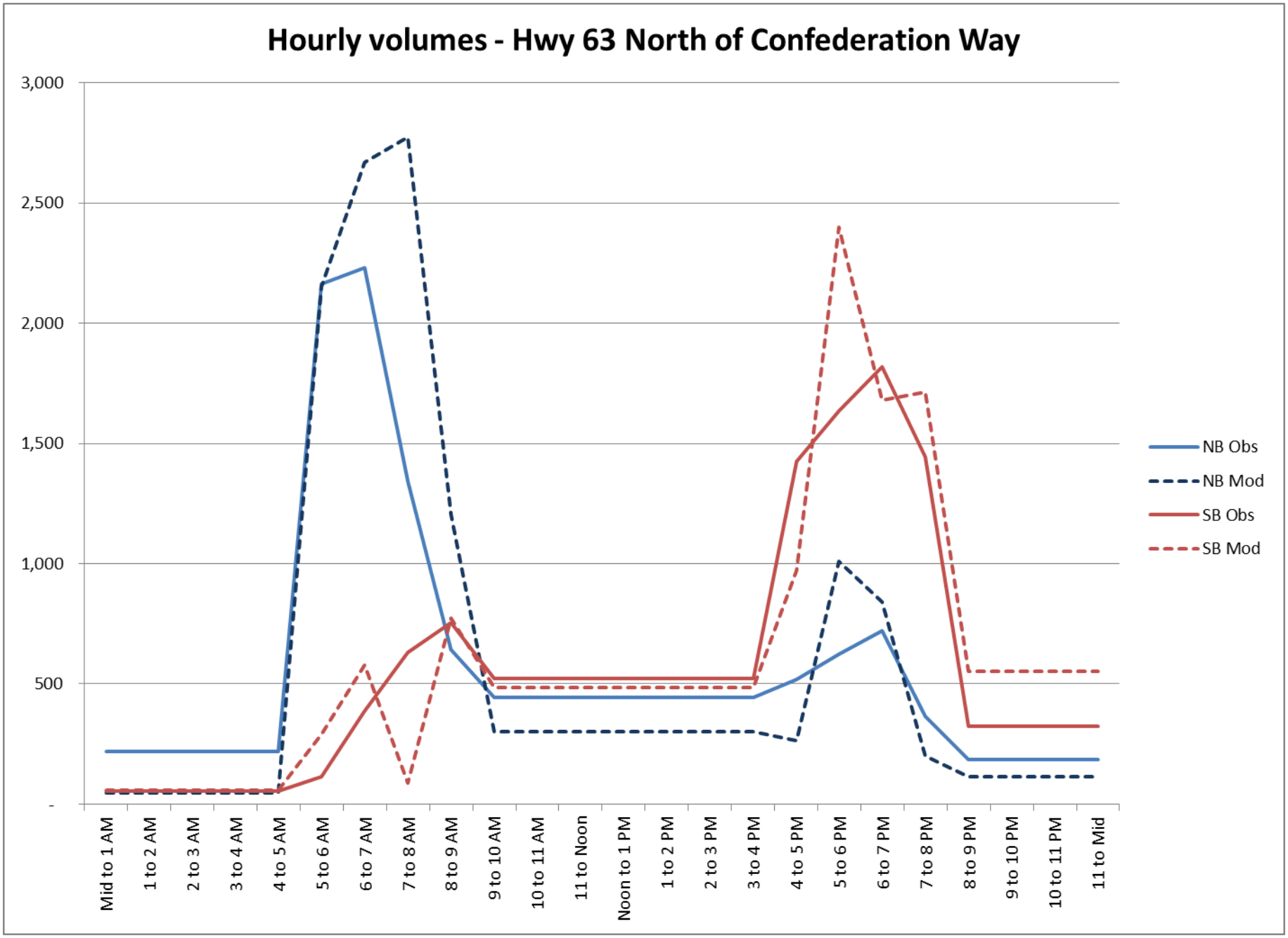

Scatter plot
y = 1.0013x
R² = 0.8974
Proposal target: R² > 0.88
Model
Observed
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000


AADT - Highway 63
40000
35000
30000
25000
20000
15000
10000
5000
0
NB Obs
NB Mod
SB Obs
SB Mod
Counts unreliable
–
Hwy 63 S of Hwy 881
Hwy 63 N of Hwy 881
Hwy 63 S Landfill
Hwy 63 N Landfill
Hwy 63 S of Hwy 69
Hwy 63 N of Hwy 69
Hwy 63 S of Mackenzie
Hwy 63 N of Mackenzie
Hwy 63 S of Parent
Hwy 63 N of Parent
Hwy 63 S of Gregoire
Hwy 63 N of Gregoire
Hwy 63 S of King
Hwy 63 N of King
Hwy 63 S of Hospital
Hwy 63 N of Hospital
Hwy 63 S of Hardin
Hwy 63 N of Hardin
Hwy 63 S of Morrison
Hwy 63 N of Morrison
Hwy 63 S of Thickwood
Hwy 63 N of Thickwood
Hwy 63 S of Confederation
Hwy 63 N of Confederation
Hwy 63 S of Bus Transfer
Hwy 63 N of Bus Transfer
Hwy 63 S of Aostra Rd
Hwy 63 N of Aostra Rd
Hwy 63 S of Suncor Access
Hwy 63 N of Suncor Access
Hwy 63 S of Syncrude Access
Hwy 63 N of Syncrude Access
Hwy 63 S of Ft Mackay
Hwy 63 N of Ft Mackay
Hwy 63 S of Shell Albian
Hwy 63 N of Shell Albian

