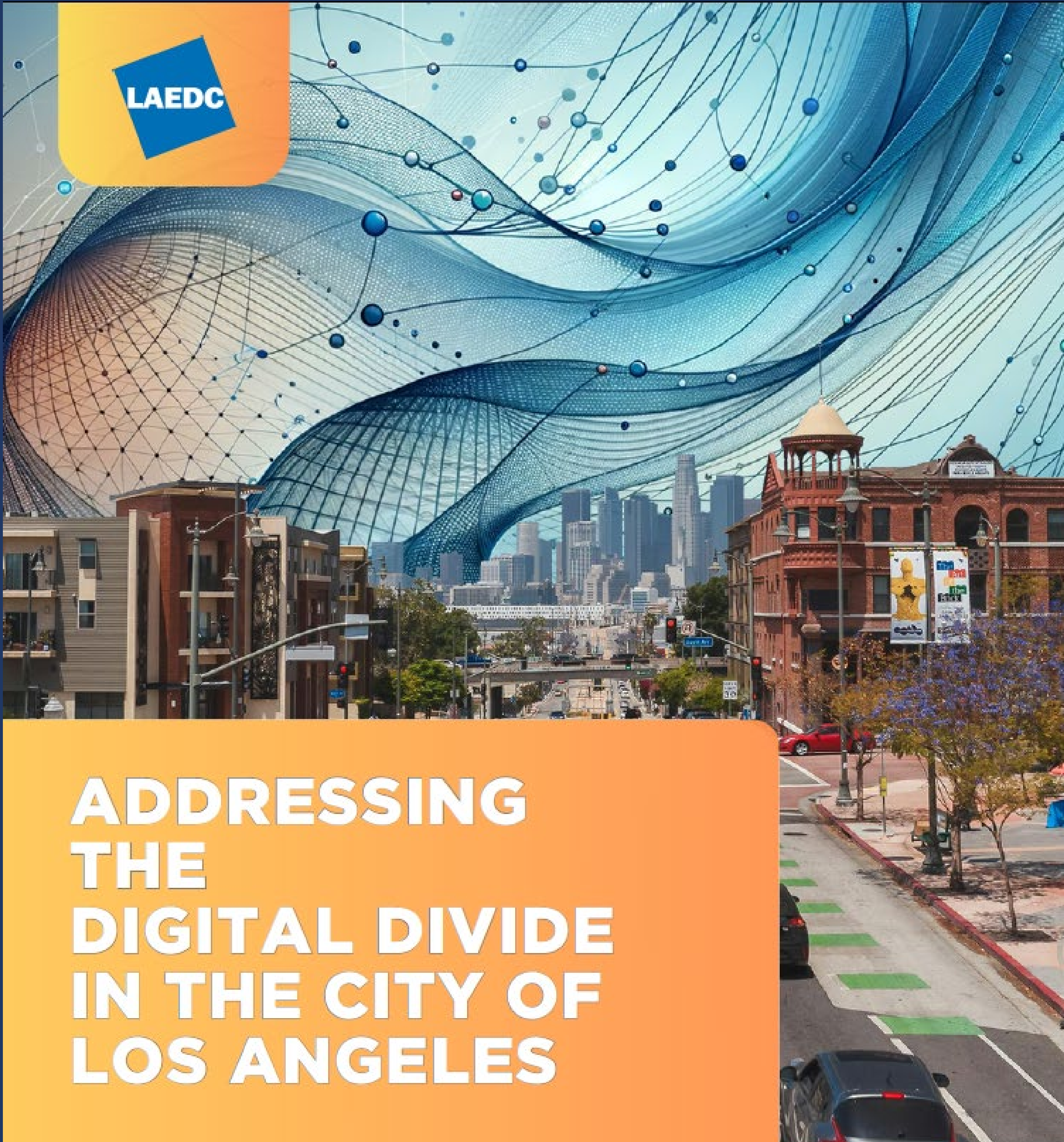

ADDRESSING THE DIGITAL DIVIDE IN THE CITY OF LOS ANGELES

AN ECONOMIC STUDY

LAEDC INSTITUTE FOR APPLIED ECONOMICS

MARCH 2024

ADDRESSING THE DIGITAL DIVIDE

In the City of Los Angeles

An Economic Study

INSTITUTE FOR APPLIED ECONOMICS
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Special thanks to our research intern Austin Domer.

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The LAEDC Institute for Applied Economics specializes in objective and unbiased economic and policy research in order to foster informed decision-making and guide strategic planning. In addition to commissioned research and analysis, the Institute conducts foundational research to ensure LAEDC's many programs for economic development are on target. The Institute focuses on economic impact studies, regional industry and cluster analysis and issue studies, particularly in workforce development and labor market analysis.

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EXECUTIVE SUMMARY

The digital divide, commonly defined as the economic, educational, and social inequalities between those who have computers and online access and those who do not, is an ongoing and pernicious issue that afflicts many people and communities across the City of Los Angeles. The City's Bureau of Street Lighting recently reported that approximately 14 percent of all individuals in Los Angeles live in households without a broadband subscription. Notably, the digital divide also disproportionately affects many diverse groups, including low-income households, older adults, those with less educational attainment, and those who identify as Black or Latino.

While top-level metrics of digital connectivity have been gradually improving—the U.S. Census Bureau's American Community Survey shows, for example, that the percentage of households without an internet subscription fell from roughly 19 percent to 8 percent between 2016 and 2022—the COVID-19 pandemic laid bare the importance of bridging the digital divide.[1,2] When households isolated themselves and businesses, schools and healthcare providers primarily went online, non-connected households suffered. Bridging the digital divide is critical to ensuring that everyone has access to vital services, from online classes to telehealth visits.

The digital divide is not just a matter of being connected, however. There are myriad reasons that households find themselves on the wrong side of the digital divide, from digital literacy to affordability to language barriers. These concepts have been discussed individually by many local, state, and national groups, although not always in a single coherent framework. A full understanding of the issues underpinning the digital divide, as well as the data available to examine these issues, is necessary to develop successful strategies for bridging it.

In discussing the digital divide, however, two points should be made at the outset. The first is that there is not a clear-cut line that demarcates who is on one side of the digital divide and who is on the other. Instead, there is a spectrum of connectedness with respect to factors such as internet speeds and available devices that prevent a simple, uniform definition from being formulated and applied.

[1] U.S. Census Bureau. (2017). 2016 American Community Survey 1-year Estimates Subject Tables, S2801, Types of Computers and Internet Subscriptions. https://data.census.gov/table?q=broadband+in+Los+Angeles+city;+California&tid=ACSST1Y2016.S2801

[2] U.S. Census Bureau. (2022). 2021 American Community Survey 1-year Estimates Subject Tables, S2801, Types of Computers and Internet Subscriptions. https://data.census.gov/table?q=broadband+in+Los+Angeles+city;+California&tid=ACSST1Y2021.S2801

The second is that there are multiple dimensions to the digital divide that must be addressed. Traditionally, much of the discussion on the digital divide has focused primarily on the access of individuals or households to information communication technologies such as broadband internet. There are other aspects to the digital divide beyond pure access to technologies, however. These include things like digital literacy.

That said, 'access' is a central theme underlying the digital divide. Access in this context means the ability to fully leverage broadband, not just connect to the internet. Access to broadband hinges on three types of access:

- **Geographical access** – being in a location where a fixed broadband connection is available and advertised at an affordable price
- **Financial access** – having the means to afford a fixed broadband connection and internet-enabled devices
- **Technical access** – developing the ability to use and speak about technology

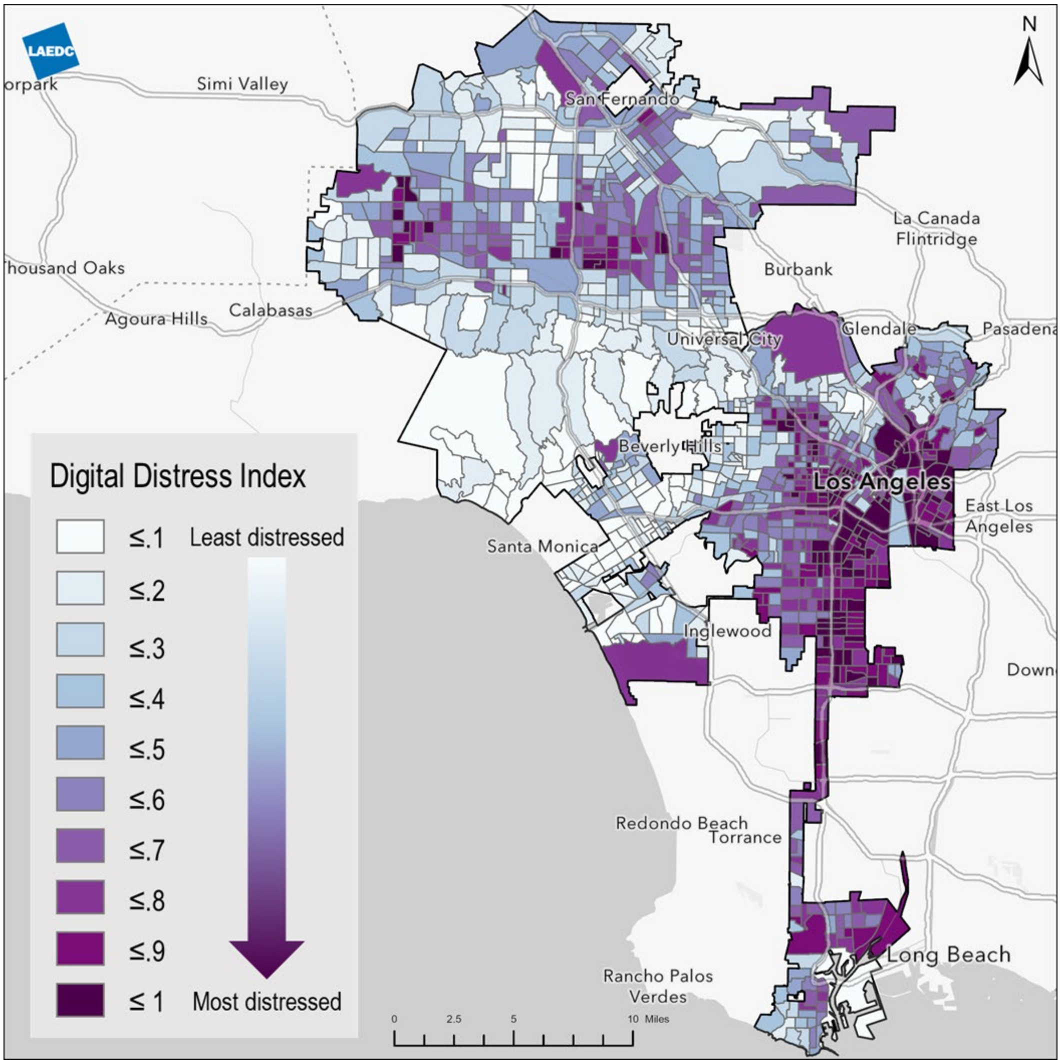
And access is affected by four specific elements: broadband infrastructure, broadband pricing, device availability, and digital literacy. With this in mind, we define those who are *digitally connected* as digitally literate individuals with an internet connected device other than a smartphone who pay less than 2 percent of their disposable income on broadband service with speeds above 100 megabits per second (Mbps) download and 20 Mbps upload. We define those who are *digitally distressed* as those who fail to meet any of the aforementioned conditions.

LAEDC Digital Distress Index (DDI)

We undertook a survey of available data on broadband infrastructure, broadband pricing, device availability and digital literacy to score different areas of the City according to their levels of digital distress and to map these results. While we encountered difficulties in this undertaking, notably the lack of available data measuring digital literacy and the dearth of data regarding the prices offered by ISPs at different geographic locations, we were successful in developing a unique LAEDC Digital Distress Index (DDI) to gauge the extent of disconnection across Los Angeles.

In **Exhibit ES-1**, we present a map of the LAEDC DDI below, showing the least distressed areas of the City of Los Angeles in white, those experiencing an average level of digital distress in a light violet color, and those experiencing the highest levels of digital distress in a dark plum. Areas in white or blue are in a state of average or below average digital distress, while those in shades of purple experience above average levels of digital distress.

Exhibit ES-1: Digital Distress Index in the City of Los Angeles, by Census Tract

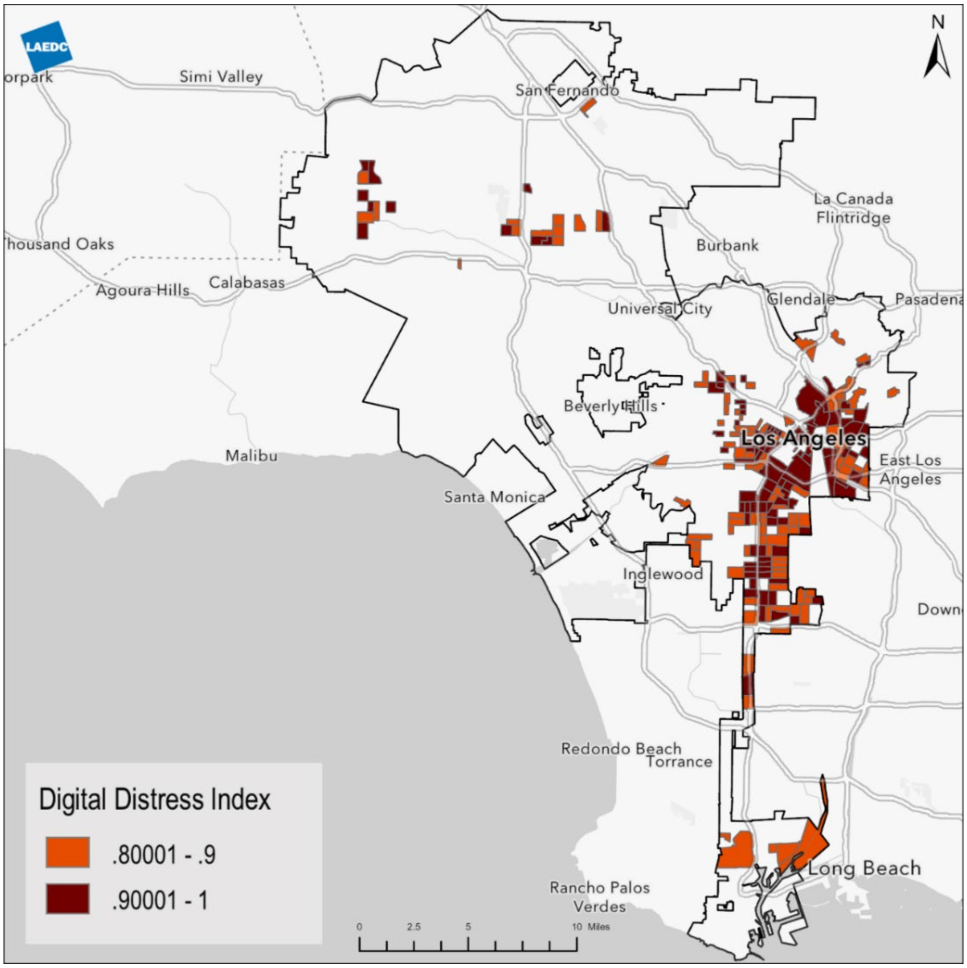


The LAEDC DDI shows a clear pattern of digital distress in the City of Los Angeles. We find elevated levels of digital distress throughout South Los Angeles, much of it straddling the 110 Freeway. Additionally, there are areas of high digital distress surrounding Downtown Los Angeles, with the areas east, north, and west of the City's financial district showing high levels of disconnection. There are notable pockets of elevated digital distress in the north part of the Harbor region, San Pedro, and the southern portion of the San Fernando Valley.[3] This pattern is more easily discerned when focusing

[3] Note that while UCLA, LAX, and Griffith Park appear to be digitally distressed, this is due to the Census Bureau's data reporting methods for broadband adoption; the outsize weight that broadband adoption has in the DDI calculation; and a low number of high-speed broadband providers since these areas do not have households that need individual broadband subscriptions or are not populated.

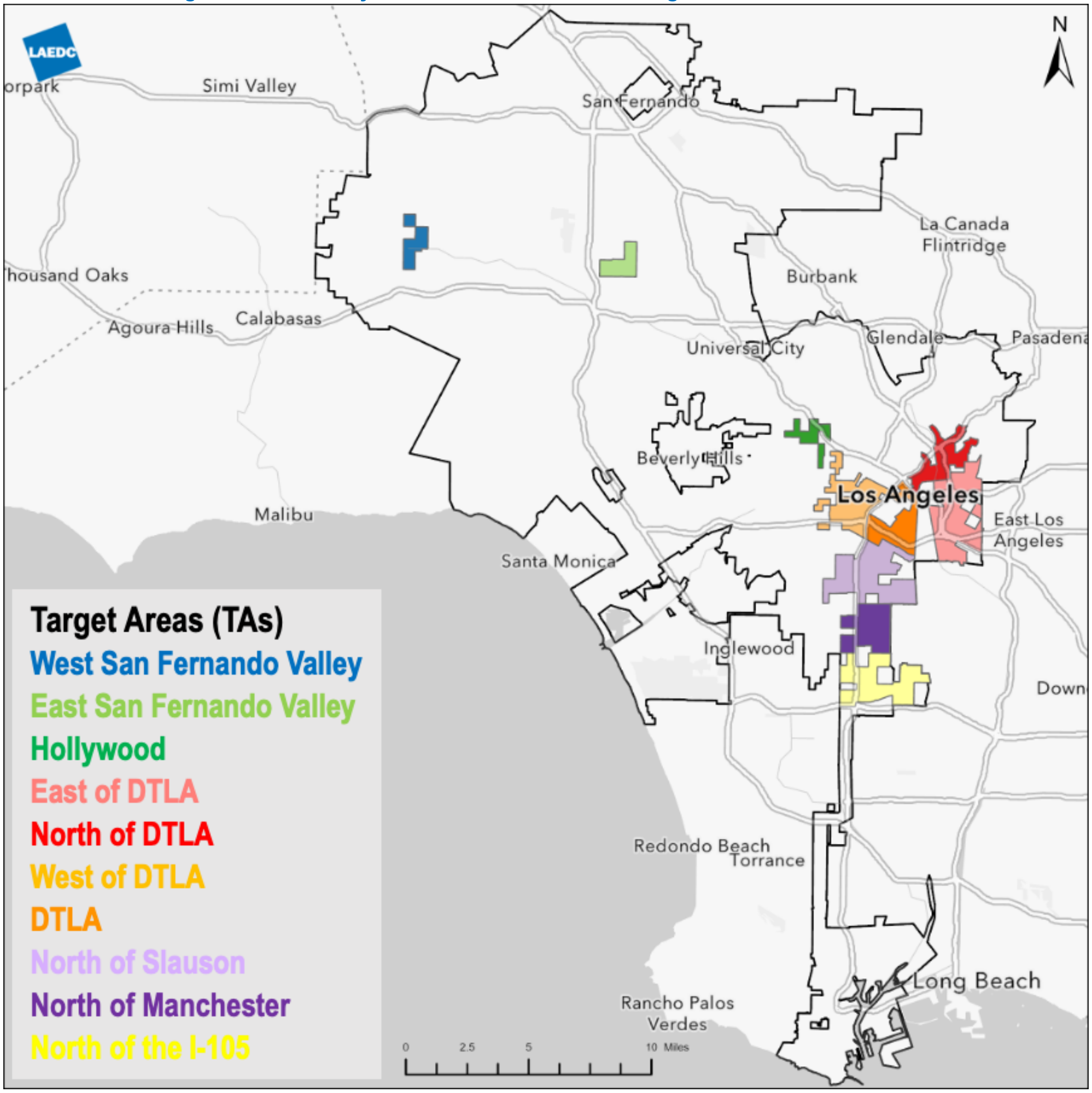
on just the top quintile of digital distress in the city, shown in **Exhibit ES-2** below in orange (DDI from .80001 to .9) and maroon (DDI from .90001 to 1).

Exhibit ES-2: Los Angeles Census Tracts with Elevated Levels of Digital Distress



We also identified 10 target areas for the Bureau of Street Lighting that would maximize the benefit provided by municipal-owned Wi-Fi resources. These are shown in **Exhibit ES-3** below. The target areas are clustered around downtown and south along the 110 Freeway until it reaches the 105 Freeway. Other than the West San Fernando Valley, East San Fernando Valley, and Hollywood target areas, the target areas are contiguous, stretching from Northeast Los Angeles to Watts and across the city from MacArthur Park to Boyle Heights.

Exhibit ES-3: Target Areas for City Wi-Fi Resources in Los Angeles



Given the significant burdens that the digital divide places on disconnected households, it is important to understand the socio-economic characteristics of these households in the City of Los Angeles. In this way we can uncover who is specifically bearing these burdens, and thus inform how the City can best address them to mitigate these impacts.

Consequently, we undertook a statistical analysis to determine how digital distress in the City of Los Angeles is related to socio-economic characteristics. We collected the following census-tract data for the City from the U.S. Census Bureau's American Community Survey (2021, 5-year estimates):

- Median household income and mean household income
- Household size
- Median age
- Racial and ethnic composition (percentage Black, Asian and Hispanic)
- Education (percentage with a bachelor's degree or higher)
- Households with children (percentage with children under 18)
- English-only speaking households (percentage)
- Poverty
- Population density and square kilometers

Statistical Analysis

The results from our statistical analysis show a strong connection between LAEDC DDI and the collected socio-economic characteristics. The analysis shows that increasing household income in a census tract entails a statistically significant reduction in digital distress, as one would expect. We find that increasing the median household income by $10,000 in an average census tract in Los Angeles is associated with a 2.6 percent reduction in digital distress, and moving from an area considered low income to an area considered otherwise results in a decrease in digital distress of 1.7 percent. Not surprisingly, lower digital distress is also tied to increases in connected households. Here, a 1 percent increase in the percentage of connected households results in a corresponding 1.13 percent decrease in digital distress. Education, household size and population density also show similar results. We also find that race and ethnicity are associated with digital distress. Holding all other variables at their means, we find that a 1 percent increase in the percentage of Black individuals results in an increase in digital distress by 0.17 percent. Similarly, a 1 percent increase in the percentage of Asian and Hispanic individuals results in increases in digital distress of 0.38 percent and 0.43 percent, respectively. This remains the case even after accounting for other factors such as income, education, and household size.

