Executive Summary
What if transit gave us more freedom?

What if public transit were more useful in Philadelphia? What if people could get to more places, sooner, than they can now?

For example, suppose you lived at 4th & Oregon. This map (Figure 1) shows you where you could be, using transit and walking, in a fixed amount of time. The darkest area shows where you could be in 15 minutes. The faintest blue is where you could get to in an hour.

If you use public transit, or want to, then this map shows you the wall around your life. If you cannot go places, you cannot do things. Beyond the ends of these blobs are jobs you cannot hold, schools you cannot go to, clubs or houses of worship you cannot belong to, and people you cannot meet in person.

If we expand where you can get to on transit, we make it useful to more people, and that is the surest way to get more people to use it. Expanding where you can get to also means you are more free, because you have more options to choose from: more jobs, more schools, more shopping options, and so on. More options and more freedom is a good thing in itself.

It is possible to expand the wall around most Philadelphians’ lives, so that they can go more places and do more things, without expanding SEPTA’s operating budget. This report explains how.

What is this report?

The bus network in Philadelphia has been adjusted in small ways over time but has never been rethought in its entirety. It may be based too much on history and not enough on the needs and values of Philadelphia today. Recent declines in ridership in the context of a growing and densifying city strongly suggest that the network is not meeting the needs of today’s city. That is why SEPTA is doing this study now.

This study is about the bus network in the City of Philadelphia, but suburban areas have a stake in it as well. Improved transit in Philadelphia means easier access to more of the city from suburban areas, and easier access to suburban jobs for Philadelphians. Similar studies should also be done for the other counties in the SEPTA area.

This report talks about speed, reliability, civic infrastructure and information. But the main focus of this study is the pattern of routes and schedules, and the way this pattern creates opportunities for citizens. This topic is called network design.

To write this report, we spent six months studying every bus route in detail. We asked:

- How many riders are using this route, and how does this compare to what the route costs to operate?
- How frequently do buses come on this route, and is that enough?
- How early or late do buses run, and is that enough?
- How reliable is the route? Do people often have to wait longer than the schedule says?
- Is this route duplicating other routes? In other words, is this route doing something that other routes do as well?

We did not just study each route, though. We also studied how they all fit together into a network. So we asked:

- How easy is it to transfer from one route to another?
- How well do the bus routes connect to rail, including both the rapid transit lines and the regional rail lines?
- Are there different ways to lay out the network that would produce more freedom and opportunity?
- What other barriers is transit facing in Philadelphia, and what are the next steps to remove those barriers?
The main conclusions

The most important conclusions of this study are:

- The network could be redesigned so that more people could get to more places, sooner.
- A majority of the service would probably be largely unchanged by any network design, because it already follows logical patterns. Thus many routes would likely follow mostly the same streets they do today, though the spacing of bus stops and the exact pattern of service would likely change.
- Changing the network means changing things that some people are used to. As a result, network redesigns always generate some opposition. For that reason, it requires a clear explanation of the benefits, and an open conversation with the public.
- Beyond network design, several other things can be done to improve the transit system, such as trying all door boarding, getting rid of the fare penalty for transfers, and improving how the network is communicated to the public.
- SEPTA does not fully control quality of transit in the city. The City of Philadelphia government has at least as much power over the success of transit. For example, the city controls the layout of streets, which determines how fast and reliably transit can operate, and it controls the planning of development, which determines where transit demand will be. As a result, the City needs to form its own transit policies and priorities, to ensure that all of its actions are consistent with its own intentions for transit in the city.

What is happening to ridership?

Philadelphia is growing, and most of this growth has been in the core of the city where transit access and usefulness is greatest. So transit use should be growing too. Instead, ridership has been falling since 2013 (see Figure 2).

Many things affect ridership. The causes of the latest decline are difficult to sort out, but they probably include lower gas prices, which make driving easier, and competition from Uber and Lyft, whose low fares are partly subsidized by private investors. Neither low gas prices nor subsidized taxi fares are likely to be permanent.

It is tempting to say that if people are using transit less, we need less transit, but Figure 3 shows why that is not true. If people drive more, or use Uber and Lyft more, they are taking more space in the city than people who use transit or ride bicycles. Even autonomous cars will not change this basic geometric challenge, as they take up almost the same amount of space as today’s cars and even carrying three to four persons per car, they cannot be anywhere near as space efficient as buses or bicycles.

