

GRETA BYRUM, ANDY GUNN, AND HOUMAN SABERI

CONNECTING COMMUNITIES FOR REGIONAL RESILIENCE

A Case Study of the Silicon Valley Region

FEBRUARY 2017

About the Authors



Greta Byrum is the director of the Resilient Communities program at New America. In this role, she reimagines the way we design, build, and manage local systems to support local residents as

leaders, organizers, and preparedness experts. Her collaborative projects build from the urban planning, design, emergency preparedness, tech, policy, organizing, and media fields to create and support flexible, resilient communications infrastructure.



Andy Gunn was a program fellow with the Resilient Communities Project and Open Technology Institute at New America. In these roles, he partnered with communities to build and govern their

own digital communications using the principles of Community Technology.



Houman Saberi is a program manager in the Resilient Communities program for RISE:NYC. In this role, he is helping to build resilient community wireless networks in Sandy-affected areas of the

city in partnership with local businesses, civic organizations, and residents.

About New America

New America is committed to renewing American politics, prosperity, and purpose in the Digital Age. We generate big ideas, bridge the gap between technology and policy, and curate broad public conversation. We combine the best of a policy research institute, technology laboratory, public forum, media platform, and a venture capital fund for ideas. We are a distinctive community of thinkers, writers, researchers, technologists, and community activists who believe deeply in the possibility of American renewal.

Find out more at newamerica.org/our-story.

About Resilient Communities

Resilient Communities works alongside local groups and leaders to design, build, manage, and leverage community wireless networks as platforms to strengthen relationships and address risks and challenges. In particular, we partner with vulnerable communities already feeling the impact of climate change.

We work to integrate these digital resources into cities and neighborhoods in ways that support community health, rather than displacing residents or weakening existing local relationships, institutions, and networks of support. In addition to increasing preparedness, our partner communities can use local wireless networks to create entrepreneurship, media, and arts opportunities; platforms for local businesses to share and coordinate services; systems for local data collection and management; and tools for local leaders to organize, connect, and compile and share information.

Contents

Introduction	2
Silicon Valley as a Regional Case Study	4
Intermodal Planning for Regional Resilient Communications	14
Putting it All Together: Designing for Emergencies and the Everyday	22
Appendix	24
Special Thanks	27
Notes	28

INTRODUCTION

From 9/11 to Sandy, almost every major emergency in the last 20 years has led to some level of telecommunications failure.¹ These experiences have spotlighted flaws and inherent weaknesses in our communications infrastructure—from aging wires to underground flood-vulnerable switching stations to cellular towers lacking power backups. In each case, the failure of brittle, overloaded telecommunications systems has threatened or undermined relief and recovery efforts.

To understand how infrastructural flaws lead to system-wide failures, it is important to note that existing telecommunications systems are not centralized, but include fiber, cable, copper, broadcast, and wireless segments connecting at different sites and at different scales, owned by a range of companies and organizations across varied geographies. Breakages and overloads may occur at any point in this network of networks, placing greater strain on other areas, which may fail in turn. This phenomenon has consequences: local groups, often operating as unofficial yet critical first responders, find themselves without critical tools to organize neighbors, distribute supplies, and manage information.

Recent disasters have also underscored the importance of backup and alternative communication platforms, from amateur (HAM) and

hyper-local FM radio to community WiFi and even word-of-mouth networks. For example, Red Hook, Brooklyn's community WiFi network kept that neighborhood connected during Sandy;² in Bay St. Louis, Mississippi, low-power hyper-local FM radio saved lives and kept the community connected throughout Katrina and its aftermath.³ Examples like these demonstrate how layered and diverse communications ecosystems could embody a core principle of resilience planning: redundancy.

The diversity built into our communications ecosystems is the product not only of infrastructure, but of the habits and behaviors among different social groups. Some people are most comfortable communicating using digital and social media, while some prefer to get their information over broadcast channels, and others trust only what they hear directly from people they know. Planning for response, recovery, rebuilding, and preparedness efforts must take into account both the hybrid and layered nature of telecommunications infrastructure and the different ways that people prefer to receive and share information. Resilience—understood as the ability to recover and respond to shocks and stresses—also depends upon the use of diversity as a design feature. However, to leverage communications diversity and redundancy, we need to plan for alignment and interconnection among different systems and scales.

This paper calls for a multi-layered approach to community-led communications readiness and resilience incorporating a diversity of media and platforms. With a view to the complexity of physical and social communications systems, we propose a set of technical recommendations for regional resilience that leverage and combine multiple communication technologies and modes.

This type of intermodal planning is not without precedent: In the world of physical and transportation planning, urban experts have converged on the concept of “intermodal mobility hubs”—physical sites where multiple different transportation modes interconnect—as key to improving overall use and function of transportation systems. Planners have found that people are more likely to use public transportation if their transitions between different modes (bicycle to train, train to bus, etc.) are easy to map and negotiate. In practice, the focus of this approach is improving and expanding interconnection points—stations, interchanges, storage, and parking—not just expanding or improving specific segments such as roads, rail, or bicycle infrastructure on their own.

We propose a theory of intermodal telecommunications planning that similarly takes into account different communications behaviors as well as the full range of physical infrastructure

involved in resilient communications systems (towers, fiber and copper lines, but also switching or peering points and broadcast facilities and official preparedness centers, as well as physical neighborhood hubs where people exchange information face to face).

This approach to resilient communications planning applies both a social and a technical lens to how information is shared and managed in an emergency or disaster situation. Rather than providing recommendations for building one unified infrastructure system for improved communications resilience in the Silicon Valley region, we will thus provide a roadmap for planning across multiple infrastructures. While this paper does not explicitly provide a roadmap for social planning, we emphasize that building social infrastructure and relationships alongside the process of technical planning as a means of creating long-term resiliency, not simply emergency preparedness.

Behind our approach to communications lies a specific definition of resiliency: not just the ability of a community to return to a previous condition, but rather a process of building collectively towards shared goals by deepening relationships and developing collaborative solutions.



New America: Response Communications Workshop, Mountain View, 6/29/15

SILICON VALLEY AS A REGIONAL CASE STUDY

In order to ground our recommendations, we will focus in particular on the Silicon Valley region, a case which embodies many of the contradictions and complexities of telecommunications infrastructure and planning—and a place faced with volatility and risk in both its natural and social ecosystems.

The Silicon Valley region is one of the most diverse in the country in terms of culture, geography, topology, and economics. It is urban and rural, mountainous and flat, wealthy and poor. There is no single communications technology or strategy that can cross all of these divides to forge universal connectedness. And yet, with the region’s many evident risks and dangers—including multiple active fault lines on either side of the Santa Clara Valley, storm surges along the coast, forest fires in mountainous areas, sea level rise, and threatening infill development on the floodplains along the South Bay—there is a clear need to develop a coordinated and diverse set of strategies to reach, inform, and support the region’s inhabitants in case of emergency or disaster.

In the spring of 2015, New America launched an effort supported by the Silicon Valley Community Foundation (SVCF) to conduct a discovery and pre-planning process for networked resilient

communications infrastructure in the Silicon Valley region. The initiative was designed to address concerns about the capacity of regional communications systems in the case of an emergency similar to the 2014 Napa Valley earthquake, in which some rural communities were cut off from communications and isolated from aid efforts. In particular, Silicon Valley representatives were interested in exploring the possibility of connecting the region with a “network of networks” similar to the local community wireless network used for resilient communications in Red Hook, Brooklyn.

New America’s Open Technology Institute (OTI) supported the early development of the Red Hook Initiative (RHI) Wi-Fi neighborhood mesh network, which withstood Superstorm Sandy to become a lifeline for the community in the aftermath of the storm.⁴ Unlike larger commercial networks, RHI Wi-Fi was locally maintained, required minimal power, and used inexpensive, adaptable equipment. As a result, local “Digital Stewards” trained by RHI and OTI were able to keep the network running throughout the storm’s aftermath.

Yet while the kind of technology used in Red Hook—mesh wireless—can perform well at the scale of a dense urban neighborhood, regional networking



Mountain ranges separate areas of the region, creating challenges for build-out of telecommunications systems.

requires a different approach. Silicon Valley’s mountainous terrain creates challenges for line-of-sight wireless network links; also, the more rural population centers in the region are spread out across wide areas and honeycombed with small clusters of households served by few roads. Some of the very mountainous and rural parts of the region are not served by internet providers at all. These factors would complicate the creation of a regional mesh wireless system—or in fact any single, unified system.