Finally, we ask what would the economic impact be of closing the digital divide in the City of Los Angeles? This is a challenging question to estimate precisely, especially given the myriad benefits associated with being connected: higher quality education and greater earning potential; access to more and better jobs; improved access to high quality healthcare. All of these affect residents' ability to escape poverty, build intergenerational wealth, and enjoy a better quality of life, and thus they are inherently difficult to quantify. At the same time, however, these are exactly the reasons why it is important to try to quantify the economic impact of closing the digital divide. Doing so can help illustrate the sheer magnitude of benefits that could result from a reasonable investment by the City.

We conducted a similar statistical analysis as described above, although here we attempted to discern how household income changes as the level of digital distress changes. We found that in some of our target areas, a one percent reduction in digital distress (as measured by the LAEDC DDI) is associated with an increase in mean household income of $240 to $325. The potential increases to household income vary across the City based on the different socio-economic characteristics present in the neighborhoods as well as their existing levels of digital distress.

LAEDC estimates that eliminating digital distress entirely from Los Angeles is equivalent to an additional $30.5 billion of income circulating throughout the economy every year.

Assuming that digital distress could be eliminated entirely in the City of Los Angeles, we estimate that doing so would be equivalent to an additional $30.5 billion of income circulating throughout the Los Angeles economy. Of course, closing the digital divide in and of itself could not guarantee these increases in income. That is because digital connectedness acts only as an enabler: it provides individuals the *opportunity* to acquire a better education, to find a more rewarding job, or receive better healthcare. The rest of society must do its part as well. For example, industry would need to provide a sufficient supply of well-paying jobs.

That said, even small reductions in digital distress in the City could result in significant and tangible benefits, particularly for low-income households. An extra few hundred dollars is money that could be saved to help buy a house or used to purchase more nutritious food. Or it could be saved for a rainy day, to cover college tuition, or to help build wealth. The impact could be transformative.

1. INTRODUCTION

The digital divide, commonly defined as the economic, educational, and social inequalities between those who have computers and online access and those who do not, is an ongoing and pernicious issue that afflicts many people and communities across the City of Los Angeles. The City's Bureau of Street Lighting recently reported that approximately 15 percent of all individuals in Los Angeles live in households without a broadband subscription. Notably, the digital divide also disproportionately affects many diverse groups, including low-income households, older adults, those with less educational attainment, and those who identify as Black or Latino.

While top-level metrics of digital connectivity have been gradually improving—the U.S. Census Bureau's American Community Survey shows, for example, that the percentage of households without a broadband subscription fell from roughly 19 percent to 8 percent between 2016 and 2021—the COVID-19 pandemic laid bare the importance of bridging the digital divide.[4,5] When households isolated themselves and businesses, schools and healthcare providers primarily went online, non-connected households suffered. Bridging the digital divide is critical to ensuring that everyone has access to vital services, from online classes to telehealth visits.

The digital divide is not just a matter of being connected, however. There are myriad reasons that households find themselves on the wrong side of the digital divide, from digital literacy to affordability to language barriers. These concepts have been discussed individually by many local, state, and national groups, although not always in a single coherent framework. A full understanding of the issues underpinning the digital divide, as well as the data available to examine these issues, is necessary to develop successful strategies for bridging it.

[4] U.S. Census Bureau. (2017). 2016 American Community Survey 1-year Estimates Subject Tables, S2801, Types of Computers and Internet Subscriptions.
https://data.census.gov/table?q=broadband+in+Los+Angeles+city;+California&tid=ACSST1Y2016.S2801
[5] U.S. Census Bureau. (2022). 2021 American Community Survey 1-year Estimates Subject Tables, S2801, Types of Computers and Internet Subscriptions.
https://data.census.gov/table?q=broadband+in+Los+Angeles+city;+California&tid=ACSST1Y2021.S2801

Report Organization

In this report, LAEDC analyzes the digital divide as it pertains to the City of Los Angeles and provides actionable information specifically to the Bureau of Street Lighting. We do so by presenting a comprehensive theoretical framework on the digital divide that leverages the prior work of others. Based on this framework, we develop a unique "digital distress" metric, which we then use to examine the extent of the digital divide across the City and identify areas where the problem is most severe and populations that are most exposed. We also estimate the economic benefit to the City of closing the digital divide.

The report proceeds as follows:

Section 2 of this report explains the elements behind digital divide and combines them into a unified theoretical framework. This section also describes the different types and sources of data that are available to analyze using the framework.

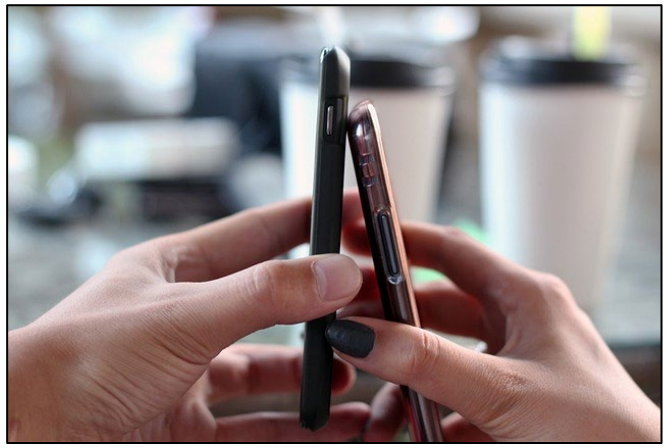
Section 3 of this report analyzes the extent of the digital divide within the City of Los Angeles. It first maps the publicly available data on the digital divide. It then combines the data into a single metric called the LAEDC Digital Distress Index (DDI), which is used to identify target areas across the City that are experiencing the digital divide to a greater extent.

Section 4 of this report examines the economic impact of the digital divide in the City of Los Angeles. It does so by quantitatively examining what socio-economic characteristics are associated with higher levels of digital distress, and by estimating the changes to household income that could result from closing the digital divide.

The report's **Appendix** presents the study's methodology and key assumptions as well as findings. It also includes data tables, maps, and statistical results.

2. UNDERSTANDING THE DIGITAL DIVIDE

In discussing the digital divide, two points should be made at the outset. The first point is that there is not a clear-cut line that demarcates who is on one side of the digital divide and who is on the other. Instead, there is a spectrum of connectedness with respect to factors such as internet speeds and available devices that prevent a simple, uniform definition from being formulated and applied. In this sense, the digital divide is a question of degree more so than a matter of absolutes.



The second point is that there are multiple dimensions to the digital divide that must be addressed. Traditionally, much of the discussion on the digital divide has focused primarily on the access of individuals or households to information communication technologies such as broadband internet. For example, the U.S. Census Bureau looks at how access to computers and broadband internet subscriptions has become increasingly important to Americans in carrying out their day-to-day lives.[6] In the same vein, the National Telecommunications and Information Administration (2021, p.6) describes coordinating a "whole-of-government approach to ensure that all Americans can access high-speed, affordable, and reliable Internet" to close the digital divide.[7] Also, the Federal Communications Commission (FCC) (2021, p.2) notes that over the past few years "the FCC's top priority has been closing the digital divide, in recognition that high-speed broadband and the digital opportunity it brings are increasingly essential to innovation, economic opportunity, healthcare, and civic engagement in today's modern society."[8]

There are other aspects to the digital divide beyond pure access to technologies, however. These include things like digital literacy. The Pew Research Center (2016, p.2) describes digital literacy as "the degree to which people succeed or struggle when they use technology to try to navigate their environments, solve problems, and make decisions."[9] Similarly, Levine and Taylor (2018, pp. 2-3) refer to 'meaningful internet access' as encompassing the digital literacy skills "necessary to utilize the programs and navigate the internet, sufficient for a consumer to utilize the use of technology to engage

[6] Ryan, C. & Lewis, J.M. (2017, September 11). *Computer and Internet Use in the United States: 2015*. U.S. Census Bureau. https://www.census.gov/content/dam/Census/library/publications/2017/acs/acs-37.pdf
[7] National Telecommunications and Information Administration (NTIA). (2021, December 23). *Access Broadband 2021 Report*. https://ntia.gov/sites/default/files/publications/ntia_access_broadband_2021_report_0.pdf
[8] Federal Communications Commission (FCC). (2021, January 19). *Fourteenth Broadband Deployment Report*. https://docs.fcc.gov/public/attachments/FCC-21-18A1.pdf
[9] Horrigan, J.B. (2016, September). *Digital Readiness Gaps*. Pew Research Center. http://www.pewinternet.org/2016/09/20/2016/Digital-Readiness-Gaps/

with online opportunities and services to improve their quality of life."[10] They also include issues like affordability. Galperin (2022), for instance, studies the effectiveness of the Emergency Broadband Benefit program to understand the effectiveness with respect to digital inclusion of reducing the cost burden of broadband connectivity for recipients.[11]

Given the different degrees and dimensions of the digital divide, developing a theoretical understanding of it is critical to analyzing the actual extent of the digital divide within the City of Los Angeles. Moreover, it is a necessary first step to synthesizing solutions to the digital distress that some residents experience, and to measuring progress as the digital divide is bridged.

Elements of the Digital Divide

A central theme underlying the digital divide is the notion of 'access.' Access in this context means the ability to fully leverage broadband, not just connect to the internet. Access to broadband hinges on three types of access:[12]

- **Geographical access** – being in a location where a fixed broadband connection is available and advertised at an affordable price
- **Financial access** – having the means to afford a fixed broadband connection and internet-enabled devices
- **Technical access** – developing the ability to use and speak about technology

Access is not determined by geography, economics, or experience with technology alone. Instead, each type of access is a necessary component to be able to fully leverage broadband service. Geographical access is determined solely by one's area of residence because internet service providers (ISPs) do not have the same technology installed and do not charge the same prices for plans across their territories. Financial access depends on the economic situation of individuals, who have some agency in determining the amount of disposable income that can be spent on being digitally connected but at the same time are subject to historical inequities and other factors. Finally, technical access hinges on familiarity and use of technology, which is impacted by factors such as age, education, and language, among other demographics.

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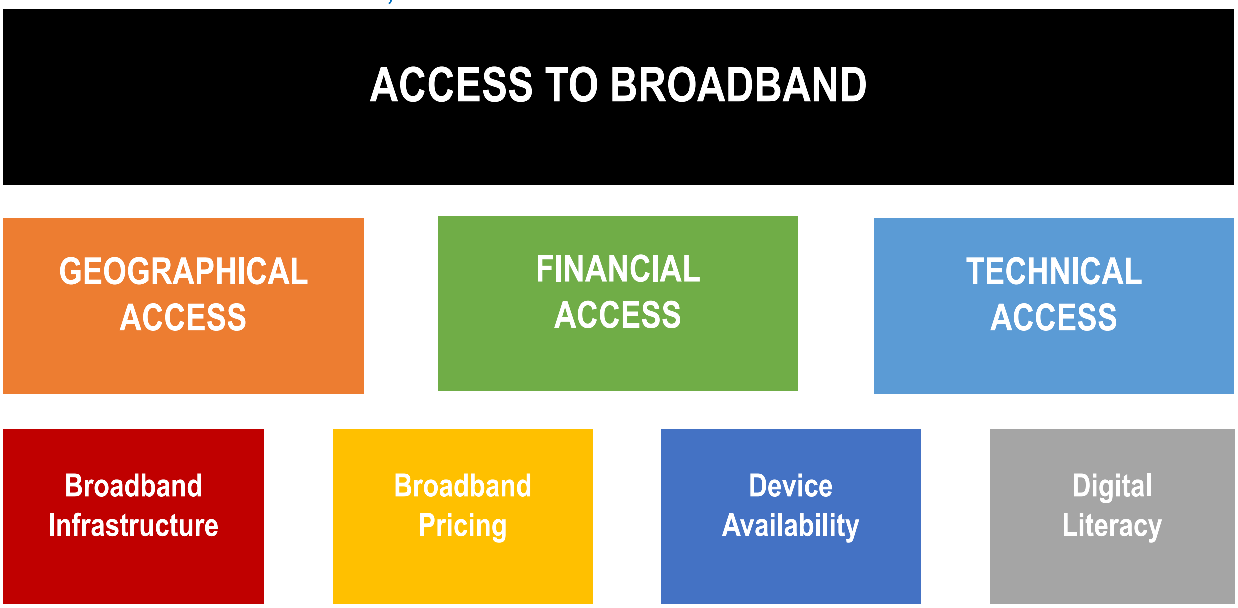
[10] Levine, L. & Taylor, M.P.H. (2018, May). *Closing the Digital Divide: A Historic and Economic Justification for Government Intervention.* WP#18-05. UC Riverside School of Public Policy. https://spp.ucr.edu/sites/default/files/2019-04/closing_digital_divide.pdf

[11] Galperin, H. (2022, October 2). *A Roadmap for Affordable Broadband: Lessons from the Emergency Broadband Benefit.* MEDIA Policy Brief #1, Annenberg Research Network on International Communication, University of Southern California. https://arnicusc.org/wp-content/uploads/2022/02/EBB_policy-brief.docx.pdf

[12] In his framing of the digital divide, Jan Van Dijk refers to physical access to computers and the Internet; skills access which is equivalent to digital literacy; and usage access which pertains to the amount of usage and the number of applications by different demographic groups. Our framework incorporates all three concepts. For more on Van Dijk's formulation, see Van Dijk, J. A.G.M. ((2017, March). *Digital Divide: Impact of Access.* https://doi.org/10.1002/9781118783764.wbieme0043

Exhibit 1-1 provides an expository exhibit with each type of access shown, in addition to the elements of the digital divide that make up each type of access. The elements are seen as the building blocks of the digital divide, as each pertains to a crucial part of the definition of digitally connected individuals. The four elements of the digital divide are broadband infrastructure, broadband pricing, device availability, and digital literacy. These elements, and the supply-side and demand-side issues that help shape them, are detailed in the sections below.

Exhibit 1-1: Access to Broadband, Visualized



Broadband Infrastructure

Broadband infrastructure refers to the deployment of existing broadband technologies and construction of new broadband technologies. One of the main drivers of the digital divide is that there is an uneven distribution of broadband resources across geographies. As a result, there are place-based limitations on how digitally connected an individual can be. For example, if someone lives in an area that has infrastructure that cannot offer speeds above 100 Megabits per second (Mbps) download and 20 Mbps upload, that individual would have to change residences to reach full connectivity meaning that buyers have very little agency. Ultimately, the market for the deployment of broadband infrastructure is shaped by high demand from households for broadband infrastructure and supply that is limited by internet service providers.

Supply-Side Issues

Internet service providers (ISPs) are the suppliers in the market, deploying broadband infrastructure to locations based on financial considerations. The main determinant in their deployment of broadband infrastructure is their ability to generate return on investment (ROI). However, there are different kinds of ISPs, each having a unique cost calculus. Traditional ISPs build and maintain wireline infrastructure in specified service areas and charge customers in those areas to use the technology. Meanwhile, mobile providers that offer fixed broadband services, municipalities that deploy technology, and satellite internet providers that can offer service anywhere have different cost considerations.

Traditional ISPs undertake more significant capital expenditure to deploy broadband infrastructure in areas where ROI is likely to be largest. As a result, more affluent neighborhoods and areas with higher broadband subscription rates logically would be favored, as they are able to afford more expensive plans and have guaranteed demand. ISPs also respond to competition from other suppliers: the supply of broadband infrastructure from multiple ISPs is anticipated to drive prices downwards, as ISPs compete for market share.

Wireless providers, municipalities, and satellite providers can provide alternatives, however. Wireless providers, for example, have begun using their 5G networks to offer fixed wireless broadband service to households. While still driven by ROI, the cost calculus for the construction of mobile infrastructure has other elements beyond the provision of broadband services such as complete mobile coverage of an area. Alternatively, municipalities can step in or create public-private partnerships to deploy broadband infrastructure that addresses inequities created by the uneven distribution by traditional ISPs. It should be noted, though, that he high levels of capital expenditure and additional administrative burden can become prohibitive factors for many municipalities. Finally, satellite providers can provide near-universal service, but their cost of service generally prevents them from providing household realistic alternatives.

Demand-Side Issues

Regarding the deployment of broadband infrastructure, individual households and businesses hold little sway over the decisions made by ISPs. While a household or business can wish for fiber optic internet, for example, there is no way to pressure the ISP to install the infrastructure. Instead, they must wait for the necessary technological and economic conditions for the ISP to act. That said, this lack of power individually in the market does not deter demand; in fact, households and businesses in an area can signal high demand for the deployment of new types of broadband infrastructure through heavy subscription to the most current available technology.

Households and businesses generally have more influence through municipal providers. If a municipality has high demand for deployment of broadband infrastructure, it can step in as a supplier or partner to meet that demand. Cities can act alone in this regard, like Culver City's Culver Connect Municipal Fiber Network for businesses;[13] establish public-private partnerships, like Culver City's agreement with Ting to build out Culver Connect to residents;[14] or build consortia like the South Bay Workforce Investment Board did with the South Bay Cities Council of Governments to deploy the South Bay Fiber Optic Network.[15]

[13] For more information, see https://www.culvercity.org/City-Projects/Culver-Connect-Municipal-Fiber-Network
[14] See https://www.culvercity.org/Have-Your-Say/Ting-Internet-Citywide-Fiber-to-the-Home-Project
[15] See https://southbaycities.org/programs/south-bay-fiber-network/

Broadband Pricing

Broadband pricing represents the rates that households and businesses pay to use the broadband services over suppliers' infrastructure. Here, suppliers try to maximize their ROI on their deployed infrastructure, while consumers want the cheapest service that meets their needs. At the same time, state and federal government-funded subsidies can affect the market to allow for greater connectivity among those who are priced out by ISPs.

Supply-Side Issues

In areas that are served by only one supplier, ISPs can exhibit pricing power. This means that ISPs do not necessarily charge the same prices for the same technologies across all areas. Instead, ISPs will price their plans differentially to recoup costs and maximize returns on their infrastructure investments. This can result in some communities with fewer likely adopters experiencing higher prices, and other communities with more likely adopters experiencing lower prices.

Researchers from the University of California Santa Barbara and the University of California Berkeley employed a novel approach to examine the offerings and pricing power of ISPs. First, they developed a broadband plan querying tool that captures the upload/download speeds and prices of broadband plans from seven major ISPs for any street address in the United States. Then, they used this broadband plan querying tool to compile a dataset of plans covering more than 837,000 street addresses in 30 cities, and analyzed these plans by comparing their carriage value (i.e., the megabits per second (Mbps) of a user's traffic that an ISP carries for one dollar).[16]

Their analysis shows, among other things, that ISP plans within a city are clustered spatially, and that the carriage value of the plans in a city can vary as much as 600 percent. Regarding pricing behavior, they found that competition can result in lower prices under certain circumstances. Specifically, cable-based ISPs were found to offer up to 30 percent more carriage value to users when competing with fiber-based ISPs in the same Census block group, although this was not the case when competing against DSL providers. Additionally, they found that the average income in a Census block group affects who receives fiber deployment – representing a better carriage value – and who does not.

[16] Paul, U., Gunasekaran, V., Liu, J., Narechania, T. N., Gupta, A., & Belding, E. (2023). *Decoding the Divide: Analyzing Disparities in Broadband Plans Offered by Major US ISPs*. arXiv preprint arXiv:2302.14216. https://doi.org/10.48550/arXiv.2302.14216

Demand-Side Issues

Similar to the deployment of broadband infrastructure, individual households and businesses have very little influence over the prices that ISPs charge them. Theoretically, consumers would seek out the lowest possible price to pay for internet services that meet their needs, but this necessitates having a choice over suppliers of broadband services. Often, this is not the situation. Instead, if plans at their desired price and speed are not available, consumers might find themselves compromising by purchasing internet services that are not affordable but meets their needs, or purchasing internet services that are affordable but does not meet their needs.

However, there are other routes for consumers potentially to obtain lower prices than an ISP might traditionally offer. One way is through bargaining with the ISP, for example by asking for an extension of the promotional discount that was initially offered, or otherwise threatening to unsubscribe service. This approach only works, though, if customers are aware of the tactic and feel comfortable entering the negotiation, or if the local market offers alternatives to the current provider. Another option is to take advantage of subsidy programs, like the federal Affordable Connectivity Program that provides $30 directly to ISPs to subsidize broadband plans for low-income households,[17] and the California Teleconnect Fund that provides 50% discounts on broadband services to schools, libraries, hospitals and community based organizations.[18] These subsidies allow households and organizations that would otherwise have to compromise or remain unconnected to receive improved broadband services.

Device Availability

Device availability refers to the ability of a user to get an internet-enabled device other than a smartphone that meets their needs. While smartphones provide a route to connectivity for many people, those with only a smartphone generally are considered underconnected, as they are not able to fully leverage many useful aspects of connectivity. With device availability, there are many stopgap solutions, however this report focuses on long-term solutions to the digital divide, so the discussion will focus on the ability for users to purchase computers and tablets. Device availability is a core element of the digital divide because it is necessary that households and businesses have suitable devices to take advantage of their broadband connections.

Supply-Side Issues

The supply-side of the device availability market is very different than broadband infrastructure or broadband pricing because device availability has very little to do with geographic location of a household or business. In the market for devices, geography does not limit supply; there are many more device manufacturers that a user can purchase from than there are ISPs from which they can purchase broadband services.

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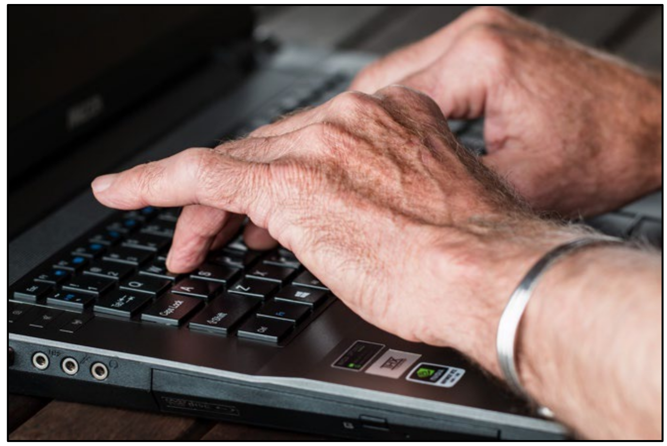
[17] See https://www.fcc.gov/acp

[18] See https://www.cpuc.ca.gov/consumer-support/financial-assistance-savings-and-discounts/california-teleconnect-fund



Three factors suggest that devices should become less expensive over time. The first is that the large number of competitors offering similar technologies helps to drive down prices. The second is that continual innovation in the device market results in faster, more powerful, and more durable devices regularly entering the market. As these new devices enter, they drive down the prices of the older technology, making those devices more affordable. The third is the growing supply of refurbished devices provided by retailers or in secondary markets, driven in part by environmental sustainability concerns of individuals and governments.