Transit’s ability to use space efficiently will continue to be the argument for why it must exist, and why it must be allowed to succeed. That is a purely geometric fact, so it will not change even as ridership goes up and down, as it always does.

While ridership declines should not be considered a crisis, they do provide a good opportunity to question how bus networks are designed, and how they are operated, marketed, and accommodated within civic infrastructure.

Figure 2: Productivity graph indicates a ridership loss for SEPTA and most peers starting in 2013.

Figure 3: Public transit, bicycles, and cars use progressively more road space to move the same number of people.

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What are other cities doing?

Many American city bus systems stayed the same for decades even as cities have grown and changed around them. For that reason, many transit agencies are now doing bus network redesigns. Houston launched a completely new bus network in 2015, followed by Baltimore in 2017. As of May 2018, almost all of the nation’s largest transit agencies—including those in New York City, Washington DC, Los Angeles, and Boston—have either launched network redesign studies or announced the intention to do so.

The key to freedom: frequency and connections

Look again at the isochrone map in Figure 1 on page 8. A high ridership network will expand where people can get to in a given amount of time. How does it do this?

As we explain in Chapter 3 on page 31, the answer is simple: frequent service, making easy connections. Frequency not only means less waiting. It also means that it is easy to connect between lines, and that means that where routes intersect it is easy to change from one line to another. These fast connections are what makes it possible to get to so many more places, sooner.

In Philadelphia, this would probably mean:

• Improving the frequent grid. Most of the city is covered by a grid pattern of lines. Increasing all of these lines to run more frequently all day would make it easy to go from anywhere to anywhere in this area with a simple L-shaped trip (see Figure 4).

• Concentrate more services at transportation centers, including 69th Street, Wissahickon, Olney, Fern Rock, and Frankford, and also to other key stations on the rail network. These transportation centers are also key opportunities to improve access between Philadelphia and its suburbs. By connecting many Philadelphia lines to many suburban lines, a network redesign could dramatically expand the number of places that are easily connected by transit.

Look at the abstract network in Figure 5 below. Route C, which comes every 60 minutes, runs on the same streets as Routes A and B, which come every 10 minutes. Route C could be useful to go from certain points on Route A to certain points on Route B. But because you have to wait so long for Route C, it is usually faster to just take Route A and transfer to Route B. That makes it hard to justify keeping Route C.

Partial duplication also happens when two parallel routes are so close together that they are serving the same places. Moving these routes further apart, so that they overlap less, can make the system more useful, especially if it means SEPTA can afford to run the buses more often.

About 10% of the Philadelphia’s bus service is duplicative by these standards. This 10% of the operating budget could be used differently to create more useful service.

About 10% of service is duplicative

A network redesign would look for service that is not very useful, and rearrange it to make it more useful. Here is an example.

When bus routes run for long distances on the same streets as other bus routes or rail lines, without combining for better service than individual routes, we call this duplication.

Figure 4: A high-frequency grid provides convenient one-transfer connections between any two points.

Figure 5: A one-seat ride on a low-frequency route is usually slower than a high-frequency connection.
Some routes have too much peak-hour service

Most bus routes have more service during the peak commute period (or “rush hour”) than they have during the rest of the day, because more people want to ride during the peaks. But this “peak-only” service is also more expensive than all-day service for SEPTA to run. Drivers have to be paid more to work very short shifts, for example, and SEPTA has to own and maintain buses that it does not use very much. So those added buses need to be well used in order to justify themselves.

But several SEPTA bus routes are less crowded during the peak commute hours than they are the rest of the day. That is a problem. During the peak, there should be enough buses so that everybody can ride, but the buses should be more crowded than they are in the midday. If not, the expensive buses that are added for the peak are not being put to good use and could be more productively used elsewhere, such as providing more frequency in midday or in the evening.

Our estimate is that about 5% of resources are being spent on excess peak service. A network redesign would look closely at that excess peak service and possibly shift it to all-day patterns, which would create more useful service.

Speed needs improvement

SEPTA is gradually slowing down. Travel speeds (including all delays) have slowed down by 0.2 mph just in the last three years. This may look small but it adds up. There are elements of the speed problem that SEPTA can work on, notably in operating and boarding procedures. For example, some agencies are now allowing passengers to board at all doors, which speeds up boarding but requires on-board fare inspection. The biggest challenges affecting speed, though, require cooperation with the City of Philadelphia, as we discuss further below.

