# INTERSECT

## WHERE DATA AND RESULTS CONVERGE

VHB's innovative platform for developing traffic volumes

Collecting traffic data is a critical piece of advancing transportation projects. Intersect, VHB's latest technology-driven innovation, revolutionizes the way we account for traffic volumes at urban, suburban, or rural intersections during typical and atypical circumstances.

**Intersect leverages big data and traffic analysis to keep critical projects moving forward.** Intersect is a transportation planning tool that combines big data analytics and traditional traffic analysis to identify traffic data at intersections more efficiently than ever before, without the need for traditional manual or electronic counts. Intersect begins with probe data from **INRIX**, VHB's data provider, then follows an innovative four-step process (see page 6) to calculate intersection traffic volumes—a vital necessity for any transportation planning effort.

Intersect has and will continue to revolutionize the way we account for traffic volume at urban, suburban, or rural intersections, regardless of cars on the street. Intersect provides valuable benefits:

- **24/7 accessible data** for any intersection
- **Year-round availability** for data collection—easy adjustments to account for holidays, summer months, etc.
- Fewer steps yield **more efficiency and faster results—a cost and time savings**
- A larger data set offers **more reliability and accuracy**
- **Customizable output**
- Virtual collection minimizes field work and **enhances safety**
- **Viable tool** during typical and atypical traffic conditions

Unprecedented disruptions, from global pandemics to extreme weather events, require flexible, adaptable, and proactive solutions. Intersect provides an innovative approach to collecting traffic volume data under typical or atypical circumstances and enables time-sensitive projects to progress. **VHB is currently working in partnership with multiple Departments of Transportation to implement Intersect and leverage the efficiency and accuracy of collecting traffic counts using probe data.**

# THE ROAD LESS TRAVELED

In March 2020, the United States and the world faced unknown challenges resulting from the COVID-19 pandemic. Everyday life became disrupted and the country began a series of coordinated social distancing and stay-at-home orders. As government officials instructed the country to remain at home, and many businesses and citizens began a transition to working remotely, transportation systems were directly impacted. Traffic volumes were significantly reduced, in some cases by greater than 75 percent on major facilities that previously served as the lifeline to residences, business, and communities. **With non-representative traffic conditions on the roadways, transportation professionals providing essential services supporting infrastructure needs were left with a new predicament—how to collect volume data for analysis of future projects when traffic conditions are atypical?**

Recognizing the value of probe (cellular, sensor, or connected vehicle) data, VHB outlined a universally acceptable procedure for leveraging probe data to produce traffic volumes under normal (pre-COVID-19) conditions. **Although derived during a time of crisis, the developed solution, Intersect, will change the way intersection data is collected forever.**


*The response to COVID-19 emptied streets in New York City (shown here) and across the globe.*

## DATA DEFINED

**Big Data**
Large sets of data that can be analyzed computationally to reveal patterns, trends, and associations.

**Probe Data**
As an internet-ready device traverses the network, such as a cellular phone or connected vehicle, it relays data like time, location, or speed from its device-enabled sensors. The probe data is collected, anonymized, and then ready for consumption.

## Why Is Traffic Volume Data Important?

**Traffic volume data serves multiple needs for transportation professionals and is vital to establishing the baseline conditions for roadways and intersections.** Transportation planning relies on traffic counts to support traffic impact studies, long range transportation plans, corridor studies, travel demand forecasting, and signal warrant studies. These studies are largely developed based on the collection of existing traffic counts to establish the conditions for roadways and/or intersections. Additionally, traffic engineers leverage volume data to assess near real-time operating conditions on corridors and/or intersections. These assessments are critical to identify operational constraints, assess safety conditions, and support the maintenance of these facilities.