Demand-Side Issues

While consumers generally are interested in obtaining the least expensive available technology that meets their needs, this desire can be impacted by both cost and knowledge. On the cost dimension, we previously theorized that the prices of devices should be decreasing over time for a number of reasons. This suggests increasing affordability of and accessibility to computers and tablets. Additionally, for those still priced out of the traditional device market, other options like device loan programs have emerged. Device loan programs became popular during the pandemic, when schools rented laptops or tablets to students and libraries created programs to loan out devices and hotspots to community members.

On the knowledge dimension, consumers face the issue of understanding which devices are best suited to their needs. Many households and businesses, especially those that are less knowledgeable in terms of digital literacy, do not know if a tablet, laptop, or high-performance laptop would be most appropriate. There also are other knowledge gaps that can adversely impact demand, such as lack of knowledge regarding device loan programs and government subsidies. Increasingly, though, there are resources coming available like EveryoneOn that helps consumers in a given area bridge these knowledge gaps.[19]

Digital Literacy

Digital literacy is not a tangible product like a modem or device, instead it represents the skills to successfully use broadband and employ a device to realize the benefit of access to broadband. Without digital literacy, those with broadband plans and internet-enabled devices struggle to realize economic benefit from their investments. Digital literacy can relate to hardware, like setting up a modem or

[19] EveryoneOn helps unlock social and economic opportunity by connecting people in under-resourced communities to affordable internet service and computers, and providing digital skills trainings. See https://www.everyoneon.org/

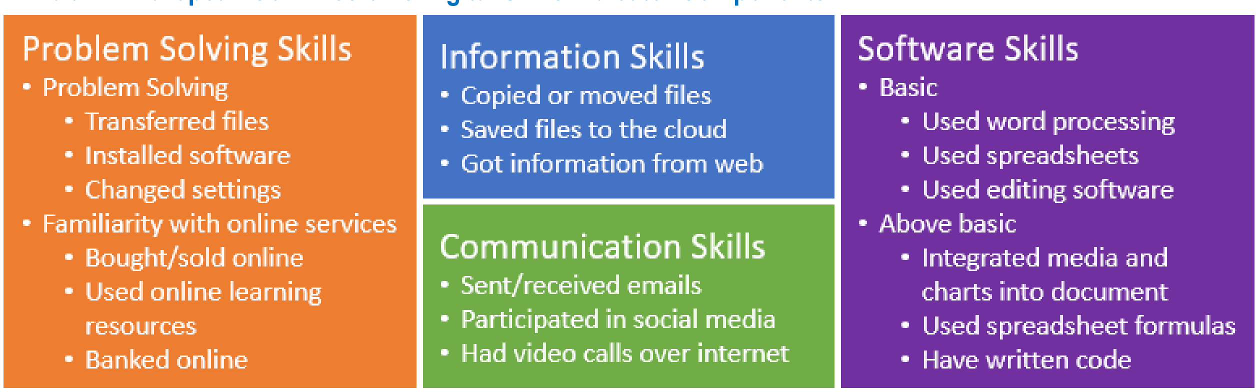
turning on a device, or software, from the ability to use Microsoft Word up to and beyond using a command prompt to communicate with a computer.

Crucially, digital literacy exists on a spectrum and is extremely difficult to measure. However, governmental organizations such as the European Commission have developed tools to break down digital literacy into component parts and measure aptitude in those, **Exhibit 1-2** displays some examples from the methodology of their Digital Skills Indicator.[20] Within each of the skills categories, problem solving, information, communication, and software, survey participants are gauged on whether they have above basic, basic, low, or no skills depending upon if they have used the internet and devices to accomplish the tasks listed. Then, using each component grade, their overall digital literacy is assessed along the spectrum.

Supply-Side Issues

Unlike providers of broadband and devices, many providers of digital literacy training are not corporations but instead non-profits seeking to maximize impact in their service areas. This does not mean that programs are always offered for free, however, as some level of revenue is necessary to provide their services. That said, the largest digital literacy trainer is neither a non-profit nor a corporation, but instead it is the public school system. The public school system teaches millions of American students how to use computers, knowledge that they build upon through the course of their education and life as well as share with others around them, such as digitally illiterate parents.

Exhibit 1-2: European Commission's Digital Skills Indicator Components



Having effective programs for all individuals at all stages of the digital literacy spectrum is crucial so that all individuals have a path to the level of digital literacy they desire. Designing, staffing, and publicizing these programs is the role of digital literacy providers. A notable supply constraint is the shortage of digital literacy trainers, especially multilingual trainers; without staff, it is impossible for these organizations to effectively provide training to those seeking skills.

[20] See https://digital-strategy.ec.europa.eu/en/library/new-comprehensive-digital-skills-indicator

Demand-Side Issues

The demand for digital literacy is reinforced when households and businesses recognize that digital literacy will help them better leverage broadband and devices for economic or personal gain. Those who generally need training in digital literacy include those who did not receive it in school, such as seniors and individuals coming from other countries or under-resourced school districts. A U.S. Department of Education report found that those with less educational attainment, who come from a different country, who are 45 years old or older, who identify as Hispanic or Black, who are not in the labor force, or who are in blue-collar and unskilled occupations are more likely to be digitally illiterate.[21]

Even if these populations are eager to receive digital literacy training, there may be barriers to their participation beyond simple awareness of programs. Through prior research efforts that involved engaging with local communities in the Los Angeles area, LAEDC has identified three main constraints preventing households and businesses from seeking out digital literacy training: time, money, and flexibility. Those who desire digital literacy training, if they are able to find a suitable program, often cannot sacrifice disposable income, time away from home, or a regular spot in their schedule to learn these skills, even if they recognize their benefit.

Summarizing the Digital Divide

Based on the four elements described above—broadband infrastructure, broadband pricing, device availability and digital literacy—we can provide a rough guide delineating the digital divide. We define those who are *digitally connected* as digitally literate individuals with an internet connected device other than a smartphone who pay less than 2 percent of their disposable income on broadband service with speeds above 100 megabits per second (Mbps) download and 20 Mbps upload. We define those who are *digitally distressed* as those who fail to meet any of the aforementioned conditions. It should be noted that even within households some members may be connected while others are digitally distressed, due to financial limitations, age, or other factors.

While digital connectivity is achieved through meeting these specified benchmarks and digital distress is defined in opposition to those, we emphasize that there are degrees of digital distress. Individuals who only have a smartphone to connect to the internet are considered underconnected, a form of digital distress, because their device lacks the full functionality present with a computer or tablet. Additionally, those receiving broadband that is less than 100/20—even though the Federal Communications Commission defines broadband as just 25/3 or above—are considered underconnected, since speeds above 100/20 increase the ability to use effectively multiple devices simultaneously over the same bandwidth.

[21] Mamedova, S. & Pawlowski, E. (2018, May). *Stats in Brief: A Description of U.S. Adults Who Are Not Digitally Literate.* U.S. Department of Education, NCES 2018-161. https://nces.ed.gov/pubs2018/2018161.pdf

Available Data on Digital Divide Elements

A survey of available data on broadband infrastructure, broadband pricing, device availability and digital literacy provides the next step towards understanding and quantifying the level of digital distress that areas in the City of Los Angeles experience. The discussion in this section focuses on spatial datasets that allow for the mapping a visualization of digital distress. After describing the extent of available resources, we analyze them for gaps that hamper the ability to measure the extent of the digital divide. We then provide recommendations for filling those gaps.

Data Dictionary

Exhibit 1-3 below lists the publicly available datasets broken out by the four digital divide elements. A full data dictionary, with descriptions, applications and shortcomings of each public data source is provided in the Appendix, a summary of which is presented in this section. The investigation of available data, applications and shortcomings only includes spatial datasets that can present the digital divide at sub-municipal geographies.

Regarding broadband infrastructure, the FCC and CPUC Form 477 datasets contain the ISP-reported information about broadband deployment infrastructure assets by census block, making them useful to the extent that they are reliable. The FCC releases an unverified record of ISP claims with an 18-month time lag, while the CPUC verifies the data but adds an additional six months for a total lag of two years. These data can be used to uncover which ISPs compete for consumers in a given area, as well as the technology present, which can serve as a proxy for investment. Both static municipal fiber maps and third-party online web maps of ISP coverage are not very useful for research purposes and require significant data gathering and cleaning. Ookla speed test data is available through their open data initiative, but speed tests are self-selective and are not a survey of regular speeds nor are they tied to ISP or plan performance, thereby preventing fair comparisons between advertised speeds and actual performance.

Exhibit 1-3: Publicly Available Datasets by Element of the Digital Divide

Element	Datasets
Broadband Infrastructure	• FCC Form 477 • CPUC Form 477 • Municipal Fiber Maps • Third-Party ISP Coverage Maps • Ookla Speed Test Data
Broadband Pricing	• ISP Website Address-Based Search • Universal Service Administrative Co. ACP Enrollment and Claims Trackers • U.S. Census Tables (e.g., B28002)
Device Availability	• Universal Service Administrative Co. ACP Claims Tracker • U.S. Census Tables (e.g., B28001)
Digital Literacy	None

The best broadband pricing data is found using the ISP address lookup tool on individual ISP websites. However, pricing information across all ISPs is not publicly available as a single dataset, instead requiring address-based queries to understand the available plans for each address. This makes it difficult to collect and analyze at scale, though the aforementioned U.C. Santa Barbara and U.C Berkeley (2023) report did this to draw wider conclusions. This data would allow a greater understanding of the pricing practices and deployment decisions by analyzing prices and speeds offered to different neighborhoods.

The Universal Service Administrative Co. (USAC) is the steward of nationwide Affordable Connectivity Program (ACP, formerly known as the Emergency Broadband Benefit (EBB)) data; they maintain a monthly dataset since May 2021 that details the number of households subscribed to the EBB/ACP subsidy programs and the total spending. The data does not directly relate to the price offered by ISPs, but points to the prevalence of subsidies as a market distortion mechanism.

Finally, the U.S. Census Bureau annually releases tables that detail the percentage of households with access to the internet, along with their type of access, broken out by a host of demographic categories by census tract. This somewhat controls for location and ISP pricing practices to understand how demographics correlate with broadband adoption. These tables do not directly link to price but serve as a proxy to understand the percentage of households in an area that deem broadband affordable enough to subscribe to it.

With respect to device availability, USAC maintains another monthly zip code level dataset that tracks the number of devices purchased with ACP vouchers, as well as the total spending on this device support. While this dataset is useful to track the impact of the program, tables from the Census Bureau are more useful when examining the rate of device adoption. Each year, the Census Bureau publishes data by census tract that looks at the types of devices in a household and also explores the presence of a computer by several demographic groupings. These data allow researchers to look at the rate of device adoption overall and by individual demographics, and to examine phenomena like underconnection.

Finally, there are no comprehensive, sub-municipal public datasets that track digital literacy. Data on digital literacy are collected only sporadically by institutions. For example, the U.S. Department of Education analyzed data it collected to find demographic trends on digital literacy. But this type of collection currently is not done on a geographical scale that would allow for targeted outreach to certain communities.

Gaps in Available Data

The most evident gap in the available data that could be used to measure the extent of the digital divide in Los Angeles County is the lack of a dataset that examines digital literacy. While the OECD Survey of Adult Skills examines the level of digital skills within their survey populations, their data is reported only at the national level. The lack of data on digital literacy means that a blind spot exists in the City's approach to bridging the digital divide. It is likely that digital literacy is less present among certain demographic groups, such as the elderly and non-English speaking Angelenos, however the extent of the disparity is unknown.

Data Gaps

- **Lack of digital literacy data at the local level**
- **Geographic price data for ISPs is not public**
- **Data on infrastructure and pricing not connected**

The other major gap in publicly available data on the digital divide regards the prices offered by ISPs at different geographic locations. Elsewhere in this report, LAEDC leveraged data collected by the California Community Foundation via ISP website searches to model the distribution of prices across Los Angeles County.[22] The collection of this data by the California Community Foundation, however, was laborious and the data they collected is limited in its geographic scope and resolution. Unlike digital literacy data, which is not collected by any known organization, this price data actually is maintained by ISPs. The downside is that it is not available for public use, thereby hampering consumers, concerned organizations, researchers, and government.

Finally, while there are datasets for broadband infrastructure (availability and performance) and broadband pricing, they are not connected in a very useful way. Specifically, the CPUC Form 477 data include the maximum advertised upload and download speeds for every ISP technology in every census block, but this data is separate from pricing and performance data. At the same time, both the pricing and performance data provided are not comprehensive but instead appear to be randomly chosen or self-selected on a limited basis. This makes it difficult for concerned parties to examine the connections between ISP offerings, the performance of broadband plans, and the prices charged to consumers.

Recommendations

Based on the data gaps identified above, LAEDC recommends the following to help close the digital divide in the City:

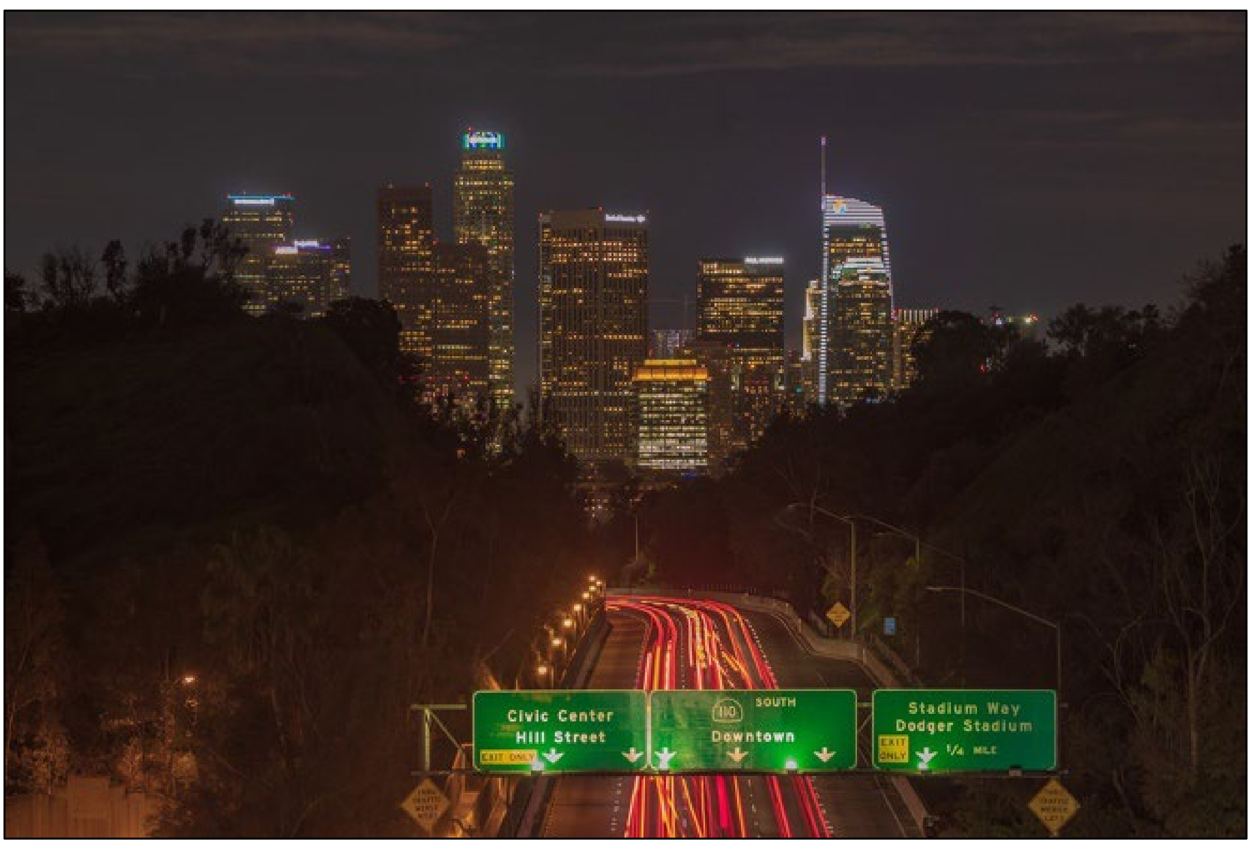
[22] California Community Foundation and Digital Equity Los Angeles. (2022, October). *Slower and More Expensive - Sounding the Alarm: Disparities in Advertised Pricing For Fast, Reliable Broadband.* https://www.calfund.org/wp-content/uploads/Pricing-Disparities-Report.pdf

Recommendation 2.1. The City of Los Angeles should begin collecting data on digital literacy at venues such as public libraries.

The City should begin collecting data on digital literacy to help understand the aptitude of those using City computer resources. City libraries would be the most obvious choice for this data collection since library patrons utilize computer resources and since they likely fall into the demographic groups with lower digital literacy. Additionally, library users would be the most likely to learn about any digital literacy courses offered by the City. Consequently, this would allow the City to design digital literacy interventions around this population.

Recommendation 2.2. The City of Los Angeles should develop data-sharing agreements with local ISPs.

To fill data gaps, particularly with respect to broadband availability, performance and prices, the City of Los Angeles should develop partnership agreements with local ISPs to share data. These data-sharing agreements ideally would provide the City comprehensive data on broadband availability, performance, and prices by census block. This access and insight would allow the City to help identify areas of Los Angeles that have a limited selection of broadband plans or that have anomalously high prices. Moreover, it would allow for additional analysis on the impact of plan availability and price differences so that the City could design effective interventions such as subsidies for households that remain underserved by ISP offerings.



3. THE DIGITAL DIVIDE IN THE CITY OF LOS ANGELES

This section of this report analyzes the extent of the digital divide within the City of Los Angeles. Building upon the previous section, we first map the publicly available data on the digital divide. We then combine the data by census tract into a single metric called the LAEDC Digital Distress Index (DDI). The LAEDC DDI helps to identify target areas across the City, as well as specific tracts within each City Council district, that are experiencing the digital divide to a greater extent than other areas. We then overlay these target areas with layers of streetlights and parcels and perform a buffer analysis to understand the optimal locations for installing Wi-Fi resources in underserved communities.

LAEDC Digital Distress Index (DDI)

We developed the LAEDC Digital Distress Index (DDI) to gauge the extent of disconnection that is present within different areas of the City of Los Angeles. We based the LAEDC DDI on the analysis in the prior section, constructing the index based on the four listed elements of the digital divide and calculating it using the available digital divide data. By evaluating these multiple factors, we were able to rank each geography from least distressed to most distressed.

We use the term "digital distress" in this analysis as opposed to digital divide or digital equity because those terms are relational in nature and the index does not examine the distance between the areas of the City that are well-connected and those suffering from disconnection. Instead, the LAEDC DDI quantifies the extent to which a community is disconnected, via a lack of high-speed broadband providers, expensive broadband prices, low broadband and device adoption rates, or a combination of these factors.

Digital distress indices have been calculated by other institutions, such as Purdue University's Center for Regional Development, and is a recognized term in the field.[23] However, our analysis is novel in its ideological framework, data sources, and granularity. While the Purdue Digital Distress Index is a useful synthesis of Census Bureau data that presents an understandable and actionable measure, the **LAEDC's DDI brings together multiple data sources—reported at various geographic scales or unique to California or Los Angeles County—and seeks to capture a wider range of the elements of the digital divide in its calculation**.

Due to a lack of granular digital literacy data, we calculated the LAEDC DDI using only measures related to broadband infrastructure, broadband adoption, broadband pricing, and device adoption. When possible, we defined broadband as speeds of 100 Mbps download and 20 Mbps upload. We combined data from the California Public Utilities Commission, Census Bureau, and California Community Foundation into a common geography, scored and weighted them, and then aggregated them to create the index. The LAEDC DDI ranges from 0 (least distressed) to 1 (most distressed).

[23] See https://pcrd.purdue.edu/ruralindianastats/broadband/distress.php

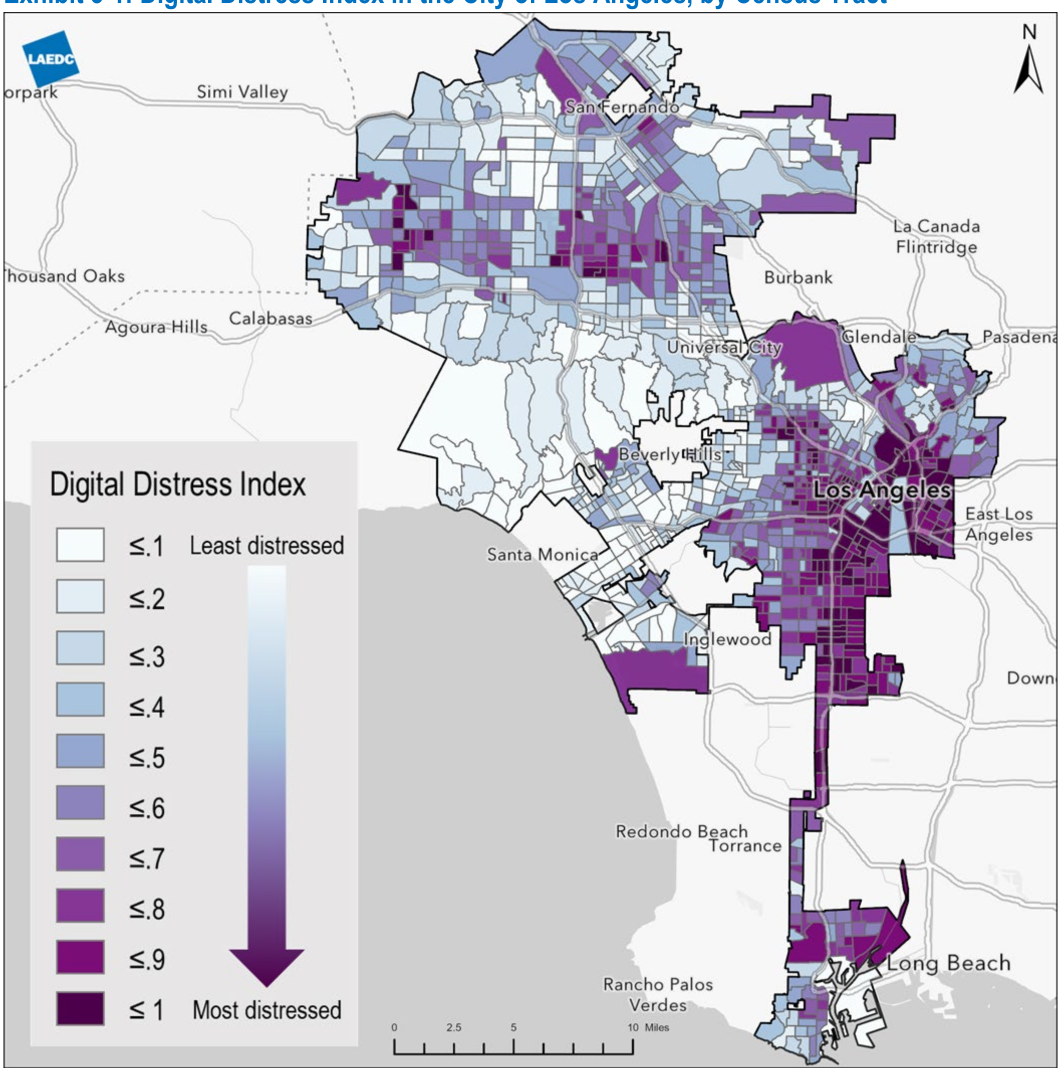
More information on the data employed and weighting of variables within the index is present in the methodology section of the Appendix.

