2 Summary of recommendations

We recommend the City and DISD consider the following next steps related to fiber and wireless infrastructure; digital equity programs; and federal funding and subsidy opportunities.

2.1 Proceed with building a fiber backbone and add additional fiber to create a 180-mile network to support growing City needs and digital equity efforts

Proposed City-owned fiber would greatly benefit City operations and provide the ancillary benefit of supporting digital equity efforts. We recommend the City continue the analysis already underway, taking into account the availability of funds and the nature and geographic distribution of its current and future networking needs.

We further recommend the City develop and refine a "hybrid" approach, with City-driven dark fiber likely a key element of the core and connectivity to many City sites and neighborhoods. In this approach, we envision a mixture of City-built fiber and managed fiber network services at the edge (accompanied by City and other wireless technologies). Approaches such as fiber lease could also be used where high capacity is needed and where it can be cost-effectively provided (but where the flexibility and capability of City-driven fiber is not as necessary).

The current City plan is to build a fiber backbone between hub points that include key public safety and library locations, with the first stage likely comprising approximately 100 miles. This would bring fiber to many City buildings, support public safety applications, and, with strategic routing, provide a strong foundation for future digital equity efforts (by bringing fiber into areas that have seen lower levels of fiber investment by private providers).

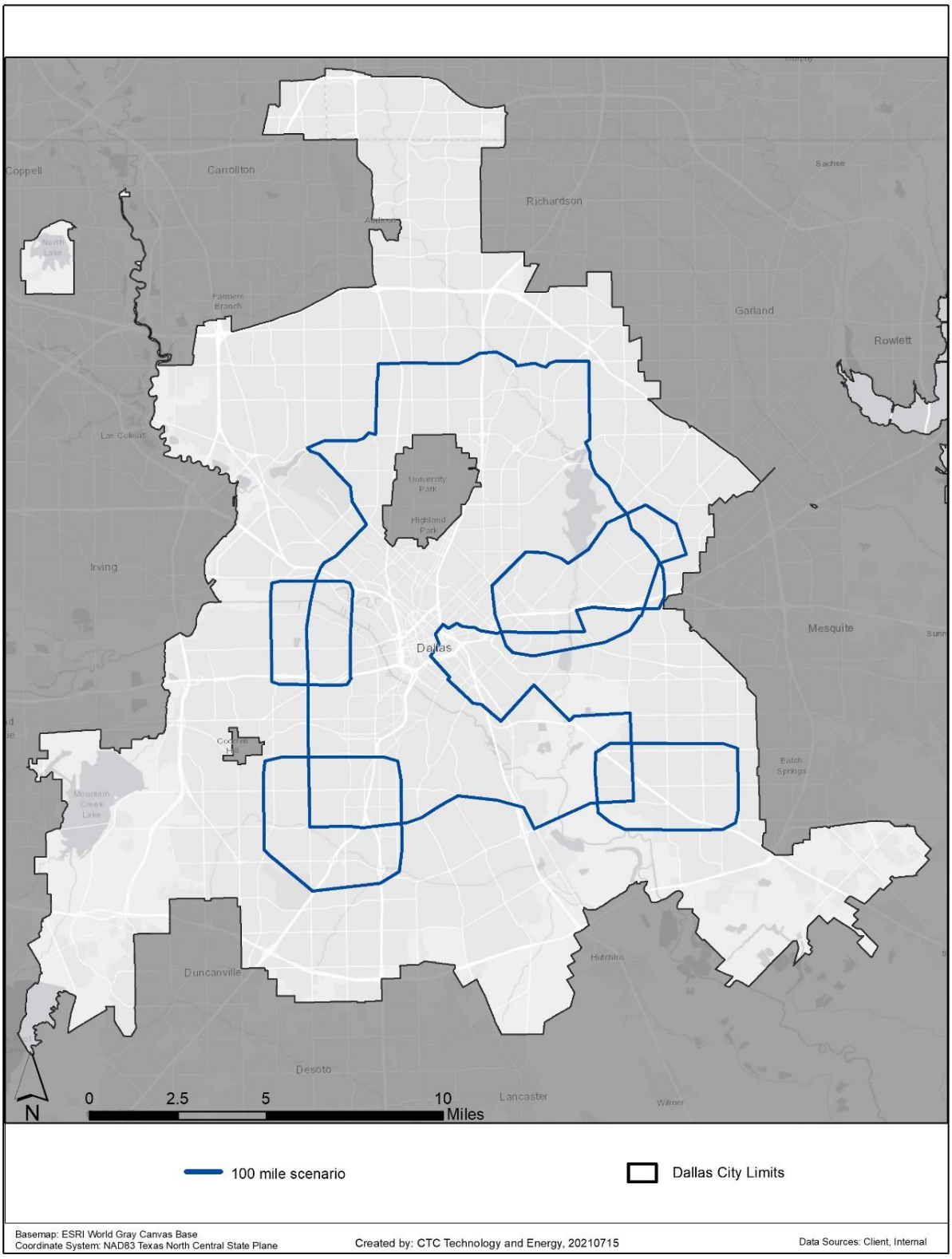
Constructing a 100-mile fiber backbone would cost approximately $13.5 million (Table 1).

