RODEL

COMPUTER MODELS

- **CRUCIALLY IMPORTANT FOR DESIGN**
- Predict Capacities, Queue and Delays.
- Predict Accidents
- Determine geometry and ROW
- Basis of Evaluation
- Basis of Justification
- FOUNDATIONAL
- **RODEL** is a UK roundabout model
- Derives queues and delays from traffic & geometry

RODEL

- Used UK empirical capacity equations
- Peak Hour divided into 1, 5, 10, 15 min slices
- Each slice is modelled
- Peak Hour evolves over time
  - Volumes
  - Capacities
  - VC Ratios
  - Queues
  - Delays
  - Exit volume

BACKGROUND

- UK has high traffic density
- Old Traffic Circles started grid-locking
- 1966 - **YIELD LINES** - Gridlock eliminated
- Surprising increase in capacity
- But some roundabouts still congested

POST 1966

- The Mini Roundabout was invented (TRL)
  - Stunningly successful
- Higher capacity than some large roundabouts?
- Yield line capacity not understood
- Traffic Circle capacity equations obsolete
- Yield line capacity model was needed

Problems with Capacity Prediction

- Gap Theory developed in UK (Tanner 1950's)
- Gap Theory used to estimate roundabout capacity
- Many **'at capacity'** roundabouts needed fixing
- Their capacity could be **directly measured**
- Gap Capacity and Measured could be compared

GAP Capacity

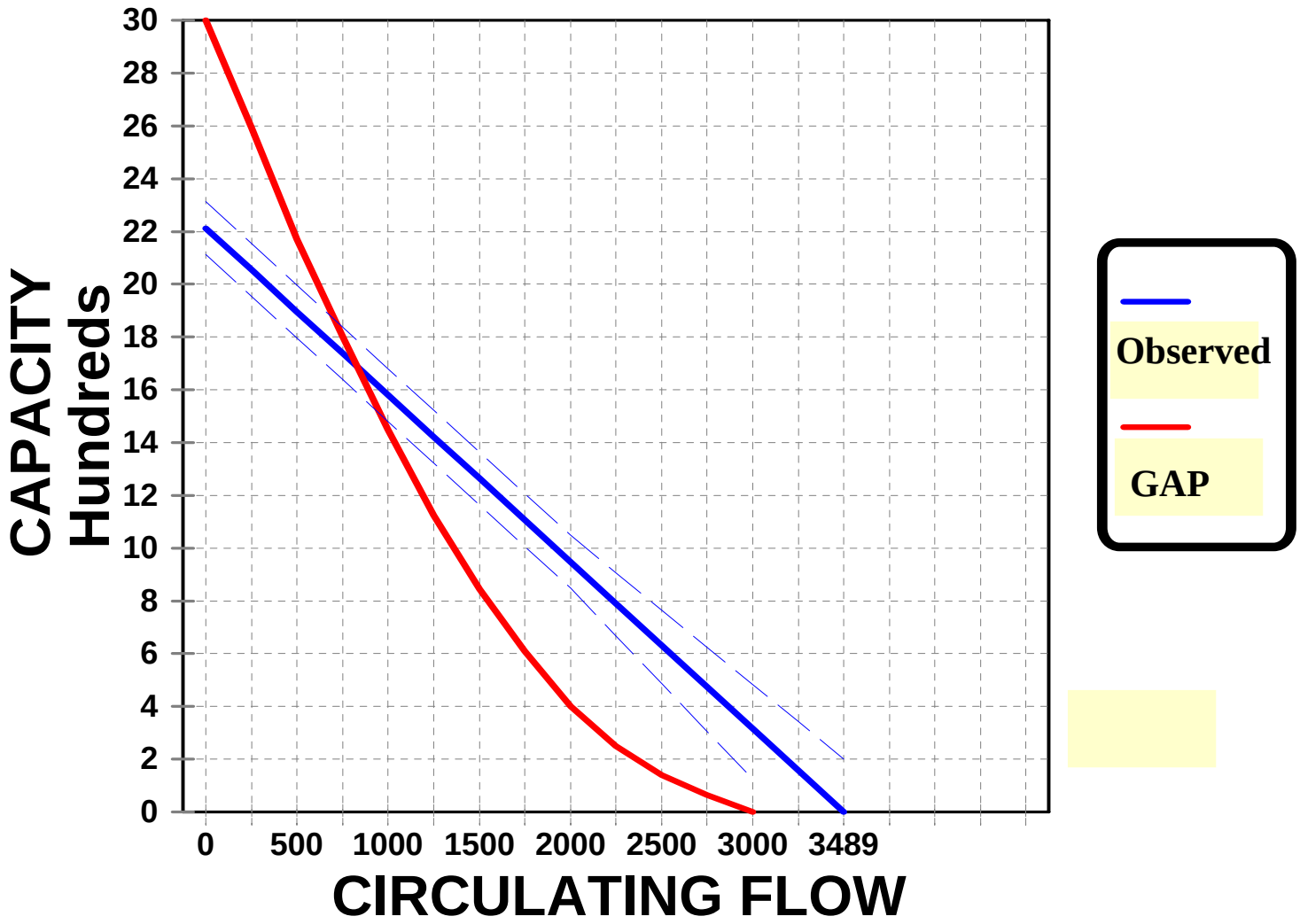
- Large disagreement with measured capacity
  - Predicted no congestion ---------- when observed
  - Predicted congestion ---------- when not observed
  - Sometimes predictions ----------were reasonable
  - No consistency ---------- very unreliable!