It should be noted that although we originally created the LAEDC DDI at the census block level due to data availability, we employ both census blocks and census tracts for visualization. This is because census tracts provide a greater sense of the geographic distribution of digital distress across the city, while census blocks are essential in identifying specific locations to site Wi-Fi resources.

Digitally Distressed Areas in the City of Los Angeles

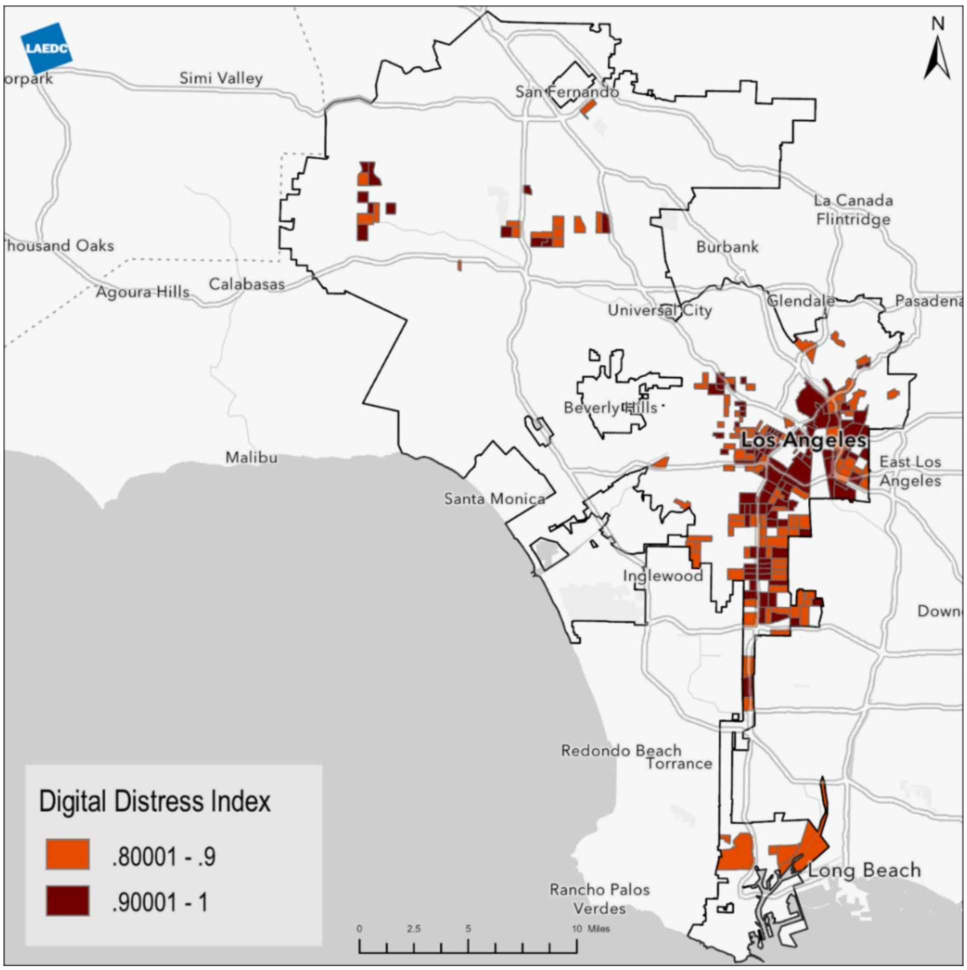
In **Exhibit 3-1**, we present a map of the LAEDC DDI below, showing the least distressed areas of the City of Los Angeles in white, those experiencing an average level of digital distress in a light violet color, and those experiencing the highest levels of digital distress in a dark plum. Areas in white or blue are in a state of average or below average digital distress, while those in shades of purple experience above average levels of digital distress.

Exhibit 3-1: Digital Distress Index in the City of Los Angeles, by Census Tract



The LAEDC DDI shows a clear pattern of digital distress in the City of Los Angeles. We find elevated levels of digital distress throughout South Los Angeles, much of it straddling the 110 Freeway. Additionally, there are areas of high digital distress surrounding Downtown Los Angeles, with the areas east, north, and west of the City's financial district showing high levels of disconnection. There are notable pockets of elevated digital distress in the north part of the Harbor region, San Pedro, and the southern portion of the San Fernando Valley.[24] This pattern is more easily discerned when focusing on just the top quintile of digital distress in the city, shown in **Exhibit 3-2** below in orange (DDI from .80001 to .9) and maroon (DDI from .90001 to 1).

Exhibit 3-2: Los Angeles Census Tracts with Elevated Levels of Digital Distress



[24] Note that while UCLA, LAX, and Griffith Park appear to be digitally distressed, this is due to the Census Bureau's data reporting methods for broadband adoption; the outsize weight that broadband adoption has in the DDI calculation; and a low number of high-speed broadband providers since these areas do not have households that need individual broadband subscriptions or are not populated.

Breakdown of LAEDC DDI by City Council District

We display in **Exhibit 3-3** below, in summarized form, the LAEDC DDI by census tract, aggregated into Los Angeles' City Council Districts. We provide more detailed information in the City Council Districts Information portion of the Appendix, where we present maps of each council district and percentage breakdowns for the LAEDC DDI.

Exhibit 3-3: Digital Distress Index by Los Angeles City Council District

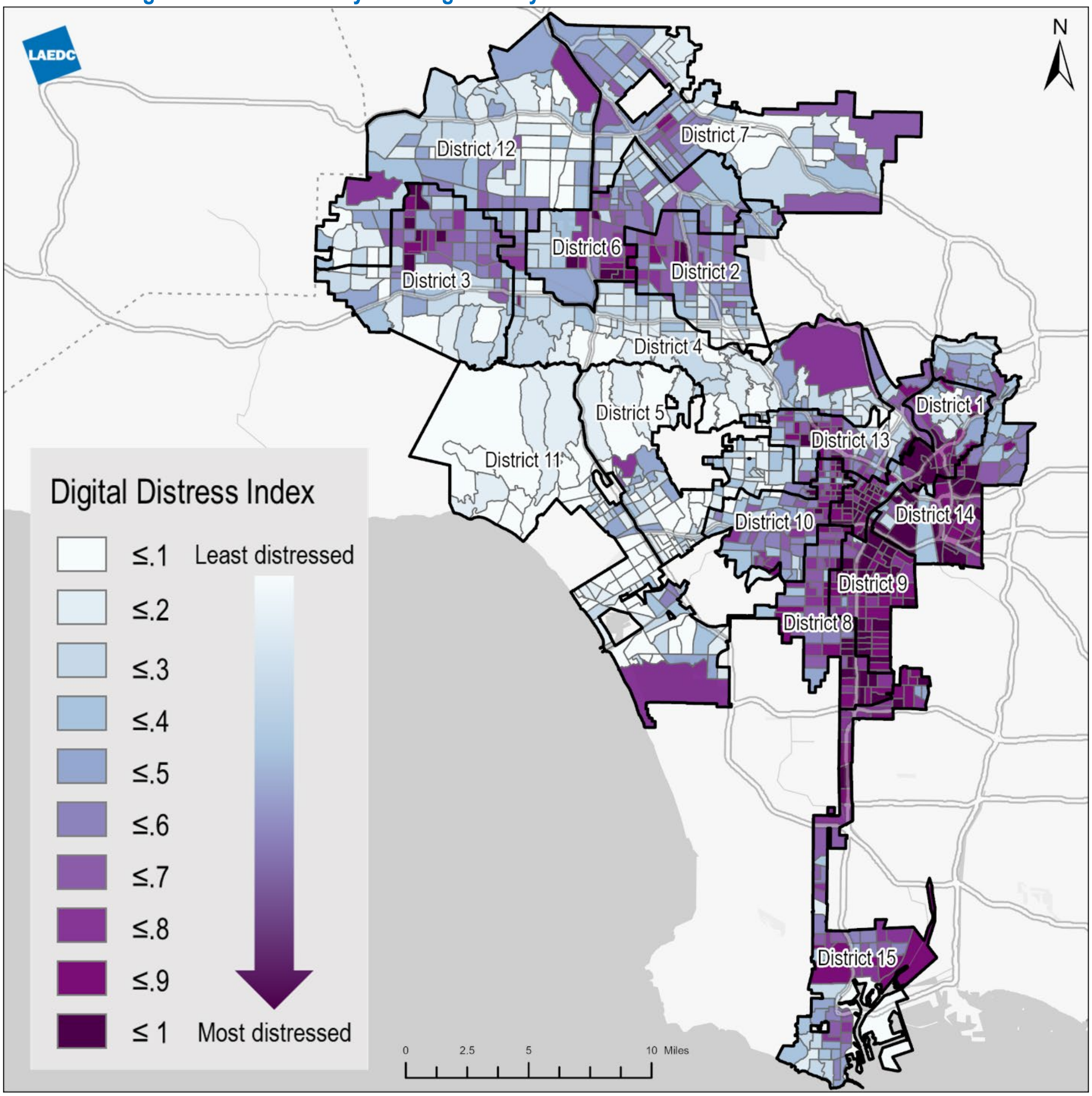


Exhibit 3-3 shows that areas of digital distress are not distributed evenly among Council Districts, with some being majority white/blue and others being almost solely purple. Using the quartile distribution of LAEDC DDI values and population estimates, we classified City Council Districts as having low, average, or high digital distress. Districts 9, 8, 1, 14, and 15 have the highest levels of digital distress (in descending order); districts 11, 5, 12, 4, and 7 have the lowest levels of digital distress (in ascending order); and districts 2, 3, 6, 10, and 13 have average levels of digital distress. The Appendix contains aggregated breakdowns of LAEDC DDI and maps of the census tracts within each council district.

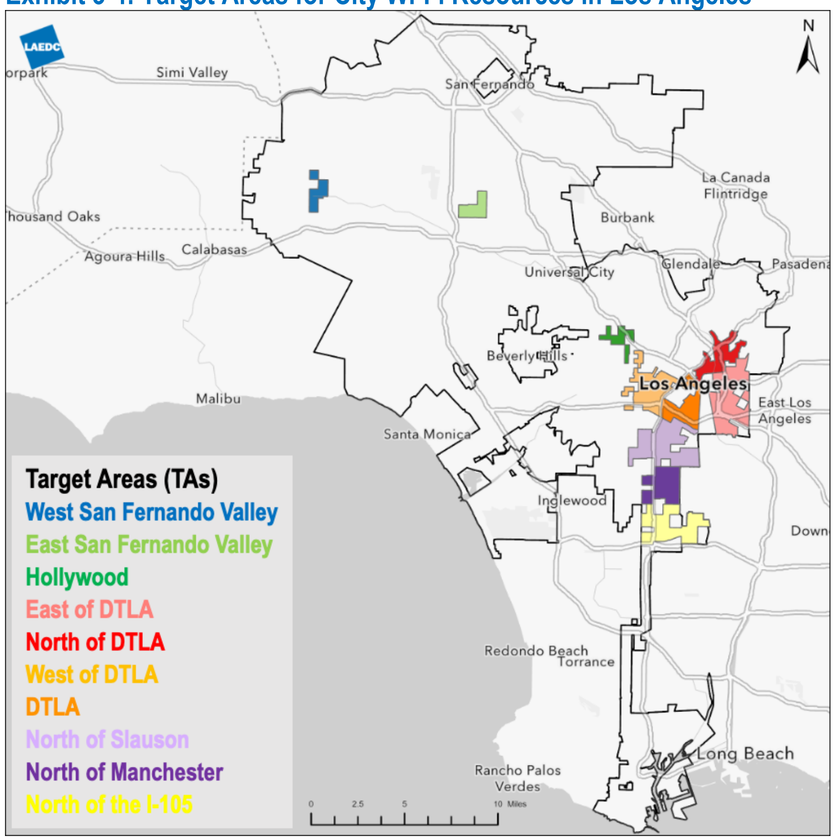
Identifying Target Areas

We identified 10 target areas for the Bureau of Street Lighting that would maximize the benefit provided by municipal-owned Wi-Fi resources. These are shown in **Exhibit 3-4** below. We used a high standard to develop these target areas: we required that areas eligible for selection had to include at least 5 census tracts in the top quintile of digital distress that have over 1,000 residents and that have queen contiguity.[25] To avoid classifying a large contiguous swath as a singular target area, we separated target areas along roadways when necessary. Note, due to the geographic constraint in the definition, not all of the census tracts in the 90th to 100th percentile of digital distress were classified as target areas.

The target areas are clustered around downtown and south along the 110 Freeway until it reaches the 105 Freeway. Other than the West San Fernando Valley, East San Fernando Valley, and Hollywood target areas, the target areas are contiguous, stretching from Northeast Los Angeles to Watts and across the city from MacArthur Park to Boyle Heights. **Exhibit 3-5** below shares the key demographics of these target areas, along with the percentage of households with broadband internet.

All target areas have a much lower percentage of

Exhibit 3-4: Target Areas for City Wi-Fi Resources in Los Angeles



Source: Analysis by LAEDC

[25] Here, queen contiguity means that the census tracts share a common border of non-zero length, implying that digital distress is concentrated.

households with broadband than the City as a whole, which has 78.1 percent, but other demographics are also anomalous: all of the areas have a higher percentage of minority individuals (71.1 percent for the City) and percentage of those with educational attainment of high school or less (40.3 percent for the City), while all except Downtown LA have a higher percentage of those who speak a language other than English at home (56.8 percent for the City). As a result, these target areas represent locations where collocating Wi-Fi resources and streetlights would not only address the digital divide, but also increase equity in access to broadband across the City.

Exhibit 3-5: Demographics of City of Los Angeles Target Areas

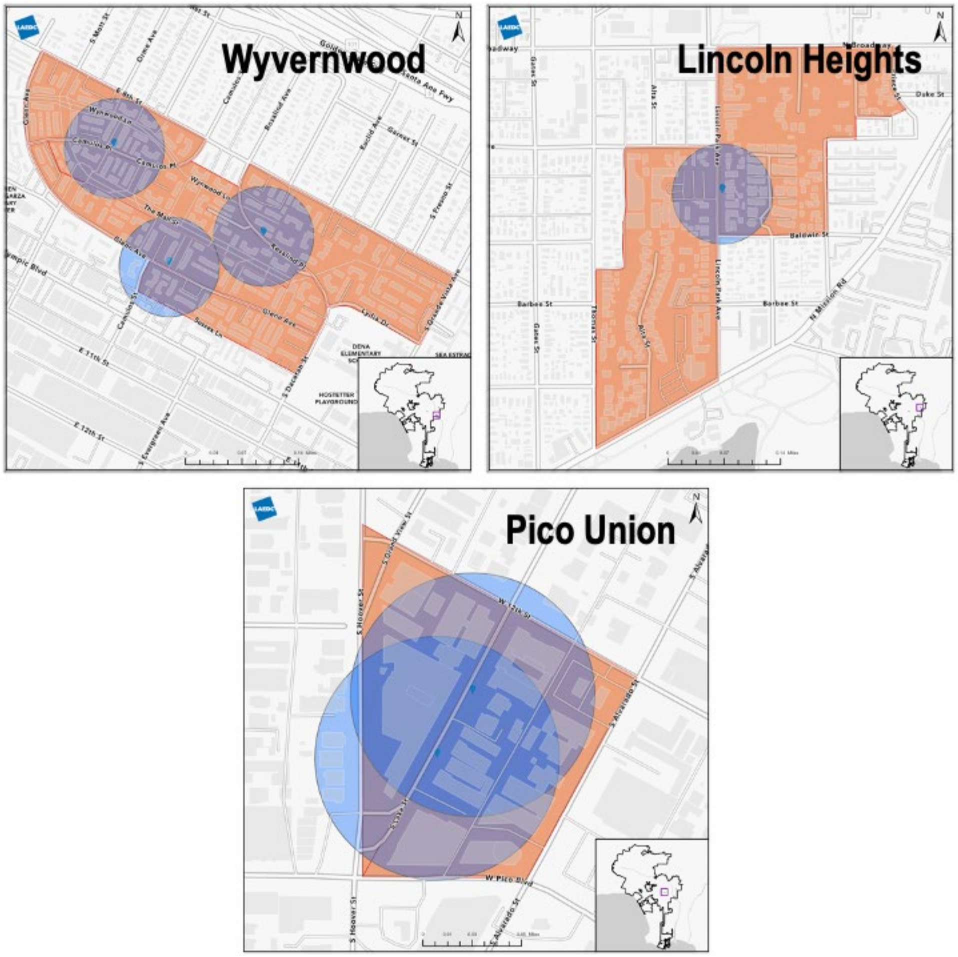
Site	Target Area	Households with Broadband (%)	Minority Race/ Ethnicity Residents (%)	Individuals with High School Diploma or Less (%)	Households where English is not Spoken at Home (%)	Average Household Size	School Enrollment Total
1	West San Fernando Valley	65.1%	85.2%	53.4%	75.3%	3.0	4,736
2	East San Fernando Valley	65.6%	85.0%	57.3%	79.0%	3.1	7,288
3	Hollywood	61.6%	82.7%	47.9%	76.5%	2.4	6,400
4	East of Downtown LA	55.1%	97.6%	71.4%	84.4%	3.4	22,515
5	North of Downtown LA	56.8%	90.9%	55.5%	75.8%	2.8	7,593
6	West of Downtown LA	53.3%	93.8%	61.2%	81.7%	2.6	37,703
7	Downtown LA	47.6%	82.6%	43.3%	50.5%	1.8	3,535
8	North of Slauson	54.2%	99.0%	75.9%	83.6%	3.9	42,955
9	North of Manchester	58.1%	99.4%	73.1%	76.6%	3.9	20,785
10	North of the I-105	54.4%	99.2%	71.1%	71.0%	3.9	27,154

Recommending Locations for Wi-Fi Resources

To identify the optimal streetlights for Wi-Fi placement, we used the LAEDC DDI dataset at the census block level. We filtered this dataset so that we considered only census blocks that are within target areas, that are in the top 95th percentile or higher of the LAEDC DDI, and that have over 500 residents. Only three areas have contiguous census blocks, the Wyvernwood garden apartments, Lincoln Heights, and an area in the Pico Union neighborhood bounded by S Hoover St to the west, S Alvarado St to the east, Pico Blvd to the south, and W 12th Street to the north.

In these areas, we identified centrally located streetlights that had an attachment to support Wi-Fi resources. These areas (in orange), along with the eligible streetlights and a 100-meter buffer (in blue) are displayed in **Exhibit 3-6** below.

Exhibit 3-6: Recommended Streetlights for Wi-Fi Placement



Only one centrally located streetlight in the highlighted Lincoln Heights area was suitable for a Wi-Fi attachment, so it is recommended that the Bureau of Streetlighting install attachments on additional streetlights nearby. Due to a lack of sub-census block population data, we were unable to calculate an exact number of served households using these streetlights. That said, if the City installed Wi-Fi resources so that all individuals in these census blocks could use municipal Wi-Fi, it would serve 6,799 residents, 94.9 percent of whom are minority residents.

These streetlight recommendations are intended to guide the City by suggesting locations that are densely populated and are experiencing significant digital distress. However, because Wi-Fi resources can require a line-of-sight to users for optimal performance, we also recommend that the Bureau of Streetlighting undertake a survey of the built environment before beginning any installation.

4. MEASURING THE IMPACT OF THE DIGITAL DIVIDE

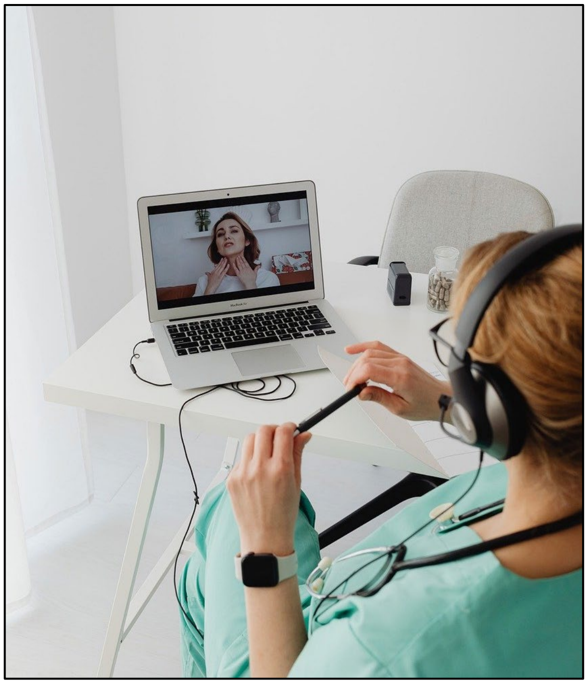
Impact of the Digital Divide

Addressing the digital divide in Los Angeles is imperative given the significant burdens it places on disconnected households over time. These impacts range from education to employment and wages to healthcare, and they have the potential to accumulate over the lifetimes of disconnected residents. Not only are there implications for disconnected households in terms of income and quality of life, but also for the economic health of the City itself.