Table 1: Estimated 100-Mile Fiber Backbone Costs

Item	Cost
Fiber Optic Outside Plant (OSP) Construction	$12,500,000
Network Hardware	$800,000
Network Integration and Testing	$200,000
Total Capital Costs	**$13,500,000**
Annual Operating Costs	**$1,000,000**

Figure 4 illustrates a conceptual design of a 100-mile fiber backbone. This design consists of one primary loop totaling 58 miles and four loops to extend further from the city center.

Figure 4: City of Dallas Fiber Backbone and Rings: One Concept for a 100-Mile Design



The 100-mile fiber backbone could be a first step toward expansion of City fiber into Dallas neighborhoods. We recommend an architecture that adds additional fiber in rings that connect to the initial backbone, starting with neighborhoods that are the least served by broadband and those with the greatest need for connecting City infrastructure, such as buildings and devices including police and traffic cameras, traffic signal controllers, as well as City efforts to address the digital divide.

Recently, the City has expanded this concept to a 180-mile network that provides a backbone and links approximately 100 City facilities, as well as approximately 100 locations that address the digital divide and provide Internet of Things connectivity along the route. Compared to acquiring the same fiber through leased services, this project could provide significant long-term operational savings. It would bring fiber to many City buildings, support public safety applications, and, with strategic routing, provide a strong foundation for future digital equity efforts (by bringing fiber into areas that have seen lower levels of fiber investment by private providers). More detailed discussion of these applications is provided in Section 6.

It is important to note that making a detailed determination of the "right" amount of City fiber, choosing among hundreds of potential sites to be connected, and assessing the appropriate construction timeline will require a more intensive City planning process, and is beyond the scope of this analysis.

At the City's request CTC conducted a financial analysis of what 180 miles of fiber to meet the objectives described above would cost to build and operate. Constructing and connecting 180 miles of fiber would cost approximately $25 million (Table 2) and then entail ongoing operating costs of about $2 million per year.

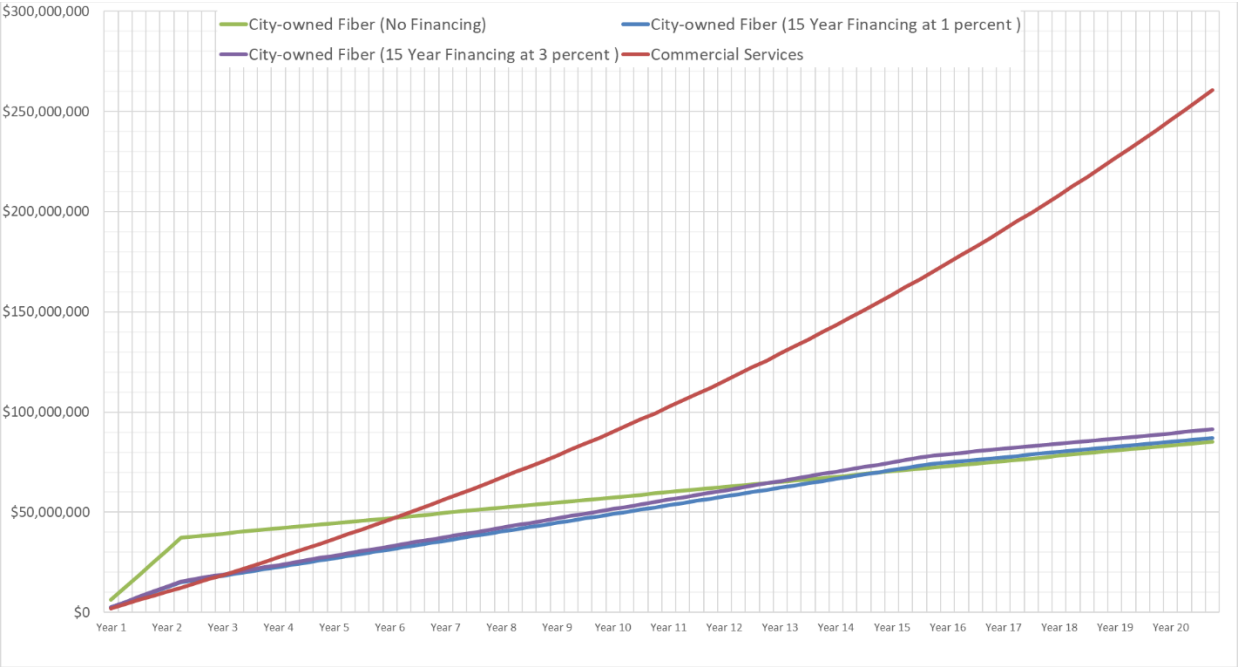
Table 2: Estimated Costs of 180 Miles of Fiber