- Also weak Geometry / Capacity relationship
- Design was therefore very uncertain
- Many complaints to Central Government

Development of a Capacity Model

- UK Government commissioned the TRL
- Gave TRL an open check to derive capacity model
- Rod Kimber was Tanners successor at TRL
- Like Tanner he was keen on Gap Models
- He wanted a better Gap Model for roundabouts
- Measured capacity at **'at capacity'** operation
- Measured the Gaps at **'at capacity'** operation
- Formally compared Gap and Measured capacities
- **Large disagreement**

OBSERVED vs GAP CAPACITY (Single entry)



WHAT WAS HAPPENING

CAPACITY

- Research started in earnest.
- Vehicles fitted with telescopic masts
- Fish-eye lens cameras on top of masts
- Parked in the middle of Central Island
- **‘At Capacity’** and **‘sub capacity’** operation filmed
- **This was a revelation**
  - At least 3 capacity mechanisms in addition to gap
  - As VC ratio rose these mechanisms grew in strength
  - They have a large effect on capacity
- Gap mechanism only a part of a complex situation

Problems with Capacity Prediction

- At capacity operation is very complex
- Impossible to separate each mechanism
- impossible to relate each mechanism to geometry
- Concluded Gap Theory inadequate for roundabouts

- **Empirical model developed by TRL**
- **Capacity directly measures**
- **Capacity related to geometric varaiation**
- **Lab Rep0rt LR942**

EMPIRICAL CAPACITY MODEL

- Capacity measured at existing real world roundbouts
- 11,000 minutes of ‘at capacity’ operation
- Over 500,000 at capacity vehicle observed
- Very wide geometric range
- Very wide traffic volume range
- Sustained queues for more than 30 minutes essential
- Queues never less than 5 vehicles
- Test track experiments on geometry and capacity

- **Cost 11 Million Dollars**

EMPIRICICAL CAPACITY MODEL

- Empirical Capacity Model published in 1980
  - TRL Lab Report LR942
- Accurate, stable, unchanged for 25 years
- Checked in 1997 against 35 Roundabouts
- Model confirmed - NO changes needed

- Very strong geometry / capacity relationships
- Revolutionised Roundabout design in UK

EMPIRICAL MODEL

- Empirical Equations were **revolutionary**
- **Capacity is unbelievably sensitive to geometry**
- Very counter intuitive - contradicts intuitive theory
- Very powerful at achieving high capacity
- Smaller - safer - higher capacity roundabouts