Reliability needs improvement, but is better than it sounds

SEPTA defines a bus as being on-time if it is between 0 and 5 minutes late. This is a tough standard. Many random events can delay a bus by 5 minutes. By this standard, SEPTA’s on-time performance in Philadelphia is around 75%, which sounds terrible. However, on high-frequency routes the customer experience is better than this number makes it sound.

For example, if your bus is scheduled to come every 10 minutes, your chance of waiting no more than 15 minutes is over 90% at all times of day, and over 95% midday. This is a better description of the customer experience, and points to the fact that on high frequency routes, keeping the buses evenly spaced is more important than following a schedule.

SEPTA should consider changing the measures of reliability on frequent routes to better align with the customer experience of reliability. Changing standards will require changes in management techniques and changes in data management and reporting. But the outcome would be clearer communication about reliability and more useful service through better management of headway reliability.

Bus stops are too close together

Philadelphia bus routes typically have stops roughly every 500 feet, or ten stops per mile. For example, a typical east-west route will stop at 16th, 17th, 18th, and so on. This is a significant part of why bus operations are so slow.

For high frequency routes, which will stop at most stops due to high demand, the North American best practice is in the range of 1000-1500 feet, or two to three typical Philadelphia blocks. Many transit agencies are studying stop spacing and coming up with consistent citywide policies, usually in that range.

A 1000 foot or two block spacing would mean that:

- Buses run noticeably faster, because customers gather at fewer stops where they can board more quickly. We estimate a 2% speed increase on segments without stop signs. This is a conservative estimate compared to recent experience with the Route 47 stop consolidation pilot.
- Everyone is still within a short walk of one bus stop, but not necessarily two consecutive stops. Of course, riders only need to reach one stop, not two.
- Fewer parking spaces are removed to accommodate bus stops, although those that remain will need stronger enforcement.

Stronger enforcement of parking restrictions at bus stops is a key part of the partnership between the City and SEPTA. It would lead to fewer disruptions and delays, increasing the speed of service.
Transit has competing goals: How will they be balanced?

The Philadelphia bus network is designed on a mixture of two competing goals. Chapter 4 explains why the geometric facts about transit lead to this conflict between goals.

A Ridership Goal seeks maximum ridership for a given amount of service. Ridership means that more people benefit from the service directly.

This goal is achieved by running frequent service in areas where the conditions are favorable: places that are dense and walkable, and where straight, logical paths for transit are available. Most urban landscapes laid out before 1945, including most of Philadelphia, are well served under a Ridership Goal.

The Ridership Goal supports goals such as urban redevelopment, financial return, and environmental and congestion benefits resulting from less car use.

A Coverage Goal seeks to provide service to all parts of the city regardless of whether ridership is a realistic expectation. This goal ensures that there is service into places where the conditions are not favorable for ridership, including areas that are low-density, or not walkable, or where the street networks make it hard to draw logical routes.

The Coverage Goal corresponds to goals such as lifeline access for people no matter where they are, equity across council districts or other political units, and access to jobs in landscapes that are not conducive to high-ridership transit, such as most industrial areas and suburban-style business parks.

1 These terms are capitalized in this report when referring to the exact meaning laid out here.

Figure 6: Ridership and coverage goals produce very different networks.
The existing balance of goals

In the current Philadelphia bus network, about 70% of the service runs in patterns that serve a Ridership Goal. About 15% are in patterns that effectively serve a Coverage Goal. About 10% is duplication and the remaining 5% is excess peak service. These numbers, and how we got to them, are explained in the Appendix on page 97.

There is no objectively correct answer to the question of how much to pursue a Ridership Goal as opposed a Coverage Goal. Both goals are an important part of why people value transit, but they do lead to different kinds of investment. So the ridership-coverage trade-off is about choosing between things that you like, just as you do in any kind of budget. This decision should arise from a public conversation.

To help people see this choice and talk about it clearly, a network redesign study would create two alternatives for the network, one with a greater focus on the Ridership Goal, the other with greater focus on the Coverage Goal. Both would remove the duplicative service, but they might differ on whether those resources are spent to improve ridership or improve coverage. Then, the community could think about where it wants to be in the triangle of Figure 8. This triangle shows the two questions that people would need to think about:

1. How much should the system change?
2. What should be the balance between Ridership and Coverage Goals?

Evening and weekend service

Evening and weekend service is relatively inexpensive to operate, and it is also crucial to a large segment of transit riders. People who work in most retail and entertainment sectors have to work on weekends and often late into the evening. Having some transit then is important to making it possible for them to rely on transit at all.