Item	Cost
Fiber Optic Outside Plant (OSP) Construction	$22,500,000
Network Hardware	$2,000,000
Network Integration and Testing	$500,000
Total Capital Costs	**$25,000,000**
Annual Operating Costs	**$2,000,000**

Figure 5 (below) illustrates models of the cumulative cost of City-owned fiber operated by the City, as described above, under three separate models of City funding (no financing, 15-year financing at 1 percent, and 15-year financing at 3 percent) and compares them on a year-by-year basis to the expected cost of the leased backbone services. In short, we estimate that the 10-year costs of building and owning 180 miles of City fiber would be less than the seven-year cost of

leased backbone networking services under current lease pricing, and that the savings would grow significantly over time. The assumptions we used in producing this financial analysis are detailed in Section 6.2.

Figure 5: Cost Scenarios for 180 Miles of City Fiber



2.2 Consider building wireless infrastructure as a partial solution to filling broadband gaps for DISD families and other residents

Using the specifications of the DISD pilot at Lincoln High School, we developed five models to estimate the effectiveness and costs of expanding the pilot concept to other parts of the City by adding antennas to the rooftops of additional DISD buildings. In our modeling we considered the rooftops of all 282 DISD schools as potential radio locations and determined the maximum number of potential subscribers that could be served under different parameters. (The addition of other publicly owned rooftops and other infrastructure, including that of the city of Dallas and the county, would further extend the potential of the network and improve coverage.)

The first two models are for DISD families only. The third, fourth, and fifth models are for all City residents. In all models we use DISD rooftops as antenna sites, both because the model is proven in the DISD pilot and because DISD buildings have fiber connections that would be necessary to connect the antennas to the internet.

Model 1 aims to serve all DISD families (and could also, as noted below, serve about 2,600 households living in DHA housing). For Model 2, we used the DISD Community Resource Index (CRI) as one tool to help establish prioritization; CRI was designed by the Child Poverty Action Lab

to inform investment decisions and resource allocations because it measures various characteristics of Dallas neighborhoods, such as education, economics, and health.[4] For Model 3, we considered areas where broadband-level speeds are not available everywhere and that have seen less investment in fiber by the incumbent providers. In Model 4 we also considered the City of Dallas Office of Equity and Inclusion's Covid-19 risk score data.[5] And in Model 5 we considered expanding the wireless capacity to serve all residents reachable from DISD rooftops in areas with a Community Resource Index (CRI) score under 40.

The five wireless infrastructure models we developed are:

- Model 1: All DISD families are potential subscribers
- Model 2: Only DISD families who can be connected from schools with a Community Resource Index (CRI) score under 40 are potential subscribers
- Model 3: All City residents (DISD families and others) in areas with less existing broadband infrastructure (as shown above in Figure 1) are potential subscribers
- Model 4: All City residents (DISD families and others) in City-designated Covid Risk 5 areas are potential subscribers
- Model 5: All residents (DISD families and others) in Dallas who can be served using DISD rooftops in areas with a Community Resource Index (CRI) score under 40

These models were used to estimate the greatest number of DISD families and other City residents who could be reached using different target areas and selection parameters. The table below illustrates the models' estimated capital and operating costs, as well as key parameters for each.