Consider education as an example. In 2018, prior to the Covid-19 pandemic, the Pew Research Center surveyed teenagers on the homework gap, which refers to the difficulty that students face in completing school assignments due to lack of broadband access or appropriate technologies. The survey found that 17% of teenagers are often or sometimes unable to complete homework assignments because they do not have reliable access to a computer or internet connection. Additionally, the survey found that 12% of teenagers at least sometimes use public Wi-Fi to complete their assignments because they do not have an internet connection at home, and that 35% of teenagers often or sometimes have to do their homework on their cellphone.[26] These affected teenagers, then, face potential educational disadvantages as they prepare to enter college or the working world.

The digital divide also impacts employment opportunities and wages. A study by the Federal Reserve Bank of Philadelphia, for example, examined U.S. Census Bureau data to determine whether having access to a broadband-enabled computer was correlated with labor force participation rates. Greater labor force participation, meaning a larger percentage of the population that is either employed or unemployed but actively seeking employment, suggests that more people have the means for economic empowerment and economic mobility. The Federal Reserve Bank of Philadelphia found that across U.S. metropolitan areas, prime-age workers (people 25–54) with a broadband-enabled computer participate in the labor force at a much higher rate than prime-age workers without access. For the Los Angeles-Long Beach-Anaheim Metropolitan Statistical Area in particular, the labor force participation rate is 84% with a broadband-enabled computer and 75% without. They also found that

[26] Anderson, M. & Perrin, A. (2018, October 26). *Nearly One-in-five Teens Can't Always Finish Their Homework Because of the Digital Divide.* Pew Research Center. https://pewrsr.ch/2JirZar



areas having lower broadband subscription rates or lower computer access were associated with higher levels of poverty.[27]

Additionally, the digital divide affects residents' access to healthcare and their quality of life. This is seen especially through the rise of telehealth over the past number of years. Telehealth encompasses the variety of activities used to deliver healthcare remotely in lieu of in-person visits, such as telephone, video or online communications between patients and doctors, electronic diagnoses and consultations, and the monitoring of patients' wearable devices. Limited access to high-speed internet and computers means that these beneficial telehealth technologies remain out of reach to disconnected households.

The Covid-19 pandemic, with its resulting reliance on at-home learning and remote work, has only placed more emphasis on the importance of having broadband connections and computer access. This reliance has exacerbated the effects of the digital divide, which can be seen in the aforementioned areas.

Researchers from Brown University examined how student reading and math achievement at the beginning of the 2021 school year had changed from the previous two years. Looking at data from over 5.4 million students in grades 3-8 who took MAP Growth assessments in reading and math, they found that math achievement dropped across the first two years of the pandemic, while reading achievement dropped primarily in the second. Importantly, they found that achievement gaps between low- and high-poverty schools widened in the elementary school grades, and that these gaps are now approximately 20% wider in math and 15% wider in reading than before the pandemic.[28]

Our own analysis of U.S. Bureau of Labor Statistics data suggests that the Covid-19 pandemic has transformed the employment prospects of residents in the region. We compared occupational employment data on the percent of total employment in the Los Angeles-Long Beach-Anaheim Metropolitan Statistical Area between May 2018 and May 2021 (the latest data available). The data showed, unsurprisingly given the medical crisis, that healthcare practitioners and technical occupations as well as healthcare support occupations saw the largest share increases, going from 2.7% and 4.8%

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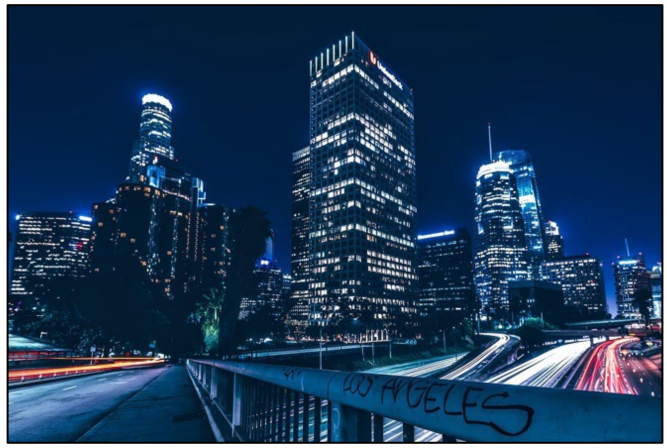
[27] Sanchez, A. & Scavette, A. (2021, June). *Broadband Subscription, Computer Access, and Labor Market Attachment Across U.S. Metros*. Federal Reserve Bank of Philadelphia. https://www.philadelphiafed.org/-/media/frbp/assets/community-development/reports/broadband-subscription-computer-access-and-labor-market-attachment-across-us-metros.pdf

[28] Kuhfeld, M., Soland, J., & Lewis, K. (2022). *Test Score Patterns Across Three COVID-19-Impacted School Years (EdWorkingPaper: 22-521)*. Annenberg Institute at Brown University. https://doi.org/10.26300/ga82-6v47



to 5.7% and 7.4%, respectively. However, the data also showed significant increases in occupations with the ability to work remotely. Management occupations, for example, increased their share of total employment from 5.9% to 7.2%. Business and financial operations occupations increased from 6.3% to 7.2%. By contrast, personal care, and service occupations such as hairstylists and fitness trainers declined from 6.3% to 1.7%. Office and administrative support occupations declined from 15.4% to 12.5%, and food preparation and serving related occupations declined from 9.5% to 7.8%.[29,30]

With respect to healthcare, the COVID-19 pandemic has created a new reality regarding virtual care, effectively forcing all healthcare systems, hospitals, and clinics to rapidly implement telehealth services and effectively change the delivery of patient care.[31] And connected households are those best able to take advantage of this new reality. Researchers studying patients who utilized the ambulatory clinics at Oregon Health & Science University (OHSU) in 2019 and 2020 found that a large portion of ambulatory patients shifted their care to telehealth, either audio or video, and concluded that the mode of telehealth used impacted their quality of care. They asserted that video is superior to an audio-only visit; while the telephone offers the benefit of access, video offers more, including a partial physical exam, nonverbal communication, and a stronger patient-provider relationship. Additionally, the use of video allows providers to check on a patient's home environment, where conditions and family wellbeing are often intertwined with health.[32]

Characteristics of the Digital Divide

Given the significant burdens that the digital divide places on disconnected households, it is important to understand the socio-economic characteristics of these households in the City of Los Angeles. In

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[29] U.S. Bureau of Labor Statistics. (2022, July 22). *Occupational Employment and Wages in Los Angeles-Long Beach-Anaheim — May 2021*. https://www.bls.gov/regions/west/news-release/2022/occupationalemploymentandwages_losangeles_20220714.htm

[30] U.S. Bureau of Labor Statistics. (2019, June 19). *Occupational Employment and Wages in Los Angeles-Long Beach-Anaheim — May 2018*. https://www.bls.gov/regions/west/news-release/2019/occupationalemploymentandwages_losangeles_20190619.htm

[31] Wosik, J., Fudim, M., Cameron, B., Gellad, Z. F., Cho, A., Phinney, D., Curtis, S., Roman, M., Poon, E. G., Ferranti, J., Katz, J. N., & Tcheng, J. (2020, May). Telehealth Transformation: COVID-19 and the Rise of Virtual Care. Journal of the American Medical Informatics Association, 27(6), 957–962.

[32] Sachs, J. W., Graven, P., Gold, J. A., & Kassakian, S. Z. (2021, July). *Disparities in Telephone and Video Telehealth Engagement During the COVID-19 Pandemic*. Journal of the American Medical Informatics Association Open, Vol. 4, Iss. 3. https://doi.org/10.1093/jamiaopen/ooab056

this way we can uncover who is specifically bearing these burdens, and thus inform how the City can best address them to mitigate these impacts.

A practical example of this importance was seen in the aforementioned study of patient clinics at Oregon Health & Science University (OHSU). The study found that certain demographic groups relied significantly more on audio-only telephone visits rather than video visits: those who were male, Black, American Indian, have Medicaid, prefer a non-English language, or were elderly. In other words, these were the groups identified as likely receiving a lesser quality of care because of their inability or unwillingness to use video consultations.

Consequently, we undertook a statistical analysis to determine how digital distress in the City of Los Angeles is related to socio-economic characteristics. We collected the following census-tract data for the City from the U.S. Census Bureau's American Community Survey (2021, 5-year estimates):

- Median household income and mean household income
- Household size
- Median age
- Racial and ethnic composition (percentage Black, Asian and Hispanic)
- Education (percentage with a bachelor's degree or higher)
- Households with children (percentage with children under 18)
- English-only speaking households (percentage)
- Poverty
- Population density and square kilometers

We then regressed the LAEDC DDI on these socio-economic variables by census tract. The final form of the econometric model as well as the results of the analysis are shown in the Appendix.[33]

The results from our statistical analysis show a strong connection between the LAEDC DDI and the collected socio-economic characteristics, where these variables explain 72 percent of the variation in DDI. The analysis shows that **increasing household income in a census tract entails a statistically significant reduction in digital distress,** as one would expect. Holding all other variables at their means, we find that increasing the median household income by $10,000 in an average census tract in Los Angeles (from $68,471 to $78471) is associated with a 2.6 percent reduction in digital distress (from 52.6 to 51.3). Separately, moving

Increasing the median household income by $10,000 in an average census tract in Los Angeles (from $68,471 to $78,471) is associated with a 2.6 percent reduction in digital distress (from 52.6 to 51.3).

[33] All of the variables described in the discussion below were statistically significant at the 0.01 level or better. The nondiscussed variables were either not included because of high correlation or were not found to be statistically significant.

from an area considered low income to an area considered otherwise results in a decrease in digital distress of 1.7 percent.

Moving from an area considered low income to an area considered otherwise results in a decrease in digital distress of 1.7 percent.

Not surprisingly, **lower digital distress is also tied to increases in connected households**. Here, a 1 percent increase in the percentage of connected households results in a corresponding 1.13 percent decrease in digital distress. Education, household size and population density also show similar results. A 1 percent increase in the percentage of **individuals with a bachelor's degree or higher, average household size, and population density, reduce digital distress** by 0.31 percent, 0.11 percent, 0.02 percent, respectively. While more education and population density (i.e., urbanization) would be expected to decrease digital distress, it is not clear at the outset why household size would play a role. It could be that the increase in household size represents a proxy for household income that is not otherwise being captured in the model, but nevertheless the impact of household size on digital distress is small.

We also find that **race and ethnicity are associated with digital distress**. Holding all other variables at their means, we find that a 1 percent increase in the percentage of Black individuals results in an increase in digital distress by 0.17 percent. Similarly, a 1 percent increase in the percentage of Asian and Hispanic individuals results in increases in digital distress of 0.38 percent and 0.43 percent, respectively. This remains the case even after accounting for other factors such as income, education, and household size.

Race and ethnicity are associated with digital distress even after accounting for other factors such as income, education, and household size.

Economic Impact of Closing the Digital Divide

What would the economic impact be of closing the digital divide in the City of Los Angeles? This is a challenging question to estimate precisely, especially given the myriad benefits associated with being connected: higher quality education and greater earning potential; access to more and better jobs; improved access to high quality healthcare. All of these affect residents' ability to escape poverty, build intergenerational wealth, and enjoy a better quality of life, and thus they are inherently difficult to quantify. At the same time, however, these are exactly the reasons why it is important to try to quantify the economic impact of closing the digital divide. Doing so can help illustrate the sheer magnitude of benefits that could result from a reasonable investment by the City.

Our overall approach to estimating the economic impact of closing the digital divide involved two parts. First, we conducted a statistical analysis on U.S. Census data for the City of Los Angeles to determine how average household income is associated with digital distress. That is, we regressed mean household income on the LAEDC DDI and other socioeconomic characteristics such as race and education to estimate how household income changes as the LAEDC DDI changes. Second, we

Being able to reduce the LAEDC DDI by just one percentage point (from 52.6 to 51.6) could increase the mean household income in Los Angeles by an estimated 0.58 percent.

used these estimates to calculate the total amount that mean household income would increase by eliminating digital distress, and then extrapolated this amount across all households in the City.

For the statistical analysis, we used the dataset of socioeconomic variables described above, collected at the census-tract level. The final form of the econometric model used, as well as the results of the analysis, are presented in the Appendix. The results from our statistical analysis show a strong connection between mean household income and the LAEDC DDI in conjunction with the collected socio-economic characteristics; together, these variables explain 79 percent of the variation in mean household income. Holding all variables at their means, the statistical analysis shows reducing the LAEDC DDI by one percentage point (from 52.6 to 51.6) increases the mean household income in Los Angeles by 0.58 percent.

This finding allows us to estimate the economic impact of closing the digital divide in different parts of Los Angeles. For the Pico Union neighborhood described in the previous section as having optimal streetlights for Wi-Fi placement, we estimate that reducing digital distress to the mean level seen in the City of Los Angeles could increase average annual household income there by $10,110. This is shown in **Exhibit 4-1** below, along with Pico Union's current DDI. For the Lincoln Heights and Wyvernwood neighborhoods, reducing digital distress to the mean level in Los Angeles could result in increases of $12,400 and $15,720, respectively. Their current DDIs are also shown in Exhibit 4-1. The potential increases to household income vary across these neighborhoods based on the different socio-economic characteristics present there as well as their existing levels of digital distress.

Exhibit 4-1: Economic Impact of Reducing the Digital Divide in Target Areas

Target Area	Current DDI	Hypothetical DDI	Increase in Mean Household Income
Pico Union	86.3	52.6	$10,110
Lincoln Heights	87.1	52.6	$12,400
Wyvernwood	94.1	52.6	$15,720

Assuming that digital distress could be eliminated entirely in the City of Los Angeles, we estimate that doing so would be equivalent to an additional $30.5 billion of income circulating throughout the Los Angeles economy.[34] Of course, closing the digital divide in and of itself could not guarantee these increases in income. That is because digital connectedness acts only as an enabler: it provides individuals the *opportunity* to acquire a better education, to find a more rewarding job, or

[34] No census tract in our dataset had an LAEDC DDI below 11.4. Thus, we estimated the impact of reducing the LAEDC DDI from 52.6 to 11.4 rather than to zero.

receive better healthcare. The rest of society must do its part as well. For example, industry would need to provide a sufficient supply of well-paying jobs.

Eliminating digital distress entirely is equivalent to an additional $30.5 billion of income circulating throughout the Los Angeles economy.

That said, even small reductions in digital distress in the City could result in significant and tangible benefits, particularly for low-income households. An extra few hundred dollars is money that could be saved to help buy a house or used to purchase more nutritious food. Or it could be saved for a rainy day, to cover college tuition, or to help build wealth. The impact could be transformative.

APPENDIX

Methodology for LAEDC Digital Distress Index (DDI) Calculation

The LAEDC used data from the Census Bureau's 2021 American Community Survey 5-Year Estimates, CPUC Fixed Consumer Deployment Data as of 12/31/2020, and a spatial dataset created from the dataset shared in CCF's Internet Pricing Disparities Report (https://www.calfund.org/wp-content/uploads/Pricing-Disparities-Report.pdf) to calculate scores for the following categories:

- No Broadband Score, Table B28002:
- Underconnection Score, Table B28001:
- Lowest Price Rank Score, CCF Pricing Disparities Report
- High Speed Providers, CPUC Fixed Consumer Dataset
- Fiber Indicator, CPUC Fixed Consumer Dataset

To calculate the index, the scores and the indicator were weighted to produce a score from a theoretical 0 to 100 and ranked to provide values between 0 and 1, with 0 representing the lowest level of digital distress (highest connectivity) and 1 representing the highest level of digital distress (lowest connectivity) The LAEDC Digital Distress Index was determined for each census block.

Using the census block level LAEDC DDI Score, we calculated DDI's for other geographic scales and geographic extents.

Data Library

Dataset	Element	Description	Shortcomings	Application
FCC Form 477 Fixed Broadband Deployment Data	Infrastructure	ISP reported presence of infrastructure by census block, updated every six months.	The FCC Form 477 data relies solely on ISP reporting. Additionally, the presence of technology assets does not ensure one or all of the occupants of the census block can receive service via the technology. Furthermore, it only includes the maximum advertised download and upload speeds, which may differ from performance. The Form 477 is being sunsetted as a form of data collection and changes to the format of the data may be coming in the next few years.	This data provides a semi-reliable survey of available internet assets. It can be used to identify the number of ISPs in an area and gauge the level of investment via the presence of fiber technology. The time series allows for the analysis of changes dating back from 2014 to roughly 18 months from the present.
CPUC Form 477 Fixed Broadband Deployment Data	Infrastructure	CPUC collects and verifies ISP reported presence of infrastructure by census block, updated every six months.	The CPUC Form 477 data independently verifies data reported by the ISPs, making it slightly more reliable, however there is a longer data lag. As with the FCC data, the presence of technology assets does not ensure one or all of the occupants of the census block can receive service via the technology. Furthermore, it only includes the maximum advertised download and upload speeds, which may differ from performance. The Form 477 is being sunsetted as a form of data collection and changes to the format of the data may be coming in the next few years.	This data provides a more reliable survey of available infrastructure however it is less relevant when released due to the additional lag. It can be used to identify the number of ISPs in an area and gauge the level of investment via the presence of fiber technology. The time series allows for the analysis of changes dating back from 2014 to roughly 24 months from the present.

Municipal Fiber Maps	Infrastructure	Static maps that display the current fiber infrastructure in an area.	The data that these maps use are often not available due to security concerns about the disclosure of the precise location of assets. As a result, researchers need to reconstruct the data based on images and may introduce some inaccuracies. Furthermore, they do not disclose what areas can be served by the technology, only disclosing its presence.	These maps can help understand the extent of municipal fiber investment but otherwise have limited use
Third-Party ISP Coverage Maps	Infrastructure	Online resources with web maps that show areas where ISPs provide service	Like municipal fiber maps, the data underneath the maps is often unavailable and would need to be reconstructed. These maps are more for public knowledge than research applications.	Maps help the public understand national coverage by an ISP
Ookla Speed Test Data	Infrastructure	Quarterly aggregation of speed tests into pixels, displays the average download and upload speeds, latency, number of tests, and devices in each pixel.	Ookla collects speed test data through its online speed test service which users selectively employ, often when they are experiencing internet issues, creating a bias in the data. Additionally, speed data is not tied to the ISP or plan of the user, so it cannot evaluate performance of given ISPs/plans.	Understand the average speeds of Ookla speed test users in an area
ISP Website Address Search	Pricing	Listing of available plans, with speeds and prices, available when searching by address on ISP websites	Data is extremely labor intensive to collect at the scale necessary for comprehensive research of available plans and prices across the county, a dataset of this information is not published by ISPs, so the data needs to be queried individually by address.	If assembled, allows to compare prices and speeds offered in different neighborhoods in a region to analyze pricing and deployment practices of ISPs

Universal Service Administrative Co. Affordable Connectivity Program Enrollment and Claims Tracker	Pricing	Monthly zip code level data on new ACP subscribers and their verification method. Claims tracker has monthly total of money spent supporting internet service provision.	Does not provide the number of eligible households, so percentage of eligible users that are enrolled cannot be quantified. Additionally, the zip code geography does not align with Census geographies.	Data goes back to May 2021 and EBB program, so subsidy adoption can be observed over time. Enrollment serves as a gauge for awareness about subsidy programs.
U.S. Census Bureau Tables (B28002, B28004, B28005, B28006, B28007, B28008, B28009A-H, and B28011)	Pricing	Annual data on percentage of households with subscriptions (dial-up, broadband, cell data, and satellite data), access without a subscription, and no internet access by census tract. Also type of plan broken down by demographics including age, educational attainment, labor force status, and race/ethnicity.	Does not directly relate to pricing of broadband. Unable to draw conclusions about the prices being paid by households or the threshold at which broadband becomes unaffordable using the data. When split by demographics, data assumes that those without a computer do not have an internet subscription.	Approximates the percentage of households that deem broadband affordable enough to subscribe to and examines the technology used to access the internet. Demographic comparisons allow for an examination of the disparities in connectivity among those in the same small area, mostly controlling for differences in ISP offerings.

U.S. Census Bureau Tables (B28001, B28003, B28004, B28005, B28006, B28007, B28008, B28009A-H, and B28010)	Devices	Annual data on percentage of households with devices (desktop or laptop, smartphone, tablet, or other) by census tract. Also, presence of a computer broken down by demographics including age, educational attainment, labor force status, and race/ethnicity.	Data combines laptop and desktop into a single category. Demographic breakdowns do not include more granular data about the types of devices present.	Able to observe levels of device adoption, as well as phenomena like underconnection. Able to observe presence of a computer by various demographic categories to identify if certain groups have lower rates of computer adoption.
Universal Service Administrative Co. Affordable Connectivity Program Claims Tracker	Devices	Monthly zip code level data on total number of ACP device vouchers claimed and dollars spent on devices.	The zip code geography does not align with Census geographies.	Data goes back to May 2021 and EBB program, so subsidy adoption can be observed over time. Enrollment serves as a gauge for awareness about subsidy programs.

City Council Districts Information

The degree of digital distress in the City of Los Angeles is not distributed evenly among the council districts. The table below shows the distribution of the population in each LAEDC DDI percentile within each Council District. Population data is from the 2020 Decennial Census.

Council Districts	0-.1	.10001-.2	.20001-.3	.30001-.4	.40001-.5	.50001-.6	.60001-.7	.70001-.8	.80001-.9	.90001-1
1	1%	1%	5%	6%	4%	6%	3%	14%	25%	34%
2	6%	8%	4%	12%	21%	15%	19%	7%	5%	2%
3	4%	7%	11%	7%	20%	18%	15%	5%	6%	8%
4	12%	29%	30%	12%	6%	4%	5%	2%	1%	0%
5	30%	23%	15%	13%	7%	4%	1%	5%	0%	2%
6	0%	4%	13%	18%	6%	15%	20%	11%	7%	6%
7	7%	15%	12%	10%	21%	16%	15%	2%	1%	0%
8	0%	2%	0%	4%	4%	13%	15%	24%	21%	18%
9	0%	0%	1%	0%	1%	0%	4%	18%	36%	40%
10	2%	2%	6%	12%	13%	16%	16%	15%	12%	5%
11	48%	23%	11%	9%	5%	3%	0%	0%	0%	0%
12	23%	21%	21%	13%	10%	10%	3%	0%	0%	0%
13	4%	7%	10%	6%	10%	16%	14%	17%	8%	7%
14	1%	1%	5%	13%	9%	11%	10%	10%	13%	27%
15	1%	2%	6%	6%	12%	13%	18%	22%	17%	5%

Looking at the Council Districts with the highest percentage of census tracts in extremely digitally distressed areas (above the 80th percentile), Council Districts 9, 1, 14, 8, and 15 have a higher incidence of digital distress than other council districts (Council Districts were listed by descending levels of digital distress). Meanwhile, districts 11, 5, 12, 4, and 7 have the highest percentage of census tracts that are experiencing extremely low levels of digital distress below the 20th percentile (Council Districts were listed by ascending order of digital distress). The remaining Council Districts, districts 2, 3, 6, 10, and 13 have LAEDC DDI values spread across the range, indicating that they have areas in their districts of both low and high digital distress. The LAEDC DDI distribution by quartile and half are featured on the next page, with further aggregation aiding in the identification of these patterns.

