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SEATTLE CONGESTION PRICING STUDY PHASE 1

Pricing Tools: Review and Preliminary Screening White Paper

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Table of Contents

Table of Figures

INTRODUCTION

The City of Seattle is exploring congestion pricing as a way to address traffic congestion, reduce greenhouse gas emissions, and create a more equitable transportation system.

Congestion pricing is based on the idea that traffic congestion comes with high costs to society and to individuals in the form of air and climate pollution, traffic collisions, and slower commutes for everyone. When tolls are charged—especially when based on demand so that the more congested a road becomes, the higher the fee to use it—some people make changes to some of their trips. To avoid tolls, they may choose to drive during off-peak times, shift to carpools or transit, or combine trips.

This white paper provides a summary of congestion pricing tools, their objective merits and drawbacks, and how they might be applied to the City of Seattle given current legal frameworks and existing and emerging technologies. It also describes the screening process used to evaluate and develop a short list of pricing tools for further study.

PRICING TOOLS OVERVIEW, TECHNOLOGIES, LEGALITIES

Background

Congestion pricing uses the economic principle of supply and demand to manage traffic. By applying an additional cost to using a certain mode of transportation at congested times and locations, a municipality can encourage travelers to reconsider their transportation choices. A small reduction in the number of vehicles on a congested road can translate to a big reduction in congestion. Additionally, as one mode of transportation becomes more expensive, alternative transportation modes can become relatively more attractive. For example, increasing prices on a tolled road during rush hour can make the choices of taking transit, carpooling, shifting travel times, using a different route, or eliminating the trip altogether more attractive than paying the higher toll. Which option a traveler will choose depends on their value of time for that trip, budget, availability of alternatives, and other preferences.

The City of Seattle is evaluating the range of available pricing tools to determine which best meet the goals of providing congestion relief, reducing climate impacts, and improving health and equity. Some tools may achieve certain objectives better than others. The City may consider using discounts and exemptions in combination with any of the pricing tools to further influence behavior or to support multiple objectives. Discounts and exemptions can mitigate negative equity impacts or provide further incentives for travelers to choose a certain transportation mode.

Ultimately, the City will need a combination of tools to achieve its goals, as no single tool can do everything. Choosing multiple pricing tools and discount strategies increases policy complexity and the challenge of communicating with travelers, implementing the program, and ensuring payment. Increasing complexity can also make enforcement more difficult, allowing more opportunity for people to cheat the system. The next sections summarize the pricing tools shown in Figure 1. This is followed by a discussion of technologies, as well as legal implications of the various tools.

Figure 1 Pricing Tools Summary

Pricing Tool	Description	Example
Cordon Pricing	Charge vehicles for crossing a boundary into pricing zone	Stockholm (implemented): ▪ Implemented in 2006. ▪ Congestion pricing charge is levied on vehicles entering city center, using license-plate recognition technology.
Area Pricing	Charge vehicles for crossing a boundary *and* for driving inside a pricing zone	London (implemented): ▪ Implemented in 2003. ▪ Prior to adoption, funding for public transport was unreliable and congestion levels in central London were extremely high.
Fleet/Vehicle Class Pricing	Charge specific vehicle types entering a zone, such as ride-hailing or commercial vehicles	New York City (in litigation): ▪ Fleet/Vehicle Class Pricing is phase two of a three-phase congestion pricing approach. ▪ Fleet pricing applies to taxis and other ride hailing services.
Connected/Autonomous Vehicle (C/AV) Zone	Create a zone that allows only licensed connected and/or autonomous vehicles	*This approach has not yet been implemented, as C/AVs are in their infancy.*
Fossil Fuel Free Zone (FFFZ)	Create a zone that allows only licensed non-fossil fuel vehicles; can also allow all types of vehicles and charge those that are not low-emissions vehicles (called a Low-Emissions Zone program)	Milan (implemented): ▪ Cordon pricing was implemented in 2012, including a low-emissions zone. ▪ In addition to applying a charge for all vehicles entering the zone: – Vehicles using gasoline Euro 0 or diesel Euro 3 or below are prohibited from entering. – Private vehicles longer than 7.5 meters (24.6 feet) are also prohibited. – Electric vehicles, motorcycles, scooters, public transit vehicles, public utility vehicles, emergency vehicles, taxis, and vehicles for people with disabilities are exempt from the charge.
License Plate-Based Restriction Zone (LPRZ)	Restrict access to a zone based on license plate numbers; functions as a management tool that has a similar effect to a pricing tool	Mexico City (implemented): ▪ Launched in 1989, with expansions in 1990 and 2016. ▪ Cars are prohibited from driving in the city on certain days based on the last digit of their license plate (e.g., license plates ending in a 3 or 4 cannot drive on Wednesdays).

Pricing Tool	Description	Example
Road Usage Charge (RUC)	Restrict access to a zone to vehicles enrolled in a RUC program that levies a per-mile charge, potentially by time of day and/or location	Washington State (piloted): ▪ Completed a 2,000-driver pilot of a road user charge program in January 2019. ▪ Participants chose one of four options for reporting their mileage: pre-selected mileage block, quarterly odometer readings, plug-in mileage meter, or smartphone app. ▪ Pilot was for a flat, per-mile fee with no variation by time of day or location.
Arterial Toll Roads	Toll all lanes of an arterial road	Singapore (implemented): ▪ Implemented electronic road pricing technology in 1998. ▪ Vehicles are charged while passing under overhead gantries. ▪ The fee varies based on vehicle type, time, and location.
Arterial Express Lanes	Convert or add lanes on arterial roads as tolled facilities; some lanes remain unpriced	Tampa (study): ▪ Conducted a proof of concept study of a Bus Toll Lane (BTL) focused on limited access corridors as a partnership between transit and toll agencies with a revenue sharing model. ▪ Tolling equipment, similar to that used on freeway express lanes, would be required for implementation.
On-Street Parking Pricing	Vary street parking prices to control demand	San Francisco (implemented): ▪ Launched in 2011, with expansion citywide in 2018. ▪ Smart parking meters update pricing within a $0.75 range per hour. ▪ Pricing is adjusted per block, based on time, location, and day of the week.
Off-Street Parking Pricing	Apply a variable fee/tax to off-street parking facilities	San Francisco (implemented): ▪ Citywide smart parking meter program is also used in operation of SFMTA-owned off-street garages and lots. ▪ Rates at SFpark off-street facilities vary by time of day, and are updated quarterly based on demand.

Pricing Tools Overview and Applicability to Seattle

The sections that follow describe each of the tools shown in Table 1, identify how the tool might be applied in Seattle, and introduce potential pros and cons associated with possible implementation.

Cordon Pricing

Cordon pricing is the concept of charging vehicles a fixed or variable toll for entering and/or exiting a congested zone within a city. Pricing can vary according to vehicle type (e.g., private or commercial vehicles, cars or trucks) and by time of day (e.g., depending on traffic conditions). Typically, tolling equipment is placed on all roads leading into and out of a cordon zone. Toll collection equipment at cordon boundaries identifies vehicles through the use of toll transponders and/or license plate recognition camera systems, and toll amounts are either deducted from toll accounts or are sent to vehicle owners as toll invoices. Cordon boundaries are selected to optimize benefits as defined within the policy, minimize unwanted effects such as diversion, and balance the cost of tolling infrastructure. Cordon pricing in Singapore and Stockholm has reduced congestion, reduced emissions, and generated revenue for reinvestment in the transportation system.

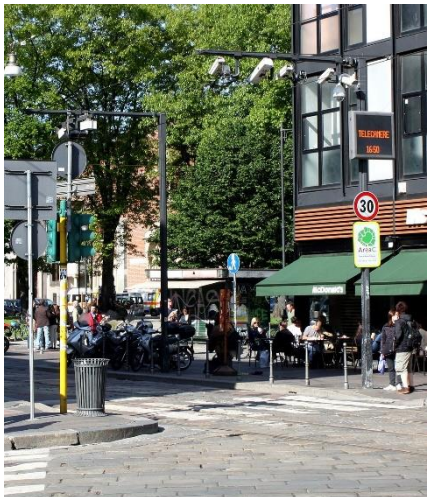

Figure 2 Tolling gantry with transponder and license plate camera used for cordon and area pricing

Applicability to Seattle

The size and extent of a cordon pricing zone in Seattle could vary depending on the program objectives. For a downtown congestion zone, it might make sense to take advantage of natural barriers such as the waterfront and I-5. If the system were to charge only vehicles entering the cordon zone, then downtown Seattle's one-way streets would further reduce the number of tolling points needed.

Pros

Cordon pricing is easy to explain to the public and effective at reducing traffic into a zone. In addition, cordon pricing can be applied in a very flexible manner to support achieving nuanced goals like reducing congestion during certain time periods or reducing congestion caused by specific vehicle types. The tolling infrastructure could also be used for other purposes, such as augmenting traffic data feeds and enlarging the City's communications network. Finally, cordon pricing could generate revenue that would more than offset implementation and operations costs and likely generate a revenue stream for reinvestment in the transportation system.