We note that the wireless models' operating costs are not insignificant, and that those annual costs are one of the challenges of wireless networking. That said, the models illustrate that as the wireless networks reach more families, the comparison with a bulk-buy subsidy option (discussed in Section 2.6) grows more favorable. For example, we note Model 2 has an estimated capital cost of $21 million and an estimated annual operating cost of about $2.5 million (Table

[4] A CRI score of less than 40 (i.e., schools with "a relative lack of resources") was chosen as the criterion for our analysis. "DISD Community Resource Index," Child Poverty Action Lab, https://childpovertyactionlab.org/disd-cri (accessed May 2021).

[5] Within that framework, the highest risk is denoted as a Risk 5 area, followed by Risk 4 and so on. Covid-19 risk score description and methodology, City of Dallas Office of Equity and Inclusion, https://dallasgis.maps.arcgis.com/home/item.html?id=186b98f0fab940118dbd9a4422db7eaa&view=table&sortOrder=desc&sortField=defaultFSOrder#overview (accessed April 29, 2021).

3). By comparison, a subsidy for the same number of student households would cost about $10.8 million annually. The infrastructure program would be more cost-effective by year three.

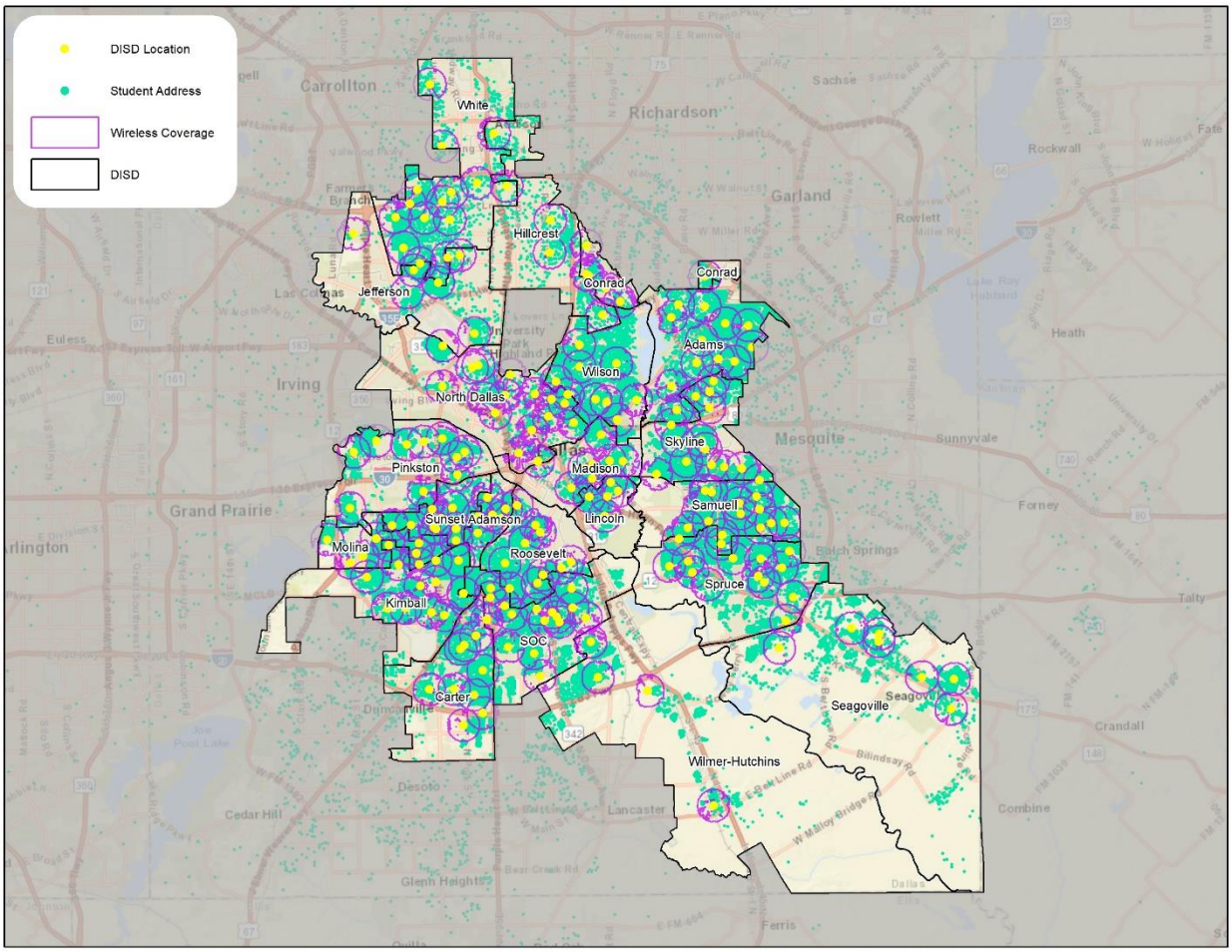
Table 3: Estimated Fixed Wireless Costs

Model	Households Served	One-time Capital Cost	One-time Capital Cost per Household[6]	Annual Operating Cost	Annual Operating Cost per Household[7]
1: DISD families at all schools	74,500	$38,173,800	$854	$4,334,500	$97
2: DISD families at schools with CRI of less than 40	44,800	$20,993,280	$781	$2,548,250	$95
3: All City residents in areas with less existing broadband infrastructure (see Figure 1)	28,235	$21,870,831	$1,291	$2,265,725	$134
4: All City residents in Covid Risk 5 areas	774	$893,664	$1,926	$453,040	$976
5: All City residents who can be served from DISD rooftops – CRI<40	106,721	$56,156,064	$877	$8,424,700	$132

The map in Figure 6 below illustrates Model 1 coverage and locations. Further details on all five models are provided in Section 5.5.

[6] Assumes 60 percent penetration. Includes $350 per household served for installation and customer premises equipment.
[7] Assumes 60 percent penetration.

Figure 6: Model 1 Coverage and DISD Locations



If the City decides to deploy a wireless service to partially fill its broadband gaps, we recommend a free, rather than paid, service. First, offering free service entails less operating cost and complexity than a paid service with respect to sales, marketing, billing, collections, and other elements of paid broadband service. Second, given the significant cost barriers associated with low adoption of broadband, a free service has potentially far greater impact than a paid service.