Houston recently had great success with a network redesign that extended evening service and expanded Saturday and Sunday service to be the same level as weekday service, but without the peak period.

We would like to recommend this for Philadelphia, but without new resources it would require cutting the weekday network too deeply. Additional weekend service should be a top priority for any new resources.
Eliminate the Fare Penalty for Changing Buses

SEPTA currently charges passengers more if their trip requires two buses (or trains) than if it requires one.

Changing buses and trains must be encouraged. Most of the area that a person can reach in an hour is reachable via a transfer. A network designed with simple and easy connections is a more efficient network to operate, which means it is a network that lets SEPTA provide more liberty for the same cost. And it is a network that carries higher ridership. It makes no sense to charge people more for behavior that is so beneficial for both SEPTA and the customer. The fare for a trip should be the same regardless of the number of buses and trains required. To charge extra for transfers is to discourage exactly the behavior that SEPTA most needs to encourage. For details see page 74 for the effects of the fare penalty on network design and page 58 and page 70 for the high rate of transfers.

City leadership is critical

This report focuses on network design, which is largely under SEPTA’s control. However, the City of Philadelphia controls the success of the transit system as much as SEPTA does, because it has two enormous powers:

- As a land use authority, the city decides whether more people and jobs will locate in places where it is easy for transit to serve them, or in more remote places where access will depend more on cars.
- The City controls most of the streets on which buses operate. Most speed and reliability problems are related to delays caused by traffic. Many cities are addressing this problem through various kinds of transit priority, including signalization improvements and bus lanes.

An unusual feature of Philadelphia is that long stretches of major bus lines encounter stop signs at every block. In many cases these were once signalized, but were changed to stop signs as travel volumes dropped due to the depopulation of some parts of the city. This is also an important issue for city leadership.

More broadly, the City needs its own transit policies and planning capabilities. We recommend studying the City of Seattle as the current best practice on how a city government takes a leadership position on transit, effectively guiding all city departments on an issue of urgency, even though it does not directly control transit operations.

One key best practice is for the City to develop its own Philadelphia Transit Plan, which would guide the city’s actions in planning and expediting transit. This plan would be integrated with both land use and transportation planning at the city, and could be relevant to other city functions such as decisions about the locations of services, and even law enforcement priorities.

Chapter 3 explores these issues in more detail.

Try All-Door Boarding

To save time, some bus systems allow passengers to board at any door. This is already common on rail services, but San Francisco allows it on all buses citywide, and several other cities do it on the busiest lines. SEPTA should continue to explore this option, which we discuss at the end of Chapter 2 on page 42.
The network can be more legible

A network redesign would probably make the network simpler, which makes it easier to understand and remember. However, regardless of the network change, several things can be done, even today, to make the network clearer:

- Identify frequent service (every 15 minutes or better all day) as a distinct service type, highlighted throughout the information system. This helps everyone see the places where the next bus is always coming soon.
- Develop an attractive network map, showing all services. Currently, SEPTA has a prominent rail diagram but is not showing the bus network clearly. Even with app-based navigation many people value clear maps that show the network structure.

Use the electric signs on buses to describe the route more completely, usually by stating the main street used and then the destination. (“SPRUCE to 69th Street”) This style provides a useful description of what the bus does, which helps everyone who sees the bus learn about the network.

Girard trolley is a barrier to travel

Many people love the trolleys in Philadelphia. Unfortunately, they also have two disadvantages:

- In mixed traffic, they get stuck more easily than buses do. Incidents that happen in their lane shut down the trolley service, where a bus could easily go around them.
- Where the rails end, everyone has to get off. This is not always the most logical location for passenger trips.

The trolleys that run into the Market Street Subway provide an important express service into the Center City that uses their capacity. There is no question that these benefits outweigh those disadvantages.

The Girard trolley (#15) has the disadvantages without the advantages. In particular, the west end at 63rd Street narrowly misses serving the 69th Street Transportation Center, and thus cuts off Girard passengers from a huge range of possible suburban connections.

This problem could be fixed either by extending the Girard trolley to 69th Street Transportation Center or, far less expensively, by converting the trolley into a high-frequency bus line.