Cons

To ensure collection of a toll from every vehicle crossing the cordon, the City would need to install a significant amount of roadside toll collection equipment and establish back-office functions (perhaps in coordination with WSDOT); both have high up-front capital costs and ongoing operations costs. The location of charge points would need to be carefully chosen to avoid unwanted boundary effects, such as diversion that could increase traffic in neighborhoods adjacent to the cordon zone. To be effective, travelers must know what they will pay at the point when they are making decisions about travel mode or time. Therefore, to take advantage of dynamic pricing approaches that respond to congestion levels or air quality or those that vary by vehicle type or income level, Seattle would need robust strategies for communicating the pricing structure.

Area Pricing

Area pricing is very similar to cordon pricing. It has the added feature of also charging vehicles that drive *within* a pricing zone, not just those crossing the zone's boundary. This approach is best suited for geographically large pricing zones where vehicles driving within a zone may not necessarily cross the zone's boundary but still contribute to congestion. Area pricing relies on tolls collected electronically with tolling equipment placed at strategic locations within a pricing zone and as well as at its boundaries. London has successfully implemented an area pricing program.

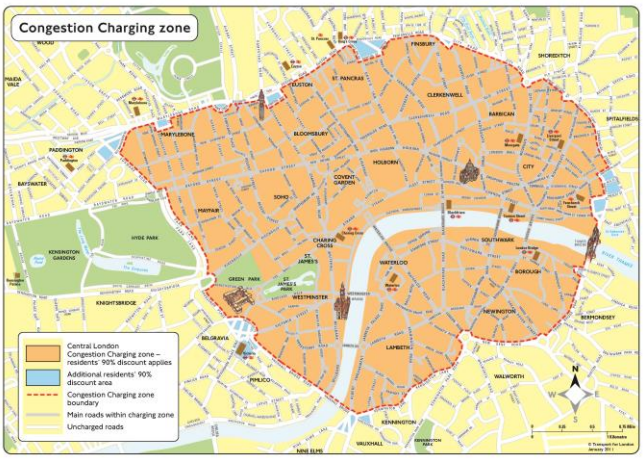

Figure 3 Map of London's area pricing zone

Applicability to Seattle

Similar to cordon pricing, area pricing would target Seattle's more congested downtown center. The area could be slightly larger in size than a cordon area, such that vehicle trips originating and staying within the zone would also be charged (to capture their role in contributing to congestion); however, this is not a requirement for an area pricing program. Area pricing would likely be more effective at reducing congestion than cordon pricing because it would capture vehicles that stay within the zone throughout the day, such as ride hailing and delivery vehicles.

Pros

In addition to the benefits of cordon pricing, area pricing can make a pricing structure fairer since it applies to those within the cordon as well as those traveling into the congested (and priced) area.

Cons

To achieve the extra benefits mentioned above, area pricing is more complex and requires more infrastructure than cordon pricing; therefore, it has higher capital and operating costs. As the congested area (and the area priced) grows larger, area pricing could bring more benefits and become more cost effective.

Fleet/Vehicle Class Pricing

Fleet pricing prices certain types of vehicles, charging a fee or toll for driving in a particular area. Pricing a large enough fleet of vehicles could reduce the number of vehicles in a congested area and improve traffic flow. For example, pricing delivery vehicles could alter traffic disruptions caused by deliveries during rush hour. In addition, pricing vehicle classes that emit greater levels of pollution could reduce their use and have a positive effect on air quality. Imposing a fee or a toll on vehicles can be done as part of annual vehicle registration or with on-board vehicle use monitoring devices, such as fare collection systems in taxis or truck GPS units. On-board vehicle devices allow prices to vary by time of day. New York City is implementing fleet pricing on taxis and other ride-hailing services

Figure 4 Example of tolling equipment used for truck tolling in Germany

(pending litigation). Many parts of Europe have truck-specific tolls in place to cover the costs of road operations and maintenance.

Applicability to Seattle

Seattle could leverage the current ride-hailing and taxi regulatory and licensing framework to add charges by time of day or location. To price commercial vehicles, the city could engage the Port of Seattle and trucking associations to develop a methodology. An example of targeted truck pricing would be applying a container truck toll charge similar to the Pier Pass program at the Port of Los Angeles and Port of Long Beach.

Figure 5 Port of LA terminal gate associated with the Pier Pass pricing program

Pros

Fleet pricing can be implemented relatively easily, especially if it leverages existing systems or infrastructure like vehicle registration or ride-hailing service payment systems. Vehicle class pricing could allow Seattle to target high emission vehicles in addition to congestion, directly supporting multiple city goals. Like cordon and area pricing, fleet pricing could generate sufficient revenues to offset the costs of implementing the program. Fleet pricing would pair well with other congestion pricing options.

Cons

Focusing only on vehicle fleets and vehicle classes may not impact enough vehicles to have a measurable effect on congestion or air quality. In addition, operators with low margins, such as owner-operators of port drayage trucks, may be more likely to drive high emission vehicles without the means to meet stricter emissions standards, so targeting such vehicles may be an inequitable solution.

Connected/Autonomous (C/AV) Vehicle Zone

A cross between a vehicle restricted zone and fleet pricing, a C/AV zone would allow only licensed connected and autonomous vehicles into a zone that is otherwise restricted to pedestrians, bicyclists, and transit vehicles. Such a zone could help to achieve efficiency gains projected for pure C/AV vehicle fleets. Since these vehicles have identification and communications technologies embedded, Seattle would have many options for licensing their entry into a particular area, from traditional electronic toll collection methods to mobile apps. Given that C/AV is cutting-edge technology, this approach has not yet been implemented.

Figure 6 Example of a Waymo autonomous vehicle

Applicability to Seattle

The limits of a C/AV zone could be very similar to a cordon pricing zone, although the zone size would likely be relatively small since limiting access to C/AV would likely cause major traffic diversion around the zone's boundary until C/AVs are widely used.

Pros

In the near term, a C/AV zone could help Seattle eliminate most vehicles in an area without having a "ban" on all vehicles. Simultaneously, commuters could be incentivized to use C/AVs and automakers would be incentivized to promote them, accelerating the value of the zone. Revenues from licensing access to a C/AV zone could support other commuter and equity-focused programs.

Cons

Lack of a significant C/AV vehicle fleet in the region could create a major traffic disruption for many years, as C/AV technology and regulations are still in their infancy. Therefore, this approach would need to be paired with a cordon or area pricing approach until the region has enough C/AVs. Depending on the ownership structure of C/AVs—such as more private ownership of vehicles rather than shared fleets—transportation inequalities could be exacerbated if C/AVs are too expensive for many to afford. As with cordon and area pricing, there would be enforcement infrastructure and operations costs, which would not likely be covered by revenues from a C/AV-only zone in the near term.

Fossil Fuel Free Zone (FFFZ)

Similar to the C/AV concept, a FFFZ would allow only clean-air vehicles not powered by gasoline or diesel, such as electric and hydrogen-fuel vehicles, to enter a zone otherwise limited to pedestrians, cyclists, and transit riders. Many regions in the United States provide special access for clean-air vehicles to use HOV and express lanes, but an FFFZ takes the concept further by restricting access to all but these vehicles within specific geographies or urban areas. Milan's Area C program charges all vehicles for entering the central area and bans the most polluting vehicles altogether.

Figure 7 Map of Milan's emissions-based pricing area

Applicability to Seattle

The limits of an FFFZ could be very similar to a cordon pricing zone, although the zone size would likely be smaller since limiting access only to electric and hydrogen vehicles would cause major traffic diversion around the zone's boundary in the near term. An extensive electric charging and hydrogen fueling station network would be required within the zone to support the restricted vehicle types.

Pros

Similar to the C/AV zone, an FFFZ could provide Seattle an opportunity to restrict most vehicles from an area without completely eliminating the opportunity to drive into the zone. Simultaneously, drivers would be incentivized to adopt clean air vehicles and automakers to promote them, therefore accelerating emission reduction benefits. Implementing an FFFZ would help fulfill the City of Seattle's 2017 commitment to "Fossil Fuel Free Streets" by 2030. Revenues from licensing access to an FFFZ could support other commuter and equity-focused programs.

Cons

Given the limited existing fleet of all-electric and hydrogen powered vehicles in the region, an FFFZ could create significant traffic disruptions for a number of years. Therefore, this approach

would need to be paired with a cordon or area pricing approach until the region has a significant number of clean-air vehicles. Transportation inequalities could be exacerbated given the current high cost of purchasing all-electric and hydrogen vehicles. As with cordon and area pricing, there would be enforcement infrastructure and operations costs, which may not be covered by FFFZ revenues in the near term. Charging and refueling infrastructure needed to encourage clean-air vehicles could also add costs.