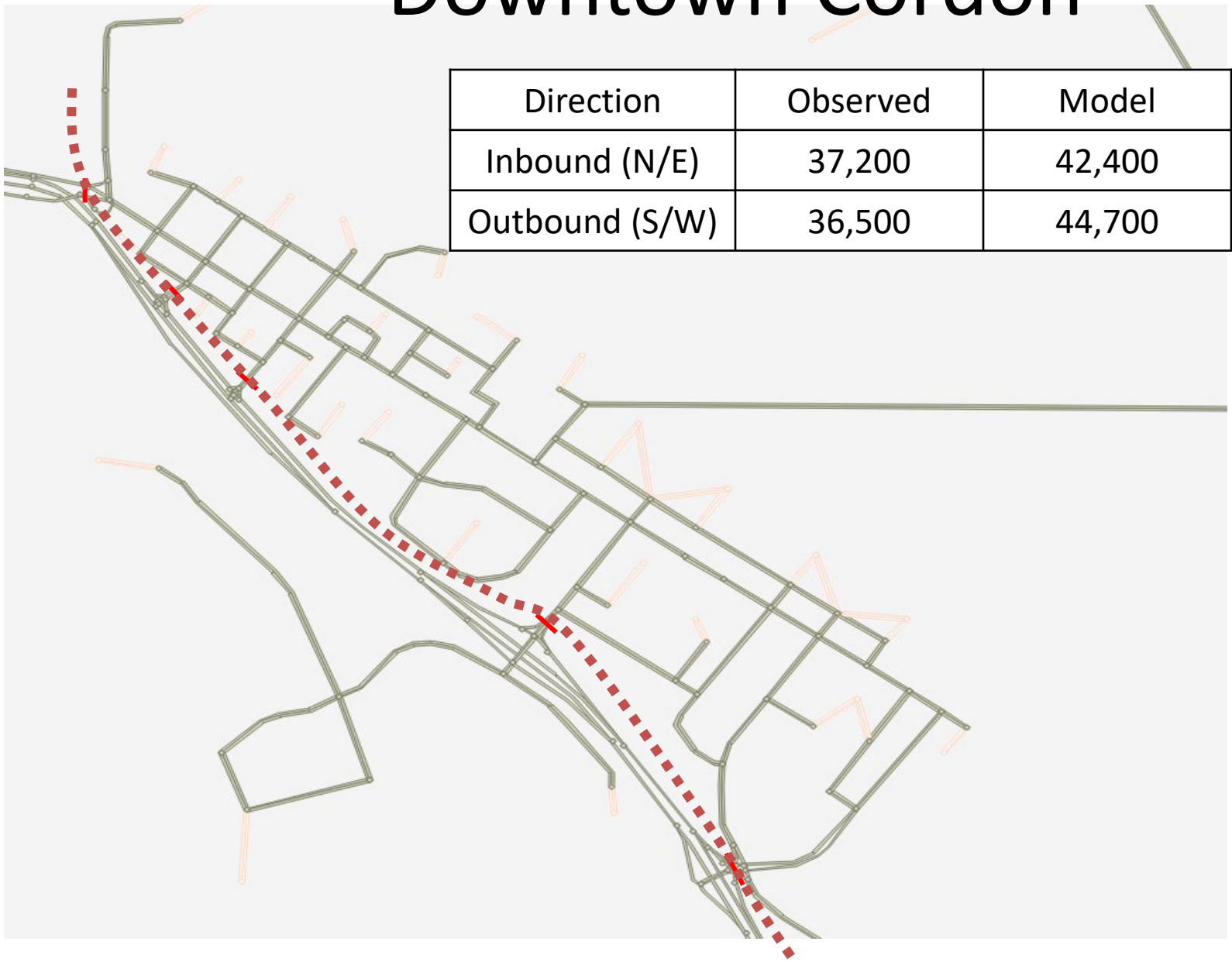

AADT - Highway 63 - Medium & Heavy
3500
3000
2500
2000
1500
1000
500
0
NB M+H Obs
NB M+H Mod
SB M+H Obs
SB M+H Mod
Counts unreliable
–
Hwy 63 S of Hwy 881
Hwy 63 N of Hwy 881
Hwy 63 S Landfill
Hwy 63 N Landfill
Hwy 63 S of Hwy 69
Hwy 63 N of Hwy 69
Hwy 63 S of Mackenzie
Hwy 63 N of Mackenzie
Hwy 63 S of Parent
Hwy 63 N of Parent
Hwy 63 S of Gregoire
Hwy 63 N of Gregoire
Hwy 63 S of King
Hwy 63 N of King
Hwy 63 S of Hospital
Hwy 63 N of Hospital
Hwy 63 S of Hardin
Hwy 63 N of Hardin
Hwy 63 S of Morrison
Hwy 63 N of Morrison
Hwy 63 S of Thickwood
Hwy 63 N of Thickwood
Hwy 63 S of Confederation
Hwy 63 N of Confederation
Hwy 63 S of Bus Transfer
Hwy 63 N of Bus Transfer
Hwy 63 S of Aostra Rd
Hwy 63 N of Aostra Rd
Hwy 63 S of Suncor Access
Hwy 63 N of Suncor Access
Hwy 63 S of Syncrude Access
Hwy 63 N of Syncrude Access
Hwy 63 S of Ft Mackay
Hwy 63 N of Ft Mackay
Hwy 63 S of Shell Albian
Hwy 63 N of Shell Albian


Major roads at intersection with Hwy 63
AADT / 24h model volume
12,000
10,000
8,000
6,000
4,000
2,000
0
EB Observed
EB Model
WB Observed
WB Model
Hwy 881
Hwy 69
Mackenzie
Gregoire
King
Hospital W of 63
Hospital E of 63
Hardin
Bus Transfer W of 63
Bus Transfer E of 63
Suncor Access
Syncrude Access
Shell Albian Access


Hourly volumes - Hwy 63 @ Athabasca River (Grant MacEwan Bridge)
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Mid to 1 AM
1 to 2 AM
2 to 3 AM
3 to 4 AM
4 to 5 AM
5 to 6 AM
6 to 7 AM
7 to 8 AM
8 to 9 AM
9 to 10 AM
10 to 11 AM
11 to Noon
Noon to 1 PM
1 to 2 PM
2 to 3 PM
3 to 4 PM
4 to 5 PM
5 to 6 PM
6 to 7 PM
7 to 8 PM
8 to 9 PM
9 to 10 PM
10 to 11 PM
11 to Mid
NB Obs
NB Mod
SB Obs
SB Mod