EMPIRICAL MODEL

- **UK roundabouts**
  - Have high capacity
  - Falsely attributed to UK driver behaviour
  - UK drivers nor supermen or superwomen
  - UK Signal Capacities is the same as elsewhere
- **The difference is due to geometry**
  - A direct consequence of the Empirical Equations
- Countries like US relatively new to Roundabouts
- US Roundabouts at **'sub capacity'** operation
- Capacity **CANNOT** be measured
- Capacity **CANNOT** be estimated from gaps

EMPIRICAL MODEL

- RODEL and ARCADY use empirical capacity
  - Used for designing new roundabouts
  - Used for modifying existing congested roundabouts
- **ACID TEST of CAPACITY MODEL**
- Fix existing **congested** roundabout
- With **existing traffic** and **no ROW**
- Model predicts subtle geometric changes
  - Reduce queues from 100 to minimal number
  - Small modification done within 4 weeks
  - Queues of 100 vehicles vanish - volumes increase
  - Excellent feed back - do not have to wait 20 years

DEVELOPMENT OF A U.S. ROUNDABOUT MODEL?

US CAPACITY MODEL

- UK Empirical model cost …….$11.0 M
- FWHA spending less than …….$ 1.0 M
- US has a small number of roundabouts
- Operating at low VC ratios (not ‘at capacity’)
- Narrow geometric range (mostly are SLR)
- Narrow Volume Range (mostly SLR)

- Sustained queues for 30 minutes essential
- Queues must never less than 5 vehicles
- Sporadic non-capacity queues useless

US ROUNDABOUT MODEL

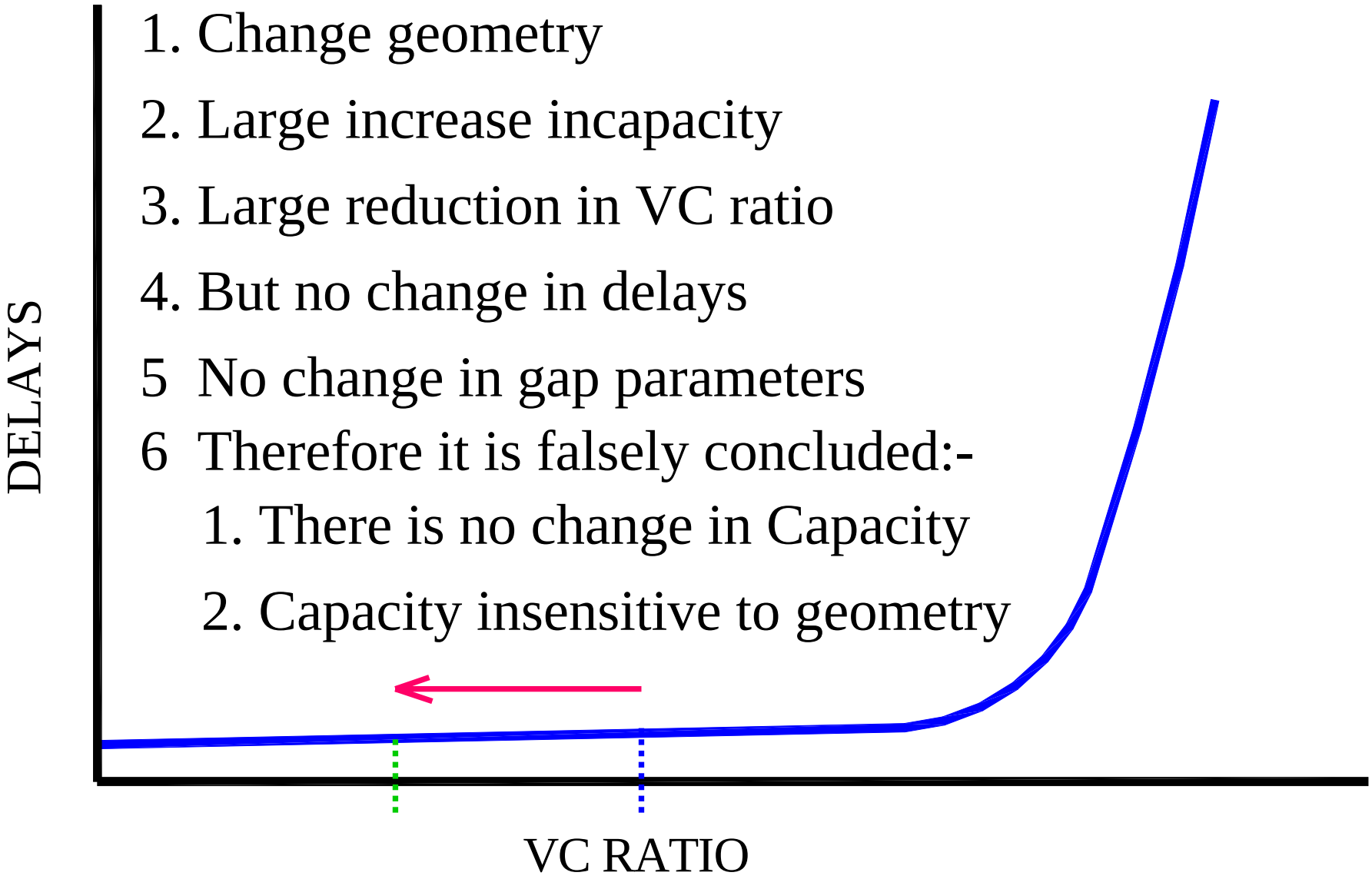
- US data insufficient for
  - Capacity Measurement
  - For an Empirical Model