License Plate-Based Restriction Zone (LPRZ)

To limit the number of vehicles that enter a specific area, License Plate-Based Restriction Zones allow only vehicles with certain license plate numbers into the zone on certain days and/or times. The approach to restrictions can range from something as simple as allowing odd or even plates on certain days to more elaborate approaches that allow ranges of numbers on certain days of the week and or times of day. Similar to cordon, area, and tolling pricing programs, LPRZs can be enforced with tolling technology and/or on-road police enforcement. Many LPRZ programs internationally were originally implemented to improve air quality and are now also used for congestion relief. Mexico City and many other Latin American cities have used this approach since the 1980s and 1990s. Some international cities, such as Beijing and Paris, have implemented temporary restrictions on severe air-pollution days.

Figure 8 Sign indicating vehicle restrictions based on license plate number on certain days and times in San José, Costa Rica

Applicability to Seattle

The limits of an LPRZ could be very similar to a cordon pricing zone. Particular attention would be required to potential traffic diversions near zone boundaries.

Pros

Restricting access to a large number of vehicles could reduce congestion significantly by incentivizing travelers to use other modes. If paired with an area or cordon pricing scheme, revenues can be used to support other commuter and equity-focused programs.

Cons

Transportation inequalities could increase if wealthier households with multiple vehicles have more opportunity to adapt to license plate restrictions. If an LPRZ approach is not paired with a cordon or area pricing program to provide a revenue stream, funding to support enforcement, alternative transportation choices, and commuter-offset programs would need to be identified.

Road Usage Charges (RUC)

Road Usage Charges, also known as a Mileage-Based User Fee or Vehicle Mileage Traveled Fee, is an approach to charging people a fee based on the number of miles their vehicle travels. Government agencies are considering RUC as a potential replacement for the existing consumption-based gas tax, especially as improving gas mileage and the increasing number of electric vehicles continues to reduce gas tax revenues. More sophisticated RUC programs vary mileage fees based on time of day and/or location to reflect congestion. RUC-enabling technologies range from a simple odometer log book and annual checks to more sophisticated in-vehicle GPS devices and mobile apps. Oregon has had a permanent RUC program in place since 2015, and many states, including Washington, are piloting RUC programs.

Figure 9 Oregon's OreGo RUC program uses several different technologies to calculate miles traveled

Applicability to Seattle

Since Washington State is proposing RUC as a long-term gas tax replacement, the City of Seattle could be an early adopter of the program and leverage the state's RUC framework to implement an additional congestion charge.

Pros

Implementation of a user fee could make a pricing program more equitable in some respects. For example, electric vehicles are not currently paying fees that match their contribution to congestion and road impacts (as they don't pay the gas tax). Pay-as-you-go programs, such as car insurance and cell phone plans, are not new to consumers, so a RUC program may be easier to explain than other types of congestion pricing. Although current RUC pricing programs are simply fixed per-mile costs, more sophisticated pricing structures could provide the City the flexibility to target congested roads and/or times of day.

Cons

Washington State's timeline for implementing RUC as a gas tax alternative is uncertain and is outside the City of Seattle's control. Because RUC is a state-level financing tool, the city would need to determine its roles and responsibilities in working with the state. Seattle could incur additional implementation and operational costs if it were to add pricing complexities not needed by the state.

Arterial Toll Roads

Tolling urban arterials is similar to tolling highways. To date, congestion pricing programs have only tolled arterials as part of a cordon or area pricing program, placing tolling equipment at a key location along a road to enforce the cordon. Tolling the length of an arterial is generally considered more complex than tolling a highway because of the numerous access points and intersections and the potential for traffic diversion onto other urban streets. However, existing electronic toll collection technology could support such a concept.

Figure 10 Example of tolling equipment used in Singapore

Applicability to Seattle

An arterial tolling program could be implemented on key north-south corridors through the downtown core to reduce congestion, such as 2nd Avenue and 4th Avenue. A small initial launch could be expand to include a network of roads, such as Mercer Street, Elliott and Western Avenues, and Denny Way.

Pros

Tolling arterial roads targets congestion on specific roads and helps to expedite the movement of through vehicle traffic. Such a program could generate revenues to offset implementation and operating costs and fund other city priorities. Tolls could vary by vehicle occupancy, vehicle type, emissions, or by time of day or congestion level, which would allow the City to achieve multiple goals.

Cons

Tolling arterial roads is a very complex concept that may have significant barriers to implementation, including jurisdiction over arterials, coordination with state-level stakeholders, and potential traffic diversion to other Seattle streets. Since arterial tolling has not been implemented elsewhere, combining a technically feasible solution that enforces tolls along a corridor and reduces congestion on and around that arterial would be expensive and time consuming. The capital costs, including both infrastructure and tolling equipment, would be high for this approach.

Arterial Express Lanes

Restricted access in arterial lanes is relatively common in the form of bus-only lanes, such as those on 15th Avenue West in Seattle. Like express lanes on freeways, arterial express lanes could also restrict access to only those who meet vehicle and occupancy eligibility requirements and those paying a toll. The state of Florida considered this concept to pay for new arterial lanes but did not implement it. Tampa, Florida has conducted a proof of concept study of a Bus Toll Lane (BTL)—a partnership between transit and toll agencies with shared funding and a revenue-sharing model—but the focus was on limited access corridors. Tolling equipment, similar to that used on freeway express lanes, would be required for such a program.

Figure 11 Bus-only lanes, such as this one on 4th Avenue in Seattle, could be considered for inclusion in an arterial express lane program

Applicability to Seattle

Similar to arterial tolling, an arterial express lanes program could target key north-south and east-west corridors. Arterial express lanes could convert and expand current bus-only lanes into dual express lanes, such as on 4th Avenue in downtown Seattle.

Pros

In general, arterial express lanes could have benefits similar to those of tolling entire arterial roads. However, limiting tolling on arterial roads to certain lanes could reduce the costs of implementation as well as traffic diversion.

Cons

Capital costs and limited right-of-way makes building new arterial express lanes cost prohibitive. Implementing arterial express lanes in Seattle would likely require converting existing general-purpose travel lanes to express lanes, which could result in more congestion in the remaining general-purpose lanes. Operational costs associated with enforcing occupancy, toll payment, and access control are significantly more complex than tolling entire roadways.

On-Street Parking Pricing

Variably priced on-street parking can be used to manage demand for parking, which has been shown to reduce congestion. Pricing on-street parking introduces a price signal that encourages some drivers to switch modes and reduces the number of drivers circling to look for parking. A combination of smart meters, embedded parking sensors, and traveler information systems are used to manage parking pricing in near real time. San Francisco is leading the nation in actively managing parking prices, and many other cities, including Seattle, have successfully implemented effective on-street pricing programs.

Applicability to Seattle

The City of Seattle could expand the current on-street parking pricing program to include a broader area or additional time periods throughout the day, or the City could increase peak-time parking prices.

Figure 12 On-street parking is dynamically priced in San Francisco

Pros

Since Seattle already manages on-street parking prices, this approach could leverage existing infrastructure. Pricing on-street parking generates revenue that can offset the cost of this or other congestion pricing programs. In addition, this approach could be combined with other congestion pricing programs to amplify congestion-reduction benefits.

Cons

On-street parking pricing alone is unlikely to have a large impact on transportation mode choice. As with many pricing programs, the ability of on-street parking pricing to change travel behavior depends on communicating the prices prior to a traveler making the choice to drive to the congested area. Thus, the congestion-reduction benefits of such a program are highly dependent on good traveler information systems.

Off-Street Parking Pricing

By pricing off-street parking in public and private lots, many regions are using these fees to influence traveler decisions about driving into certain parts of cities. Cities typically leverage existing sales or property taxes to levy parking surcharges, which are passed on to drivers. Melbourne and San Francisco are case studies for managing off-street parking prices. Seattle has also implemented off-street parking fees.

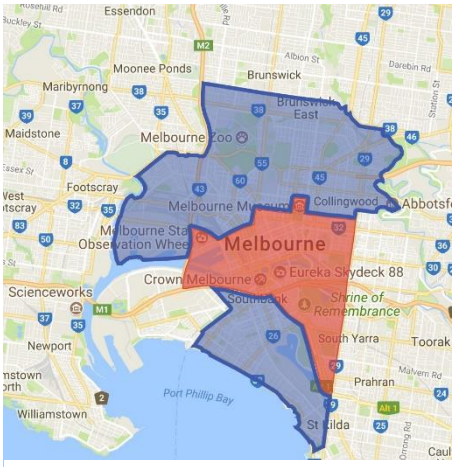

Figure 13 Example of Melbourne's parking pricing area

Applicability to Seattle

The City of Seattle could leverage existing taxation frameworks to apply a parking congestion surcharge. The charge could vary depending on time of day or days of the week to target peak congestion periods. The City could engage parking lot operators to gauge their ability to pass this pricing directly to travelers. The City could also pursue charging fees directly to drivers, but this would require implementation of new parking payment system functionalities and accounting procedures by the City and lot operators.

Pros

By leveraging existing parking payment infrastructure, pricing off-street parking could be a low-cost approach to demand management. The prices could influence regular commuters because they would apply to monthly parkers and other regular drivers. Like on-street parking pricing, this approach could be combined with other congestion pricing programs.