We anticipate a free service would be provided on a "best effort" basis, without particular service level guarantees, but the program would still necessitate certain operations support to deliver a reliable service and ensure the overall technical success of the initiative.

2.3 Expand the Digital Navigators program to maximize participation in low-cost programs and federal subsidy programs

CTC recommends the City and its partners on the Internet for All Coalition expand the piloted Digital Navigators program to help expand enrollment in providers' low-cost programs (i.e., Charter's Spectrum Internet Assist program, AT&T's Access program) as well as the FCC's Lifeline

and Emergency Broadband Benefit[8] programs. These programs offer opportunities for qualifying residents to receive low-cost or discounted broadband services,[9] but each program has its share of hurdles that make enrollment challenging—and participation rates (both locally and nationally) have historically been low.

The survey data show these programs are extremely underutilized in Dallas. A partnership between the Digital Navigators, DISD, and potentially Dallas County to undertake this effort could educate residents about eligibility and program benefits. Such a strategy would leverage existing efforts to maximize the impact of existing, long-standing programs that are available to a large number of residents.

The Digital Navigators program may want to consider providing call center support to help residents understand and navigate these programs; the call center could also help small ISPs get qualified by the FCC to participate in Lifeline and the Emergency Broadband Benefit program, and then to determine that families are eligible.[10] (Well-trained call center staff could also potentially assist residents in obtaining other resources, such as rental assistance or food assistance.)

In our experience, a relatively modest call center staffed by three people could have a potentially large impact—assisting approximately 8,000 families per year. (The number aided by three staff members could be higher or lower based on demand for the service and the ease or difficulty in connecting families with the relevant programs.)

The table below estimates the costs of staffing, marketing, and operations for a call center and related communications efforts to increase community awareness of these opportunities. The first section provides year-one costs; the second section provides annual costs for the initiative in subsequent years. The numbers are based on CTC's experience with similar initiatives.

[8] See Section 2.7 for more details.
[9] Further information about these programs and the difficulty in enrolling in them is provided in Section 7.
[10] This approach would take some of the burden off smaller ISPs. For big ISPs, this is a relatively easy chore; they have access to the federal Lifeline verifier, as well as their own low-income programs.