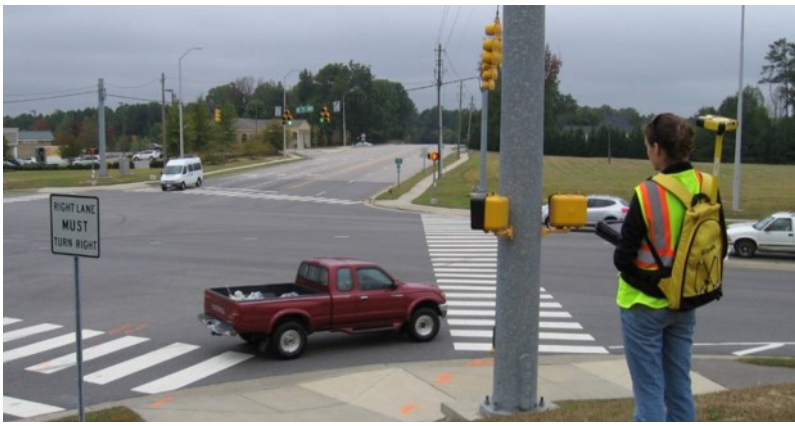
## Traditional Traffic Data Collection

Traditional traffic data collection techniques include the use of automatic traffic recorders (ATRs), manual turning movement counts, and video detection devices to quantify the number of vehicles on highways or at an intersection. Depending on the need, traffic counts are collected for a minimum of one hour and can be extended for periods of time using continuous counters. In addition, agencies often restrict the collection of traffic counts to traditional times of year (non-holidays and months when schools are in session). This creates the potential for project delays if weeks or months past before a count can be collected.

Traditional standard operating guidelines for conducting traffic counts include:

- Typical weekday traffic counts are collected between noon on Monday and noon on Friday.
- Typical traffic counts avoid collection on holidays (plus a day before/after the holiday), unless the collection of a holiday is the purpose of the study.
- Typical traffic counts avoid conducting counts in or within the area of influence of construction zones (unless it is the purpose of the study).
- Typical traffic counts avoid collection during non-recurring traffic conditions (accidents, inclement weather, special events, etc.).

As there are a significant number of transportation applications that use traffic counts, it is important to know that a wide range of collection periods or procedures are available. **Having the flexibility to collect traffic counts using probe data for any duration, date, or time period provides advantages.**




*As shown here, most traditional traffic data collection techniques require on-site installation and/or operation of hardware.*

In addition, using probe data enables exploration of traffic conditions before, during, or after the impacts of COVID-19. For the "before" condition, probe data is available for dates prior to March 2020. Likewise, probe data is currently being collected during the pandemic to monitor the near real-time conditions on transportation systems. Lastly, it is anticipated that "after" the pandemic, use of probe data will, in some cases, potentially replace the traditional traffic counting process.

## Evolution of Probe Data

Transportation-related probe data has evolved over the past decade. Available Information from probe data sources has become functionally more complex as the saturation of data providing devices and the speed at which this data is made available has greatly expanded, with a majority of these data sources now reporting latencies under one minute or near real-time. This expansion has seen data become readily available for agencies for use in operational needs and has enhanced opportunities for planning level analysis. Information can now be collected from the convenience of your desk 24-hours a day, 7 days a week, and 365 days a year.

While there are many sources of probe data in the market, VHB partnered with INRIX to support the development of turning movement volumes based on the easily manipulated discrete data, ability to conflate for accuracy to roadway infrastructure, and flexibility to isolate vehicle classifications (personal vehicles, trucks, and commercial vehicles).

Probe data generally has a capture rate of 10 to 25 percent of the total number of vehicles passing through an intersection depending on the nature of the surrounding area. **Estimating what reasonably "normal" volumes are at a study intersection from a smaller sample size is challenging. Intersect provides that solution by thoroughly understanding capture rates.**


*Intersect can be used to account for traffic volume at urban, suburban, or rural intersections, regardless of cars on the street.*

# INTERSECT: THE PATH FORWARD

Probe data provides the flexibility to produce intersection data more efficiently than the traditional counting of vehicles and can seamlessly be collected for any duration of time and/or geographic area. However, to effectively manage the billions of individual records of continuous flow INRIX data, a big data environment is required to ingest and evaluate the data. A significant benefit of using the INRIX probe data is that multiple days can be evaluated, versus a traditional single-day count. This multi-day collection allows for the normalization of the intersection design volumes accounting for anomalies in daily conditions.