Cons

Demand management depends on responses to pricing signals. The method of charging the parking owner and then passing the charges through to the drivers removes the ability to directly influence driver behavior. If it was possible to charge drivers directly, there could be more implementation, auditing, and operational costs to ensure fees are charged properly.

Technology Requirements and Enablers

If Seattle selects one or more pricing tools for further study and potential implementation, the City will need to consider how the underlying technology supports Seattle's pricing program goals and objectives. The technology will perform two primary functions: accurately and correctly charging travelers; and ensuring that travelers make payments and obey restrictions (i.e., enforcement). To adequately charge and enforce, a pricing system should include the following elements:

- **Vehicle identification devices:** In addition to using images of vehicle license plates, systems can also use devices attached inside or outside a vehicle, integrated with a vehicle, and/or carried by drivers and passengers to identify vehicles.
- **Roadside detectors and enforcement equipment:** Most systems use field devices on the roadside or over the roadway to detect vehicles, whether they have a payment account or will be billed through the mail based on the vehicle's license plate.
- **Back office:** Technologies are required to manage customer accounts, process transactions and payments, interface with other external systems (e.g., Department of

Licensing), conduct audits and financial reconciliations, set prices, and monitor performance.

When considering a technology system to support a preferred pricing program, Seattle should assess the following:

1. *Technology maturity* – Deploying existing technologies will likely be less expensive to implement and reduce scheduling risks compared to deploying emerging or in-development technologies. However, existing technologies carry the risk of the technology becoming obsolete in the near future or vulnerable to future market disruptors. Additionally, the City should avoid proprietary technologies to reduce the risk of high costs from a sole source procurement.
2. *Physical footprint of infrastructure* – Since space and urban aesthetics will constrain equipment placement, system performance, and public acceptance, Seattle should include these factors in its technology system evaluation. For instance, a typical tolling system requires overhead mounted antennas to effectively read transponders, which may be visually intrusive. Some technologies also require intensive high-bandwidth communications, which would require construction of communications infrastructure such as conduit banks and telecommunications hubs. However, some technologies can disseminate pricing and congestion information, potentially eliminating other electronic road signs.
3. *Cost* – Seattle should consider both the upfront capital cost of implementation and ongoing operational costs to evaluate the lifecycle costs for various pricing approaches.
4. *Market penetration and interoperability* – Widespread adoption of technologies in the region and by travelers, such as Washington State Department of Transportation's (WSDOT) *Good to Go!* toll transponders and video tolling, could reduce costs and increase customer convenience. Other possibilities include interoperability with the Road User Charge program being examined by the Washington Transportation Commission, private payment systems (e.g., ride-hailing app platforms like Uber and Lyft), and accounts used for other transportation modes, like the ORCA card.
5. *Scalability and flexibility* – The City should also consider the ability of the technology to support sophisticated business rules, such as charging or applying discounts by vehicle class, time of day, and/or location. Any selected technology should have the ability to scale up from a local or pilot program to a region-wide system.

Technologies and approaches for pricing tools described in the previous section can be broadly categorized into three groups based on their similarities: toll-like, parking, and road user charge. The next section discusses potential technologies for these three groups of pricing programs.

Tolling Technologies

Applies to: Cordon Pricing, Area Pricing, Fleet Pricing, Arterial Toll Roads, Arterial Express Lanes, Connected/Autonomous Vehicle Zone, Fossil Free Fuel Zone, and License Plate-Based Restriction Zone

A number of the pricing tools can leverage technologies traditionally used for tolling because they share the concept of identifying a vehicle at a particular location to apply the appropriate price or enforcement consequence. Area and cordon pricing involve checking for vehicles entering and/or exiting an area; therefore, tolling equipment is placed on the edges of a pricing area or strategically distributed within a pricing area. Pricing tools based on charging specific vehicle

types (i.e., C/AV or fleet pricing) and/or restricting access to certain vehicle types (i.e., FFFZ, LPRRZ) can also use toll equipment to categorize vehicles within a zone or on the borders of a zone.

Since the introduction of electronic tolling in the 1980s, the tolling industry has made progressive advancements in Automatic Vehicle Identification (AVI) and Automatic License Plate Reader (ALPR) technologies, which identify vehicles without impeding traffic flow. Typically, AVI antennas mounted over roadways read transponders in vehicles to identify those with pre-paid toll accounts. ALPR cameras mounted overhead capture images of vehicle license plates to identify those without a transponder. The system can use the images to match a vehicle to a pre-paid account, send its owner a notice of penalty, or send post-paid invoices.

Figure 14 Example of AVI antennas to read transponders and cameras to capture license plates

Alternatively, several emerging technologies may augment and eventually replace these current AVI and ALPR technologies:

- *Cell Phone Apps* – Several companies are using cell phone-based technologies, such as apps, to determine vehicle location and collect tolls. The app sends the toll and the associated license plates number to the toll facility operator to reconcile with license plates captured by toll operators. Some firms also use Bluetooth-based technologies connected to their app to help identify the number of carpoolers for discounts and for occupancy enforcement. Although firms are promoting "virtual" toll points, toll operators will still need ALPR on the roadside to enforce payment from travelers without apps. Some mobile apps can also pair with devices connected to vehicle On-Board Diagnostic (OBD)-II ports to get more accurate vehicle information and mileage. Cell phone apps can also provide travelers with pricing information and reduce the need for electronic signs.

Figure 15 Cell phone apps like GeoToll can create virtual pricing boundaries

- *Dedicated Short Range Communications (DSRC)* – The National Highway Traffic Safety Administration (NHTSA) proposes to federally mandate that vehicles manufactured after 2023 have built-in vehicle communications devices to "talk" to other vehicles and roadside equipment. DSRC could allow vehicles to communicate their locations and use on-board sensors to indicate the number of vehicle occupants. DSRC could change the need for travelers to obtain transponders. However, roadside equipment to support DSRC and ALPR cameras to enforce payment by vehicles without DSRC likely will still be needed. If the NHTSA rulemaking for DSRC requirements passes, this technology could be very useful to support a C/AV Zone pricing concept. DSRC can also help vehicles receive and display pricing information to travelers and reduce the need for electronic pricing signs in the field.

- *5G LTE Wireless* – Like mobile phones, vehicle manufacturers are starting to build cellular communications capabilities into their vehicles. This technology could enable vehicles to transmit location information to self-identify and/or pay when they enter into a pricing zone or tolled roadway. Similar to DSRC, roadside equipment and ALPR cameras likely would be needed to enforce and/or charge vehicles without 5G wireless communications. Wide adoption of 5G-enabled vehicles could boost support for a potential C/AV Zone pricing concept. Similar to DSRC, 5G-equipped vehicles could receive and display pricing to travelers, thereby reducing the need for electronic pricing signs in the field.

Figure 16 Connected vehicles with DSRC or 5G LTE could enable pricing

- *Mobile License Plate Readers Improvement* – As video camera and automatic character recognition processing improve and prices are lowered, enforcement of payment and vehicle restrictions based on license plate captures could support distributed deployment of mobile ALPR. Instead of implementing tolling equipment at fixed locations, mobile ALPR systems can be mounted on roving vehicles and/or portable stations. For example, San Francisco Municipal Transportation Agency (Muni) currently mounts mobile ALPR on some transit buses to enforce illegal bus lane parking violations. The Georgia Department of Public Safety mounts mobile ALPR on police vehicles to identify potential carpool scofflaws on the I-85 Express Lanes in Atlanta. With mobile ALPR, Internet of Things (IOT) communications, and computing advancements, costly fixed-location infrastructure could be avoided. Another option that could be considered—albeit with privacy considerations as well—is the ability to leverage multiple sourcing of public video feeds for pricing enforcement.

Figure 17 Mobile License Plate Readers are compact portable systems to aid in pricing enforcement

- *Automated Vehicle Occupancy Detection (AVOD)* – For pricing programs such as express toll lanes with carpool discount rates, verification and enforcement of the number of occupants in vehicles has been challenging due to the need for police enforcement, limited field coverage, and the cost of enforcement. However, in recent years, multiple vendors have deployed camera vision systems to automatically identify vehicle occupants with greater confidence.
- *Autonomous Enforcement Drones* – With advancements in autonomous ground vehicle- and aerial drone- capabilities, acceptability, reliability, and costs, potential new concepts

for checking transponders, vehicle types, and license plates could become more practical and cost effective than fixed tolling equipment installations.

Although Seattle could purchase one of the many back office suites that system integrators sell to process payments, handle customer accounts, and issue invoices and violations for tolling and pricing schemes, the City could also leverage one of several back offices already established in the Puget Sound region. For example, WSDOT has a back office system to support its *Good to Go!* tolling program with over 763,000 customer accounts handling over 50 million toll transactions annually. Seattle could also consider leveraging the ORCA card transit payment system, which supports over 1 million cards and approximately 450,000 daily transactions. Although the ORCA system does not currently support tolling, this could be a good option for a pricing program with multimodal incentives.