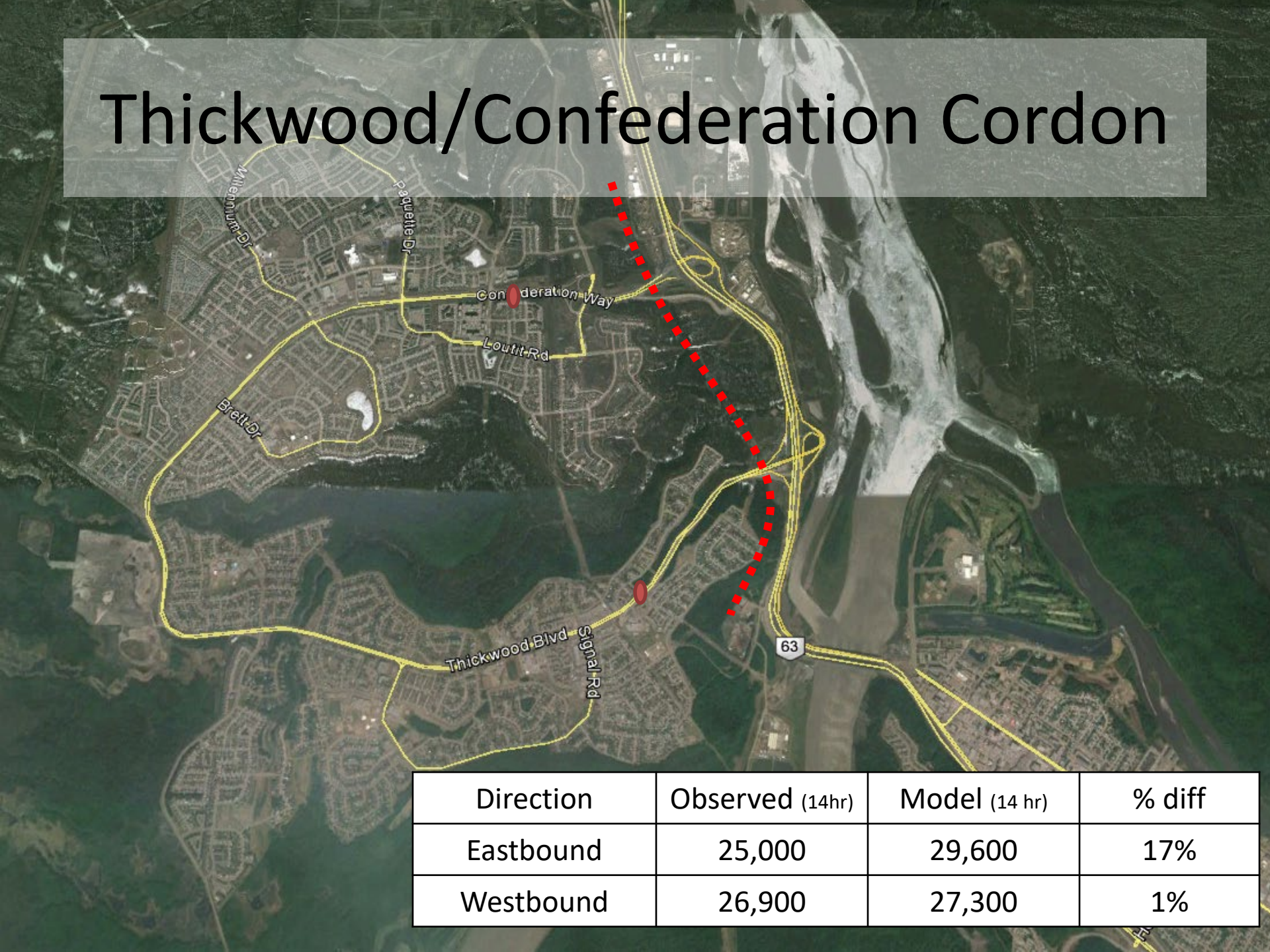

Hourly volumes - Hwy 63 North of Confederation Way
3,000
2,500
2,000
1,500
1,000
500
-
Mid to 1 AM
1 to 2 AM
2 to 3 AM
3 to 4 AM
4 to 5 AM
5 to 6 AM
6 to 7 AM
7 to 8 AM
8 to 9 AM
9 to 10 AM
10 to 11 AM
11 to Noon
Noon to 1 PM
1 to 2 PM
2 to 3 PM
3 to 4 PM
4 to 5 PM
5 to 6 PM
6 to 7 PM
7 to 8 PM
8 to 9 PM
9 to 10 PM
10 to 11 PM
11 to Mid
NB Obs
NB Mod
SB Obs
SB Mod

Downtown Cordon



Direction	Observed	Model	% diff
Inbound (N/E)	37,200	42,400	14%
Outbound (S/W)	36,500	44,700	23%