In order to address these constraints and provide recommendations for a regional system of connections that serves all populations, builds on existing assets, and supports networked local official, volunteer, and nonprofit response efforts, New America conducted a mixed-methods assessment including: spatial analysis; telecommunications needs assessment and asset mapping; and interviews and discussions as well as a participatory workshop for local residents and organizations. Our findings are broken down by four major thematic areas we discovered in our research:

- Locating and strategizing for vulnerable populations;

- Planning for the rural/urban divide;
- Communications connectedness; and
- Emergency management and readiness.

Locating and Strategizing for Vulnerable Populations

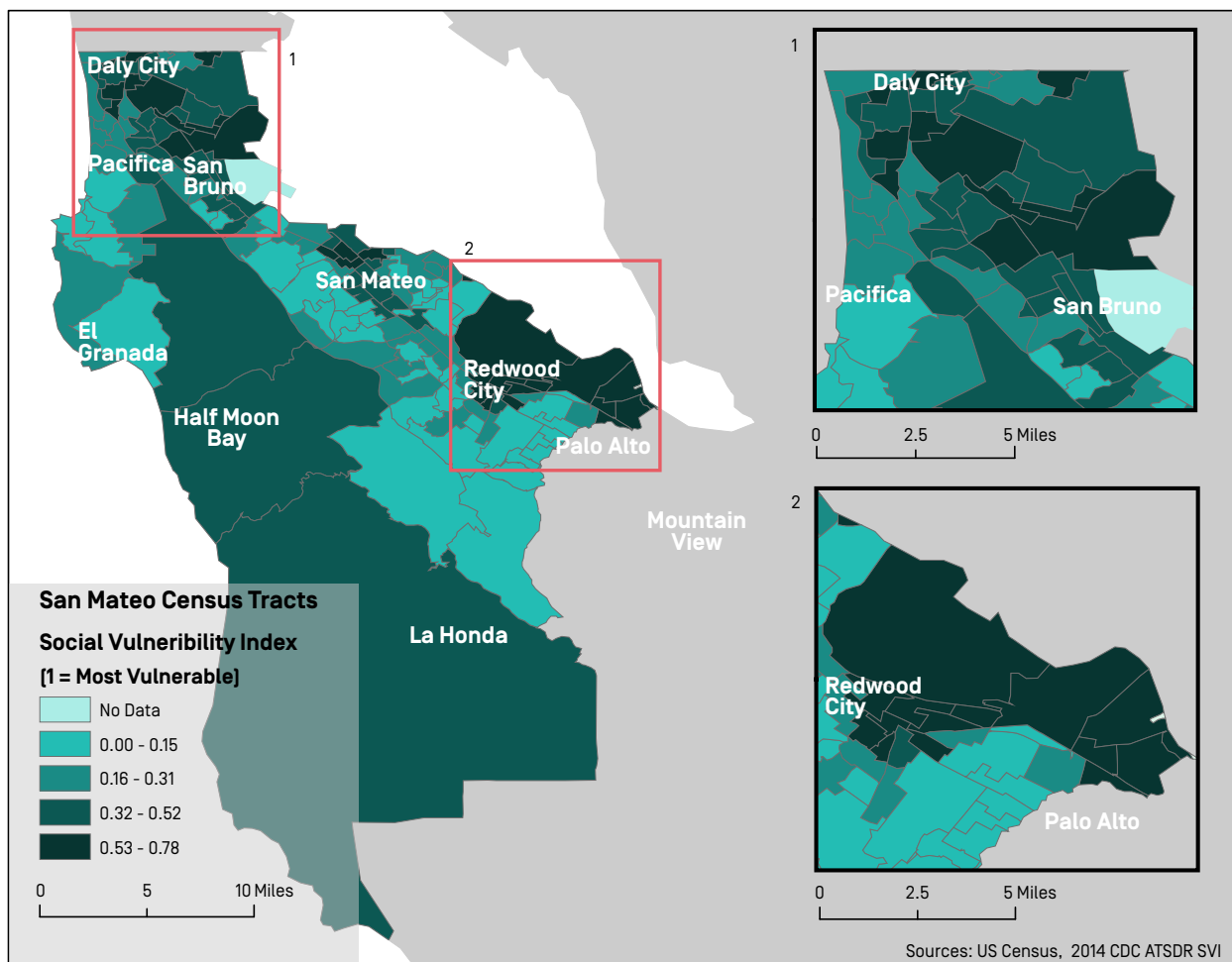
While Silicon Valley is home to the headquarters of globally prominent technology companies including Google, Facebook, and Twitter, it also contains many rural and isolated communities, as well as California’s fastest growing city, San Jose. And despite (or in some cases because of) the tech boom, a growing socioeconomic divide is creating pockets of risk and isolation, even within well-connected urban areas.

The region’s housing and infrastructure systems are under strain with the influx of new residents relocating to the Valley for tech jobs, as well as thousands of workers commuting in daily from San Francisco and Oakland via a handful of gridlocked highways and at-capacity rail lines. The basics are already out of reach for most: Housing

prices are \$411,000 above the median price for the state, and rents are \$1,626 higher on average than rents in the rest of the country.⁵ Meanwhile, since 2006, per capita income has decreased by over 20 percent for Black/African-American populations (compared to a 5 percent decrease for the rest of the country), and by almost 12 percent for Hispanic/Latino populations. More than 30 percent of the population does not make enough money to meet basic needs without public assistance. Perhaps most importantly for preparedness and disaster communication efforts, 51 percent of the population speaks a language other than English at home. All of these factors must be considered in preparedness, as vulnerability compounds risk, and stratification among different social groups creates the need for a diversity of approaches, methods, and modes.

In order to better understand where and how to target communications preparedness efforts, we used the Centers for Disease Control’s (CDC) Social Vulnerability Index (SVI)⁶ to create heat maps highlighting areas with the highest concentration of vulnerable residents. The CDC defines social vulnerability as “the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks.” The index can be used to identify shelter locations, plan for evacuations, and allocate supplies and human capacity during an emergency and throughout long-term recovery, as well as identifying where to target communications planning efforts.

Based on data from previous disasters and emergencies showing which types of households



sustained the most damaging effects, four themes are included in the SVI: socioeconomic, household composition, minority status/language, and housing/transportation. The darkest areas on the maps below thus show the areas with the greatest social vulnerability relative to the U.S. as a whole (not only in comparison to surrounding areas).

Using the SVI, we found a set of vulnerable urban areas in Silicon Valley with populations at risk of sustaining disproportionate impact in a future disaster or emergency:

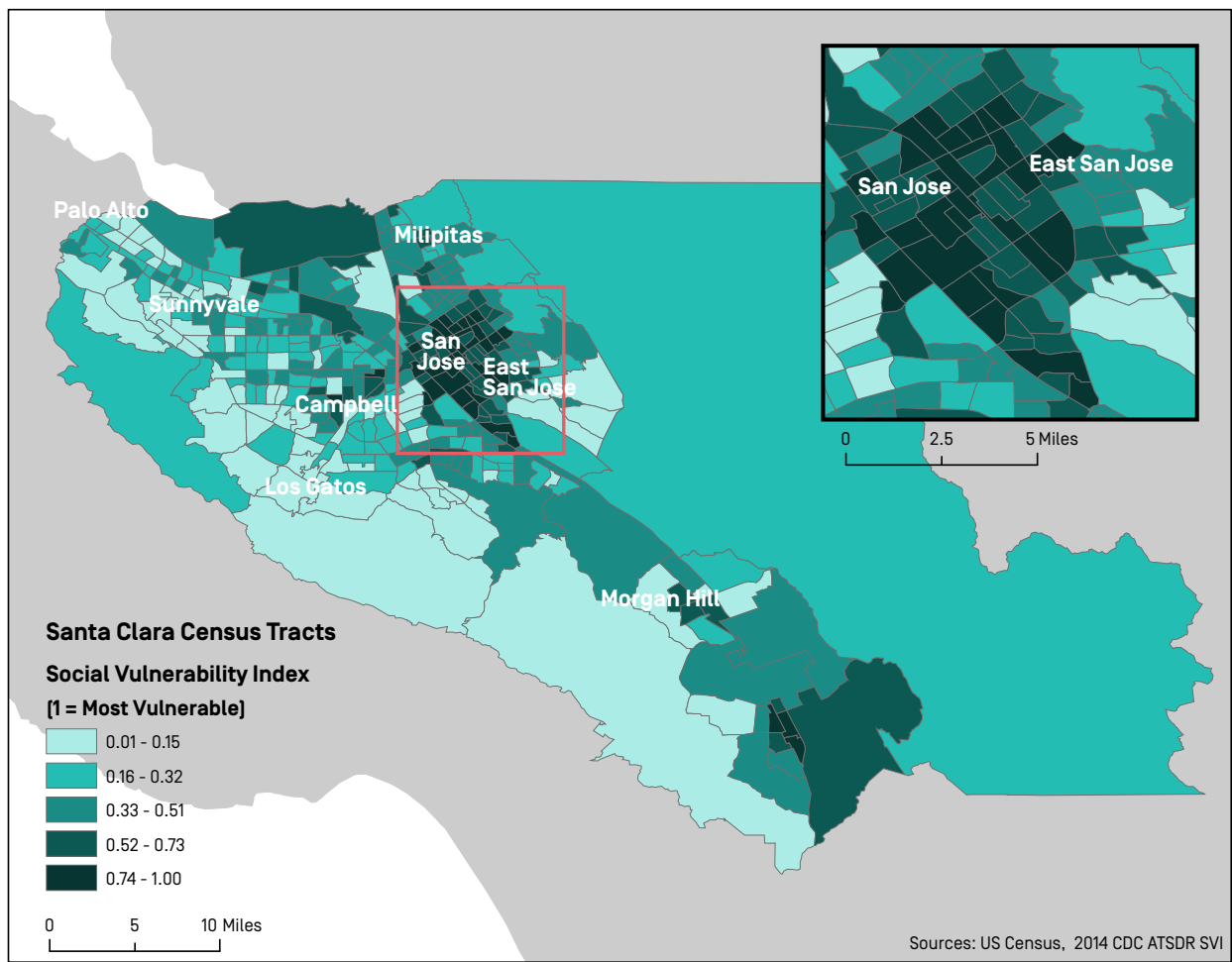
- San Mateo City
- East Palo Alto
- Daly City/South San Francisco