Another alternative would be to work with a private Mobility as a Service (MaaS) provider, such as Lyft or other ride-hailing firms. These platforms are moving toward allowing travelers to have a single account that handles payments for various transportation modes, such as car sharing, bike sharing, transit, and ride-hailing services. A MaaS platform could handle congestion pricing as another service charge and enable multimodal incentives.

Figure 18 Example of the Swedish MaaS combined mobility program app

Whether operated by the City of Seattle, another public agency, or a private third party, there are many advancements that can make back office systems more customer friendly. Website interfaces, apps, and artificial intelligence-powered Interactive Voice Recognition are technologies that supplement more traditional staffed customer service centers. More advanced back office systems allow payment methods beyond credit cards or bank accounts, which helps to meet the needs of unbanked customers. For example, there are payment networks that use kiosks located in grocery and convenience stores to make it easier for people to pay their chargers with cash and/or their mobile phones.

To address privacy concerns, back office systems can isolate payments and accounts from traveler location information. For example, Oregon Department of Transportation's (ODOT) OreGo road user charge program isolates traveler trip information with third party vendors, and only charged amounts are reconciled with ODOT's financial system. Additionally, some toll agencies, such as the Georgia State Road and Tollway Authority, have developed accounts that only need license plate information, bypassing the need for driver information or other identifiers.

Parking Technologies

Applies to: On-Street Parking and Off-Street Parking

Parking technologies have progressed dramatically with the introduction of electronic payment systems. Advancements in vehicle detection, payment methods, traveler information, and enforcement have improved the customer experience and operations for both on-street and off-street parking.

For on-street parking, the City is already using pay stations and a mobile payment app (PayByPhone) to make it easier for customers to pay for and track their parking use. Both of these electronic payment methods could help the City support an additional parking price for

congestion reduction, although some older pay stations may need to be replaced to implement dynamic pricing. There are also other parking technologies the City could use to enable more dynamic parking pricing:

Figure 19 Siemens radar sensors can monitor parking spaces

- *Parking space detectors* – Embedded pavement sensors, video cameras, and radar detector technologies can help monitor on-street parking availability. These types of technologies could allow the City to set parking prices more dynamically and to communicate available parking spaces to reduce traffic caused by circling vehicles looking for parking.
- *DSRC* – As mentioned above, the Federal Government may mandate that vehicles built after 2023 have 5.9 GHz networking capability, which could provide another tool for monitoring parking availability. With built-in vehicle communications, the City and other DSRC-equipped vehicles could broadcast parking space and pricing information to vehicle navigation systems in real time. The City could also allow parking payments through DSRC once a vehicle is parked.
- *Autonomous vehicles* – Like DSRC, the ability for autonomous vehicles to communicate enables parking space detection, dissemination of pricing information, and parking payments. A potential future scenario might be for a traveler to select a destination and their willingness to pay for on-street parking; once the choices were made, the autonomous vehicle would do the rest. AVs could contribute to traffic congestion if they were to calculate the price of parking and decide not to park and instead continue circling.
- *Mobile license plate readers* – With a mobile license plate readers system, video cameras mounted on enforcement vehicles can automatically detect and alert parking staff to violators. This approach could increase parking enforcement efficiency, particularly if dynamic parking pricing is introduced.
- *Parking information dissemination and analytics* – Although the City currently disseminates parking information through its web-based parking map, more private sector involvement in on-street parking could improve travelers' decision making and reduce the need for parking pricing signs. Several parking information service providers, such as TomTom, provide both parking information and predictive parking availability information. The City should continue to engage the private sector on ways to share parking pricing and availability data.

For off-street parking, the electronic payment technologies market varies tremendously to reflect the wide range of parking business cases. For instance, a private gated parking garage leverages different parking technologies tied into a building security system then a non-gated public parking surface lot. Additionally, parking payment business rules vary since customers can pay for off-street parking in different ways, even in the same parking lot. For example, some people have their parking pre-paid by their employers monthly, whereas infrequent drivers might pay for their hourly parking upon exit. The many types of parking systems reflect this variance in off-street parking, which makes standardization of system interfaces and data exchange challenging.

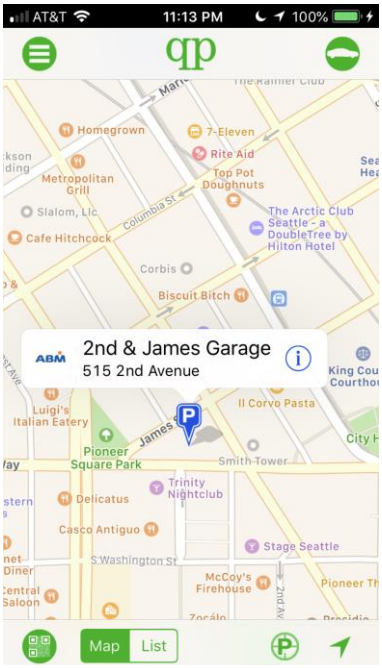

Figure 20 QuickPay app enables travelers to pay for off-street

Despite the lack of standardization, advancement in electronic parking payments can make off-street parking a more effective pricing tool. Electronic payment technologies that continue to advance include the following:

- *Point of sale system upgrades* – Many parking garages use point of sale systems and can handle added fees and taxes, so it could be possible to add a congestion surcharge. Close coordination with parking operators and vendors is needed to assess any potential pricing program, frequency of pricing changes, and communication.
- *Mobile payment applications* – Some cash-based parking facility operators may need assistance transitioning their customers to an electronic payment system and changing their pricing. A simpler electronic implementation approach could use a parking mobile app offered by companies such as ParkMobile, PayByPhone, and QuickPay, which operate off-street parking payment systems in the Puget Sound region. Similar to tolling, parking facilities could charge a higher price when customers pay with cash instead of electronically. Many cash facilities have an operational incentive to transition away from cash payment to reduce labor costs of processing cash and revenue leakage from cash handling.
- *6C Protocol Transponders* – WSDOT's *Good To Go!* tolling system uses transponders with the 6C communications protocol, and these same transponders can be used for parking garage access. For example, the toll operator E-470 in Denver partners with the Denver International Airport for parking payment and access using the ExpressToll transponders. The use of the 6C protocol in transponders is increasingly prevalent—for tolling, fleet vehicle management, and in-vehicle payment methods—because these transponders are inexpensive, allowing for wider distribution and adoption. If the City were to implement multiple pricing tools, 6C transponders could be used for both a cordon pricing and an off-street parking program, for example.
- *DSRC and autonomous vehicles* – As with on-street parking, a vehicle with the capability to communicate and/or navigate could help people make better decisions on parking options and help parking lot operations run more efficiently. For example, a DSRC vehicle linked to a payment account could be processed by a gated parking system,

thereby reducing bottlenecks at garage exits and reducing the need for parking attendants.

- *Parking information dissemination and analytics* – For parking pricing to affect a person's decision to drive or use another transportation mode, the price must be effectively communicated and transparent.

Road Usage Charge

Applies to: Road Usage Charging

Although tolling and RUC share many similarities, RUC is based on charging by the total distance traveled. Therefore, deploying current tolling technology based on AVI and ALPR on every roadway would be impractical and prohibitively expensive to build and operate. However, some of the future alternative technologies discussed in the tolling section could be applied to RUC. Cell phone apps, DSRC, 5G LTE, and autonomous vehicles are technologies that can track vehicle distance traveled. But more importantly, these technologies could help to identify when and where vehicles travel on charged (or tolled) roadways. In terms of back office technologies, RUC and tolling are very similar—they must support customer accounts and process charges—and would use similar technologies.

Privacy Considerations

Privacy is one of the chief concerns raised whenever discussing congestion pricing, whether it is tolling, road user charging, or parking.[1] Inherently, congestion pricing requires identifying a customer at a particular time and place in order to properly charge them. This introduces a concern related to "Personally Identifiable Information (PII)," called "Personal Customer Information (PCI)." PCI incudes details that can uniquely identify a person, such as name, address, or financial information.

Models for protecting PII are already established in the larger electronic payments space, which includes tolling and transit fare cards. In particular, hundreds of toll facilities in the U.S. that use electronic toll collections have developed business practices to deal with PII regulations, which could be transferable to a broader set of congestion pricing projects. For example, WSDOT's *Good to Go!* Program has technologies and procedures in place to safeguard PII information, such as using proprietary internal identifiers, encryption, and anonymizing or aggregating travel data.

In addition, since toll operators handle credit card information, they are subject to the credit card industry's stringent security standards called Payment Card Industry Data Security Standards. Some toll operators also offer cash-based accounts that do not require customer information, further ensuring anonymity. Many toll operators also proactively educate customers on privacy issues and disclose privacy terms on customer agreements, websites, and other media. These tolling industry practices are well established and tested in court; therefore, they offer a practical roadmap for application to other types of congestion pricing tools.

A second privacy concern is location tracking, which reflects where a customer has been. Any potential pricing program in Seattle would be required to comply with the City's Privacy

[1] Washington State has several RCWs addressing customer privacy. The Washington Public Records Act (RCW 42.56) broadly addresses protecting public records. Specific tolling regulations cover tolling PII (RCW 42.56.330) and tolling enforcement (RCW 46.63.160).