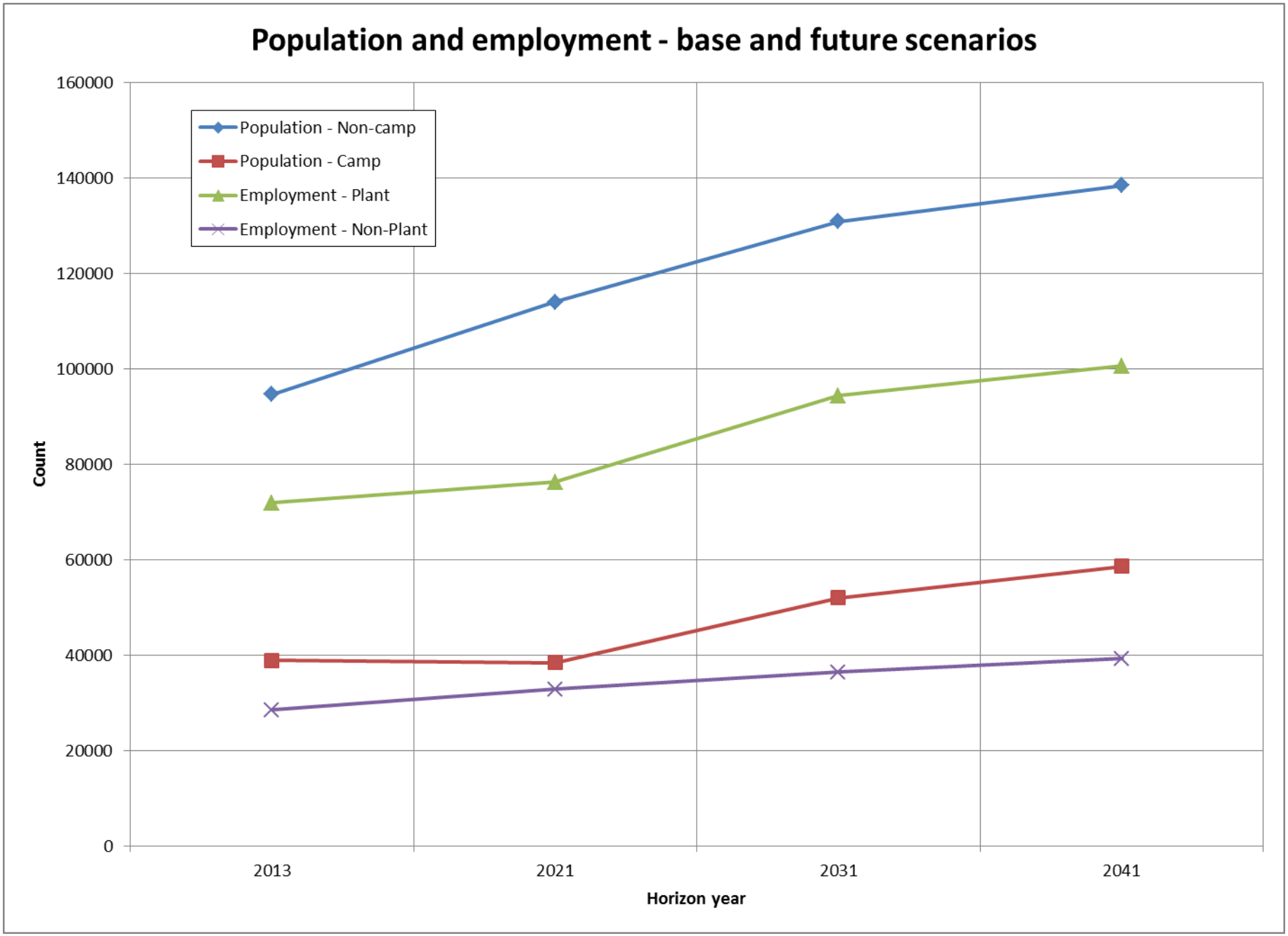
Thickwood/Confederation Cordon



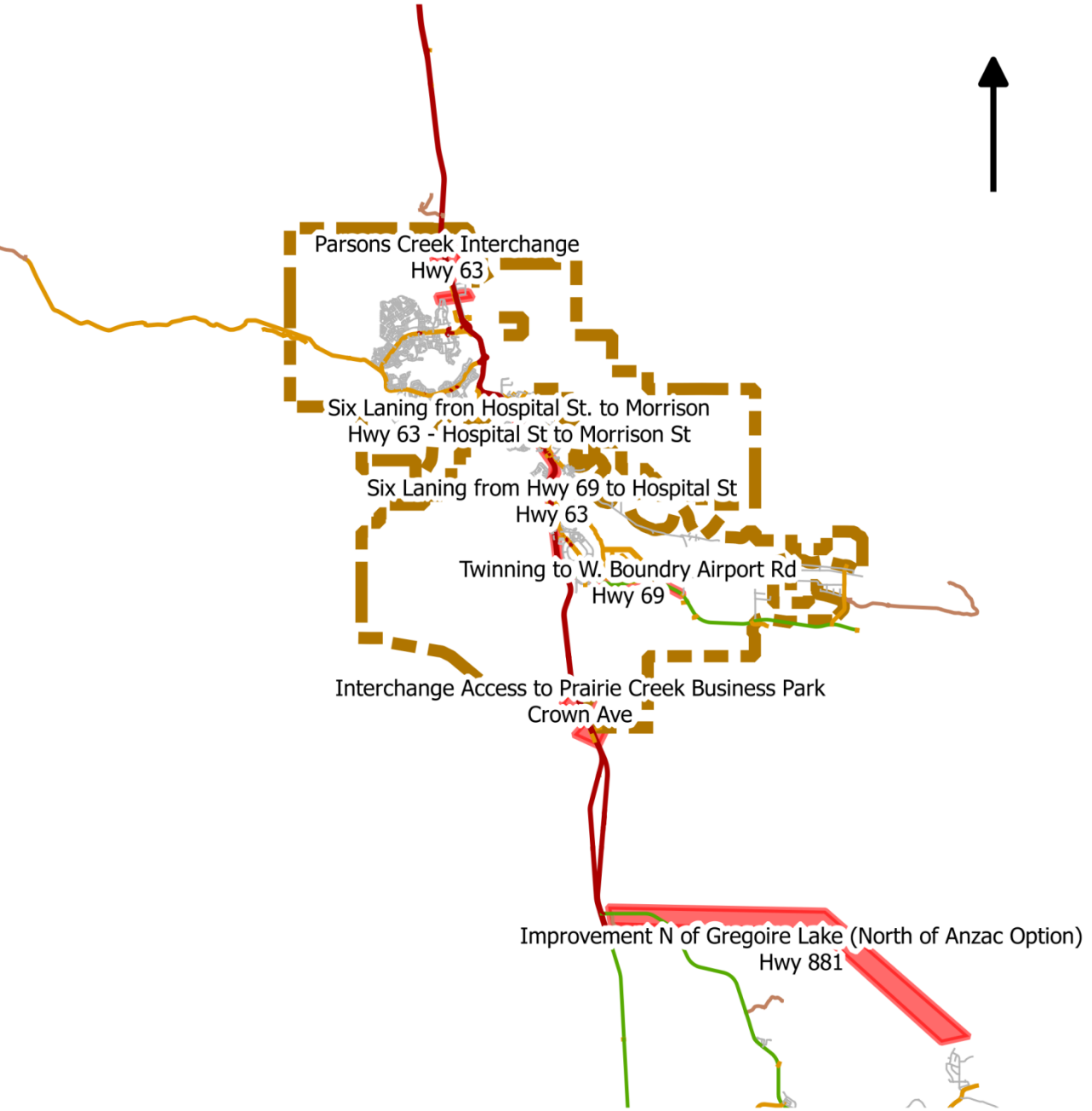
Direction	Observed (14hr)	Model (14 hr)	% diff
Eastbound	25,000	29,600	17%
Westbound	26,900	27,300	1%

Key project phases

- Data collection / processing
- Model development / calibration / validation
- Future scenario series
  - Develop future land use scenarios
    - Population, employment, school enrollment
  - Develop future transportation system alternatives
    - Roads and transit
  - Multiple years: 2021, 2031, 2041 (“full build out”)


Population and employment - base and future scenarios
160000
140000
120000
100000
80000
60000
40000
20000
0
Count
Population - Non-camp
Population - Camp
Employment - Plant
Employment - Non-Plant
2013
2021
2031
2041
Horizon year

2021 improvements



Legend

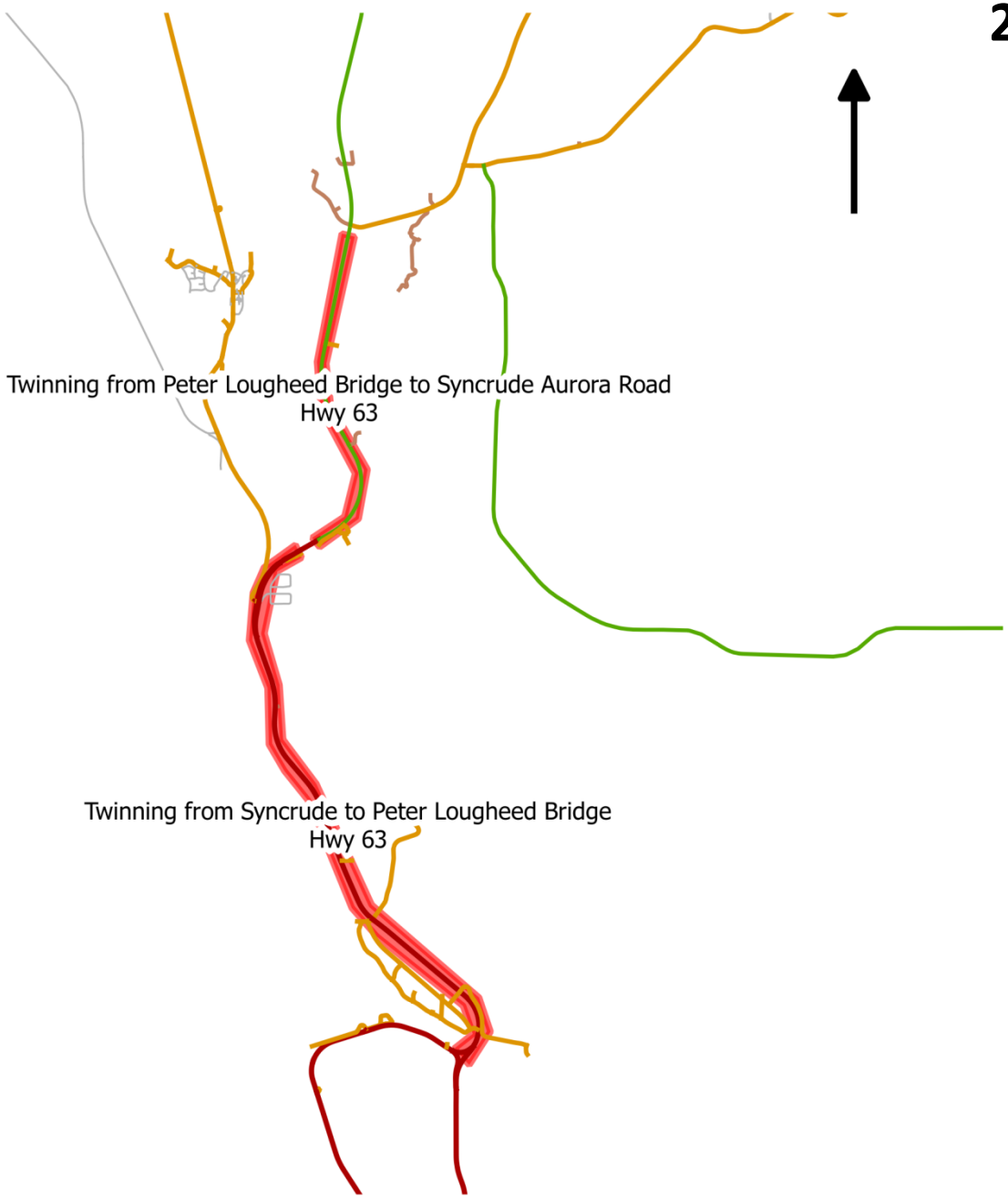
RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