In addition to the ability to run a more logical route, buses also have the advantage that they can go around obstacles that arise in their lane, and even make detours if needed, while trolleys are stuck until the obstruction is cleared.
### Summary of network design strategies

Figure 12 summarizes some of the key strategies that effective, freedom-increasing network redesigns generally employ, and why those strategies work. These strategies are associated with increased ridership because they make service useful to more people, for more purposes.

### How do we get more service without more money?

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<table>
<thead>
<tr>
<th>Strategy</th>
<th>Benefits</th>
<th>Downsides</th>
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<tr>
<td><strong>Strategies that Decrease Duplication and Excess Service</strong></td>
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</tr>
<tr>
<td>1. Remove Duplicative Route Segments</td>
<td>Resources can be reallocated to create more useful services.</td>
<td>More people have to transfer during their trip, but this does not mean total travel times are longer. Sometimes they are shorter due to less waiting.</td>
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<tr>
<td>2. Remove Excess Peak-Only Service</td>
<td>Resources can be reallocated to create more useful services. Peak-only service is especially expensive to run, so more resources are freed.</td>
<td>Minor, as this would only be done only where demand does not justify added peak service and frequency is high anyway.</td>
</tr>
<tr>
<td>3. Consistent Route Spacing</td>
<td>Avoids partial duplication where parallel routes serve the same area. Resources can be reallocated to create more useful services.</td>
<td>Longer walks to service are difficult for those who have difficulty walking.</td>
</tr>
<tr>
<td>4. Wider Stop Spacing</td>
<td>Increase average speed. Faster trip times free resources to create more useful services. Better infrastructure is possible at each stop.</td>
<td>Longer walks to service are difficult for those who have difficulty walking.</td>
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<tr>
<td><strong>Strategies that Increase Connection Opportunities</strong></td>
<td></td>
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<tr>
<td>5. Remove Fare Penalty for Transfers</td>
<td>Encourages connections, which are the essence of an efficient network. The more connections a route makes, the more useful it is.</td>
<td>Would require review of fare structure. Could increase base fare.</td>
</tr>
<tr>
<td>6. Focus Service on Transportation Centers</td>
<td>Expands usefulness of all routes serving a transit center. Especially important for travel between City and suburban counties.</td>
<td>Transit Centers must accommodate more buses. In some cases this may require infrastructure.</td>
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<tr>
<td>7. Strengthen the Frequent Grid</td>
<td>The most efficient form of network for dense cities.</td>
<td>Frequency is expensive, so can be deployed only where many people will use it.</td>
</tr>
<tr>
<td>8. Link to Regional Rail Connections</td>
<td>Improved travel between city and suburban counties.</td>
<td>Difficult, due to low frequencies and irregular schedules of regional rail, but worth doing to extent possible.</td>
</tr>
</tbody>
</table>

*Figure 12: Budget neutral strategies for increasing service.*
What should happen next?

We recommend that SEPTA undertake a redesign study for the Philadelphia network, building on the analysis from this report. A redesign should:

- Develop multiple alternatives for what the network might look like, depending on different priorities that might be chosen. For example, one network alternative might focus more on ridership, and the other on coverage.
- Launch a major public conversation about these alternatives, to get feedback from citizens about what the priorities should be.
- Develop a draft recommended network based on the priorities that have been expressed.
- Conduct a second round of public conversation, to get public feedback on the recommended network.
- Revise the recommended network and implement it.

While this report focuses on just the network within the City of Philadelphia, a similar conversation and redesign process can, and should, be undertaken in the other jurisdictions within the SEPTA service area. How that conversation and process is structured is a critical next step in the overall redesign process.

It is sensible, though, to work on the network in separate parts, in parallel planning processes. This way issues in one part of the network do not sidetrack the planning process in a far away part of the network elsewhere. Of course, where the network in different areas overlap, coordination in the planning process will be crucial to a successful redesign.

Outline of this report

Chapters 1 and 2 introduce the network and its current performance.

Chapter 3 discusses speed and reliability issues, and the important role of City of Philadelphia leadership in this area.

Chapter 4 explores the transit market, looking at how the patterns of development and demographics affect transit demand.

Chapter 5 dives deeper into existing performance at the route and stop level. It studies examples of different kinds of design problems and showing why certain design principles make sense.

Chapter 6 lays out recommended design principles that should guide a network redesign.