Principles. The Privacy Principles are applied through Privacy Assessments conducted with the City's Privacy Program and aim to limit data collection, storage, and dissemination through program design.

Additionally, any technology used to implement a pricing program may be subject to the Surveillance Ordinance 125376, which "is designed to provide greater transparency to City Council and the public when the City acquires technology that meets the City's definition of surveillance."[2] The ordinance requires that City Council review and vote on the acquisition and use of any surveillance technologies and also stipulates community involvement and analysis of potential privacy implications, especially relating to equity and community impact.

Piloting Pricing

When considering a new technology or operational strategy, private companies and public agencies may choose to pilot the program to reduce the economic and political risk of making a significant investment. A pilot can reduce many different types of risk, but the two main sources of risk are generally the following:

- **Technological** – Does the technology supporting the program actually work? For example, does a vehicle occupancy detection technology accurately determine the number of passengers in a vehicle?
- **Program** – Do travelers actually respond to the program in the intended fashion? For example, does increasing parking prices discourage people from driving?

In order for a pilot to reduce risk, the piloting entity must understand what type of risk it wants to reduce and design the pilot accordingly. By its nature, a pilot is a limited test of a concept. Pilot designers can constrain the implementation of a concept by limiting the physical area of the test, limiting the number or types of participants in the pilot, or testing only a portion of the technology. If an entity wants to ensure that the technology works, then piloting in a limited physical space and/or piloting with volunteer participants could be an adequate test of the technology. On the other hand, if the purpose of a pilot is to test traveler response to a pricing tool, then piloting with volunteers or in a small area may skew the results; a pilot focused on a limited technological scope may be a better design in this case. Pilot design may also depend on factors including the budget, schedule, and level of coordination required with other parties, such as integration with other systems.

After accounting for the considerations above, Seattle could conduct a pilot on any of the pricing tools described in this memo, depending on the goals and circumstantial constraints. The list below describes potential pilot approaches for different pricing tools. (All program selections are theoretical for the purpose of exploring potential pilot program designs.)

- *Cordon/area pricing with cell phone app* – In this example, Seattle could require all vehicles travelling within a certain zone to have an app that determines when the vehicle travels into the priced zone. Seattle could conduct a pilot to demonstrate that the app can accurately determine when the vehicle is in the priced area. This pilot would be limited in both geography and in the number of travelers with the app downloaded to their phones. Enforcement could be done with strategically placed mobile license plate readers to

[2] City of Seattle Surveillance Ordinance 125376: https://www.seattle.gov/tech/initiatives/privacy/surveillance-technologies/about-surveillance-ordinance

identify violators. The priced area could be small to start and then gradually expand beyond the pilot.

- *FFFZ, LPRZ, and C/AV only with police and mobile ALP* – In this pilot, Seattle could combine restrictions to certain vehicle types, license plate numbers, or clean air vehicles to lessen the traffic disruption impacts caused by prohibiting other vehicles. Enforcement could be handled by police and/or strategically placed mobile license plate readers to identify violators. Violation fees could be used to offset operational and program costs. Restrictions to vehicles could start with a small area and focus first on an end license plate number on certain week days. The pilot could then introduce more vehicle type restrictions, prohibit more license plate numbers, and expand the restricted area over time.
- *Vehicle fleet with transponders* – As a proof-of-concept pilot, the City could price an area with higher concentrations of fleet vehicles, such as intersections near industrial areas or TNCs in the downtown area.
- *Road User Charge* – Seattle could engage the Washington State Transportation Commission to pilot road user charges that vary by location and/or time of day.
- *On-street parking* – Seattle could modify parking systems in downtown to dynamically vary parking rates. The City could also pilot different parking sensor technologies to verify availability of street parking in real time.
- *Off-street parking* – The City could pilot a pricing surcharge in Seattle's ePark program parking garages. The technology that tracks space availability could be used to set parking congestion prices. More importantly, the ePark website enables travelers to see parking prices in real time before starting their trip, instead of relying on a sign board when arriving at their destination. To expand the pilot, the City could engage private lot operators and provide subsidies for system upgrades (potentially funded by the ePark pricing surcharge).

Legal Implications of Pricing Tools

Along with weighing the relative advantages and disadvantages of each pricing tool, the City will need to evaluate pricing tools in the context of federal, state, and local legislation and regulations. These legal considerations can have a significant impact on the ease or difficulty of implementing a particular tool or set of tools. This section takes a high-level look at existing laws and regulations that apply to each tool. As the City narrows the tools under consideration, a more extensive review of preferred tools will be required. The level of regulatory change needed may also depend on Seattle's coordination with other government entities, such as WSDOT and the Federal Highway Administration. Current laws and regulations related to pricing may affect the City's authority to implement a pricing tool, constrain how the City can implement a pricing tool, or impact enforcement effectiveness.

A review of the Revised Code of Washington (RCW) and Washington Administrative Code (WAC), as well as Seattle's Municipal Code (SMC), points to laws and regulations that may apply to various pricing approaches. (Appendix A contains links to the material reviewed to inform this section.) A summary of the ways the legal framework for tolling, parking, and vehicle fleet restrictions may impact the various tools is below.

Tolling Vehicles

Applies to: Cordon Pricing, Area Pricing, Fleet Pricing, Road Usage Charge, Arterial Toll Roads, and Arterial Express Lanes. (May apply to: Connected/Autonomous Vehicle Zone, Fossil Free Fuel Zone, and License Plate-Based Restriction Zone)

For tools that depend on the collection of tolls, RCW 36.73.040 establishes the right of the Seattle Transportation Benefit District (STBD) to charge "vehicle tolls on state routes, city streets or country roads within the boundaries of the district unless otherwise prohibited by law." Further, RCW 36.73.065 states that, "tolls may not be imposed by a district without approval of a majority of the votes in the district voting on a proposition at a general or special election."

Should the City of Seattle decide to move ahead with any of these tools, coordination with WSDOT and the Washington State Transportation Commission will be needed related to enforcement, rate setting, and potential impacts to state plans and facilities.

Parking Pricing

Applies to: On-Street and Off-Street Parking

Seattle already charges parking fees on city streets and parking facilities, under SMC 11.76.005. Municipal Code 11.31.121 lays out penalties that the City may charge for all types of parking infractions, including failure to pay parking fees. If the City were to implement a more complex dynamic pricing structure and charge drivers directly, the ordinances that authorize these parking fees may need to be revised.

Vehicle Fleet/Class Restrictions

Applies to: Connected/Autonomous Vehicles Zone, Fossil Free Fuel Zone, Arterial Express Lanes, and License Plate-Based Restriction Zone

Several of the potential pricing tools would require the City to limit access to certain geographic areas for certain vehicle types. The City of Seattle does have the right, under SMC 11.16.280, to create special zones, such as pedestrian zones and car sharing zones; however, additional analysis would be needed to evaluate whether this could be used to limit access to specific geographic areas. Currently, State law limits the use of automated traffic safety cameras to detecting speeding, stoplight, railroad crossing, and school zone violations. Using cameras to enforce such zones with automatically-issued tickets would require legislation similar to City Ordinance 11.50.570 for automated traffic safety cameras, as well as changes to State law.

CONGESTION PRICING TOOLS SCREENING

The tools introduced earlier in this document were screened using a process designed to prioritize the most promising congestion pricing approaches for further study and refinement. The assessment was informed by focus areas that align with larger City goals and preliminary desired outcomes. It is similar to the process Vancouver, B.C. used, described in Appendix B. The screening process applied the following criteria and scale to qualitatively assess each potential pricing tool.

Figure 21 Preliminary Screening Criteria

Focus Areas	Initial Desired Outcomes
Equity	▪ Potential to reinvest resources to enhance equity and affordability ▪ Opportunity to increase and improve transportation options for low-income populations ▪ Opportunities for inclusive decision-making around mobility options
Climate and Health	▪ Potential to change travel behavior to support active and sustainable modes ▪ Likelihood of decreasing peak-period congestion and reducing particulate matter ▪ Opportunity to encourage more fuel-efficient and fossil-fuel-free travel
Traffic Congestion	▪ Increase predictability and reliability of travel in Seattle for people and goods
Implementation	▪ Overall feasibility, technologies, legal frameworks, and potential efficiencies

We screened the tools using a simple low-medium-high scale for each of the focus areas. A higher score means that the tool has greater potential to meaningfully influence the focus area and its desired outcomes. So, for example, a tool that has strong potential for reducing traffic congestion received a higher score. Similarly, a tool that does not offer opportunities to improve transportation equity received a lower score.

Figure 22 Screening Scale

Score	Potential	What Defines the Score
1	Low	The tool can influence some or all of the elements associated with this criterion but only at a small magnitude relative to the other tools.
2	Moderate	On balance, the tool has moderate potential to influence this criterion.
3	High	On balance, the tool has high potential to meaningfully influence this criterion.