Future Infrastructure

- 2021
- 2031
- 2041

2021 improvements



Legend

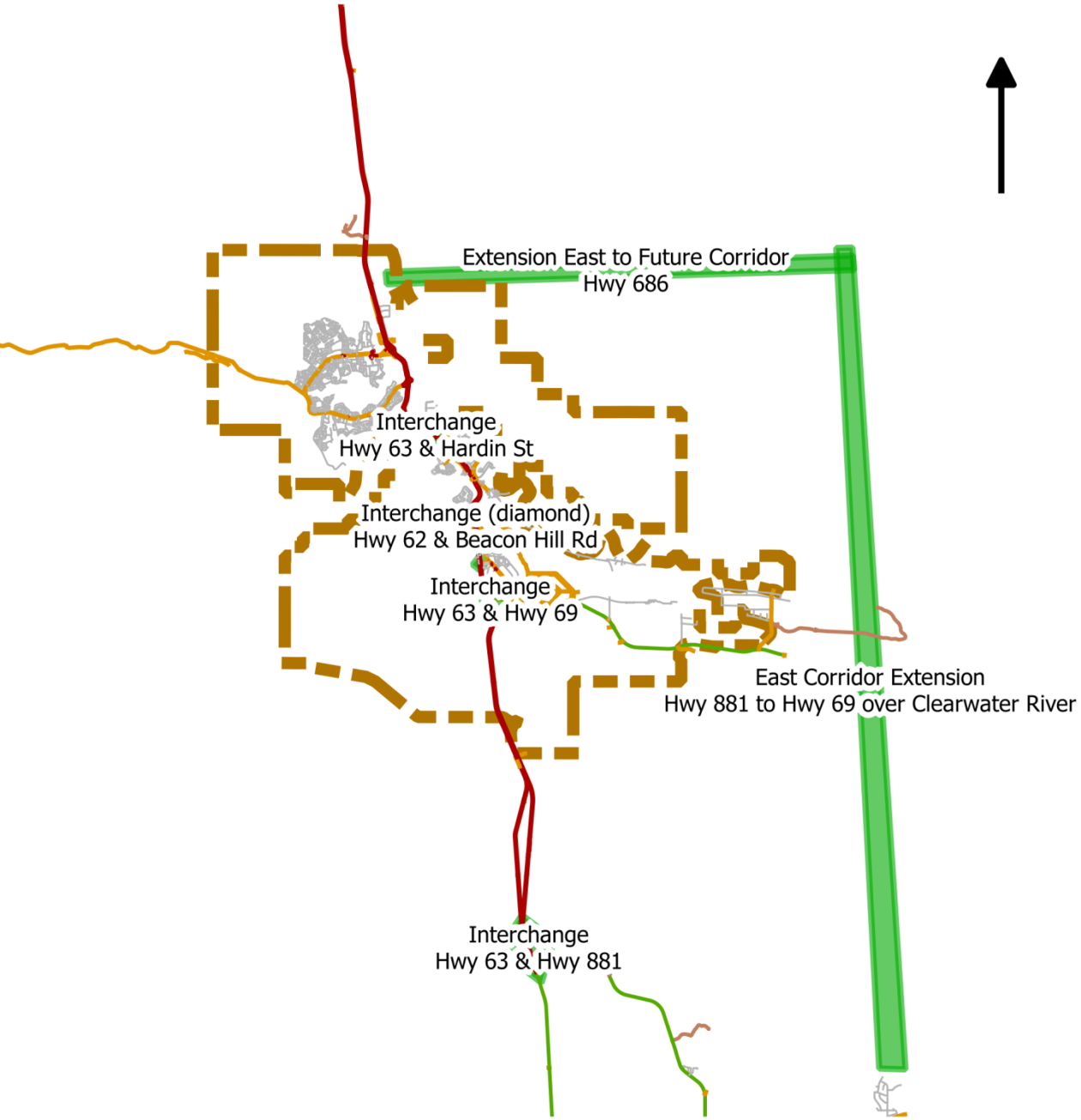
RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

Future Infrastructure

- 2021
- 2031
- 2041

2031 improvements



Legend

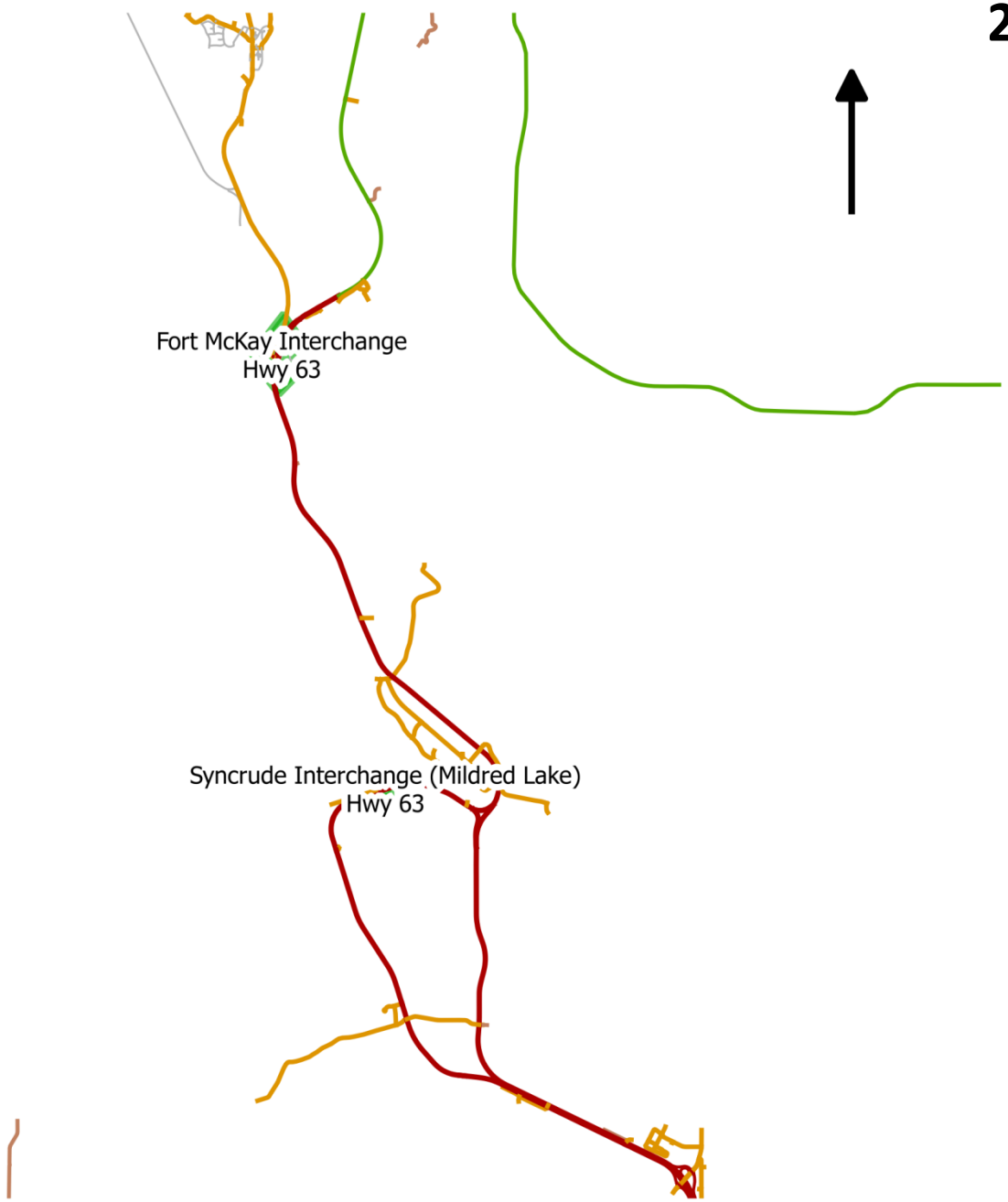
RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