- East San Jose

We also found evidence of vulnerable rural areas, where populations may be hard to reach in an emergency:

- Gilroy/Morgan Hill
- Coastside San Mateo County (Pescadero/La Honda)

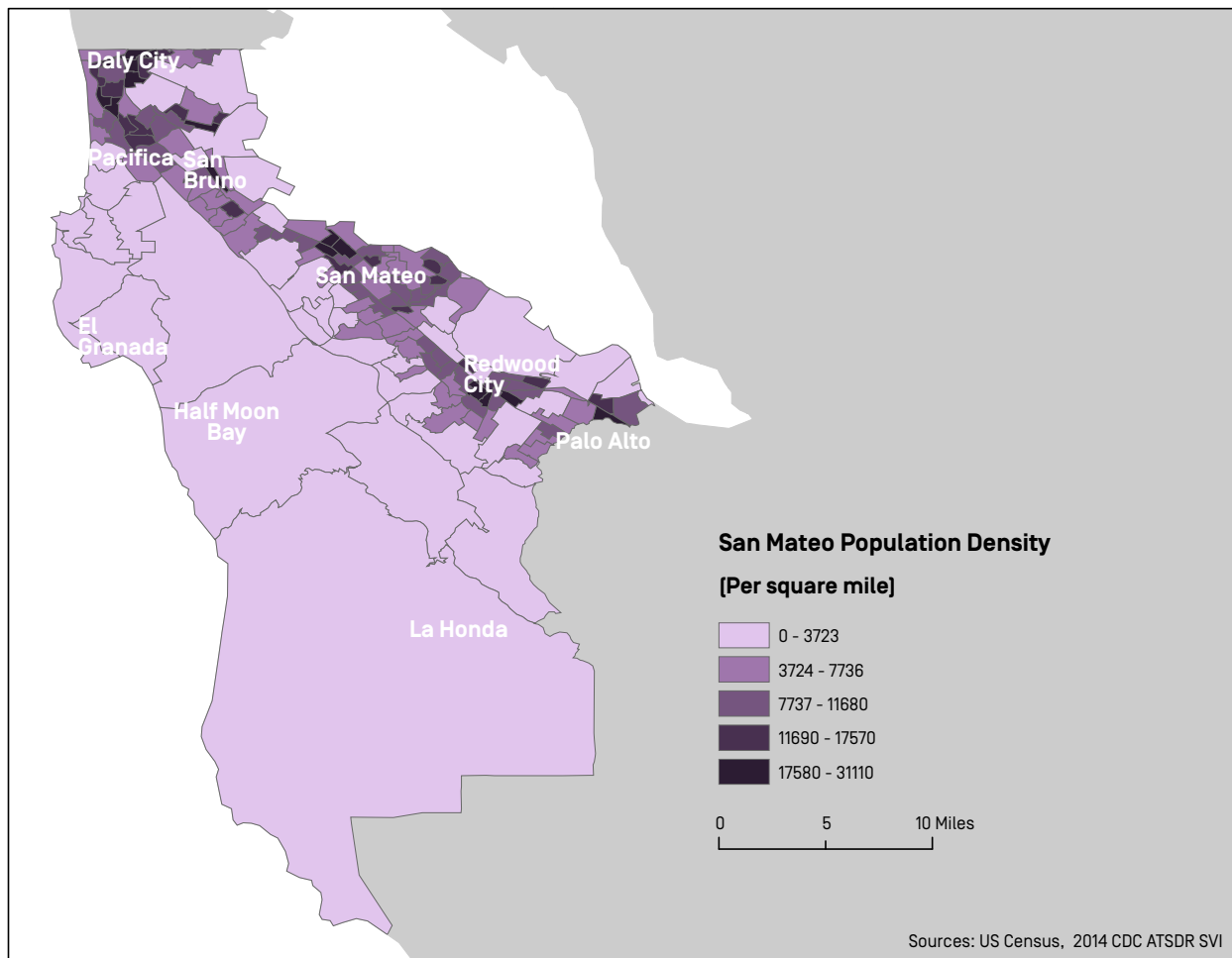
It is important to note that this method of diagnosing social vulnerability has limitations. Percentiles are calculated by averaging social vulnerability across the population of a census tract. In tracts that have sparse populations, data from just a few households is averaged across a relatively large land mass.



Additionally, these maps may not clearly show places with variation within a census tract. Pressure on housing and transportation infrastructure has created many pockets of vulnerability even within generally well-off, less vulnerable communities; for example, recent reports show that homelessness in Mountain View has doubled within the last two years, with many residents now living in cars, garages, or encampments, and thus often not counted in census or other survey data.⁷ Further detailed analysis with input from local residents is needed to create local disaster communications plans, though these maps give us a general sense of areas of high priority.

However, our vulnerability analysis also has limitations with regard to transportation and daily

commuting patterns. While the Census data that inform the SVI provide a clear view of the locations of vulnerable households, many people migrate throughout the region with their daily commutes; even service workers may travel a long way to work. Since it is impossible to predict the timing of emergencies—and since the region’s limited highway system can be gridlocked even on normal days—communications preparedness planning must take into account locations where daily commuters might seek shelter, as well as the communications needs of stranded commuters. Overall in our qualitative data-gathering efforts, however, local respondents verified our prioritization of high-risk sites as demonstrated by the SVI analysis.