**VHB conducted an assessment to comparatively evaluate three conditions:**

- A single day of probe data
- Three days of probe data
- A traditional single day of turning movement counts

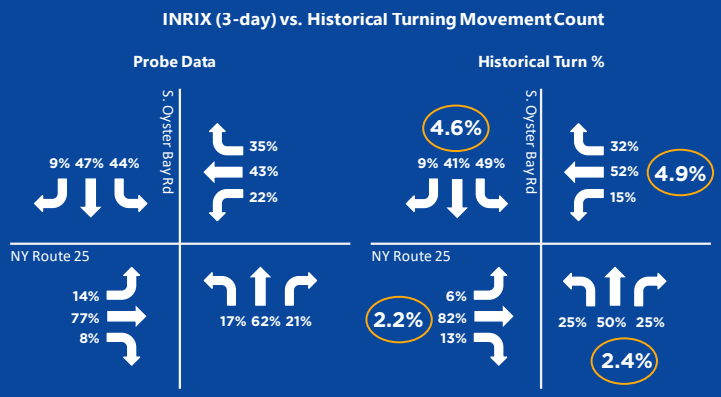



*Figure 1. A minimum of three days of probe data is needed to achieve an acceptable confidence of turning movement counts for planning purposes.*

As demonstrated in **Figure 1** above, a comparison between three days of probe data resulted in approach percentages less than five percent for each approach. It is important to note that the use of a single day of probe data resulted in variations in excess of 20 percent. To achieve an acceptable confidence for planning purposes, a minimum of three days of probe data should be used. Facilities with lower traffic volumes may require additional days or weeks of data to achieve an acceptable confidence level with the intersection design volumes.

# INTERSECT'S INNOVATIVE PROCESS

Intersect's ground-breaking four-step process was created for developing intersection traffic counts obtained using probe data.

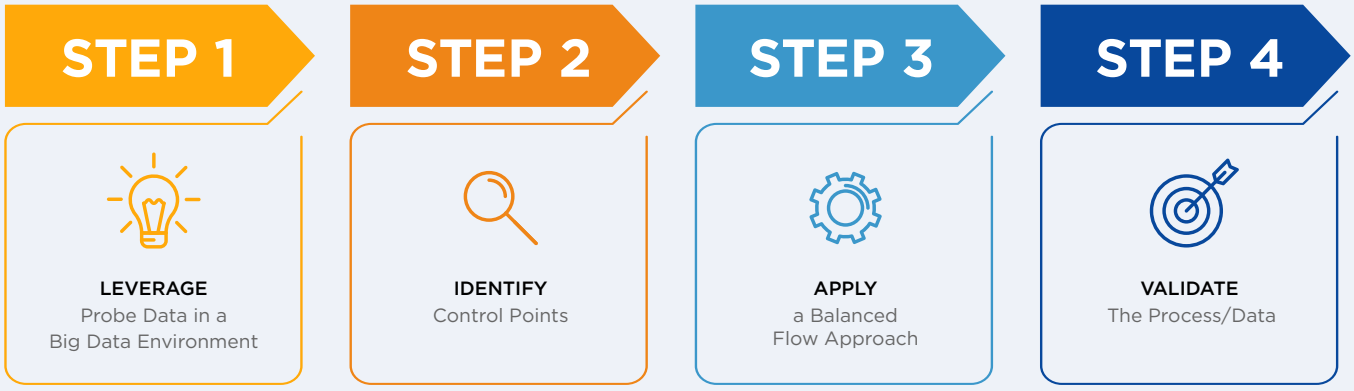



*Figure 2. Intersect's four-step process is used to develop intersection traffic counts using probe data.*

# STEP 1

## Intersect Leverages Probe Data in a Big Data Environment

Probe data is a geospatial set of collected data points that need to be aggregated by algorithms to produce a single value. As seen in **Figure 3**, the development of intersection volumes is the sum of the individual records using a "point-to-point" concept. From the summation of data points, transportation professionals can either estimate the turning percentages for each movement or develop turn volumes directly from the probe data. Using this example, the total number of probe records traveling from the south leg of the intersection (Point "A") with destinations to Point "B" will be recorded as a left-turn movement. A summation of probe vehicles traveling from Point "A" to "C" will be identified as through movements and those traveling from Point "A" to Point "D" will be classified as right turning vehicles.