Future Infrastructure

- 2021
- 2031
- 2041

2031 improvements



Legend

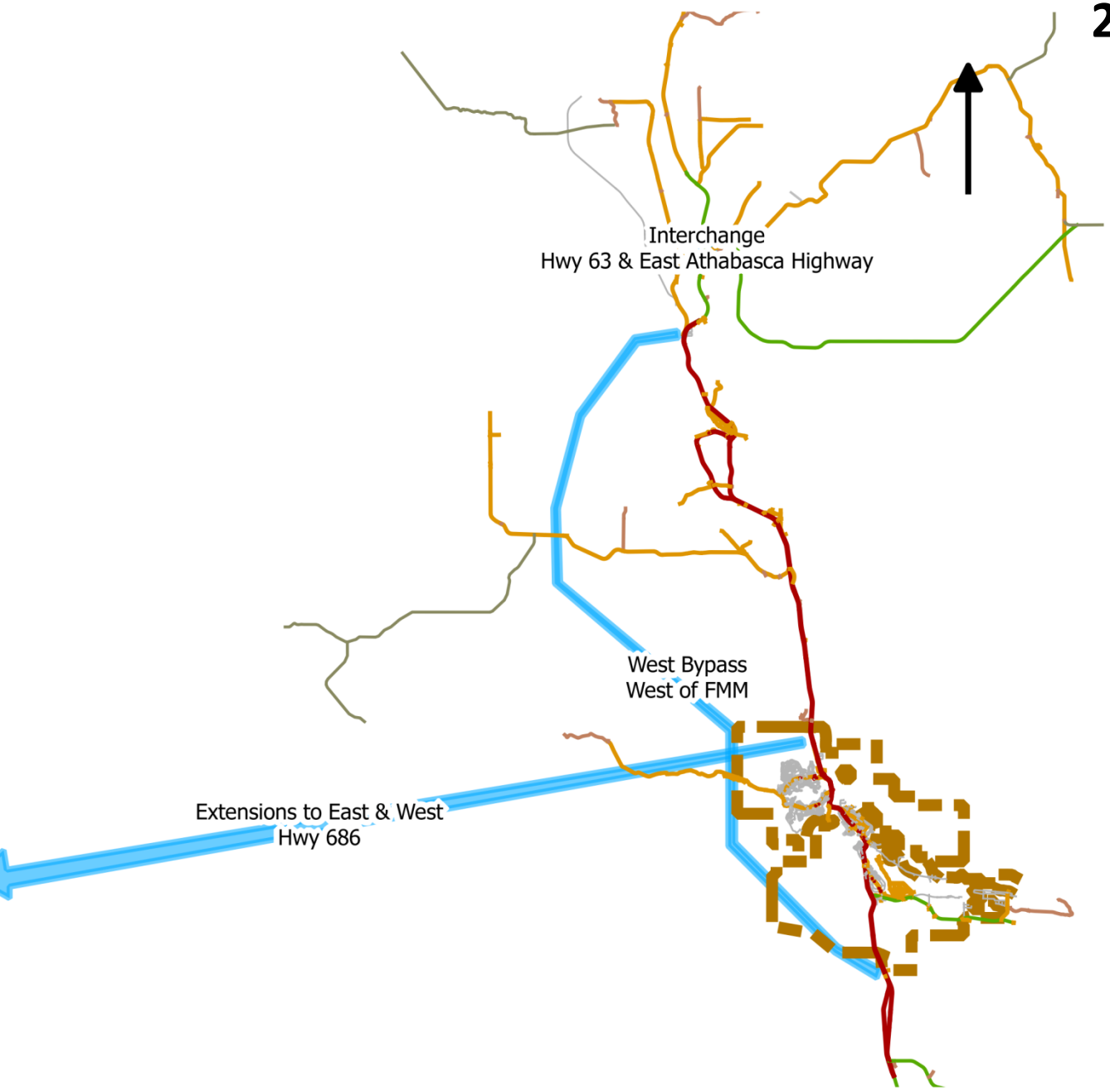
RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

Future Infrastructure

- 2021
- 2031
- 2041

2041 improvements



Legend

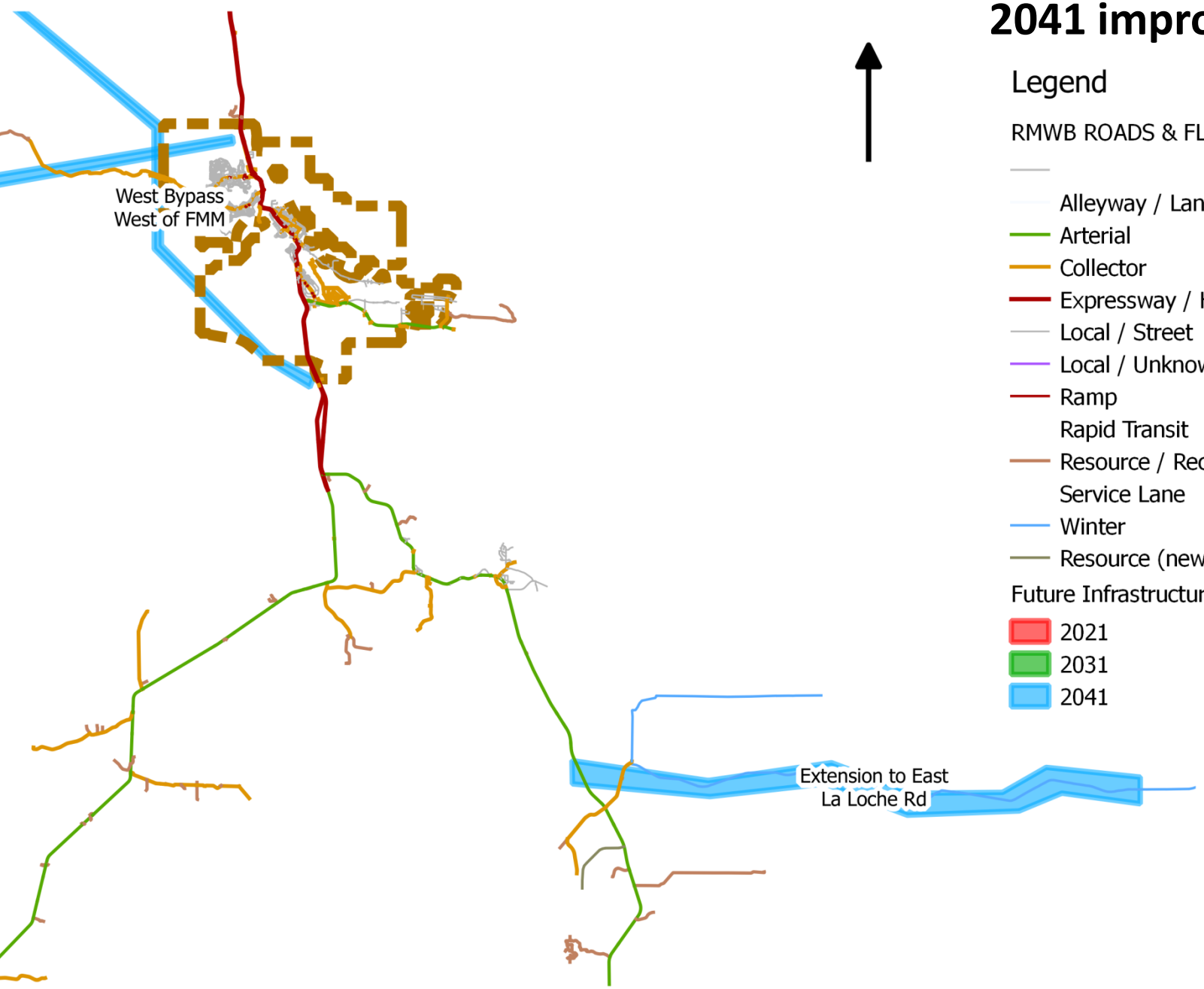
RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