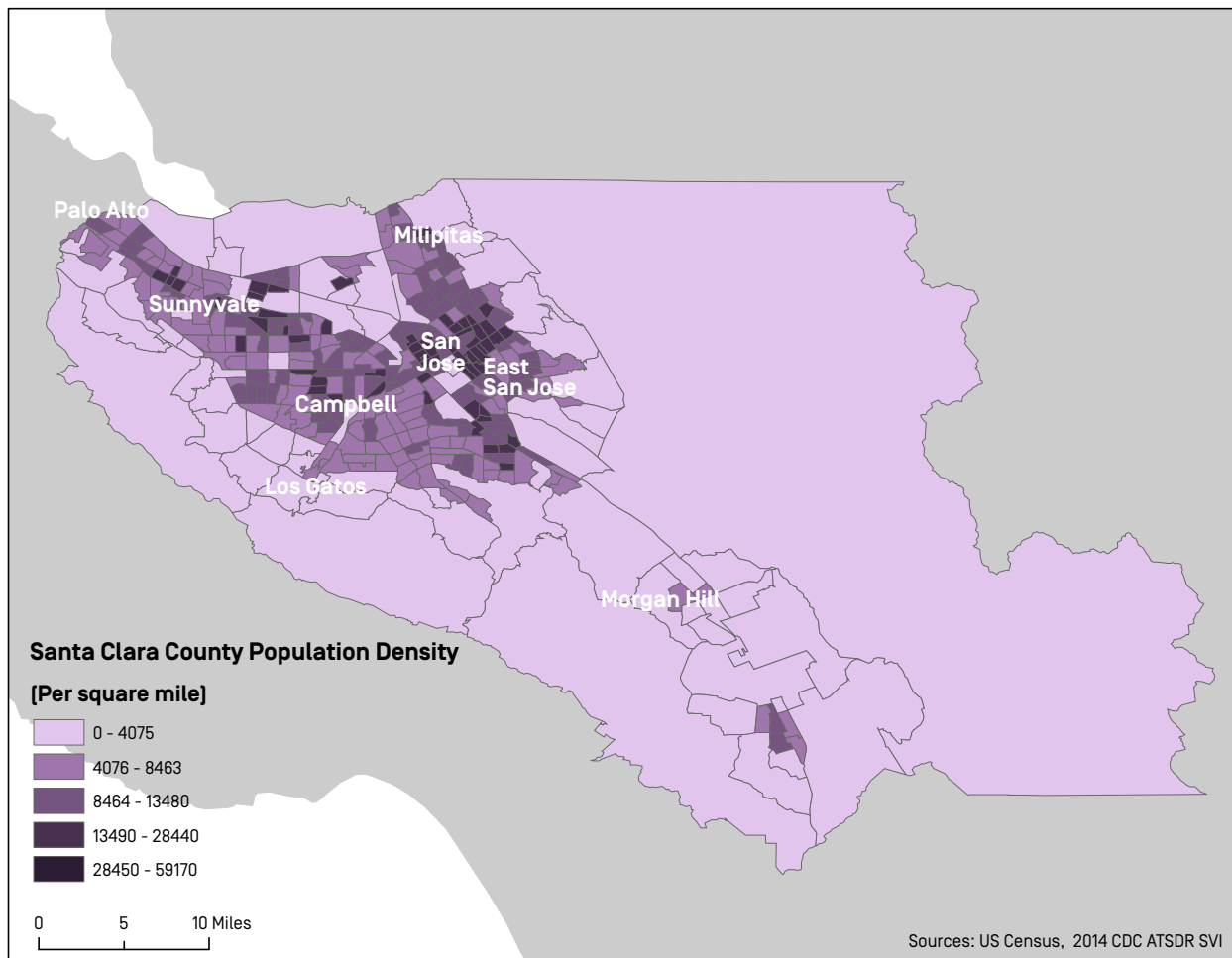
Planning for the Rural/Urban Divide

In order to increase specificity and understanding of vulnerability taking into account additional demographic factors, we also examined population density. The region shows striking variation, with both urban crowding and very isolated rural inhabitants.

Comparing these population density maps with the social vulnerability analysis, we find three places with particularly high density combined with high vulnerability. Based on this analysis, we have identified **Daly City/South San Francisco, East Palo Alto** and **East San Jose** as high priority urban sites for resilience planning. Additionally, while the **Coastside area of San Mateo County** (south

of Half Moon Bay) and **Gilroy/Morgan Hill** both show relatively low population density, they also show high social vulnerability, making them rural resiliency planning priority areas.

In interviews and discussions with local residents and officials across the region, we learned that sparsely populated rural areas often don't show up in official statistical analysis, so are sometimes not included in county-level preparedness planning. With limited time and resources, preparedness efforts tend to focus on urban areas, where greater numbers of people can be reached more efficiently. Many rural residents live in single households or small clusters along mountain roads, or in unincorporated communities, and are particularly vulnerable to fires, mudslides, and generally to



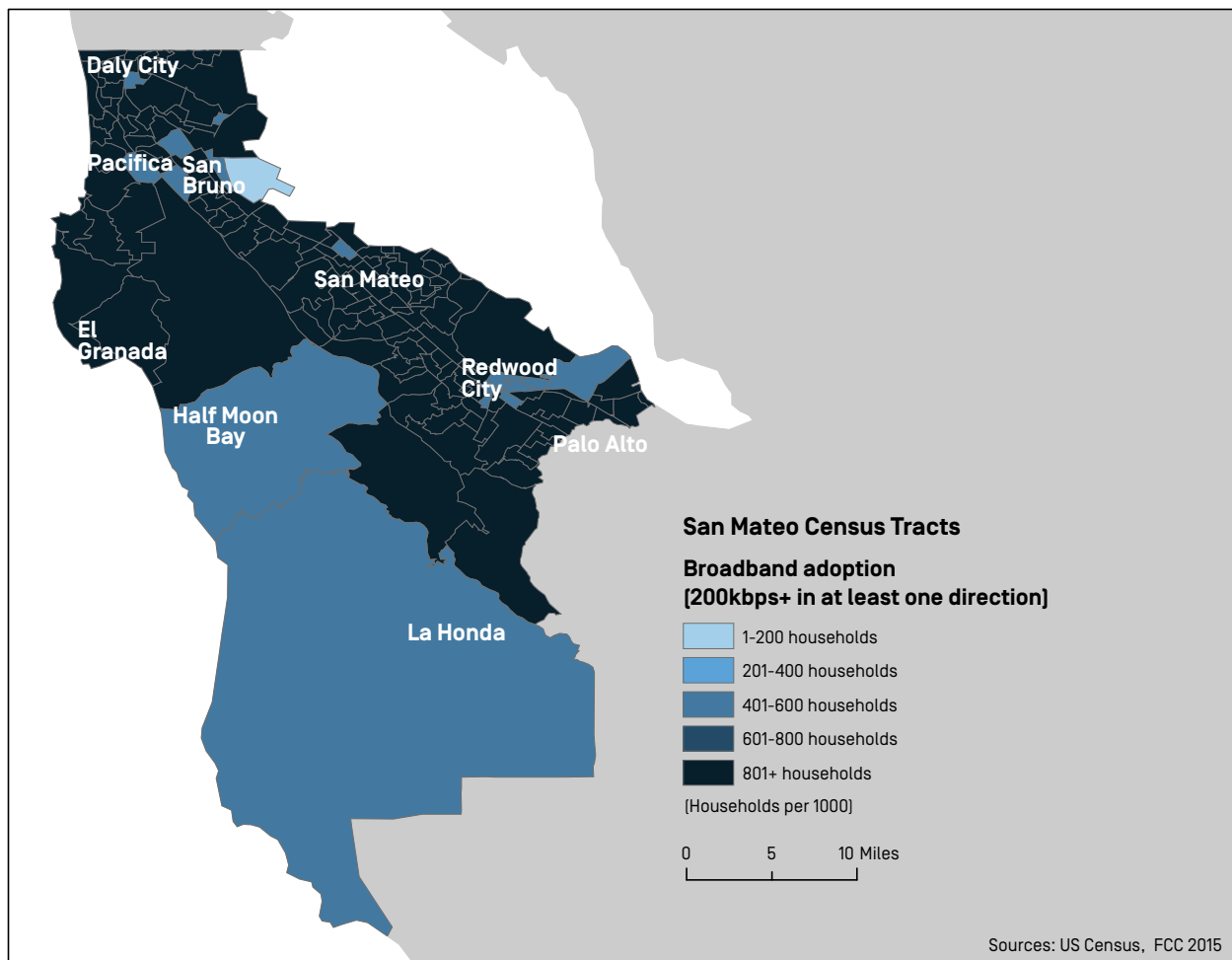
losing contact with outside groups and resources. Yet there is a strong “self-sufficiency vibe” in these communities, many of which have licensed amateur radio operators and self-organized preparedness plans, including emergency supply stashes and even horseback rescue corps in some places.

Telecommunications Connectedness

In order to understand telecommunications markets and access in the region, we examined data on broadband subscription rates. These data show us areas with low levels of broadband subscription both in rural areas that may lack infrastructure, and in urban areas where broadband prices may be too high for people already facing housing and other financial challenges.⁸

As an industry cluster with thousands of tech startups and entrepreneurs, Silicon Valley is home to many data centers and internet providers within the Santa Clara valley, as well as fiber-optic infrastructure connecting most of its central urban hubs. New efforts to expand access are also underway: For example, the municipality of Palo Alto is in the planning process for a proposed fiber-to-the-premises build-out throughout the city, and both Google and Facebook are planning for wireless broadband build-out in rapidly expanding San Jose; meanwhile, Mountain View also has plans for high-capacity wireless in its downtown.