- A theoretical gap model is almost certain
- Only gap capacity mechanism
- Other NON gap capacity mechanisms omitted

- FHWA Model will be limited by gap limitations

Gap capacity - insensitive to geometry

1. Change geometry
2. Large increase incapacity
3. Large reduction in VC ratio
4. But no change in delays
5 No change in gap parameters
6 Therefore it is falsely concluded:-
   1. There is no change in Capacity
   2. Capacity insensitive to geometry



CASE STUDY

A
ROUNDABOUT
IN ISRAEL

ROUNDABOUT IN ISRAEL

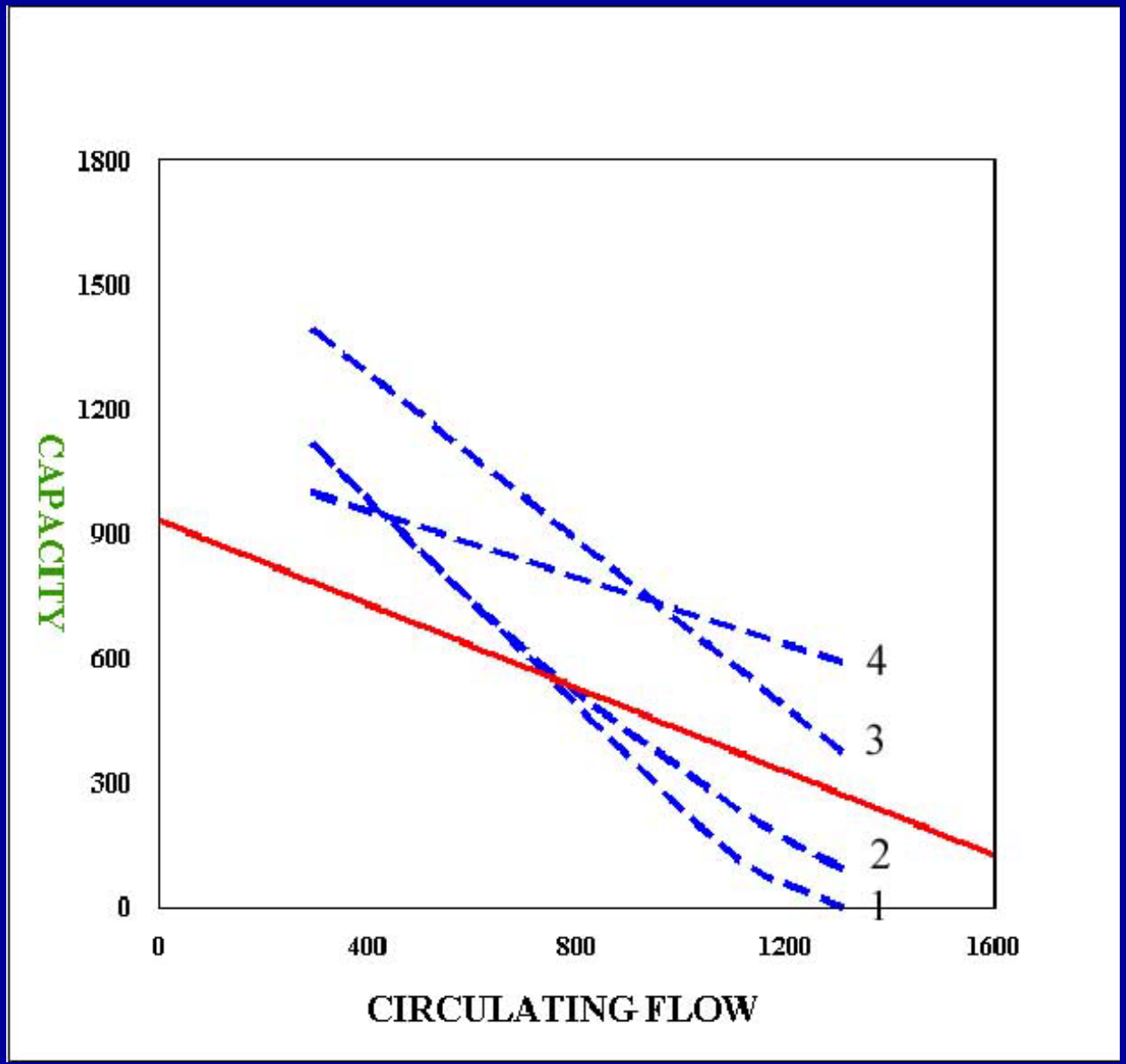
- Single lane roundabout built in Israel
- Capacity overestimated