Future Infrastructure

- 2021
- 2031
- 2041

2041 improvements



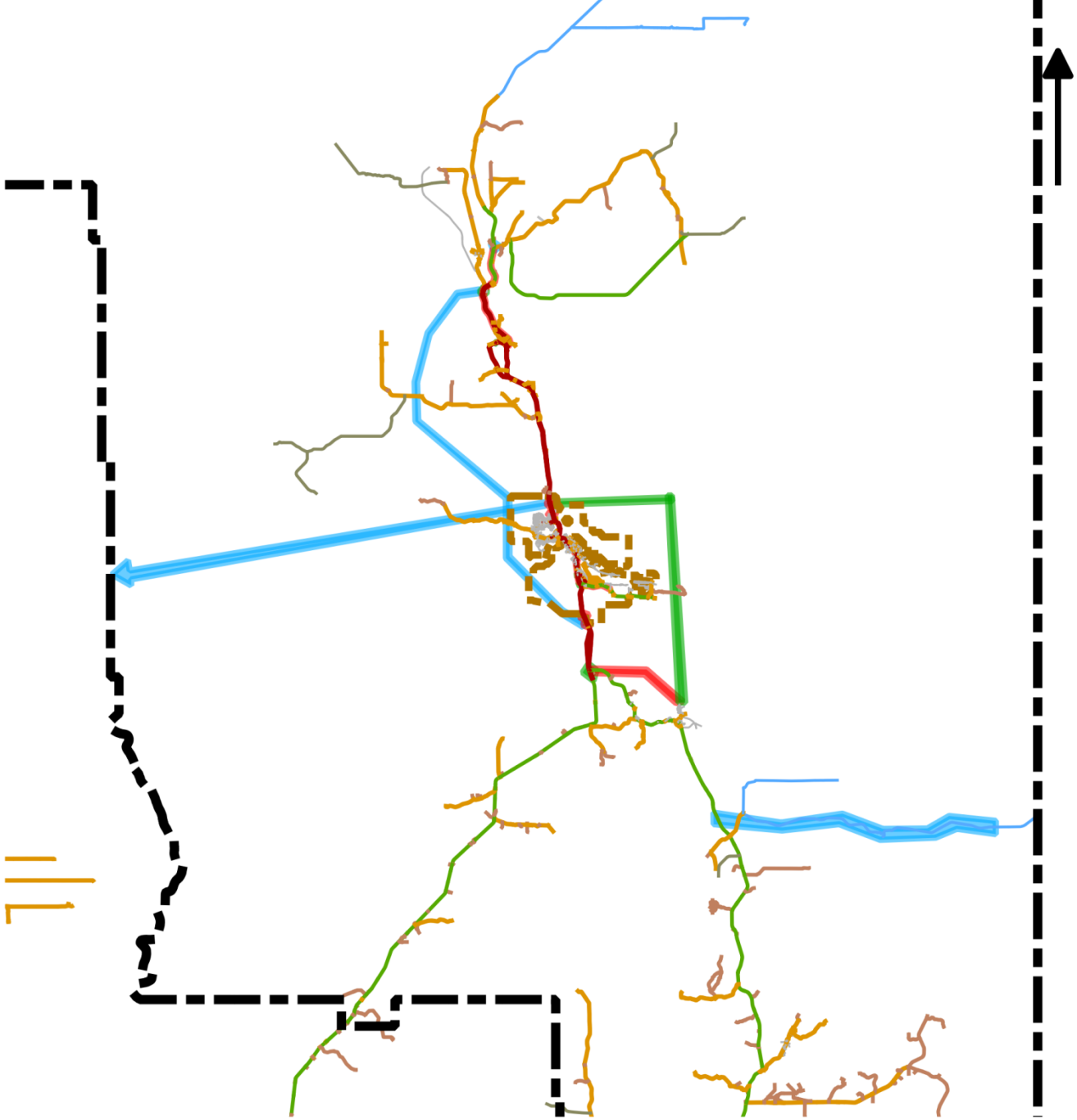
Legend

RMWB ROADS & FLOWS (NRN)

- Alleyway / Lane
- Arterial
- Collector
- Expressway / Highway
- Local / Street
- Local / Unknown
- Ramp
- Rapid Transit
- Resource / Recreation
- Service Lane
- Winter
- Resource (new)