The scoring and rationale for each individual congestion pricing tool is provided below, followed by a summary table of these coarse screening results. Composite scores for each strategy are the sum of each metric's individual scores and range between 8 and 24.

This qualitative process also required professional judgment. For example, the screening results suggest that fleet pricing be considered for further study even though it scored lower than off-street parking pricing and tolling arterial roads. There are two reasons for this: 1) Fleet pricing is a focused approach that can be used with other strategies; and 2) It could be a logical first phase of a cordon or area pricing program.

All of the tools considered are valuable and could be used (or used more extensively, in the case of parking pricing) by the City of Seattle to meet related goals. As the City works closely with the community in the next phase of this study to develop refined goals and desired outcomes, it may be necessary to re-evaluate the larger set of tools or prioritize others for additional study.

Cordon Pricing

Figure 23 Cordon Pricing Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
1	2	2	2	2	3	2	2

Evaluation Rationale:

Cordon pricing is a toll for vehicles crossing the boundary into a pricing zone. Although this measure could provide moderate funding resources for reinvestment in the transportation system, cordon pricing, if not designed in an equitable manner, could effectively exclude lower-income populations from accessing high-demand parts of the city. Abundant access to transit alternatives into and out of the cordon could help to mitigate this impact. A carefully designed program of discounts or exemptions could also help to make the distribution of the cost burdens more equitable.

Cordon pricing can be varied over the course of the day to discourage vehicle use during the most congested hours. The cordon boundary can also be drawn around the most congested parts of the city, making it a flexible and effective option for reducing congestion at specific "hot spots." However, because the charge is incurred only upon *crossing* the cordon boundary, this strategy may not reduce trip *length* or discourage vehicle trips starting and ending *within* the cordon area—the larger the cordon, the greater this challenge becomes.

Implementation of this strategy may be challenging depending on the road network in question or the size of the cordon area. Areas with fewer entry or exit routes are better-suited for easy and cost-effective cordon implementation. Larger areas with many routes in or out result in higher operating and capital costs, stemming from a higher number of gateways to maintain, and may encourage drivers to circumvent payment points by diverting onto unmonitored side streets. Digital location trackers may address these implementation challenges without the need for excess on-street infrastructure, but they may also carry significant technical risks. The overall cost of implementation would depend on the size of the cordon, the choice of technology, and the complexity of the pricing scheme.

Recommendation: Include for Further Study

Cordon pricing is easier to implement than area pricing or road user charges, and can provide moderate funding resources for reinvestment in housing and affordability. However, a cordon pricing program must be designed carefully to avoid impacts on vulnerable populations and to maximize the ability to reduce vehicle travel within the target area.

Area Pricing

Figure 24 Area Pricing Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
2	3	2	2	3	3	1	1

Evaluation Rationale:

Area pricing is a toll for vehicles driving *within* a pricing zone. As with cordon pricing, this measure represents moderate reinvestment potential but may be difficult to use for precisely targeting or exempting particular populations. If not carefully designed with an equity-first approach, an area pricing program may effectively exclude populations who can't afford the charge from accessing high-demand parts of the city by private auto. Abundant access to transit alternatives into, out of, and within the priced area could help to this negative impact along with other equitable pricing program investments.

Area pricing charges can be varied over the course of the day to target the most congested hours, and the cordon itself can be drawn to target the most congested parts of the city, making it a very effective congestion-reduction strategy. It is more effective than cordon pricing for reducing congestion *within* the cordon, and it encourages drivers to make both *fewer* trips as well as *shorter* trips.

Implementation of area pricing is likely to be more difficult than cordon pricing, as it requires either a sophisticated on-board monitoring technology for all drivers or an extensive on-street monitoring and tolling system within the congested area. An on-board system may be less effective in areas with large numbers of inter-regional drivers (who would not be typically equipped with the required monitoring technology).

Recommendation: Include for Further Study

Area pricing has a high potential to reduce congestion as well as a flexibility in pricing and program design, like cordon pricing, that could provide opportunities to design an equitable program. Further investigation into available technologies may reveal an opportunity to implement this strategy within the cost constraints of the project.

Fleet Pricing

Figure 25 Fleet Pricing Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
3	1	2	2	1	1	2	3

Evaluation Rationale:

Fleet pricing is a charge on specific vehicle types, such as for-hire vehicles (taxis, TNCs) or freight vehicles. It can be a highly-targeted approach, which can help prevent the cost burden of the program from impacting low-income populations. However, a highly-targeted approach may also limit the reinvestment potential or congestion that could be eliminated with this strategy. For some target vehicle types, cost burdens could also be passed along to other users (for example, a fleet pricing strategy aimed at TNC drivers may be passed along to riders as part of the fare).

This strategy could be designed to discourage the use of certain types of high-polluting vehicles, which would improve local air quality and create positive health impacts. However, the narrow focus of this strategy limits the overall impact on regional health and congestion.

This strategy is likely to be relatively easy and inexpensive to implement. Depending on the vehicle type that is targeted for fleet pricing, the charge could be incorporated into an existing registration fee or permitting process. A more sophisticated pricing scheme would require more resources for monitoring and enforcement.

Recommendation: Include for Further Study

Fleet pricing is a focused approach that can be used in conjunction with other strategies with low cost and resource requirements. Despite its composite score being lower than off-street parking pricing and tolling arterial roads, these attributes merit further study for this strategy in a paired implementation approach.

Connected/Autonomous Vehicle Zone

Figure 26 Connected/Autonomous Vehicle Zone Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Impacts	Within Seattle	Through Seattle	Ease	Cost
1	1	1	1	1	1	1	1

Evaluation Rationale:

A connected/autonomous vehicle (AV) zone would designate a certain area or portion of the street network for the exclusive use of connected/autonomous vehicles. This strategy is unlikely to be effective at reducing congestion or providing additional health, climate, or equity benefits. High projected initial cost of autonomous vehicle ownership would exclude lower- and middle-income populations from use of a connected/autonomous vehicle zone in the near-term, which would be detrimental to Seattle's equity goals.

The timeframe during which this strategy would be effective at reducing congestion is narrow, requiring a sufficiently high number of AV users to justify dedicating road space for exclusive use but a low enough number of users to make access to such a space a "special" benefit. As AV market penetration increases, congestion levels in the connected/autonomous vehicle zone could likely return to pre-program levels or worse.

Recommendation: Do Not Include for Further Study

Designating a connected/autonomous vehicle zone for exclusive use is unlikely to be an effective congestion mitigation strategy in the near- or long-term.

Fossil Fuel Free Zone (FFFZ)

Figure 27 Fossil Fuel Free Zone Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Impacts	Within Seattle	Through Seattle	Ease	Cost
1	1	3	1	1	1	1	1

Evaluation Rationale:

An FFFZ would designate a certain area or portion of the street network for the exclusive use of clean-air vehicles not powered by gasoline or diesel, such as electric and hydrogen-fuel vehicles. This strategy is unlikely to be effective at reducing congestion, and implementation would be challenging. Limiting access only to electric and hydrogen vehicles would cause major traffic diversion around the zone's boundary in the near term. An extensive electric charging and hydrogen fueling station network would be required within the zone to support the restricted vehicle types.

An FFFZ would have positive environmental benefits, although these would be limited to a small area. The current high cost of clean-air vehicles would exclude lower- and middle-income populations from use of an FFFZ in the near-term, which would be detrimental to Seattle's equity goals.

The timeframe during which this strategy would be effective at reducing congestion is narrow, requiring a sufficiently high number of fossil-fuel-free vehicles to justify dedicating road space for exclusive use but a low enough number of vehicles to make access to such a space a "special" benefit. As market penetration increases, congestion levels in the FFFZ could return to pre-program levels or worse.

Recommendation: Do Not Include for Further Study

While an effective climate strategy that Seattle may want to pursue in limited areas, designating an FFFZ zone is unlikely to be an effective large-scale congestion mitigation strategy in the near- or long-term.

License Plate-Based Restriction Zone (LPRZ)

Figure 28 License Plate-Based Restriction Zone Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Impacts	Within Seattle	Through Seattle	Ease	Cost
1	1	2	1	2	3	1	1

Evaluation Rationale:

A License Plate-Based Restriction Zone allows only vehicles with certain license plate numbers into a designated area on certain days and/or times. This strategy is likely to be effective at reducing congestion, as restricting access to a large number of vehicles could incentivize travelers to use other modes. However, diversion around the zone could be significant, especially because it would be challenging to communicate the program to non-residents. An LPRZ could have some climate benefits by reducing the number of cars in the zone each day.

Transportation inequalities could increase if wealthier households with multiple vehicles might have more opportunity to adapt to license plate restrictions. An LPRZ is challenging from an implementation standpoint, as the rules may be difficult to communicate and significant enforcement is required. Additionally, an LPRZ is not a revenue-generating program; therefore, funding to support enforcement, alternative transportation choices, and commuter-offset programs would need to be identified.

Recommendation: Do Not Include for Further Study

Designating an LPRZ would have congestion-reduction benefits but would be very difficult to implement and enforce. The program would not generate revenue, which would mean no opportunities for reinvestment to support non-driving modes or equity-based programs.