- One leg congestion on Day 1
- Sustained queues during peak hour

- Researchers measured capacity directly

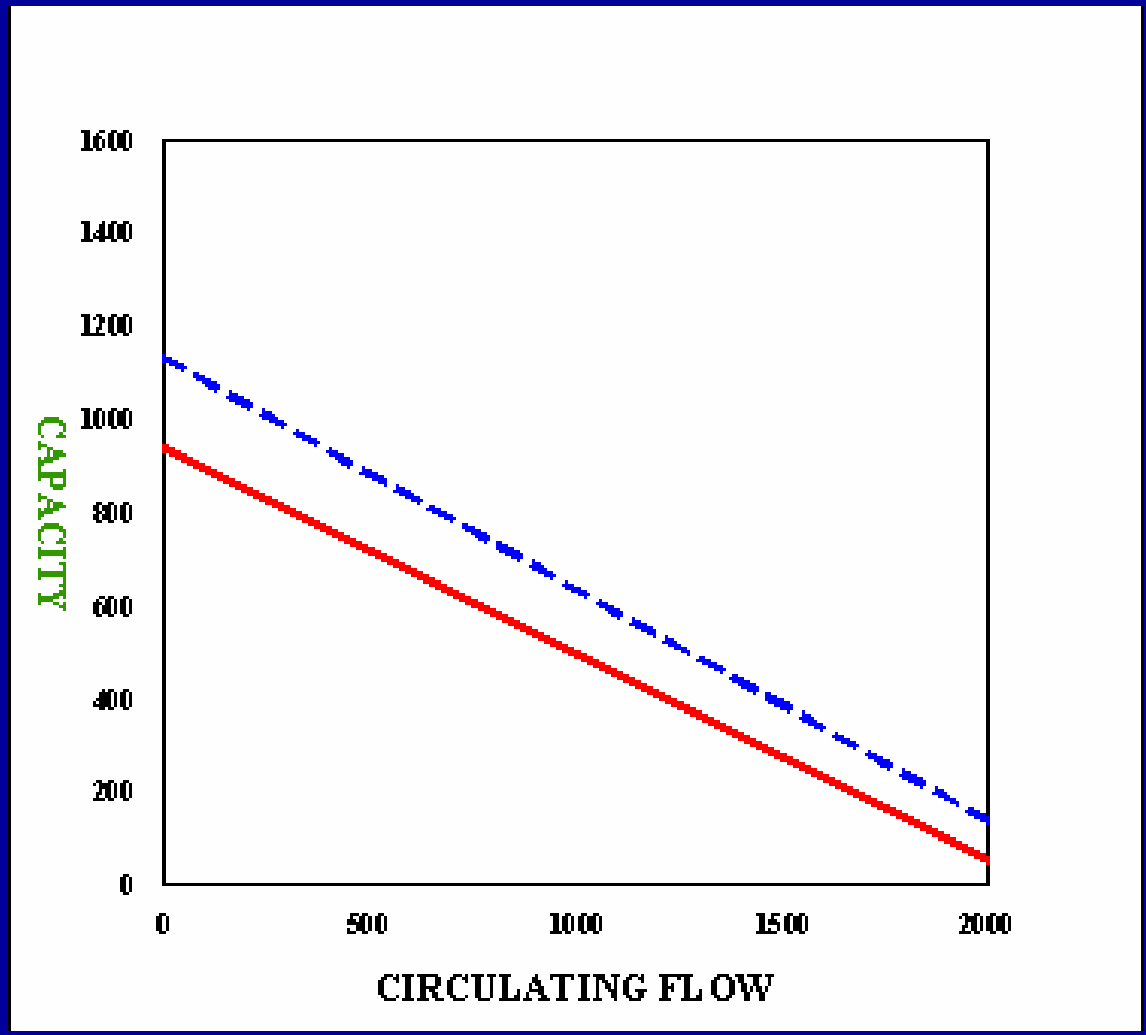
- Compared capacity with Capacity Models