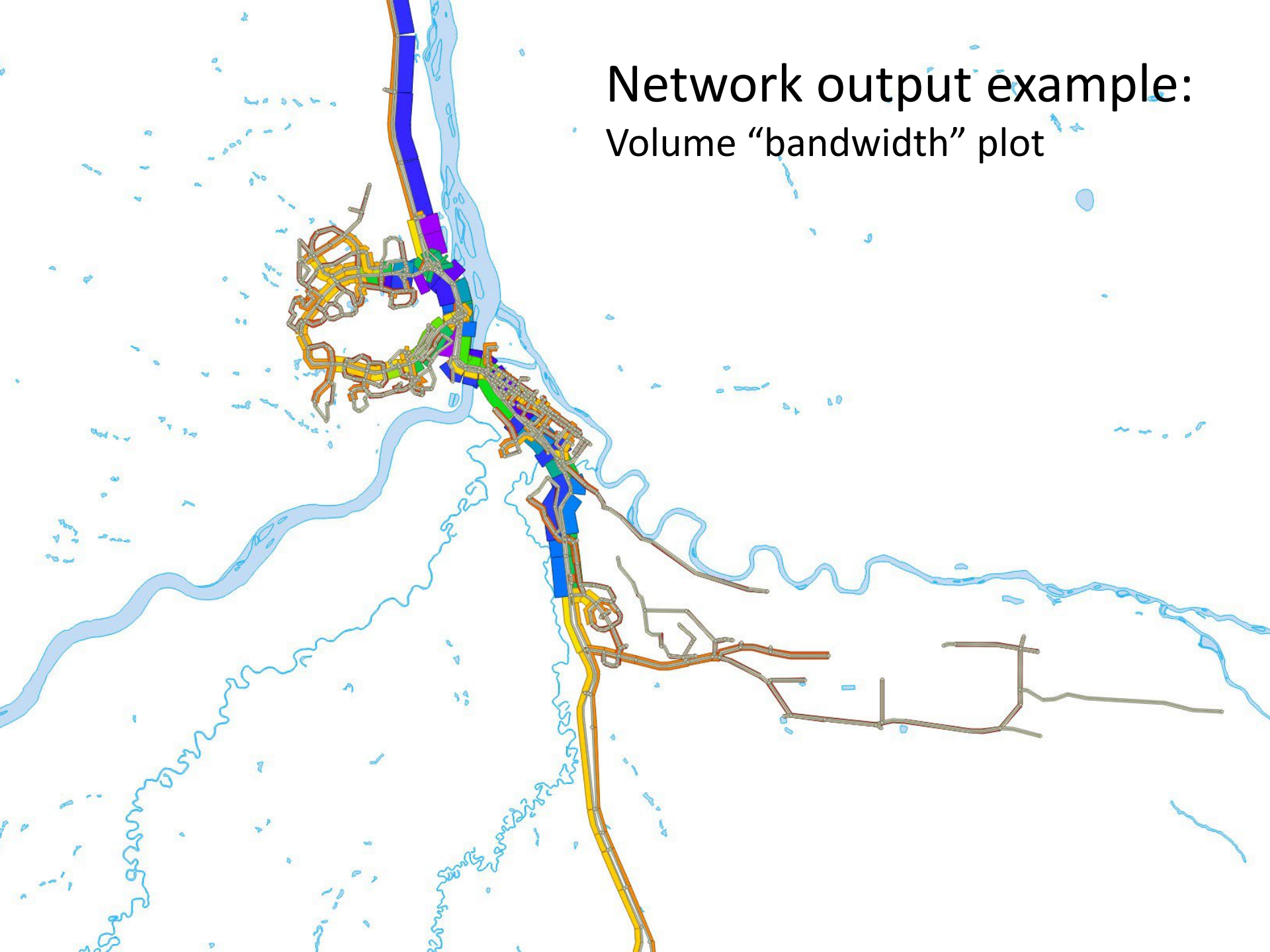
Future Infrastructure

- 2021
- 2031
- 2041

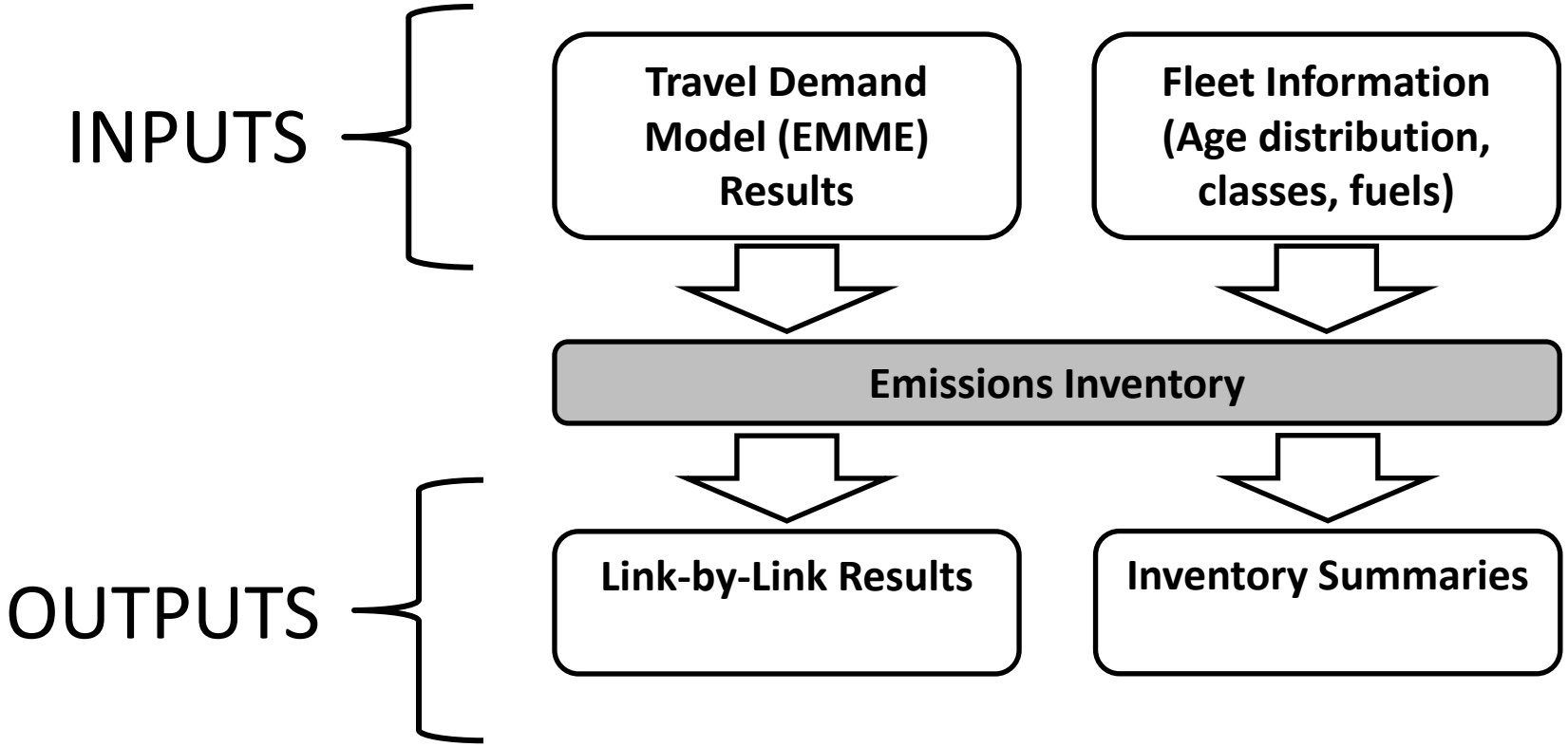

Legend
RMWB ROADS & FLOWS
Alleyway / Lane
Arterial
Collector
Expressway / Highwa
Local / Street
Local / Unknown
Ramp
Rapid Transit
Resource / Recreatio
Service Lane
Winter
Resource (new)
Future Infrastructure
2021
2031
2041

Network output example:

Volume “bandwidth” plot



Vehicle Emissions Sub-Model




2016 Wildfire

Just as we were finishing the model…

- May 3, 2016 a wildfire SW of Fort McMurray forced the largest evacuation in provincial history - ~88,000 people
- Fire destroyed 2,400 homes and buildings and displaced 2,000 residents.
- 9.9B CAD in damage – most costly disaster in Canadian history.
- Declared under control on July 5, 2016 and fully contained August 2, 2017.

New Scenarios

- How can we evacuate Fort McMurray?
- Could we use the winter road to the east into Saskatchewan?
- What is the cost to upgrade the road and what is the typical use (i.e., during non-evacuation scenarios)?

Questions?