Road User Charge

Figure 29 Road User Charge Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
2	2	3	3	3	2	1	1

Evaluation Rationale:

Road user charges could supplement or replace the fuel tax with payment per mile traveled. This strategy can be designed to charge a flat fee per mile for everyone using the road network, or it can be designed to vary the fee depending on distance, time, location, or traveler type. A more flexible design would allow for a more equitable distribution of the cost burden of this strategy. The reinvestment potential is very high, but use of the revenue is likely to be highly competitive as fuel tax revenues decline and current fuel tax beneficiaries seek alternative revenue streams.

Climate and health impacts of this strategy are likely to be very positive, with a high potential for reducing vehicle miles traveled. As with area pricing, implementation of a road user charge would require monitoring technology on board all vehicles within the target area, which would represent a significant cost and technological risk.

Recommendation: Include for Further Study

A road-user charge is likely to have a major impact on congestion with a high degree of flexibility and adaptability in pricing and program design.

Arterial Toll Roads

Figure 30 Arterial Toll Roads Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Impacts	Within Seattle	Through Seattle	Ease	Cost
2	1	2	1	1	3	3	2

Evaluation Rationale:

Tolling arterial roads would charge a fee for all road users on major highways or surface streets. This strategy targets regional infrastructure, and therefore distributes the cost more consistently across residents from different areas. The reinvestment potential is significant, though it is inversely proportional to the congestion reduction impact—the more effective a toll is at discouraging driving, the less reinvestment potential it generates.

The congestion reduction potential is high, though it is likely to have a localized effect rather than regional congestion reduction impact. Implementation is relatively easy and can be accomplished with widely-used and readily available technology.

Recommendation: Do Not Include for Further Study

While tolling arterial roads through Seattle would be relatively easy to implement, congestion reduction impacts are likely to be localized and long-term reinvestment potential is low.

Arterial Express Lanes

Figure 31 Arterial Express Lanes Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Impacts	Within Seattle	Through Seattle	Ease	Cost
1	1	1	1	1	2	2	3

Evaluation Rationale:

Creating arterial express lanes would involve converting some lanes on major arterial roads or highways to tolled lanes. These lanes offer drivers the option of paying a fee for a quicker commute. As a "pay-to-play" strategy, it is unlikely to provide equitable congestion reduction benefits or heath and climate impacts. Though this strategy is relatively easy and inexpensive to implement, reinvestment potential and congestion reduction impacts are likely to be low and localized.

Recommendation: Do Not Include for Further Study

Arterial express lanes are unlikely to significantly reduce congestion or provide other public benefits.

On-Street Parking Pricing

Figure 32 On-Street Parking Pricing Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
1	2	1	1	1	1	2	1

Evaluation Rationale:

On-street parking pricing would vary street parking prices to control demand. It is a supply-side strategy that has limited potential for targeting or exempting particular populations. Parking pricing may disproportionately discourage, exclude, or burden lower-income populations from

accessing high-demand parts of the city in a privately-owned vehicle if equitable program parameters are not established. Abundant access to transit alternatives could mitigate this negative impact.

Climate, health, and congestion benefits of this strategy alone are likely to be small. However, it could be used in conjunction with other measures or initiatives to discourage car ownership and encourage alternative travel modes. The ease and cost of implementing an on-street parking strategy depends on the existing parking payment technology and the sophistication of the pricing strategy desired—more dynamic pricing structures will require more sophisticated on-street technology and monitoring efforts.

Recommendation: Do Not Include for Further Study

On-street parking pricing has limited potential to meaningfully reduce congestion or generate revenue to fund other mitigation efforts.

Off-Street Parking Pricing

Figure 33 Off-Street Parking Pricing Screening Scores

Equity		Climate and Health		Congestion		Implementation	
Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
2	2	2	2	2	1	1	2

Evaluation Rationale:

Off-street parking pricing would apply a fee or tax to off-street parking lots. Off-street parking typically represents a large percentage of the parking supply in a downtown area, and is more likely to be associated with daily commute behavior than on-street parking. The potential for reducing congestion and providing health and climate benefits through an off-street parking fee or tax is moderate, though traffic passing through Seattle is unlikely to be impacted.

Implementing an off-street parking pricing program may be challenging, as cooperation with private parking facility owners and operators may be difficult and time-intensive. Monitoring and enforcement costs are likely to be higher than on-street parking pricing.

Recommendation: Do Not Include for Further Study

Off-street parking pricing has more congestion reduction potential than on-street parking pricing, but may be better implemented as a transportation demand management (TDM) program through other city-led commute management efforts.

Summary Findings

Four tools are recommended for further study:

- Cordon Pricing
- Area Pricing
- Fleet Pricing
- Road User Charge

These stand out as tools with the most individual potential to meaningfully influence and balance across the draft goals. While fleet pricing is not one of the top scoring tools, its highly-targeted approach, relative ease, and low cost to implement merits evaluating it further as a possible complementary strategy. Fleet pricing could be an effective supplement, coupled with one or more of the other three tools recommended for further study.

Figure 34 Screening Scores - All Pricing Tools

Pricing Tool	Composite Score	Equity		Climate and Health		Congestion		Implementation	
		Equitable Cost Burden	Reinvestment Potential	Climate-Friendliness	Health Benefits	Within Seattle	Through Seattle	Ease	Cost
Cordon Pricing Toll for vehicles crossing the boundary into a pricing zone	16	1	2	2	2	2	3	2	2
Area Pricing Toll for vehicle driving inside a pricing zone	17	2	3	2	2	3	3	1	1
Fleet Pricing Targeted pricing of specific vehicle types	13	3	1	2	2	1	1	2	3
Connected/Autonomous Vehicle Zone Create connected/autonomous vehicle-only zones	8	1	1	1	1	1	1	1	1
Fossil Fuel Free Zone Create zone that allows only licensed non-fossil fuel vehicles	10	1	1	3	1	1	1	1	1
License Plate-Based Restriction Zone Restrict access to zone based on license plate numbers	12	1	1	2	1	2	3	1	1
Road Usage Charge Charge per mile traveled on downtown roads	17	2	2	3	3	3	2	1	1
Arterial Toll Roads Price entire roads	15	2	1	2	1	1	3	3	2
Arterial Express Lanes Convert some lanes to tolled lanes	12	1	1	1	1	1	2	2	3
On-Street Parking Pricing Vary street parking prices to control demand	10	1	2	1	1	1	1	2	1
Off-Street Parking Pricing Apply a fee/tax to off-street parking lots	14	2	2	2	2	2	1	1	2

Appendix A Statute and Code Sources

The following are relevant links to statutes and codes for pricing:

1. Transportation Benefit Districts - RCW 36.73.040 - Specific language on tolling city streets
   http://app.leg.wa.gov/RCW/default.aspx?cite=36.73.040
2. Transportation Benefit Districts – RCW 36.73.065 - Election needed to impose a toll
   http://app.leg.wa.gov/RCW/default.aspx?cite=36.73.065
3. State Toll – RCW 47.56 – Tolling of State Highways
   http://app.leg.wa.gov/RCW/default.aspx?cite=47.56
4. Setting toll amount – WAC 468-270 – Setting tolls on toll facilities
   http://apps.leg.wa.gov/wac/default.aspx?cite=468-270
5. Toll enforcement - RCW 46.63.160 – Photo enforcement and civil penalties
   http://app.leg.wa.gov/RCW/default.aspx?cite=46.63.160
6. Parking – Title 11, Part 1, Chapter 11.76 – Parking payments
   https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT11VETR_SUBTITLE_ITRCO_PT7STSTPALO_CH11.76PAPADEOP_11.76.015PAVIBLPOTHREPAPA&showChanges=true
7. Parking enforcement – Title 11, Part 1, Chapter 11.32.280 – Parking enforcement and issuance of violations
   https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT11VETR_SUBTITLE_ITRCO_PT3EN_CH11.32CI_11.32.080RECI&showChanges=true
8. Special Zones – Title 11, Part 1, Chapter 11.16.280 – Creation of special traffic zones
   https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT11VETR_SUBTITLE_ITRCO_PT1GEPRAD_CH11.16TRAD_11.16.280TRENUTPEZO
9. Seattle Surveillance Ordinance 125376 – Requirements related to surveillance technologies
   https://seattle.legistar.com/LegislationDetail.aspx?ID=2981172&GUID=0B2FEFC0-822F-4907-9409-E318537E5330&FullText=1

Appendix B Case Study: Vancouver, BC

Vancouver has mounting congestion, continued population growth, and two bridges that were tolled while others were not, leading some to drive extra distances to avoid the cost. While some type of bridge tolling or congestion charging seemed a likely outcome, Vancouver created an Independent Pricing Commission that studied a broad range of alternatives. They first adopted a set of transportation goals that included promoting fairness in transportation costs and impacts. They then evaluated which alternatives, if any, could best achieve their goals. After detailed analysis and community input, they settled on the two potential alternatives that seemed to be the best fit: distance-based charges and congestion point charges (similar in principle to cordon charges).