Table 4: Estimated Initiative Budget – Providing Resources to Help Residents Enroll in Low-Cost and Subsidy Programs[11]

Year One	**Budget**
Creation and distribution of informational materials such as web pages, fliers, inserts, and mailers	$20,000
Call center technology and software licenses	$20,000
Three full-time call center staff ($40 hourly rate)	$249,600
Total	**$289,600**
Estimated cost per household if 8,000 households are assisted	*$36*
Subsequent Years	**Budget**
Creation and distribution of fliers, inserts, and mailers	$5,000
Maintenance of call center and equipment	$10,000
Three full-time call center staff, based on an hourly rate of $40	$249,600
Annual Costs for Year Two Onward	**$264,600**
Estimated cost per household if 8,000 households are assisted	*$33*

2.4 Purchase devices and fund the expansion of digital skills training and device recycling—building on the Digital Navigators program

In addition to access to robust and affordable broadband, residents require digital skills and devices in order to fully take advantage of the opportunities that come with a broadband connection. The survey identified both significant gaps in skills and broad interest in programs that would help close those gaps—with interest stronger among older residents.

Given the availability of funding in the current moment, Dallas could make a one-time purchase of new devices for households that lack computers and build on its Digital Navigators program to continue to support community organizations with the capacity needed to enable digital skills training initiatives. (The short, one-month duration of the program has been identified as a challenge.) Additional funding for the Digital Navigators program would allow service providers to expand their digital skills training initiatives and would allow the City to support additional organizations in providing such training, especially organizations that serve senior residents.

In concert with the digital skills training efforts, the City or DISD, and potentially the County, could forge partnerships with, or replicate programs offered by, organizations around the nation such as Comp-U-Dopt, PCs for People, Tech Soup, and Tech Goes Home. These organizations have a variety of successful and scalable models for reselling, refurbishing, or offering new laptops and

[11] Numbers are estimates derived from CTC's experience designing and operating call centers to support broadband subsidy programs on behalf of state government entities.

other devices and training to partner organizations. Table 5 describes the estimated budget for training 5,000 residents.

Table 5: Estimated Budget for Digital Navigators Training Program

Category	Budget
Training cost per student	$200
Estimated cost if 5,000 residents are assisted	*$1,000,000*

In addition, given the availability of funds for efforts such as this, we also recommend the City purchase new devices at a far larger scale to address Dallas residents' immediate challenges. A one-time purchase of new computers for the roughly 65,000 households that lack a computer[12] would cost approximately $13 million (Table 6).

Table 6: Estimated Budget for One-Time Device Purchase Program

Category	Budget
Obtain 65,000 devices (based on 2019 American Community Survey data that 12.8% of Dallas households lacked a computer)	$13,000,000
Total	**$13,000,000**
Estimated cost per household	*$200*

Community-based groups in Dallas are well-positioned to offer direct support services to residents. Supporting these established organizations would be an effective and efficient way for the City to enable digital skills training programs and device distribution efforts that meet residents' needs. Potential grantees include community centers, senior-serving organizations, health care centers, neighborhood organizations, faith-based organizations, immigrant support organizations, and organizations that provide support to those experiencing homelessness.

2.5 A municipal fiber-to-the-premises deployment would be unlikely to succeed without large and ongoing subsidies

While the City and DISD did not request an estimate for building a citywide fiber-to-the premises network, the topic arose during several of our meetings and reflected the City and DISD's desire to ensure all residents have access to state-of-the-art broadband service. Based on our decades of experience in other jurisdictions—and considering the presence of two incumbent providers with large service footprints—we can assert with a reasonable degree of confidence that building fiber-to-the-premises in Dallas would entail substantial capital expenditures—likely more than

[12] "Quick Facts: Dallas city, Texas," U.S. Census Bureau, https://www.census.gov/quickfacts/fact/table/dallascitytexas/PST045219 (accessed June 2021).

$1.5 billion—and would likely require ongoing operating subsidies from the City, DISD, or another entity. While such a network would provide state-of-the-art service, this approach would not constitute a digital equity solution. To support capital and operating expenses, the monthly costs to consumers would not necessarily be more affordable than existing options, and in fact could be more expensive, even with subsidies.