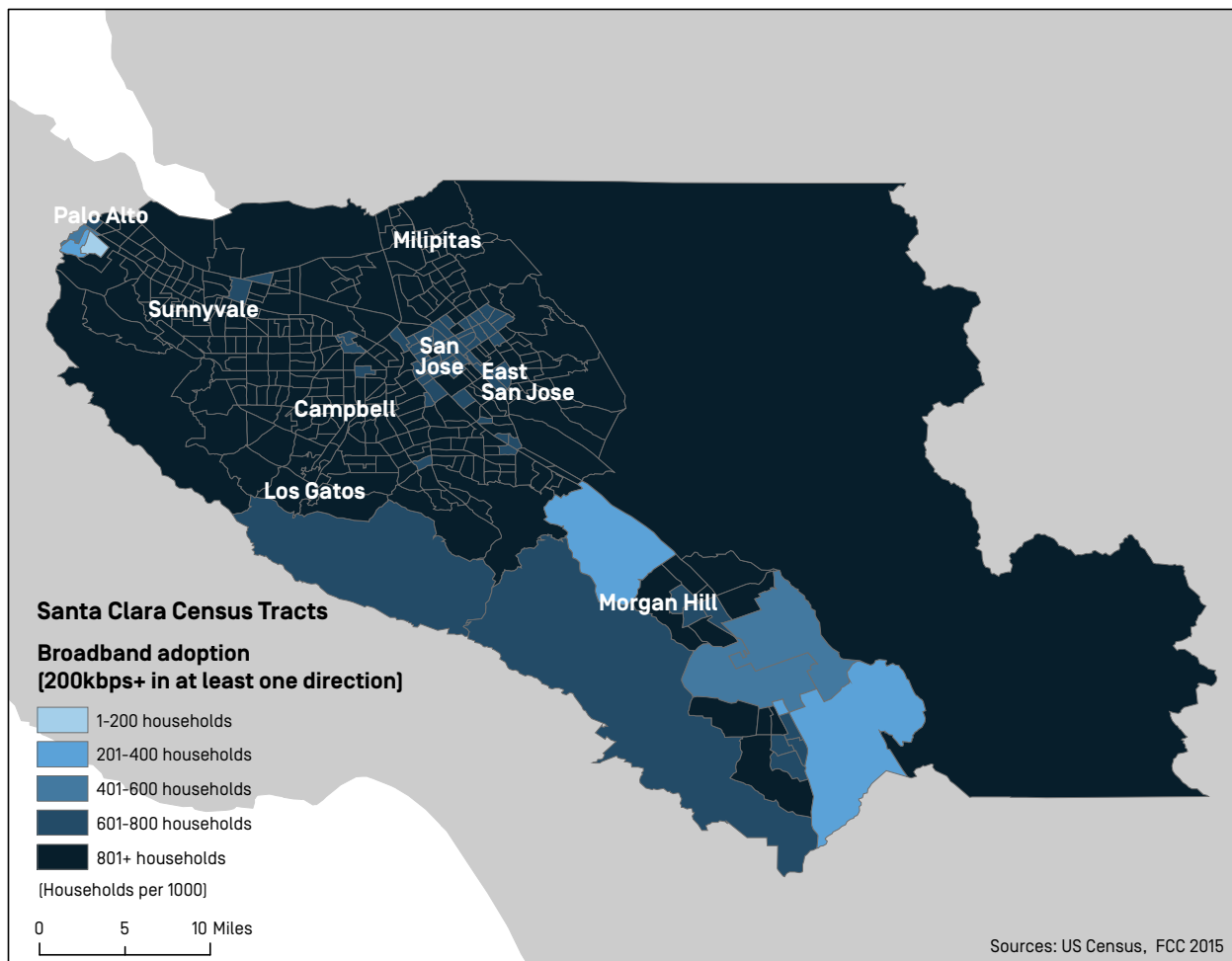
However, with regard to the region as a whole, telecommunications infrastructure build-out is uneven. The Santa Cruz mountain range divides San Mateo’s coastal communities from the Santa Clara



Valley, presenting a major obstacle to a centralized regional system, as described above. To the East, the Diablo mountain range complicates build-out to some Santa Clara County communities. There are Wireless Internet Service Providers (WISP) in many rural areas, but both they and traditional ISPs are more likely to build out connectivity in discrete areas on a contract-by-contract basis than to attempt to connect all parts of the region together.

Thus while broadband adoption rates are high across the Silicon Valley region relative to the U.S. as a whole, in some urban places like East Palo Alto and East San Jose, high social vulnerability corresponds with lower rates of adoption. And aside from particular low-adoption areas shown on the maps above, the region's digital connectivity profile as a whole is fragmented and uneven. Since

Internet Service Providers (ISP) tend to build out infrastructure from their backhaul (data) sources to individual towns or clusters rather connecting towns directly to each other, regional systems are more likely to converge on central hubs than to connect towns directly to one another. In an emergency, two adjacent towns might be linked to the same remote data center but not directly to one another; if the data center were to lose power, those towns would not be able to communicate despite proximity to each other. Additionally, some existing systems linking populous to rural areas are fragile due to a lack of system redundancy. For example, the **Gilroy/Morgan Hill** areas to the South of Santa Clara Valley are connected by very limited fiber lines running along Highway 101. These lines are vulnerable to multiple sources of failure, including sabotage and natural disaster.⁹



Thus, it is very possible that districts, towns, or areas of the region could be cut off from normal telecommunications systems—and from each other—in an emergency. Considering the location of many of the region’s technology hubs, including several data centers and telecommunications assets along the South Bay, it is possible that hubs and central switches could be flooded in an emergency. If these fail, other sections of the region’s telecommunications and transportation systems could become overloaded, stranding residents and commuters and isolating communities.

We asked a range of local residents about how to plan for this possibility. Some residents emphasized that particularly vulnerable populations—for example the undocumented and homeless—would be difficult to reach using digital networks, and that some groups, like non-English speakers, are best reached via FM radio. In rural areas, many see amateur radio is often the most viable emergency communications tool. Almost everyone we spoke with emphasized that digital networks alone—even if built out evenly across the region— would be insufficient to provide resilient communications in an emergency.

Many of our respondents also emphasized the region’s existing social support networks and the need to coordinate with neighborhood advocates and faith-based leaders, especially to reach vulnerable populations. Indeed, many working in the resilience field already have a practice of plugging into existing leadership to find out what vulnerabilities exist and how people generally communicate. Faith-based and local advocacy organizations, as well as libraries and public access media centers, are generally seen as assets for engagement since they are attuned to community needs and are trusted by local residents. Overall in our conversations with local trusted “hub” organizations like these, leaders spoke about how they value their roles as information hubs in their communities, and how increased and redundant connectedness could improve their ability to translate emergency information between digital, broadcast, and other media.

Emergency Management and Preparedness

Both San Mateo County and Santa Clara Counties have emergency response and management agencies tasked with preparedness and resilience planning. Each county’s government has federal funding for disaster preparedness, as well as protocols for outreach and coordination. In terms of communications preparedness, they have access to various communications assets, from satellite phones to mobile communications buses. County-level emergency operations centers also coordinate with municipal governments and have protocols in place to disseminate official information in the case of an emergency. These county offices also participate in some citizen- and coalition-led preparedness activities including Voluntary Organizations Active in Disasters (VOAD); official response and recovery organizations like the Red Cross; municipal governments; amateur radio clubs; and community-based, faith-based, and service organizations.

Of note, the coastal region of San Mateo County (SMC) has two cross-sector coalitions actively supported by the County Office of Emergency Services (OES). The Coastside Emergency Action Program (CEAP) VOAD in Half-Moon Bay works in coordination with the Half Moon Bay Chamber of Commerce to build preparedness and resilience plans by leveraging its network of local businesses and other anchors. This group works closely with community members to establish plans and protocols for emergency response.

The SMC OES also convenes the Coastside Emergency Corps (CEC), a unified team of 120 members that have training in various critical skills, including CERT, amateur radio, and medical skills. One CEC member owns a license for an FM station in Pescadero, which is located at the high school and run by students day-to-day, while also serving as a community resource for emergency response in a disaster. Similarly, the CADRE coalition of organizations in Santa Clara County works closely with that county’s OES and provides extensive

resources and training to organizations that serve vulnerable residents—including linguistically isolated and traditionally marginalized groups—to ensure that all residents receive critical information in emergencies and disasters.

The larger Bay Area region is also home to official emergency management resources and assets for resilient regional communications. For example, the Bay Area Urban Area Security Initiative (BAUASI), a Department of Homeland Security program, includes twelve counties in the Bay Area, as well as the municipal governments of San Francisco, Oakland, and San Jose. The BAUASI disburses federal emergency response funding through a yearly proposal process. It also manages an interoperable communications initiative that has a microwave backbone network in place for official first-response communications (FirstNet). While this network is not available to community-based organizations or volunteer responders, coordinated efforts like the CEC can facilitate information-sharing from official responders to community and volunteer leadership.