ISRAEL- Measured vs Gap Methods

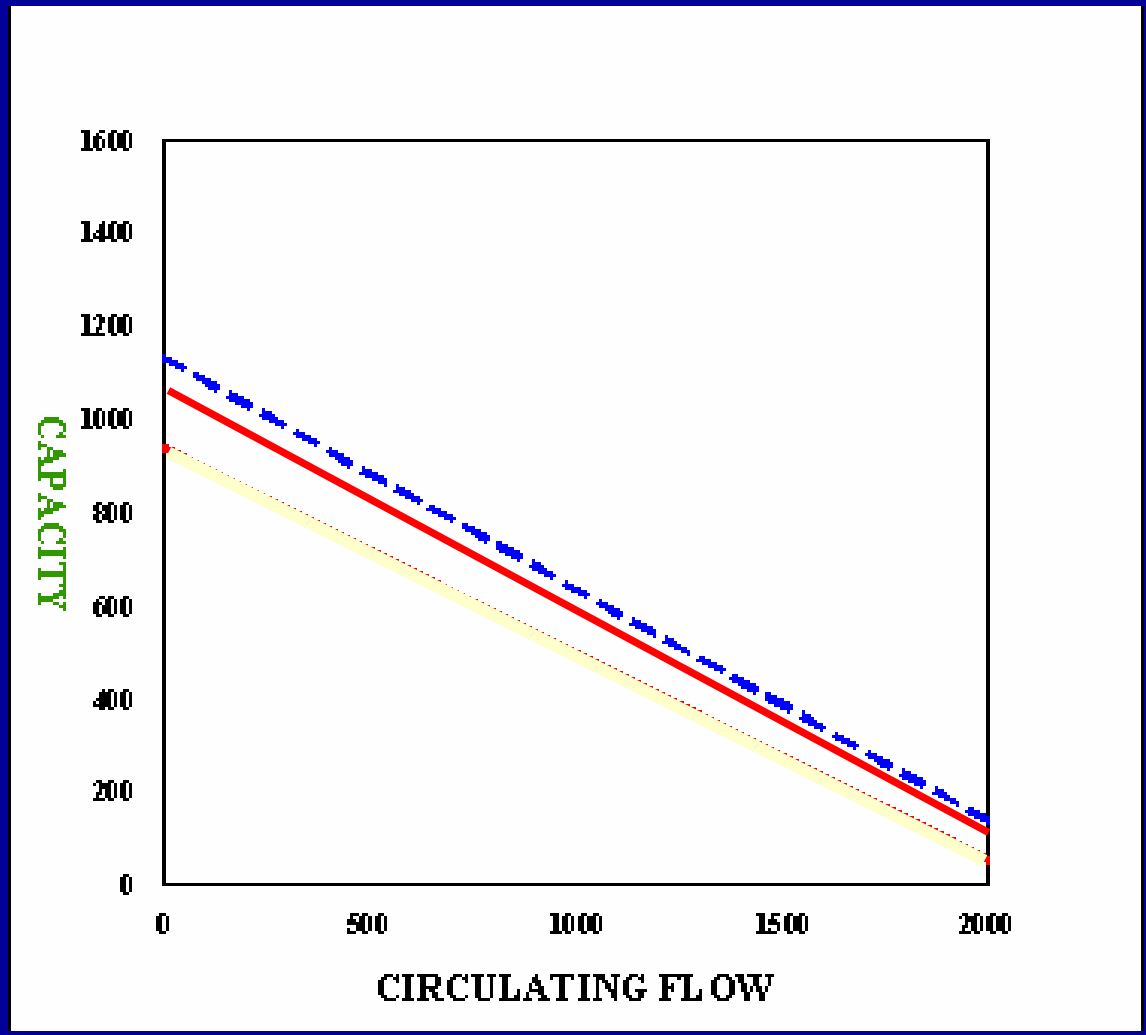


- 1. Tanner
- 2. Troutbeck
- McDonald
- Ashworth

Empirical vs Observed (Unfamiliar, timid driver behaviour)



ISRAEL- Empirical vs Observed (Revised for familiar driver behaviour)



RODEL

- A is design tool for generating designs
- Developed by a designer for designers
- Not just for checking designs after drawing
- Rodel used **before** drawing to derive geometry
- Geometry known before drawing starts
- Far better than drawing blind then checking

TWO MODES

- RODEL has two Modes of operation

- **Mode 1**

- Generates ~ 40 geometry options / leg
- From user specified target delays / leg
- Alternative selected for each leg
- That best fits ROW and maximise safety

TWO MODES

- **Mode 2**

- Refines selected geometry
- Fully Interactive with 3 sec ‘What If’ cycle

- Mode 1 = ‘the driver’
- Mode 2 = ‘the putter’
- Many like to ‘put’ from the ‘tee’ to ‘green’

INPUT AND OUTPUT

- **All Input and Output on a single screen**

- All relevant information always visible
  - Relationships between geometry
  - Relationships between flows
  - Relationships between geometry and flows
  - Relationship between INPUT and RESULTS
- Fully interactive
- Very educational
- Generates a feel for geometry / capacity / delay

BETTER DESIGNS IN LESS TIME

- Results understood in relation to input
- Rapid understanding of problem
- Rapid solution
- Saves a LOT of time
- **Better designs in a fraction of the time**

FINDS SOLUTIONS OTHER MISS

- Other models are not Fully interactive
- Input on several screens
- Output in separate FILE that needs editing
- ‘what if’ cycle takes several minutes
- When results found – question forgotten
- Miss solutions Rodel finds

- **RODEL finds solutions other models miss**

TRL and RODEL

- Current negotiations between Rodel and TRL
- Aim for TRL to adopt Rodel
- Partnership between Rodel and TRL
- To develop new version of RODEL
- Full Windows program
- Many very powerful enhancements
- Designed by a designer, for designers
- Animated Graphical output

Finish