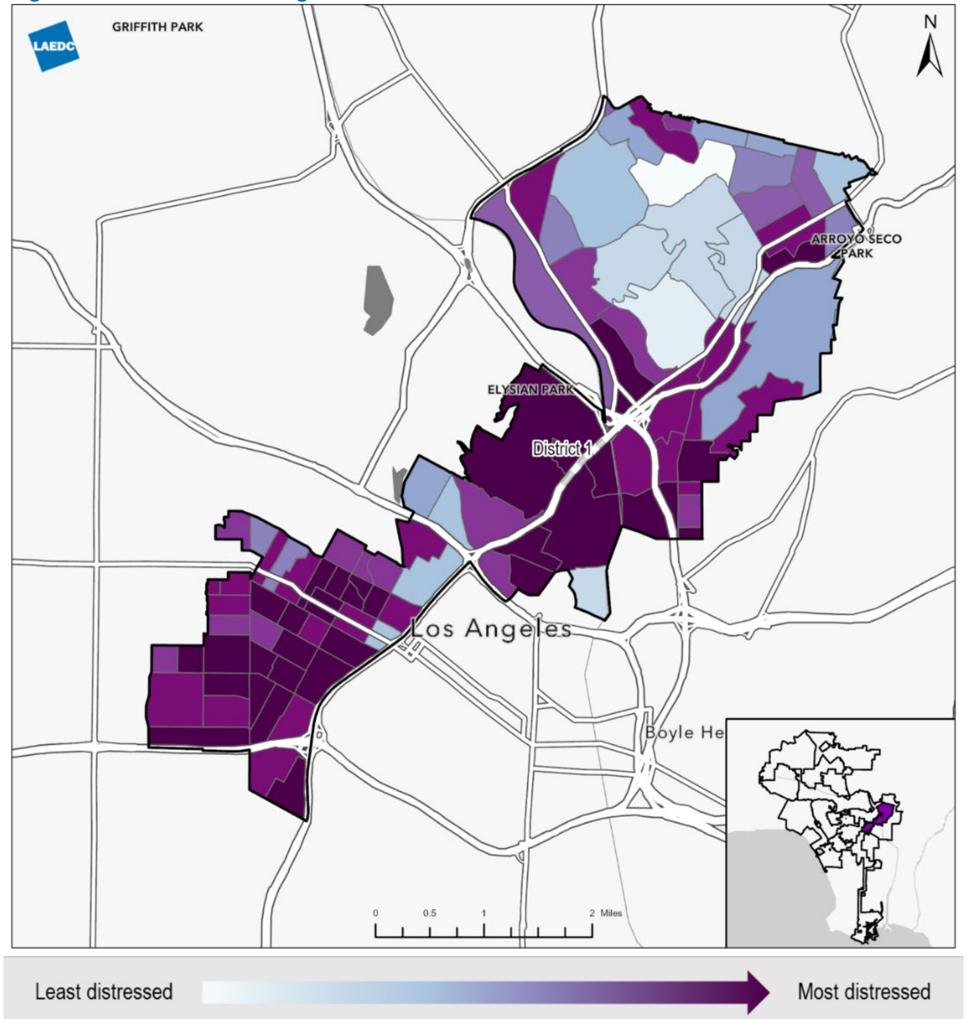
Council Districts	0-.25	.25001-.5	.50001-.75	.75001-1	Below Average	Above Average	Digital Distress Level
1	3.8%	14.3%	18.6%	63.3%	18%	82%	High
2	17.5%	34.8%	38.1%	9.7%	52%	48%	Average
3	17.0%	31.3%	33.0%	18.6%	48%	52%	Average
4	55.9%	32.5%	10.6%	1.0%	88%	12%	Low
5	64.4%	24.1%	9.9%	1.5%	89%	11%	Low
6	8.3%	32.3%	42.5%	17.0%	41%	59%	Average
7	30.3%	35.3%	32.2%	2.2%	66%	34%	Low
8	1.7%	7.8%	38.0%	52.4%	10%	90%	High
9	0.0%	1.7%	12.5%	85.8%	2%	98%	High
10	5.7%	29.9%	37.0%	27.4%	36%	64%	Average
11	75.0%	21.7%	3.4%	0.0%	97%	3%	Low
12	56.7%	30.7%	12.6%	0.0%	87%	13%	Low
13	15.7%	21.8%	41.1%	21.4%	37%	63%	Average
14	1.9%	26.4%	26.0%	45.7%	28%	72%	High
15	4.7%	21.2%	43.1%	31.0%	26%	74%	High

We evaluated the level of digital distress in each Council District by the distribution of population among the quartiles: more than thirty percent of the district's population in the first quartile or fourth quartile led to the respective designation of low digital distress or high digital distress. Because the LAEDC DDI is an index ranked from 0 (least digital distress) to 1 (most digital distress), a percentage breakdown of those living in areas below and above the average LAEDC DDI can also be synthesized.

From this breakdown, it is evident that District 9 has significant digital distress throughout its jurisdiction, with 98 percent of census tracts experiencing above average digital distress.

To show the distribution of census tracts within each City Council District, we present a series of fifteen the districts have been isolated in the below series of fifteen maps. A brief explanation of the maps is also presented to aid comprehension.

Digital Distress in Los Angeles Council District #1

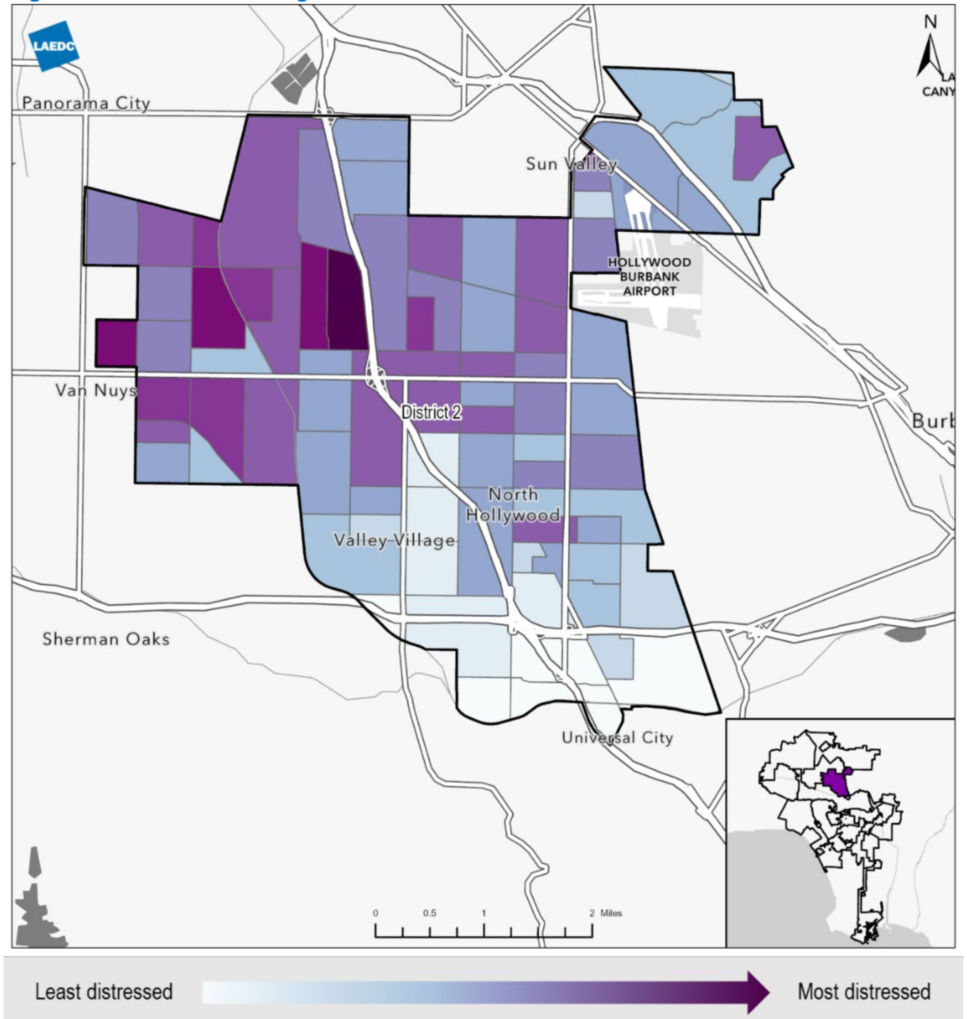


Council District 1 is characterized as experiencing high digital distress, with 82 percent of the population experiencing above average digital distress, with 63 percent of the population in the top quartile of digital distress. These areas are around three main areas within the district: the Pico-Union neighborhood and MacArthur Park in the southwest, adjacent to Lincoln Heights and Elysian Park in the middle, and in Highland Park near Arroyo Seco Park. Some areas in the district are experiencing low levels of digital distress, with the largest of these clusters present around Mount Washington and Glassell Park in the north of the district.

Recommended Areas for Streetlight Wi-Fi Installation

One of the recommended areas for streetlight Wi-Fi installation that was identified in the report, bounded by S Hoover St to the west, S Alvarado St to the east, Pico Blvd to the south, and W 12th Street to the north, is in this Council District and serves as the principal target area for this council district, though much of the district also contains much of the North and East of DTLA target areas.

Digital Distress in Los Angeles Council District #2

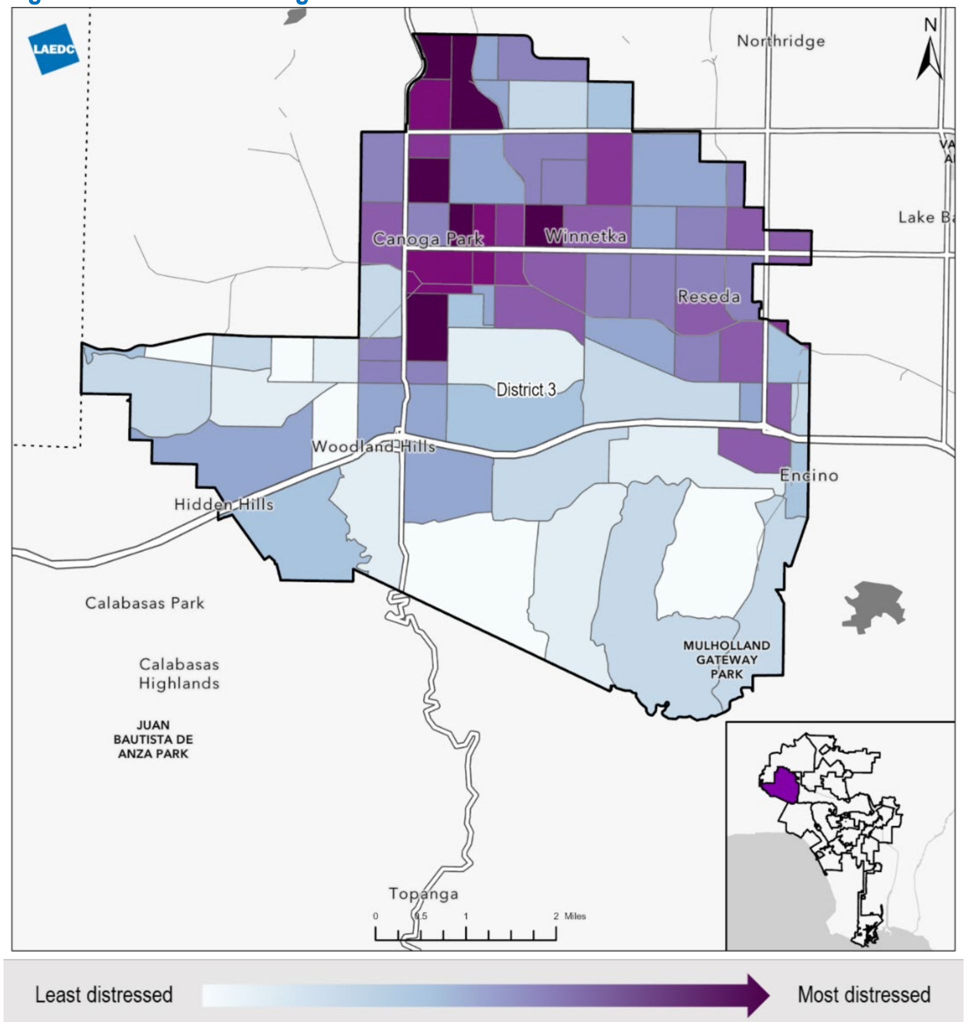


Council District 2 experiences a moderate level of digital distress, with an almost identical amount of people above and below the mean level of digital distress in the City. Interestingly, there is a very noticeable gradient in the extent that different areas in the council district experience digital distress: those in the southeast part of the district, around Valley Village, Studio City, and Toluca Lake experience low to moderate digital distress, while many in the northwest part of the district experience severe digital distress. The most severe level digital distress is concentrated southwest of the intersection of the Metrolink line and the 170, but a strip of contiguous areas with elevated digital distress runs from the Hollywood Burbank Airport west across the district.

Recommended Areas for Streetlight Wi-Fi Installation

The census tract described above, west of the Valley Plaza Sports Complex, should be considered a target area for this district. Additionally, the census tracts in the western part of the district are part of the East San Fernando Valley target area identified in the report.

Digital Distress in Los Angeles Council District #3

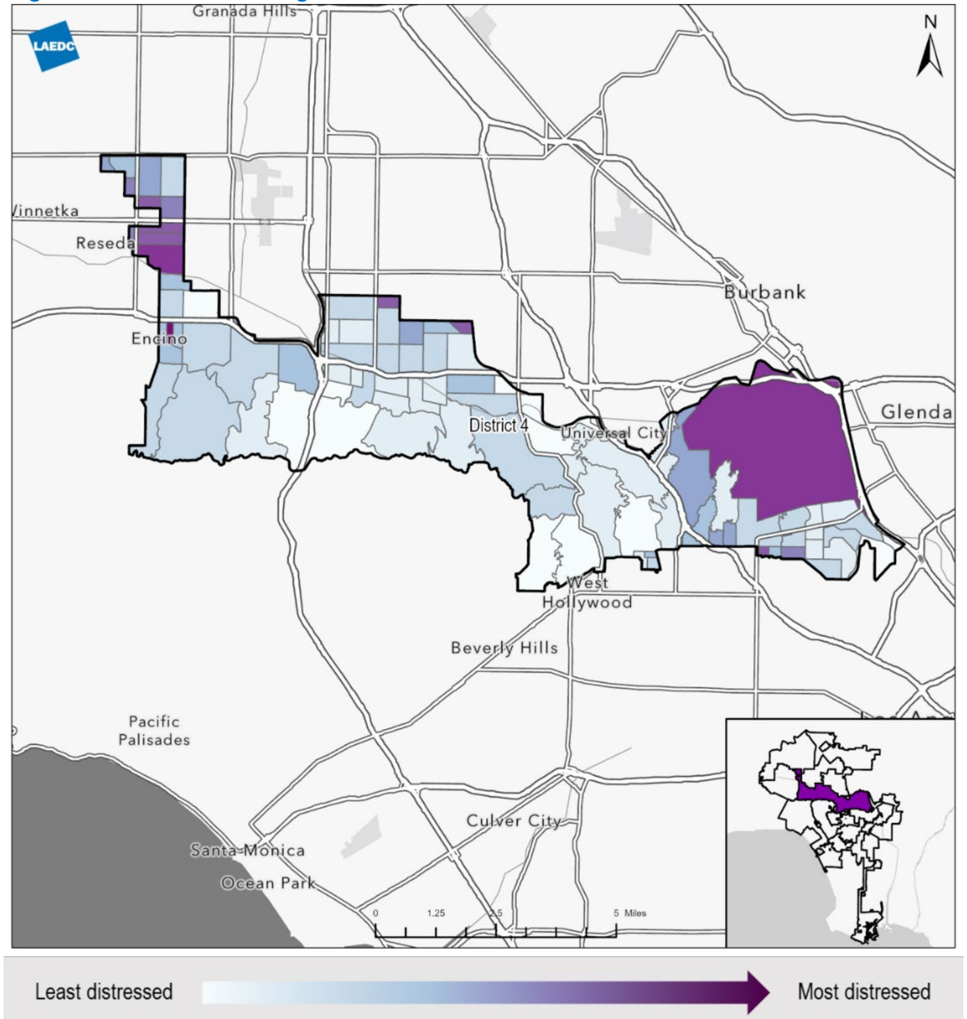


The pattern of digital distress in Council District 3 is very similar to that of Council District 2: Council District 3 has nearly the same amount of people who experiencing below and above average digital distress, however there is gradient from north, where areas are experiencing severe digital distress, to south, where areas are in the bottom quartile of digital distress. Except for two clustered around Reseda Blvd, all the census tracts bracketing the 101 Freeway all have low or average levels of digital distress. Meanwhile, those in Canoga Park, Winnetka, and Reseda all have above average levels of digital distress.

Recommended Areas for Streetlight Wi-Fi Installation

The dark plum areas of Canoga Park, a subsection of which make up the West San Fernando Valley target area, and Winnetka should be areas where efforts to alleviate digital distress are focused for this council district.

Digital Distress in Los Angeles Council District #4

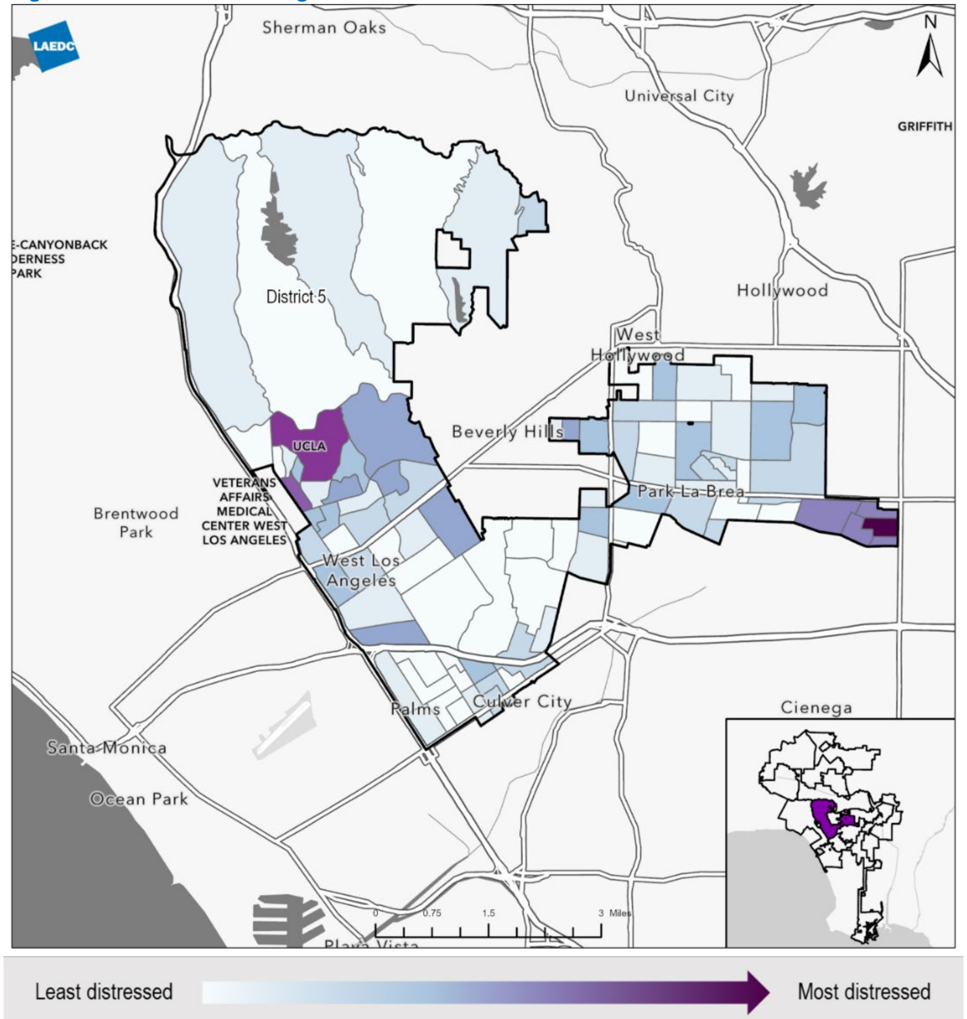


Council District 4 stretches along the southern edge of the San Fernando Valley and does not have the levels of digital distress observed in the northern part of the valley. The district is considered to have low digital distress, with 88 percent of the population living in areas with below average DDI. The most visually striking area in the map is around Griffith Park, however the low population in the census tract means that it does not affect the distribution of LAEDC DDI by population.

Recommended Areas for Streetlight Wi-Fi Installation

The worst levels of digital distress are experienced by those in the western part of this district, as well as those bordering Van Nuys and East Hollywood. The target area for this district are the several census tracts bounded by Reseda Blvd to the west, Sherman Way to the north, White Oak Ave to the east, and Oxnard Ave to the south. Additionally, there is a block in Encino bounded by Newcastle Ave to the west, the 101 Freeway to the north, Zelzah Ave in the west and Ventura Blvd to the south with very low broadband and device adoption where services should be sited.