2.6 DISD should prepare for procurement of home-based services under the Emergency Connectivity Fund—potentially with bulk purchase from Charter or AT&T

The FCC's Emergency Connectivity Fund represents a significant opportunity for DISD to apply for federal funding to offset the costs of its efforts to ensure all unserved DISD families have broadband access for the coming school year. Importantly, federal reimbursement from the ECF could dovetail with a bulk-purchase of services from Charter or AT&T for unserved DISD families.[13]

As an estimate of the number of DISD households lacking broadband, we consider wireless infrastructure Model 2 (see Section 2.2), which aims to serve the 45,000 student households at schools with low CRI scores. If we estimate that a bulk purchase price might be around $20 per household per month, DISD could potentially facilitate the provision of broadband to those families for about $10.8 million per year—reimbursed by the Emergency Connectivity Fund in the first year to the extent a student is not currently connected. (While there has been some discussion in Washington of continued subsidy, we would not assume that ECF will continue to pay in future years.)

By way of background, the FCC's E-rate program has previously subsidized broadband service to schools and libraries. As we describe in Section 8.2.3, the American Rescue Plan Act included a $7.2 billion appropriation to create the Emergency Connectivity Fund, which extends E-rate support to reimburse schools and libraries for providing equipment and connectivity services to K-12 students *at their homes and other locations*. All schools and libraries that are eligible for E-rate are also eligible for the Emergency Connectivity Fund.

The FCC issued rules for the Emergency Connectivity Fund in May 2021. Priority is given to students and library users who will be unserved by broadband in this school year. The first application window has passed, but a second ECF application window will be open on Sept 28,

[13] Charter offers bulk-purchase option for entities such as cities or school districts to purchase internet services for residents. In February, Charter responded to a Region 10 ESC request for proposals (RFP) with an offer to provide 50 Mbps service for $29.99 monthly per household, which would be reduced to $24.99 if 3,000 or more subscribers were added.

2021 to October 13, 2021 for the current school year (specifically for July 1, 2021 to June 30, 2022). ECF will allow for reimbursement retroactively for qualified expenses within this period.

This program will pay 100 percent of a school or library's "reasonable" costs for mobile hotspots (up to $250 each), connected devices (up to $400 per device), and services; it will not cover the cost of infrastructure construction. Wi-Fi hotspots for school buses are allowed—and present an option for delivering service beyond individual homes.

In terms of services purchased with Emergency Connectivity Fund money, the FCC does not specify a minimum definition of broadband (such as the 25 Mbps download and 3 Mbps upload requirement for some other programs); rather, it requires the connection be sufficient to enable remote learning, which includes videoconferencing. As mentioned above, if DISD were to negotiate a bulk purchase of Charter or AT&T services to connect unserved DISD families, that contract could be eligible for reimbursement.

Unlike the standard, rigorous E-rate procurement process, the Emergency Connectivity Fund will require participating school districts and libraries to verify and self-certify that beneficiaries are not also receiving benefits under other federal programs such as the FCC's Emergency Broadband Benefit Program subsidy. If DISD or the Dallas Public Library tap into this funding source, they should develop a rigorous process and document every step, so as to be prepared for a potential future audit of their participation.

2.7 Evaluate bulk purchase of service for unserved residents

If the City were to consider a bulk-purchase of services for unserved residents, the annual costs could be considerably higher than a bulk-purchase program only for DISD families—depending on the scope of the subsidy effort (Table 7).

According to the Census, as of the American Community Survey for 2019, only 76.6 percent of Dallas' 513,000 households had a broadband internet subscription. We thus estimate 23.4 percent of households, or 120,000, lack a broadband subscription. Assuming a bulk purchase price of $20 per month, subsidizing service to those households would cost $28.8 million annually.

Alternatively, if the City were to bulk-purchase service for the estimated 56,000 households in poverty, its annual cost would be an estimated $13.4 million.

Table 7: Estimated Alternative Annual Budget for Ongoing Broadband Connectivity Subsidy Program

Alternative Proposed Criteria for Eligibility	Estimated Number of Eligible Households	Total Annual Budget
Households without a broadband internet subscription as of 2019 (American Community Survey)	120,000	$28.8 million
Households in poverty as of 2019 (American Community Survey)	56,000	$13.4 million
Estimated annual cost per household	*$240*	

2.8 Pursue relevant recent federal funding opportunities

Recent federal actions have led to an unprecedented magnitude of available broadband funding. Both the Consolidated Appropriations Act and the American Rescue Plan Act (ARPA) created new broadband funding opportunities, and the latter included a sizeable appropriation for the Department of Commerce's Economic Development Administration (EDA) Public Works and Economic Adjustment Assistance Program—which continues to be one of the most promising sources of funding for broadband projects in urban communities such as Dallas.