To calculate the percent turns at the intersection, as seen in **Figure 4**, the big data environment will provide the summations of probe vehicles for a specific time period identified by the transportation professional.

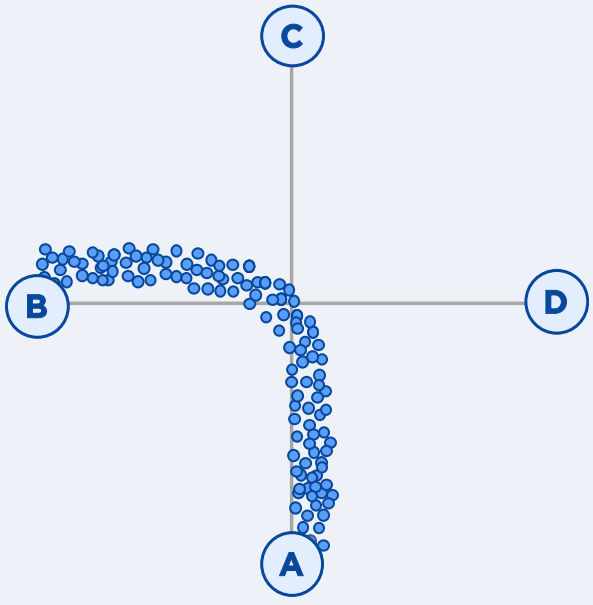



*Figure 3. The summation of data points is used to estimate left-turn, right-turn, and through movements.*

$$\%\ \text{Left Turns (4-6 pm)} = \frac{\sum_{4-6pm} Point\ A \rightarrow B}{\sum_{4-6pm} Point\ A \rightarrow B + \sum_{4-6pm} Point\ A \rightarrow C + \sum_{4-6pm} Point\ A \rightarrow D}$$

*Figure 4. An algorithm is used to calculate percentage of turning movement counts, such as the one shown here for Left Turns (4-6pm).*

# STEP 2

## Intersect Identifies Control Points

Leveraging probe data over multiple days improves the normalization process for developing intersection design volumes. While not required, the use of additional control points, where available, can provide a point of reference for verifying the intersection volumes and increasing the reliability of the data. There are multiple sources that can be used as control points, including permanent count stations, portable counts, sensors, advanced traffic controllers, local counts, and private counts. As in most scenarios with data collection, the more granular amount of information, the greater the level of accuracy for the output. Therefore, using a permanent count station will provide the highest level of confidence, while single day counts will provide less reliability.

As seen in **Figure 5**, the preferred control points will be located at each of the intersection approaches. For the southern leg to the intersection (control "A"), the control point count "TA1" will be identified as the inbound count to the intersection and "TA2" will be identified as the outbound count. The greater the amount of control points surrounding the intersection, the higher the confidence for turning movement volumes.

In addition to the control points located at the intersection, there are conditions where the control point is separated from the intersection by a driveway or a vehicle generator. The control points can be adjusted to account for traffic volumes exiting or entering the system. These interim exiting or entering volumes are referred to as "sink" or "source" traffic volumes, respectively. Sink conditions occur when traffic exits the network and source conditions occur when traffic is added to the network from a driveway or connecting roadway. Adjustments must be made to the control point for these locations using the proportional probe data identified. As seen in **Figure 6**, the formula provided will identify the adjusted control point "TD1" based on the prorated probe data sink volumes at the subject driveway (or street) and the traffic traveling into the intersection from control point ("TE1").