In our discussions with local groups and stakeholders engaged with preparedness and resilience efforts, broader regional networks and resources beyond the county level were rarely mentioned. Overall, it appears from our scan that no particular organization or manager is tasked with overseeing *regional* communications preparedness, nor with integrating and coordinating multi-sector, multi-level efforts, in either the Silicon Valley or the Bay Area region as a whole. Furthermore, there remain some communities that are not served or do not participate in existing efforts.

A perception of fragmentation, siloes, and a lack of coordination among resilience efforts and initiatives were frequent themes in our conversations with the region’s residents. While some existing coalitions like CEAP and the CEC do provide a robust preparedness framework, these are not sufficient to coordinate resilience efforts across the region. Some preparedness tools and platforms are also seen as flawed; for example, multiple respondents said

that county-provided SMS alert systems are hard to use (even for tech-savvy and connected people) and not well publicized. One interviewee described it this way: “Resilience is everyone’s and no-one’s responsibility. Everyone is in charge of their own program, yet no one full-time person has the capacity to manage and coordinate across the entire region.” Additionally, we were told that it is difficult to find funding for preparedness efforts, so they become the last priority for many organizations.

Summary of Key Findings

1. Silicon Valley is home to both urban and rural vulnerable areas and diverse multilingual populations, which require different technologies and information distribution strategies.
2. Although local community organizations are valued as information and social support hubs, many do not have communications plans and resources in place to coordinate emergency communications.
3. Online, offline, traditional, and next-generation information distribution and communications systems are all necessary for an interconnected and resilient region. Currently, communications infrastructure is uneven and fragile in places.
4. While multiple local and county-level groups are coordinating holistic local preparedness efforts, no entity is planning for communications resilience at the regional scale.

INTERMODAL PLANNING FOR REGIONAL RESILIENT COMMUNICATIONS

Based on our findings, we have developed the following strategic approach and technical recommendations for intermodal, regional, resilient communications in the Silicon Valley region.

While county-level and municipal governments are planning for communications preparedness, the task is too big to be managed by those officials only. Furthermore, the social support sector is well suited to lead local, diverse, tailored resilience efforts. Community-based groups, including direct service organizations, community development corporations, local libraries and schools, and local media, already serve as on-the-ground communication hubs for local communities. In an emergency, they can act as interchanges for translating and disseminating information via different media and channels. Success of such efforts relies on incorporating and supporting specialized and adapted communications trainings, planning assistance, and relationship development among local organizations, so that participation in a regional communications system grows capacity in an organic and coordinated way.

Our technical recommendations focus on providing local anchor organizations with redundant and resilient telecommunications resources so that they have the ability to act as “intermodal hubs.”

This goal was verified by our outreach: Many respondents underscored the need for a layer of communications managed and led by community-based organizations, which would empower local groups to organize critical response and informal communications services in an emergency—for example, helping individuals locate loved ones, bringing supplies to people with mobility challenges, broadcasting critical information in multiple languages, and other work that may be beyond the remit or capacity of official first response.

We do not advocate for our recommended community-based resilience planning process to replace official preparedness communications, nor do we recommend technical integration of the two systems, as FirstNet and other official channels have a different purpose and function from community-led communication infrastructure. Rather, we advocate following a process such as the one modeled by the Coastside Emergency Corps to establish a set of roles and socialize protocols for harmonization and collaboration between different layers of emergency communications before disaster strikes, with community-based anchors working as hubs between official and unofficial efforts.

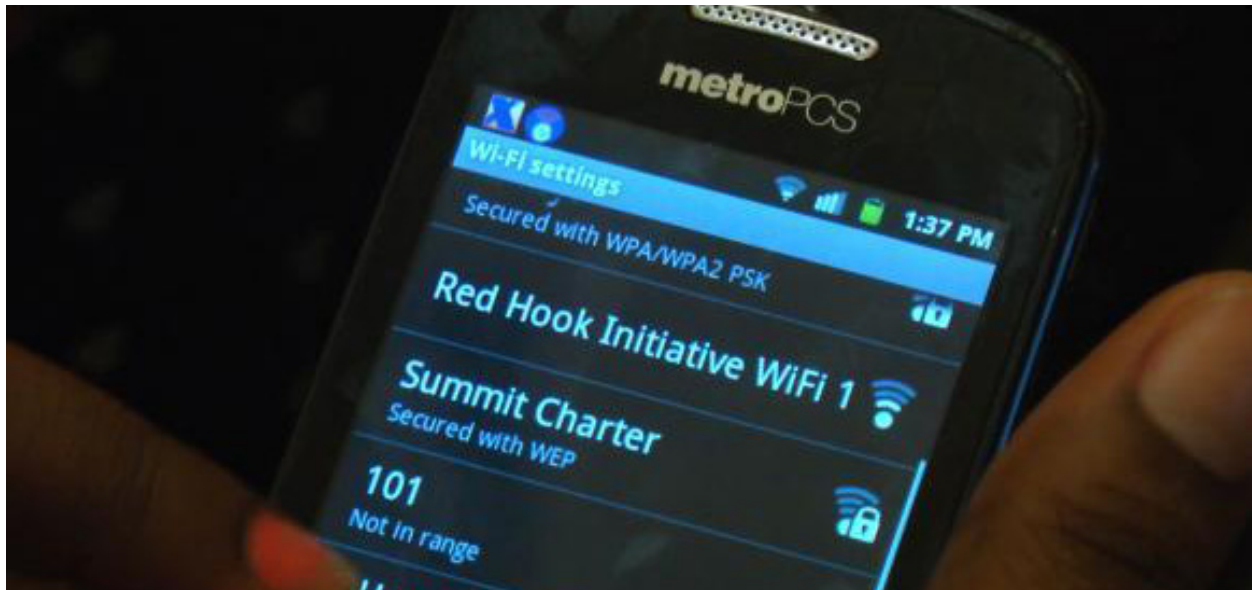


Photo: Becky Kazansky/TechPresident

This approach mirrors the “whole community” approach to preparedness, in which informal and volunteer response efforts are coordinated and leverage official ones. In the case of Red Hook’s Wi-Fi network, the existence of locally-built and maintained communications infrastructure allowed the Red Hook Initiative to support its constituency in ways that official first responders were unable to do. For example, RHI’s social media manager Frances Medina was able to coordinate donations and volunteers from across the city and the country to direct resources toward people in public housing who were otherwise cut off from communications.¹⁰ People in the local community knew and trusted RHI, and when FEMA reached Red Hook, the agency was able to underscore and expand RHI’s efforts by adding data capacity to RHI Wi-Fi via a satellite uplink, and even used the network for some of its local operations.

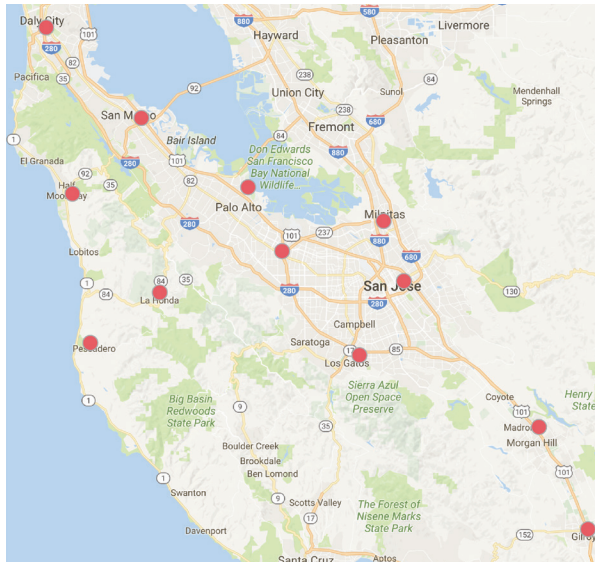
Similar stories about innovative uses of technology as a platform for mutual aid were common after Hurricane Sandy. The Department of Homeland Security (DHS) documented the process of tapping into the self-organizing capacity of volunteer and grassroots response efforts using the internet and social media. “The Resilient

Social Network,” a 2013 DHS report on the mutual aid effort “#occupysandy,” outlines the limits of traditional response and recovery procedures, and provides guidance on how to engage and leverage self-organized response efforts for better overall outcomes.¹¹ Occupy Sandy recruited, trained, and mobilized nearly 60,000 volunteers—largely by using social media—and emerged as one of the leading humanitarian efforts providing relief in 2012.

Creating a regional strategy for intermodal communications resilience would break new ground in the field of disaster preparedness. It would require multi-sector engagement, effective leadership, and coordinated governance. Such a project does not fall under the jurisdiction of any existing agency, but rather would require multi-sectoral cooperation and coordination across many local groups in the region. Yet the process itself of building cooperation, coordination, and consensus on such an initiative could catalyze a defining approach to building “whole community” responsiveness at the regional scale.