Based on our analysis of legislative language and guidance available as of the end of August 2021, we believe certain programs represent strong options for the City and DISD, while others are not realistic targets of opportunity. That said, it is important to understand the funding landscape is shifting in real time—and the agencies writing rules to distribute funds are in some cases adding requirements that were not part of the statutory language that created some of the programs.

We note that the current version of the infrastructure bill includes $65 billion toward broadband infrastructure and funds for subsidizing broadband service. We can assess the potential for the bill to assist the City and DISD when it becomes law. In terms of other near-term opportunities, we also note that EDA (Economic Development Administration) grants have a rolling application process and that the National Telecommunications and Information Administration (NTIA) Historically Black Colleges and Universities (HBCU) Grant is due December 1. Section 8 provides more detailed discussion of grant and funding opportunities.

2.8.1 Coronavirus State and Local Fiscal Recovery Funds Program

The Local Fiscal Recovery Funds program may be Dallas' most viable source of broadband funding because the City will control the funds. Established in ARPA, this program will distribute $350

billion in emergency funding to eligible state, local, territorial, and Tribal governments. Treasury has allocated about $350 million to Dallas.[14]

When Treasury announced its interim final rules, those guidelines included new restrictions that were not part of the authorizing legislation. The interim rules said the Local Fiscal Recovery Funds should not be targeted for areas where there is "reliable" 25/3 Mbps broadband service. Treasury has since clarified that these funds can be used in areas that already have 25/3 if the funds are primarily targeted for areas where 25/3 is not available.

2.8.2 Connecting Minority Communities Pilot Program

The Connecting Minority Communities Pilot Program[15] will provide $285 million in grant funding to eligible recipients to purchase broadband or eligible equipment, or to hire and train IT personnel. The program will be administered by NTIA.

This nascent program represents an opportunity for several institutions in Dallas to pursue funding to support instruction and remote learning capabilities, with priority placed on serving students who meet certain criteria to indicate need. Entities in Dallas that are eligible to apply for this program include the following:

- Dallas Nursing Institute (PBI)
- El Centro College (HSI)
- Mountain View College (HSI)
- Paul Quinn College (HBCU)
- Richland College (AANAPISI & HSI)
- University of North Texas at Dallas (HSI)

For higher education recipients, grants are intended to support instruction and learning, including remote learning.

2.8.3 Emergency Broadband Benefit Program

The Emergency Broadband Benefit Program, administered by the FCC, provides a monthly discount to eligible households for broadband service. This program (which we describe in Section 7.1.4,) pays a subsidy directly to eligible residents (in the form of a credit on their ISP's

[14] "Allocation for Metropolitan Cities," U.S. Department of the Treasury, page 24, https://home.treasury.gov/system/files/136/fiscalrecoveryfunds-metrocitiesfunding1-508A.pdf (accessed May 14, 2021).

[15] "Consolidated Appropriations Act, 2021," U.S. Congress, December 21, 2020, https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf (accessed May 10, 2021).

bill), so the City and DISD's role would be limited to encouraging and enabling residents to enroll, and potentially assisting residents who have difficulty accessing these benefits.

2.8.4 Coronavirus Capital Projects Fund

The $10 billion Coronavirus Capital Projects Fund is not a competitive-application program; states will receive a fixed allocation from this fund. Treasury's current guidance note that states will be asked to submit proposals on how the Capital Projects Fund allocations should be used. Until we have more defined rules, Treasury's guidelines indicate that state governments will have wide discretion for determining how to identify worthy projects.

That means, for example, that the City could propose to inject all funding from the Capital Projects Fund into its current programs with alignment to overall program guidelines on timing and purpose of expenditure.

We note that overbuilding is not a program goal. It is not clear what the final Capital Projects Fund rules will be, but Treasury's statement emphasizes the need to demonstrate bringing critical connectivity to those who do not currently have it. The companion State and Local Fiscal Recovery Funds also disincentivize overbuilds.

In other words, the Capital Projects Fund does not seem—according to Treasury's brief guidance released to date—to be designed to create more affordable service options by increasing competition (such as by building new infrastructure in an area that already has high-speed wireline service).

Section 8 describes grant and funding opportunities in greater detail.