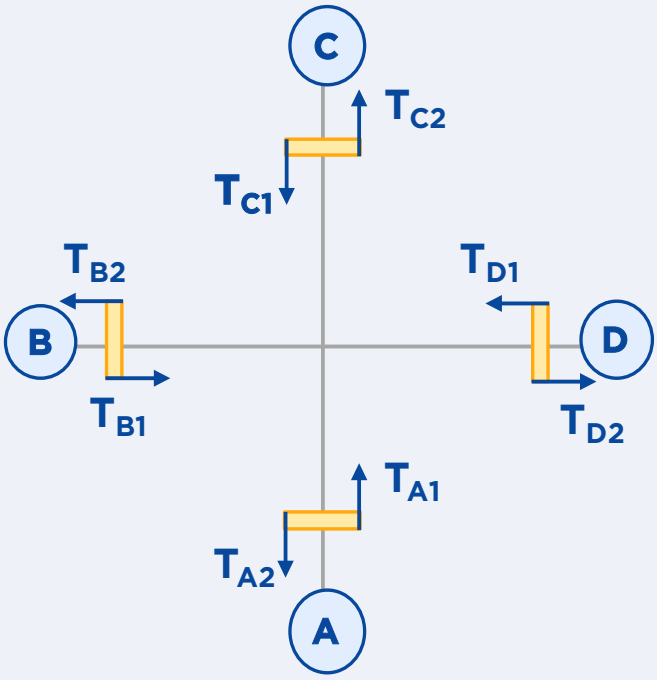



*Figure 5. Control points are located at each intersection approach to verify inbound and outbound counts.*

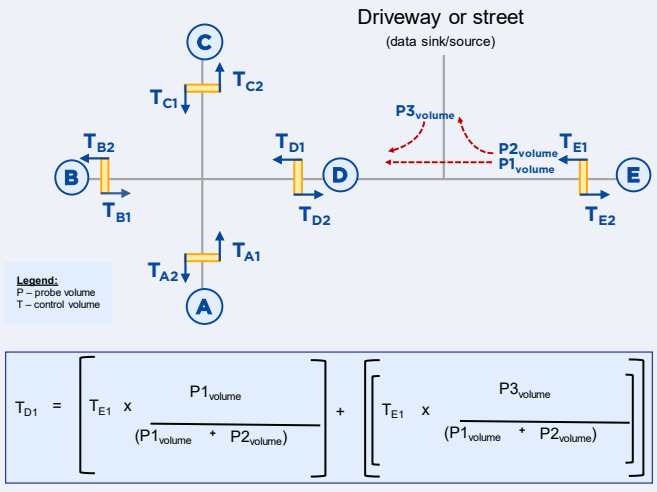



*Figure 6. An algorithm is used to adjust control points for interim exiting or entering volumes, referred to as "sink" or "source" traffic volumes, respectively.*

# STEP 3

## Intersect's Balanced Flow Approach

When using the intersection control points to develop the design level intersection traffic, it is important to confirm that the overall intersection balances for each of the inbound traffic control points "T1", and the outbound traffic control points "T2". Essentially, what goes into an intersection is expected to exit an intersection. It is ideal to have the intersection traffic volumes balance with both directions of a control point and for all approaches to the intersection.

Based on the balanced flow approach, as seen in **Figure 7**, the total volume generated from control point "TD1" will approximately equal the sum of the volumes entering the intersection (VD—RT + VD—TH + VD—LT). The total volume at control point "TD2" will approximately equal the sum of the volumes exiting the intersection (VA—RT + VB—TH + VC—LT).