Based on our spatial analysis, we have created a tentative regional blueprint for resilient

connectivity. The map below includes both particularly vulnerable urban and rural communities as well as less-vulnerable hubs that could function as supports across the network and connect local response and recovery efforts with official agencies and first responders. In each section of the region identified on the map, digital equipment should be installed at one or more physical hub or “community anchor” organizations.



There are twelve regional hub sectors across the region.

This interconnected network of local hub sites serves as the first of three layers in our recommended intermodal system: **a regional high-speed data backbone**. This backbone would supply bandwidth and connectivity to **local community wireless networks**, the second layer of the regional system. These networks should be developed and maintained by local organizations and adapted to serve their constituents’ needs. A third layer of the intermodal system is comprised of **broadcast and amateur radio** operators supplementing and interconnecting areas that do not have direct digital connections. Below, we describe each layer in detail including specifications and estimated costs.

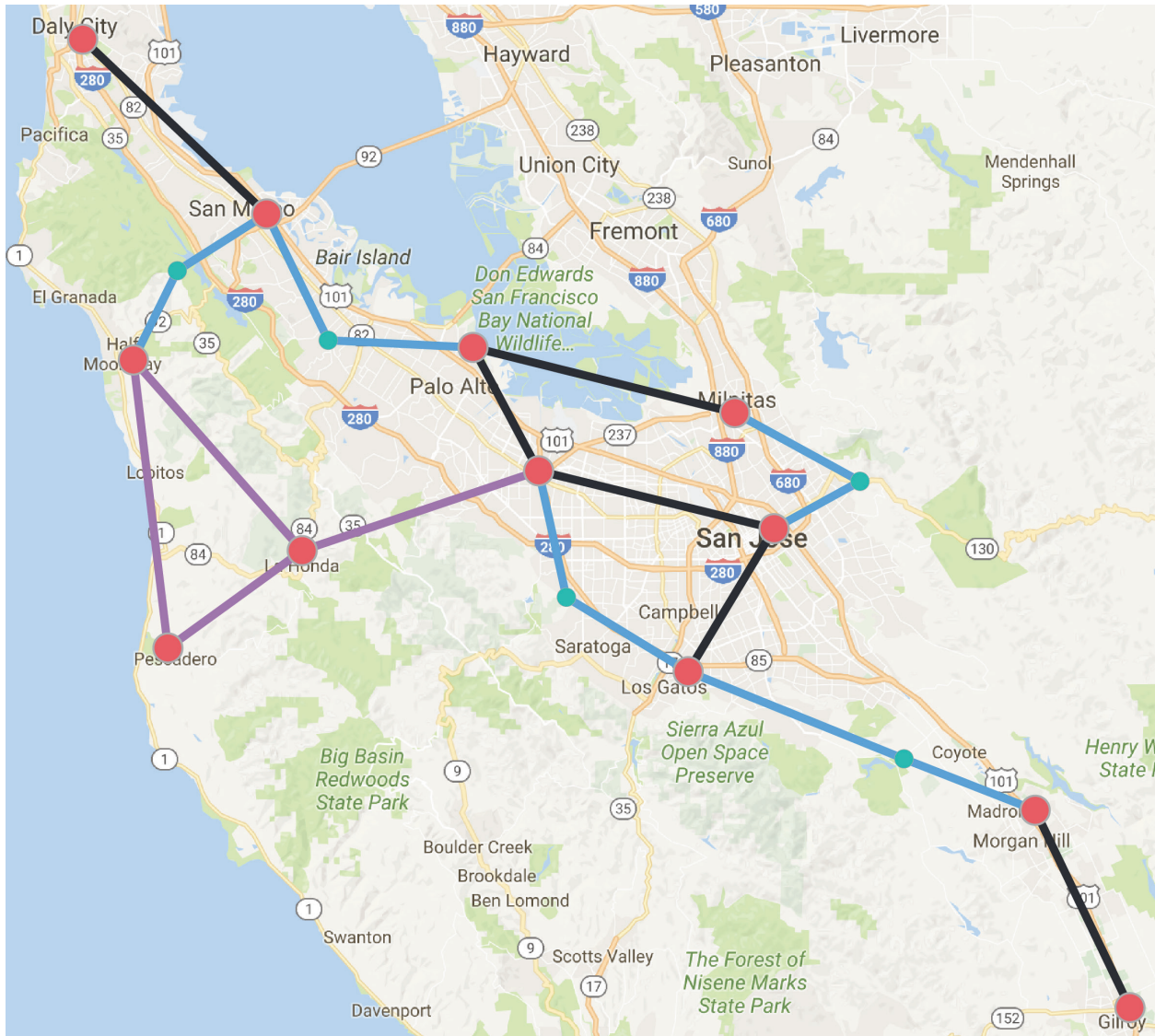
Layer 1: Regional High-Speed Backbone Network

As shown on the map above, this layer links all twelve regional hub sectors of the region together—however, the proposed backbone itself comprises three different digital technologies in order to manage topographical and coverage challenges.

While the much of the backbone network would comprise point-to-point wireless links among relatively nearby sites, constructing a regional backbone network also requires building relationships with data centers (telecommunications facilities that house servers and physically interconnect different networks to each other), as well as with municipal authorities and community broadcast media outlets, many of which have rooftops and towers that provide ideal mounting sites. The backbone network should also utilize commercial wireless internet service providers (WISP) in mountainous areas that are unreachable via point-to-point links, as well as innovative “experimental” connection technologies like millimeter wave or TV White Spaces (unused broadcast spectrum) for particularly remote locations, if desired.

While the high-speed backbone is primarily intended to supply data backhaul and interconnect local wireless networks, engineers should also set up links at hub installation sites to install access points (hotspots) at those sites and in nearby public areas. These can provide basic connectivity via the resilient backbone immediately, providing a valuable service to organizations and residents, as well as generating data on the functionality of the backbone for the engineers. These access points should be placed at participating community anchor organizations that also provide critical preparedness and support functions.

The network shown in the adjacent map, including point-to-point, commercial WISP, and experimental links, is only an example. Before any network such as this could be built, network organizers would need to initiate an extensive discussion with data



- Key:**
- Blue = WISP
 - Purple = Experimental
 - Black = Point-to-point

Example of a regional backbone network design including Point-to-Point, WISP, and experimental technology links. The points on the map below do not designate particular addresses, but rather zones that can function as local area hubs, where people on the ground can coordinate on- and offline.

centers and municipalities, and to commission an engineering feasibility study. In addition, organizers would need to approach regional WISPs to discuss options for providing connectivity in remote areas. In early stages, organizers should consider backhaul provider options as well as identifying pathways for long-term sustainability planning. Engaging multiple sources of bandwidth (connections to the internet) is recommended for redundancy. It may

be possible to purchase connectivity from the same data centers hosting the backbone network hubs, or to request donated bandwidth (data connectivity) from an institution such as an academic institution affiliated with Internet2.¹² Regardless of source, the backbone network should be fed from geographically diverse connections and multiple service providers for the greatest resilience.

While the need to address the need for backhaul sources early on is evident, there are multiple options for overcoming this obstacle:

- Use a WISP carrier with existing links on both sides of the mountain range to bridge between the backbone in the Valley and organizations on the coast;
- Set up long distance links using mountaintop tower sites to reach over the range. This presumes access to towers that can “see” both sides of the mountain. Municipal communications sites may be well-positioned options;
- Utilize experimental wireless technology such as TV White Spaces to provide non-line-of-sight links (though using beta technology presents other challenges);
- Develop a relationship with local ISPs in coordination with resilience groups such as the County OES.