Digital Distress in Los Angeles Council District #5

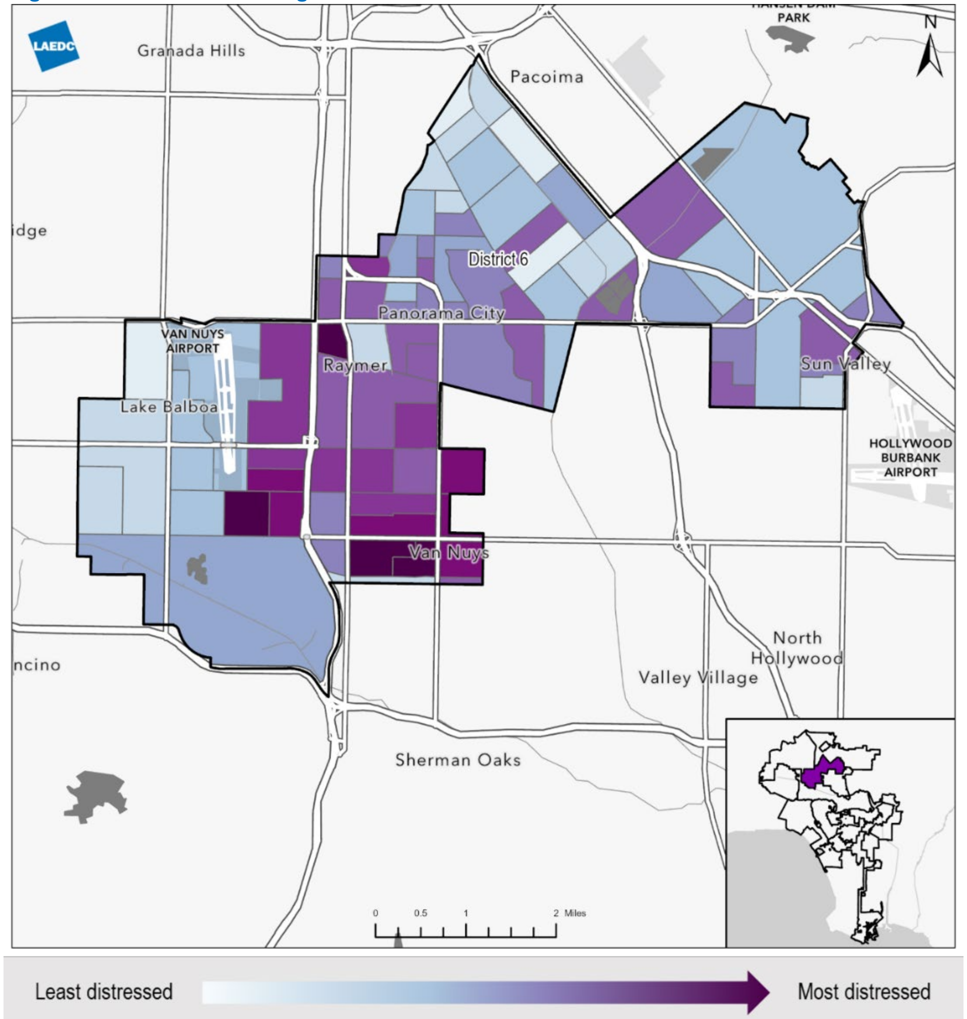


Council District 5 has nearly two-thirds of its population in the lowest quartile of digital distress, with very low DDI in several areas, including Bel-Air, Beverly Crest, Cheviot Hills, and Palms. Many areas are in the middle quartiles of digital distress, such as the areas bracketing Santa Monica Blvd and in Park La Brea. The digital distressed areas are concentrated in two locations, around the UCLA campus, which are flagged due to low broadband adoption reported by the Census Bureau and few high-speed providers with technology in the area reporting to CPUC, and to the east, south of Wilshire Blvd in Mid-Wilshire and Koreatown.

Recommended Areas for Streetlight Wi-Fi Installation

The latter area should be considered the target area for increasing digital equity and relieving digital distress. These areas have a low level of broadband adoption, a very high incidence of underconnection, and prices for high-speed broadband that are much higher than other areas of the county.

Digital Distress in Los Angeles Council District #6

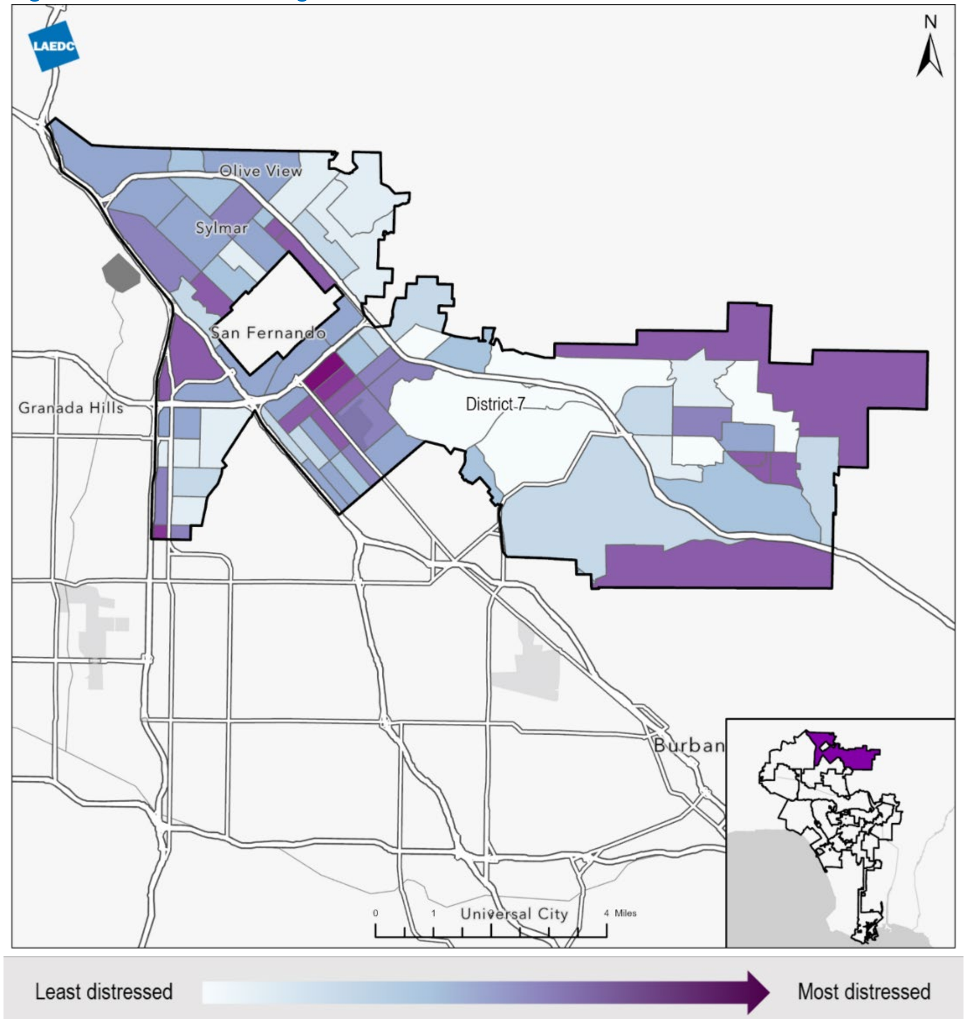


Council District 6 experiences an average level of digital distress, with nearly 75 percent of its residents in the middle two quartiles of digital distress. Census tracts in the neighborhoods of Lake Balboa, Arleta, and San Valley tend to be in those middle quartile, while there are not that many areas in the lowest quartile of digital distress.

Recommended Areas for Streetlight Wi-Fi Installation

The target area for this district is very pronounced, located principally in Van Nuys but also stretching up to Panorama City. Within this general area, digital distress is most severe just south of Van Nuys Airport and south of Victory Blvd. Many of the census blocks in these areas have no high-speed broadband providers, with those who do paying more than most of the city, and households have very low rates of broadband and device adoption.

Digital Distress in Los Angeles Council District #7

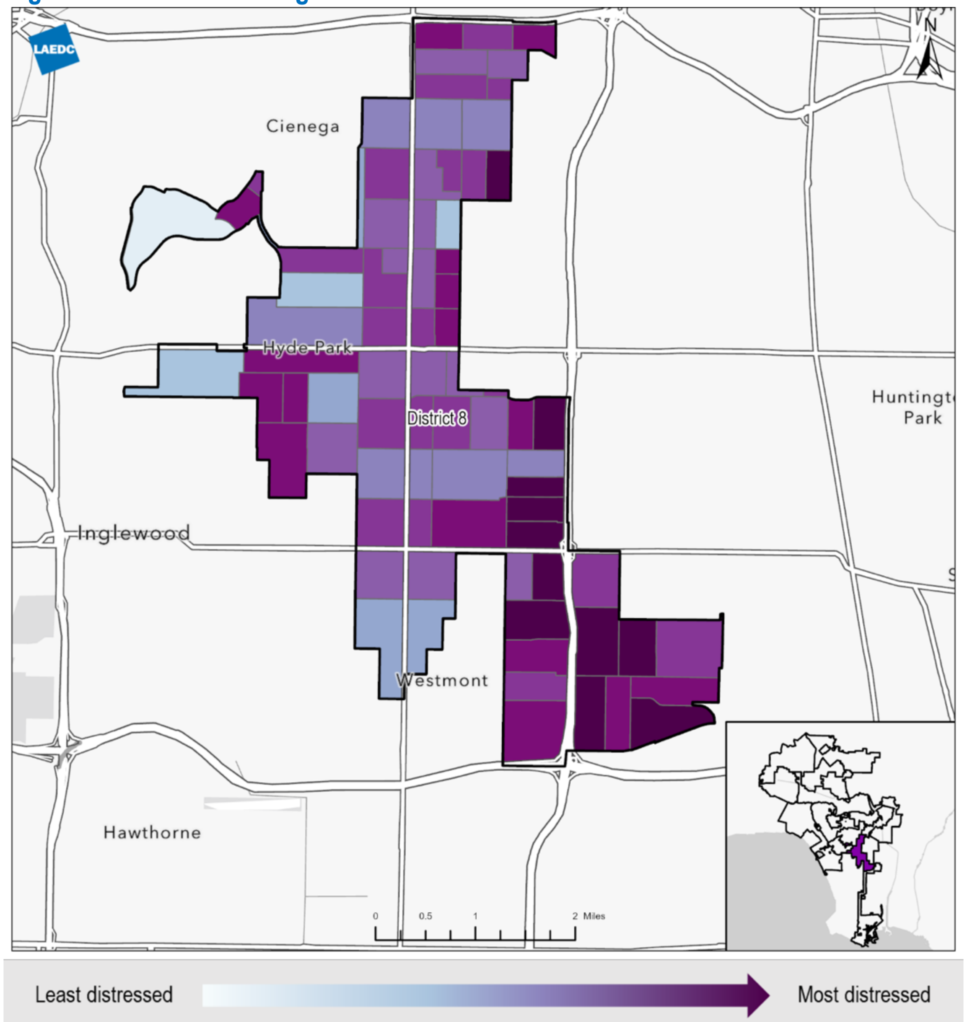


Council District 7 is considered to have low levels of digital distress, with only 2.2 percent of residents experiencing severe digital distress in the top quartile of the DDI. Additionally, the eastern areas of the district with higher LAEDC DDI are more sparsely populated. The areas in Sylmar and Mission Hills have a mix of census tracts experiencing various stages of digital distress.

Recommended Areas for Streetlight Wi-Fi Installation

The area with the most severe digital distress is in Pacoima, sandwiched between the 118 Freeway and Whiteman Airport. While prices for high-speed broadband in these areas is thought to be affordable, there are very low rates of broadband and device adoption. The Pacoima Branch Library is located nearby the target area and may be a good location for digital literacy courses, ACP information dissemination, and other digital equity interventions.

Digital Distress in Los Angeles Council District #8

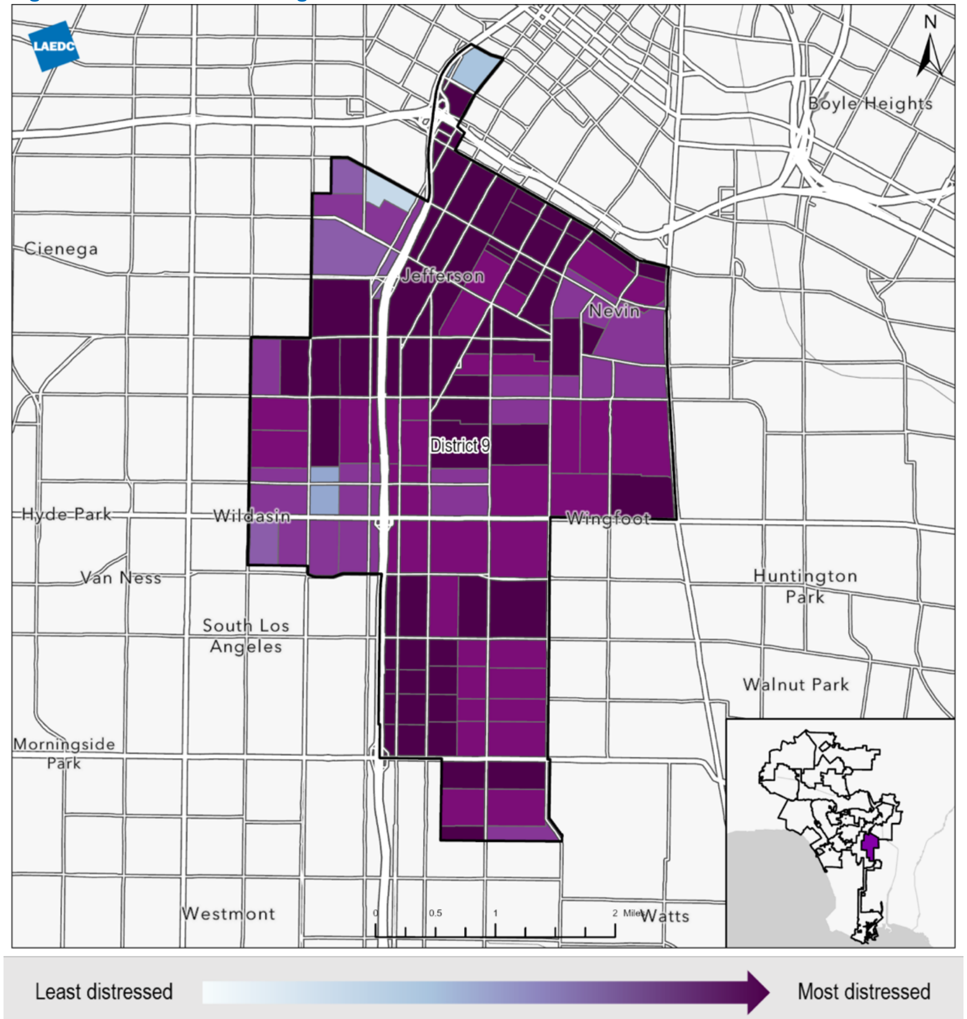


Council District 8 has the second most severe digital distress in the City of Los Angeles, sharing the most entrenched digitally distressed area around the 110 Freeway with Council District 9, its neighbor to the east. While the western part of the district has some census tracts that with only slightly above average DDI, less than 10 percent of the population is in the bottom half of LAEDC DDI scores for the City. Digital equity efforts should be rigorously pursued throughout the district, as more than 50 percent of residents live in areas in the top quartile of DDI scores.

Recommended Areas for Streetlight Wi-Fi Installation

The elevated level of LAEDC DDI in the southeastern part of the district, the target area for this district and part of the North of Manchester target area, is principally due to higher prices for high-speed broadband in those areas compared to the west of the 110 Freeway; however, the district is experiencing low broadband adoption and underconnection. Programs focusing on ACP enrollment, discounted devices, and digital literacy could all help this area.

Digital Distress in Los Angeles Council District #9

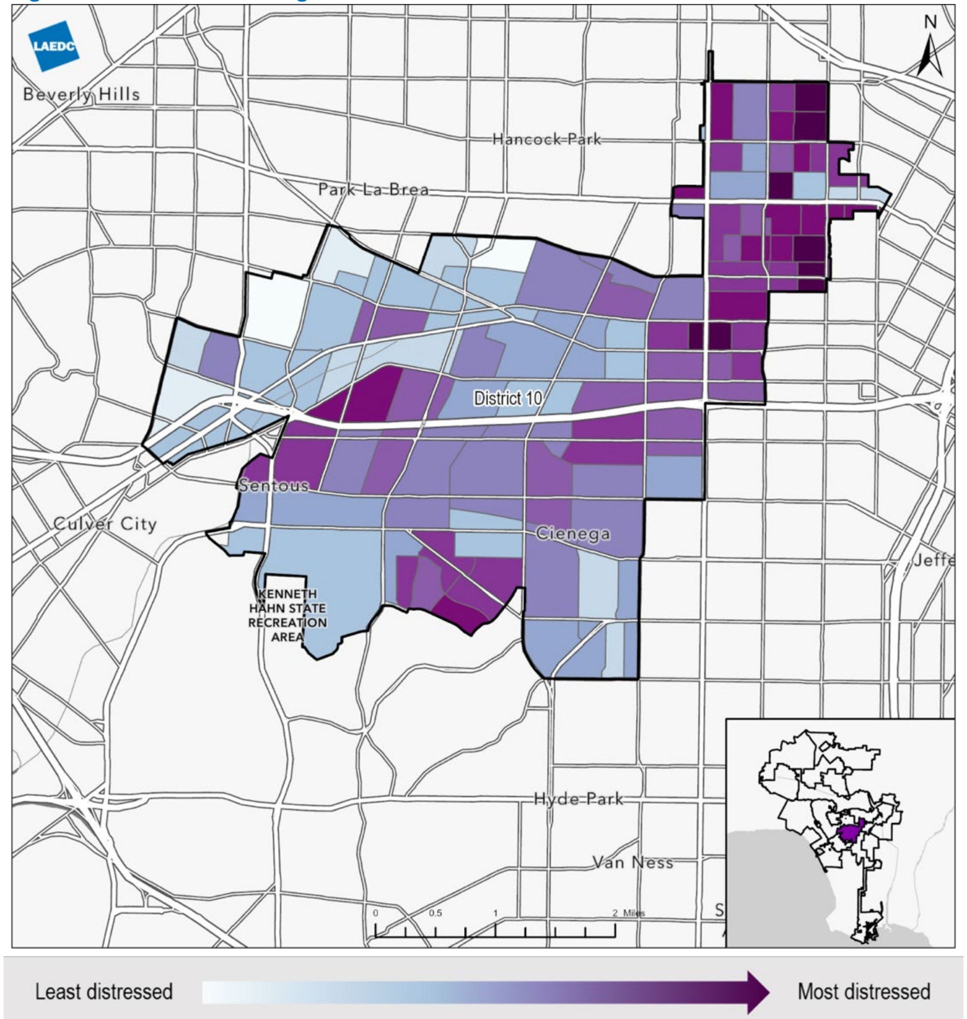


Council District 9 has by far the most severe, entrenched digital distress in the city, with 86 percent of its residents living an area in the top quartile of DDI and with all but two census tracts having an above average digital distress level. The digital distress in this area is due to poor scoring on all elements of the LAEDC DDI: low broadband adoption rates, high underconnection rates, and high prices for high-speed broadband.

Recommended Areas for Streetlight Wi-Fi Installation

This district makes up most of the North of Slauson and North of Manchester target areas defined in the report, as well as the northern part of the North of the I-105 target area. The whole of the district should be prioritized as a target area for increasing digital equity in the City, with places like the Avalon Gardens apartment complex a promising, densely populated to site interventions.

Digital Distress in Los Angeles Council District #10

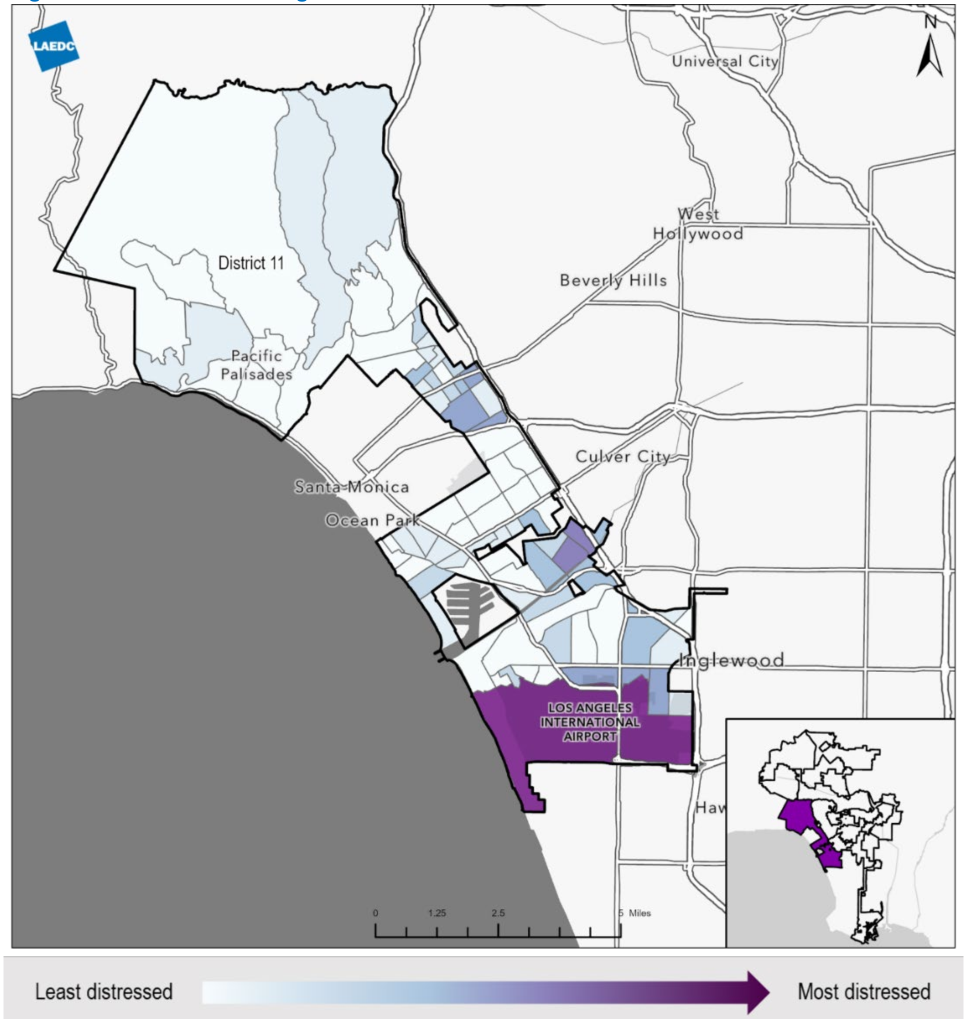


Council District 10 is considered to have an average level of digital distress, though it is elevated compared to over average districts, with only 6 percent of the population in the bottom quartile of DDI. However, 36 percent of residents do fall within the bottom half of values. Those residents are mostly in the western part of the district and tend to be further from the 10 Freeway. As the district stretches eastward, digital distress worsens, with a handful of census tracts in the top ten percent of LAEDC DDI values.