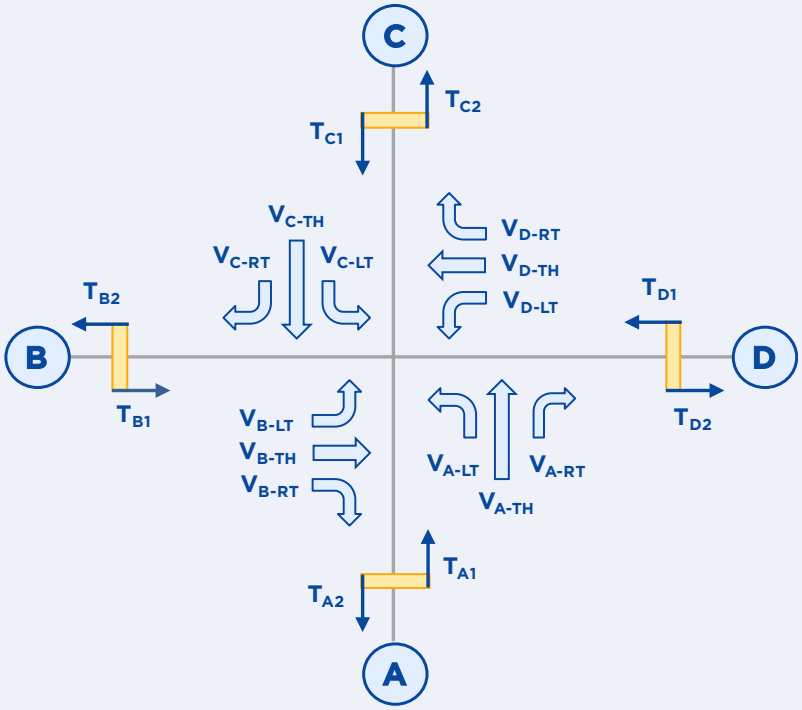



*Figure 7. Identification of intersection turning movement counts. A balanced intersection will have equal inbound and outbound volumes.*

### Deviation for inbound traffic:

$$\text{Deviation}_{A1} = \frac{T_{A1}}{(V_{A\text{-}LT} + V_{A\text{-}TH} + V_{A\text{-}RT})}$$

$$\text{Deviation}_{B1} = \frac{T_{B1}}{(V_{B\text{-}LT} + V_{B\text{-}TH} + V_{B\text{-}RT})}$$

$$\text{Deviation}_{C1} = \frac{T_{C1}}{(V_{C\text{-}LT} + V_{C\text{-}TH} + V_{C\text{-}RT})}$$

$$\text{Deviation}_{D1} = \frac{T_{D1}}{(V_{D\text{-}LT} + V_{D\text{-}TH} + V_{D\text{-}RT})}$$

### Deviation for outbound traffic:

$$\text{Deviation}_{A2} = \frac{T_{A2}}{(V_{D\text{-}LT} + V_{C\text{-}TH} + V_{B\text{-}RT})}$$

$$\text{Deviation}_{B2} = \frac{T_{B2}}{(V_{A\text{-}LT} + V_{D\text{-}TH} + V_{C\text{-}RT})}$$

$$\text{Deviation}_{C2} = \frac{T_{C2}}{(V_{B\text{-}LT} + V_{A\text{-}TH} + V_{D\text{-}RT})}$$

$$\text{Deviation}_{D2} = \frac{T_{D2}}{(V_{C\text{-}LT} + V_{B\text{-}TH} + V_{A\text{-}RT})}$$

*Figure 8. Deviation calculations for inbound and outbound turning movement counts.*

Leveraging an automated, iterative process, the intersection will be balanced when each of the control points divided by the summed volumes equals or is as close to 1.0 as possible for the inbound and outbound legs of an intersection, as seen on **Figure 8**. In an ideal scenario, each of the eight deviations shown will be equal to or as close to 1.0 as possible, reflecting an equilibrium state.

# STEP 4

## Intersect's Process and Data Validation

The traffic volumes generated from probe data are validated for reasonability by verifying the saturation rates of the probe vehicles traveling through the intersection, confirming that the capture rates are reflective of the local region, and lastly, confirming that the inbound/outbound flow convergence rates are as equally balanced. Validation is an automated process that is reviewed by transportation practitioners as the last step in the Intersect process. Final traffic volumes can then be used to advance transportation planning efforts efficiently and seamlessly.

Traffic counts are a critical piece of advancing transportation efforts, and often where a project begins. Intersect provides the flexibility to use big data and revolutionizes the way we account for traffic volumes.

# HOW VHB CAN HELP

The COVID-19 pandemic, and ultimate recovery, has fostered the need for innovation and creativity to address challenges and uncertainties. VHB is dedicated to embracing technology and helping our clients keep critical transportation projects moving. Are you faced with collecting volume data when traffic patterns are atypical or simply in need of more efficient traffic data collection? We can help! Connect with Amir Rizavi, PE, ENV SP, to learn more about Intersect.

### INRIX

Effectively managing billions of individual records of continuous flow data, a big data environment is required to ingest and evaluate the data. INRIX provides transportation professionals with multiple days of probe data, versus a traditional single-day count. This multi-day collection allows for the normalization of the intersection design volumes accounting for anomalies in daily conditions. Connect with our partners at **INRIX** to learn more about probe data capabilities.