Recommended Areas for Streetlight Wi-Fi Installation

These areas make up a lot of the East of DTLA target area outlined in the report and are considered the focus area for the district. These areas, which sit in the Harvard Heights and Koreatown neighborhoods, have low rates of broadband adoption and comparatively higher prices than the rest of the district, so ACP enrollment outreach may be helpful, making sure that outreach materials are in multiple languages including Korean and Spanish.

Digital Distress in Los Angeles Council District #11

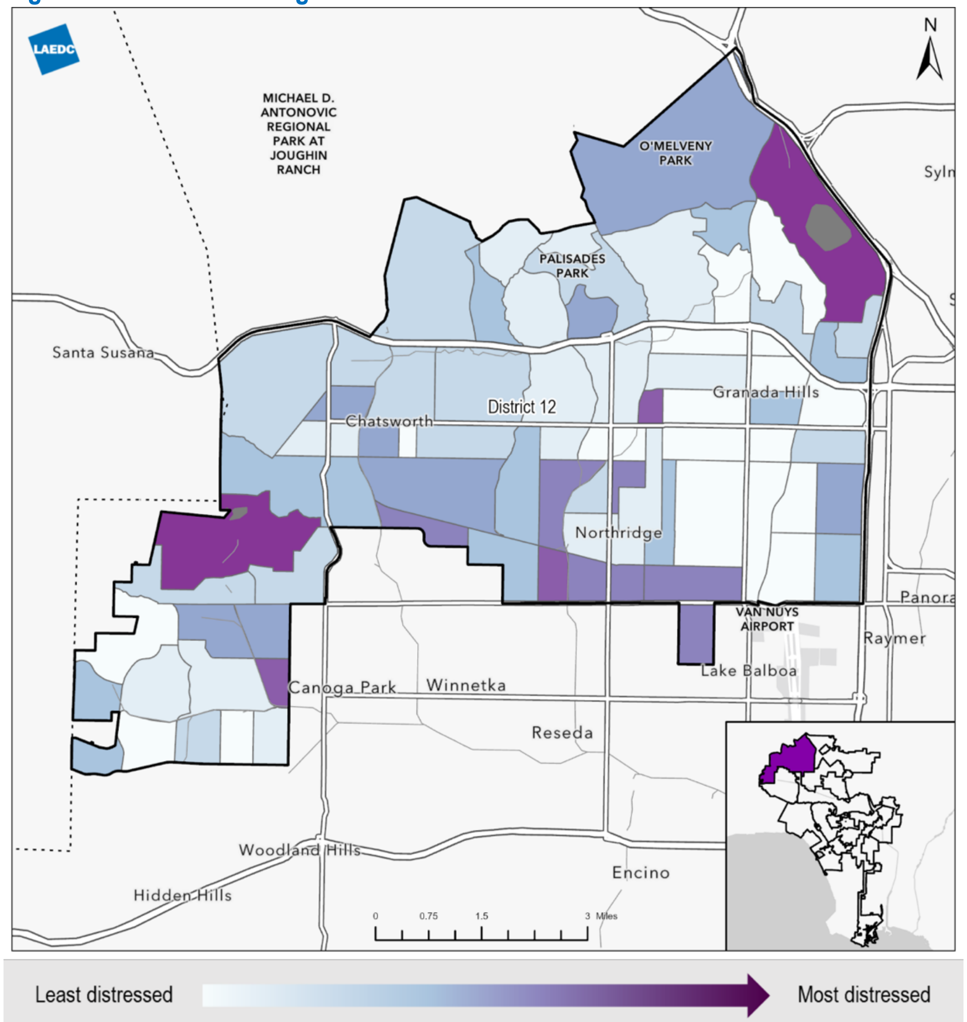


Council District 11 is the least digitally distressed district in the City of Los Angeles, with 75 percent of the population in areas of very low digital distress, the bottom quartile of DDI. The area around and including LAX is flagged as having a low DDI but the population in that census tract is quite small despite its size. The LAEDC DDI in this area is so low because the number of high-speed providers, ubiquity of fiber investments, and low prices, but it is principally because the rates of broadband and device adoption are so high across the census tracts.

Recommended Areas for Streetlight Wi-Fi Installation

In all, there are three census tracts with above average digital distress, the smaller two being just south of Culver City in the Del Rey neighborhood. These areas would benefit from ACP enrollment outreach and information on discounted devices, as broadband and device adoption are the attributes causing an elevated LAEDC DDI compared to neighboring regions.

Digital Distress in Los Angeles Council District #12

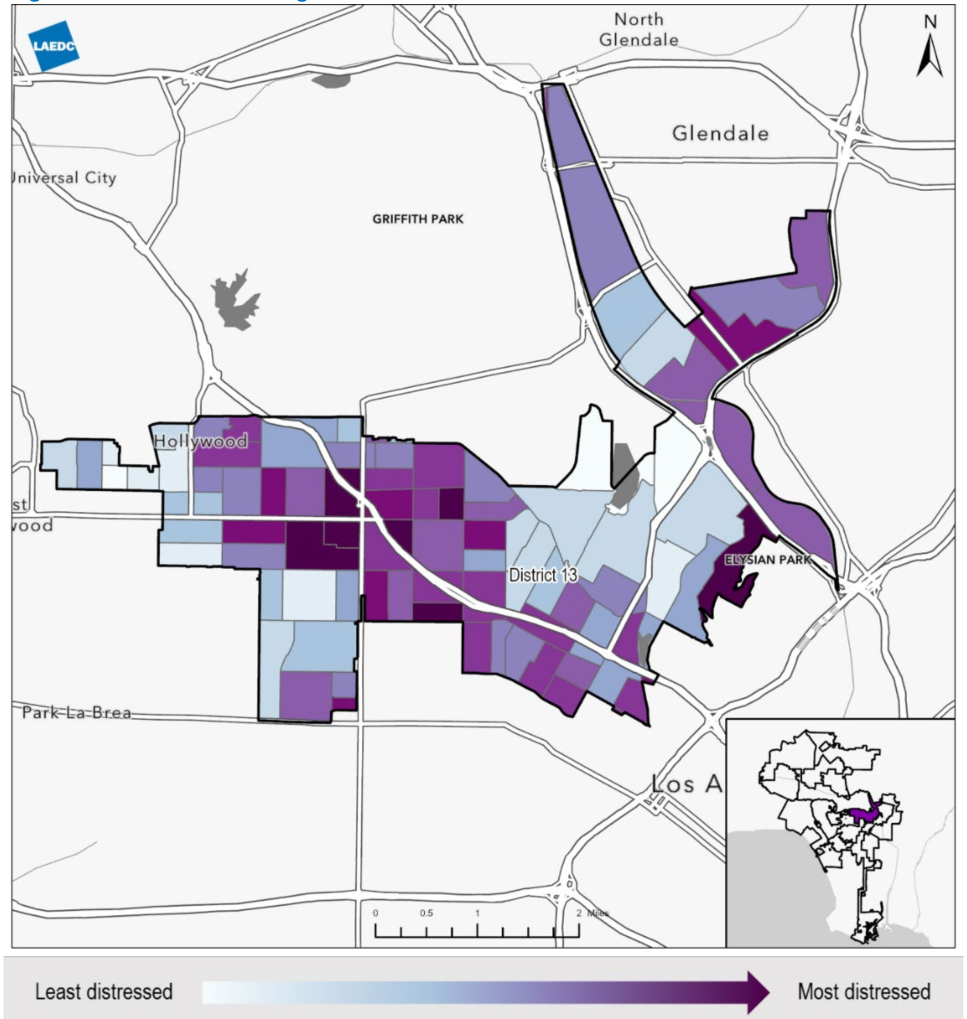


Council District 12 is one of the more sparsely populated districts in the City of Los Angeles, but not so sparsely populated that it suffers from the digital distress often affecting rural areas. Instead, the district has a low DDI, with a majority of the population in the bottom half of LAEDC DDI values. The areas with the deepest purple hues are both very sparsely populated, while areas like Granada Hills and the eastern portion of Northridge are densely populated and have a lot of connectivity.

Recommended Areas for Streetlight Wi-Fi Installation

The target area in this council districts sits in the southern and western parts of Northridge. The areas below the border with Council Districts 2 and 3 contains many distressed census tracts and the census tracts here are a continuation of that pattern.

Digital Distress in Los Angeles Council District #13

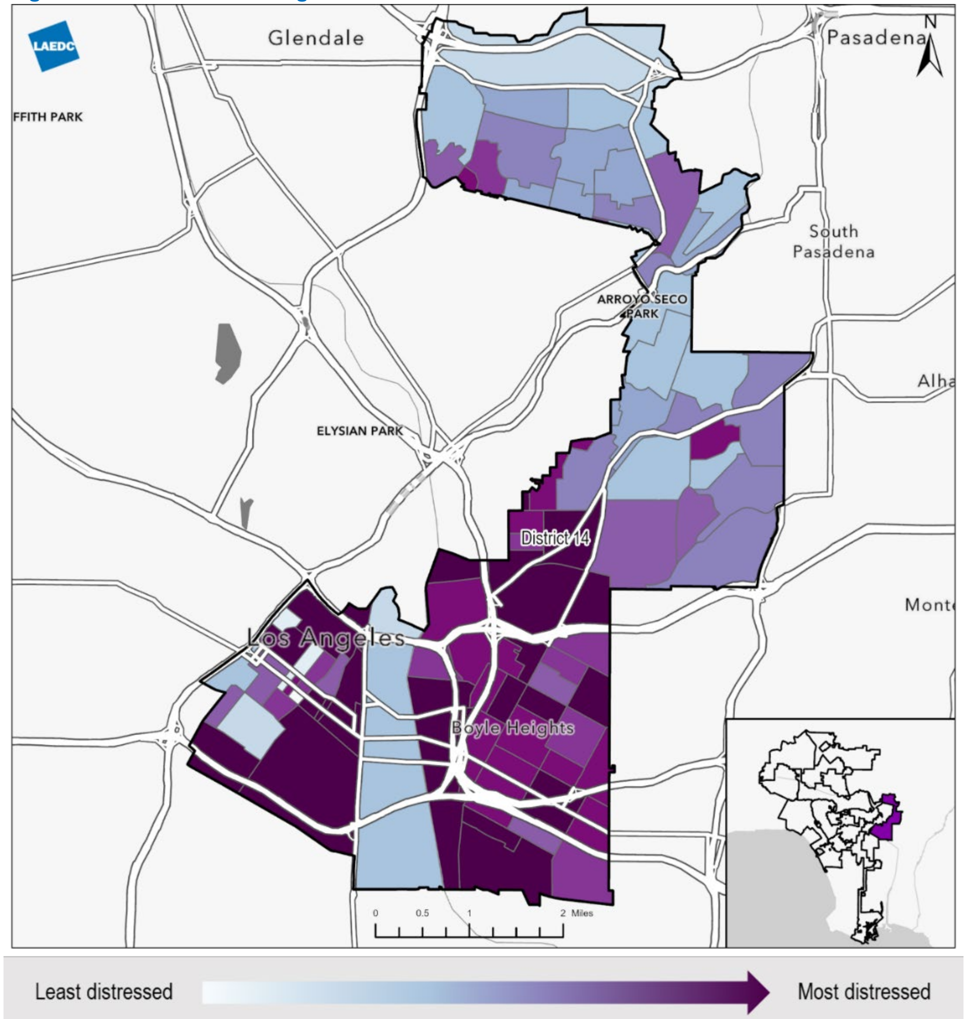


Council District 13 has an average level of digital distress, with a distribution between LAEDC DDI quartiles similar to that of Council District 10. The areas with the lowest LAEDC DDI sit to the west of the district, bordering West Hollywood and the Hancock Park neighborhood. Additionally, Echo Park, which sits next to the deep purple but sparsely populated census tract in Elysian Park, has high levels of connectivity. The northeastern part of the district has elevated digital distress, but the main target area of the district is central within its geography.

Recommended Areas for Streetlight Wi-Fi Installation

Council District 13 is home to the bulk of the Hollywood target area, which serves as the target area for the district. The area is principally bordered by N Western Ave to the east, Hollywood Blvd to the north, N Hoover St to the west, and Beverly Blvd to the south. Outreach about ACP enrollment in this area should be done in multiple languages.

Digital Distress in Los Angeles Council District #14

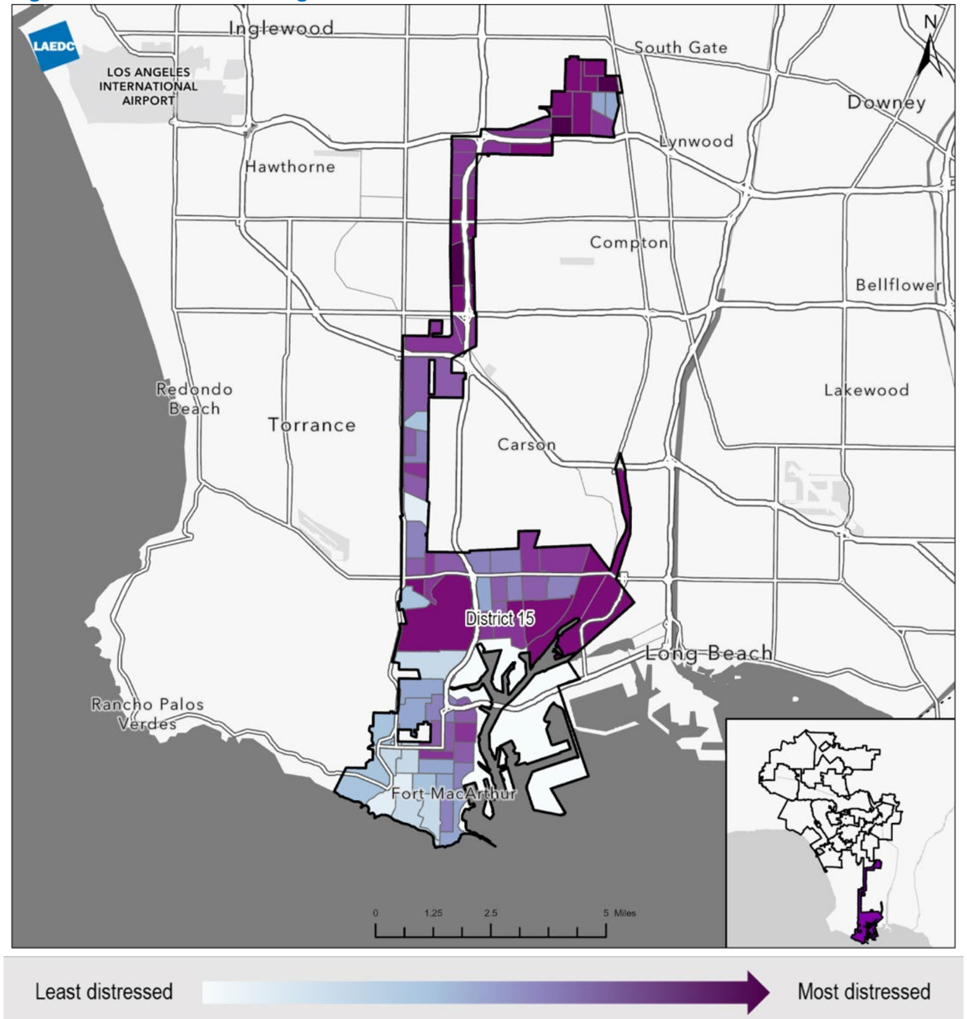


Containing much of DTLA and NELA, Council District 14 is considered to have high digital distress, with 46 percent of the population in top quartile of DDI and only 2 percent in the bottom quartile. The areas with relatively lower LAEDC DDI tend to be in the top of the district, but these areas are still much more digitally distressed than areas in the western part of the city. Additionally, the Arts District in the western part of DTLA and the Financial District in the eastern part also have low levels of digital distress.

Recommended Areas for Streetlight Wi-Fi Installation

The most digitally distressed areas sit either side of the strip formed around the Arts District, with the Fashion District to the west and Boyle Heights and its neighboring census tracts to the northeast. Both areas are target areas presented in the report and should be areas of focus for any digital divide efforts.

Digital Distress in Los Angeles Council District #15



Council District 15 is considered to have high levels of digital distress, with 74 percent of the population in an area with above average digital distress, though it is the only district with high digital distress that has more residents in the 50th to 75th percentile than the 75th to 100th percentile. The western half of San Pedro has the largest cluster of low LAEDC DDI values among populated census tracts in the region, while the eastern half of San Pedro has a small cluster of above average DDI values. However, the most problematic area is in the northern part of the district, as much of the corridor from Watts to the Harbor is severely digitally distressed.

Recommended Areas for Streetlight Wi-Fi Installation

Along that strip, the two most digitally distressed areas the cluster of census tracts in Watts and the census tracts around 135th St Elementary School. These two target areas should both have digital equity efforts, with public housing in Watts (Gonzaque Village, Jordan Downs, Nickerson Gardens, and Imperial Courts) offering a promising area to implement digital equity interventions.

Regression Results

Digital Distress and Socio-Economic Characteristics

We performed an econometric analysis to determine how digital distress in the City of Los Angeles is related to socio-economic characteristics. We performed this analysis on the LAEDC DDI as well as on the following census-tract data for the City from the U.S. Census Bureau's American Community Survey (2021, 5-year estimates):

- Median household income and mean household income
- Household size
- Median age
- Racial and ethnic composition (percentage Black, Asian and Hispanic)
- Education (percentage with a bachelor's degree or higher)
- Households with children (percentage with children under 18)
- English-only speaking households (percentage)
- Poverty
- Population density and square kilometers.

The econometric analysis used Ordinary Least Squares. The final form of the estimated equation is shown below, with statistically insignificant variables removed:

$$DDI_i = \alpha + \beta_1 * PCon_i + \beta_2 * HSize_i + \beta_3 * PBach_i + \beta_4 * PBlack_i + \beta_5 * PAsian_i + \beta_6 * PHisp_i + \beta_7 * PopDens_i + \beta_8 * \log(MInc_i) + \beta_9 * LInc_i,$$

Where:

- DDI_i is the Digital Distress Index Score for census tract *i*
- $PCon_i$ is the percentage of households in census tract *i* that reported having both internet and a computer (i.e., percentage connected)
- $HSize_i$ is the average household size for census tract *i*
- $PBach_i$ is the percentage of individuals in census tract *i* with a bachelor's degree or higher
- $PBlack_i$ is the percentage of individuals in census tract *i* who are Black
- $PAsian_i$ is the percentage of individuals in census tract *i* who are Asian
- $PHisp_i$ is the percentage of individuals in census tract *i* who are Hispanic
- $PopDens_i$ is the population density for census tract *i*
- $〚\log(MInc〛_i)$ is the natural log of the median household income for census tract *i*
- $LInc\ _i$ is a dummy variable taking on the value of 0 or 1 for census tract i based on whether or not it is in the lowest quartile of median income (i.e., low income)
- $\alpha,\ \beta_1 - \beta_{16}$ are coefficients to be estimated.

Coefficient estimates are shown in the table below.

Coefficient Estimates for Socio-Economic Characteristics

Variable	Coefficient	Significance	Standard Error
Constant	214.3	***	15.55
PCon	-0.597	***	0.052
HSize	-2.042	**	0.753
PBach	-0.165	***	0.039
Log(MInc)	-9.990	***	1.479
PBlack	-0.091	**	0.032
PAsian	-0.201	***	0.031
PHisp	-0.225	***	0.030
PopDens	-0.002	**	0.001
Log(MInc)	-9.990	***	1.479
LInc	3.564	***	1.045
F-statistic (9 and 1083 DF)		317.4	
Prob > F-statistic		0.000	
Adjusted R^2		0.723	
Number of Observations		1092	

Source: LAEDC

Note: *** means P < 0.001, ** means P < 0.01, * means P < 0.05, and means P < 0.1

Economic Impact of Closing the Digital Divide

We also performed an econometric analysis on the dataset above to determine how changes mean household income are correlated with changes in digital distress in the City of Los Angeles. This specification allows for estimating the potential economic impact associated with closing the digital divide.

The econometric analysis used Ordinary Least Squares. The final form of the estimated equation is shown below, with statistically insignificant variables removed:

$$\log(AvgInc_i) = \alpha + \beta_1 * PPChild_i + \beta_2 * MAge_i + \beta_3 * PBlack_i + \beta_4 * PAsian_i + \beta_5 * PHisp_i + \beta_6 * SquareKM_i + \beta_7 * PopDens_i + \beta_8 * LInc_i + \beta_9 * DDI_i,$$

Where:

- $〚\log(AvgInc〛_i)$ is the natural log of the mean household income for census tract *i*
- $PPChild_i$ is the percentage of households in census tract *i* that reported the presence of children
- $MAge_i$ is the median age for census tract *i*
- $PBlack_i$ is the percentage of individuals in census tract *i* who are Black
- $PAsian_i$ is the percentage of individuals in census tract *i* who are Asian
- $PHisp_i$ is the percentage of individuals in census tract *i* who are Hispanic
- $SquareKM_i$ is the size of census tract *i* in square kilometers
- $PopDens_i$ is the population density for census tract *i*
- $LInc\ _i$ is a dummy variable taking on the value of 0 or 1 for census tract i based on whether or not it is in the lowest quartile of median income (i.e., low income)
- DDI_i is the Digital Distress Index Score for census tract *i*
- $\alpha,\ \beta_1 - \beta_{16}$ are coefficients to be estimated.

Again, we obtained all data other than the LAEDC DDI from the U.S. Census Bureau's American Community Survey (2021, 5-year estimates) for Los Angeles County. Coefficient estimates are shown in the table below.

Coefficient Estimates for Closing the Digital Divide

Variable	Coefficient	Significance	Standard Error
Constant	11.79	***	0.066
PPChild	-0.006	***	0.001
MAge	0.009	***	0.001
PBlack	-0.007	***	0.001
PAsian	-0.003	***	0.001
PHisp	-0.008	***	0.000
SquareKM	0.004	***	0.001
PopDens	-0.000	***	0.000
LInc	-0.232	***	0.019
LAEDC DDI	-0.006	***	0.001
F-statistic (9 and 1083 DF)		449.8	
Prob > F-statistic		0.000	
Adjusted R^2		0.787	
Number of Observations		1092	

Source: LAEDC
Note: *** means P < 0.001, ** means P < 0.01, * means P < 0.05, and means P < 0.1

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