The costs for the regional backbone network include equipment, labor, and technical planning and engineering:

- Capital expenditures for high-capacity wireless links among data centers, municipal or other public buildings, public access media and radio stations, and anchor sites including interested service and community organizations;
- Consulting fees for communications engineers to design and plan the regional backbone network and perform a feasibility study;
- Labor fees for installers and technicians to build the regional backbone network;
- Bandwidth costs from multiple ISPs, if free or donated internet connections cannot be secured;
- Ongoing operating expenses for maintenance,

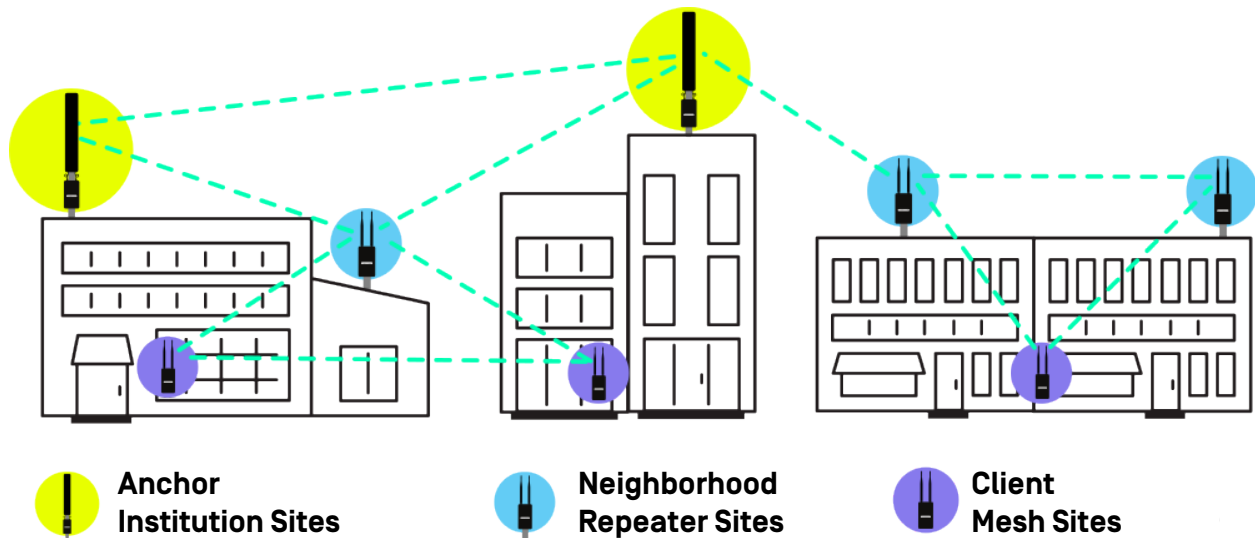
including consulting engineer fees for troubleshooting and repair and equipment upgrades.

An initial estimate for the Regional High-Speed Backbone Network—which includes 12 hub sites linked with various technologies and carriers—comes to between \$250-350,000, depending on the choice of technology. This includes wireless equipment, power backup hardware, installation costs, engineering evaluation costs, and WISP carrier fees for one year. This would not include the costs of local wireless networks, nor internet backhaul. Additionally, any up-front investment should also consider ongoing operational and maintenance expenses for long-term sustainability as well as day-to-day uses in order to gather support and investment. Note that these costs are estimated.

Layer 2: Local Community Wireless Networks

Community wireless networks like RHI Wi-Fi in Brooklyn can be vital sites for local engagement and resilience planning. They can be built at the scale of a neighborhood or small town, and grow over time as new hosts and users join. From the backbone network, links branch out to community-based networks located in cities, towns, and neighborhoods. Meanwhile, the high-speed backbone works like a highway system connecting local road networks. As local networks are built, they connect to the regional backbone for data backhaul and for streamlined connections to each other.

For long-term viability, community-based organizations leading the development of local networks should recruit local individuals interested in learning valuable IT and networking skills. For example, in Red Hook, Brooklyn, the Red Hook Initiative runs a “Digital Stewards” training program for residents of public housing in the neighborhood. These individuals learn hands-on how to design and build networks. In addition, some are then placed in certification training courses on IT and wireless



Distributed mesh network design, in which households, interested community organizations, and/or businesses mount wireless devices on rooftops, and create connections with routers within range. These routers are connected with neighbors, forming multiple links between sites.

Due to the diversity of communities and the organizations that serve them, community wireless networks may look very different from site to site, especially since each location will engage in a separate and unique community planning process. The budget will therefore vary depending on the technology used, the scale of the network, the number of sites with backup power, and the expense of organizing and training local residents. However, following are the major cost categories for community wireless:

- Capital expenditures for wireless equipment to bridge from the regional backbone to local buildings and public Access Point locations;
- Consulting fees for a wireless or communications engineer to do initial planning and construction of a small-scale installation for the initial pilot network;
- Ongoing operating expenses for maintenance, including engineer and technician fees for high-level troubleshooting and repair;
- Operating expenses for community-based organizations and partners to host trainings on IT, networking, and media production.

An initial equipment estimate for a mesh pilot in a single neighborhood—which includes five anchor sites, 10 repeater sites, and 50 client mesh sites—comes to at least \$30,000. This includes wireless equipment, power backup hardware, electrical installation labor for anchor sites, and mounting hardware. Consulting engineer and installation labor is not included in this estimate.

Layer 3: Broadcast and Amateur Radio

While a high-speed backbone and local community networks will provide the capacity to feed photos, video, and other digital data to local databases and the internet for recovery efforts in an emergency, it may not reach every local organization, nor every vulnerable area. We recommend integrating amateur (HAM) radio operators and clubs into regional resilient communications planning, as amateur radio signals require little power, are hardy and easy to troubleshoot, and can reach a very broad geography without interference from topographical features such as mountains.

Amateur radio operators are already integrated with official emergency response systems; many have protocols in place to receive and broadcast

Emergency Alert System (EAS) notifications and regularly run preparedness drills in coordination with county officials. Thus they can play a vital role in coordinating official and self-organized response efforts, enabling all involved in response and recovery to share information among systems that are technically not connected. Ideally, every network hub location in the backbone, as well as every local anchor organization hosting a local wireless network, should have a base station transceiver on the premises and multiple staff with portable transceivers, as well as relationships with amateur radio operators and clubs in their area, such as BAEARS, ARES, and Bay-Net.

Many stakeholders have had questions for us about the mechanics of combining different communications systems such as amateur radio, FM radio, and Wi-Fi. However, in some locations local groups are already working on mapping their communications assets and creating protocols and plans for coordinating among them. Integration of amateur radio into the other layers of the regional system would be part of the resilience planning framework and process. This is already happening in the context of the SMC Coastside Emergency Corps (CEC), which includes amateur and broadcast (FM) radio operators in its ranks. We recommend

looking to learnings from this group in moving forward with this network component.

The costs for adding amateur radio capacity for interested community-based organizations are low. They include:

- Capital expenditures for base station and an adequate number of portable transceivers for each interested community organization;
- Supporting staff time to take training courses on amateur radio rules and operations;
- Providing support to local organizations to cover expenses related to equipment maintenance and ongoing staff training, on a yearly basis.

Additionally, the region is home to three public access media centers or Public, Educational, and Governmental (PEG) media centers: MidPen Media Center, KMVT (Silicon Valley Community Media Center), and CreaTV San Jose. All three have emergency alert systems as well as multilingual training capacity and connections to municipal governments.

Ideally, every network hub location in the backbone, as well as every local anchor organization hosting a local wireless network, should have a base station transceiver on the premises and multiple staff with portable transceivers, as well as relationships with amateur radio operators and clubs in their area, such as BAEARS, ARES, and Bay-Net.

PUTTING IT ALL TOGETHER: DESIGNING FOR EMERGENCIES AND THE EVERYDAY

The goal of our recommended integrated approach to intermodal communications resilience is to ensure that systems are both resilient in emergencies and useable for everyday needs and community-defined goals. Infrastructure that is only intended for emergency situations may fall into disuse and become less functional due to lack of maintenance or support capacity. For these reasons, we believe it is essential to define the uses and benefits of such a system beyond emergency communications early on; this will help drive uptake, adoption, and use.

It is also important to be aware of possible challenges. Of note, a few earlier attempts at building local and regional wireless systems in Silicon Valley have had various degrees of success, and faced serious obstacles, for example: difficulties with engaging a bandwidth service provider, lack of local buy-in or engagement, and challenges with developing effective, collaborative leadership structures or sustainable financial support models.¹⁴

While we have found that stakeholders are generally supportive of the intentions of this proposed system and have validated its goals, launch and implementation will require political power, funding, and the right combination of personalities

and interests. Multi-sectoral leadership is necessary to open doors and align and leverage priorities and goals, and coordinate efforts with other initiatives, while also ensuring that the interests of different communities are represented. Leadership will also need to manage different methods, approaches, and practices among a diverse group, including:

- Municipal or city officials and leaders
- County administrations, in particular emergency management offices
- Community-based organizations, including direct service as well as grassroots, advocacy, and faith-based groups
- Dedicated disaster relief and aid organizations
- Public, Educational, and Government (PEG) and other local media organizations
- Community and Low Power FM radio stations
- Local internet service providers (ISP), data centers, and other technology providers
- Local Chambers of Commerce

- Amateur Radio Clubs
- Regional multi-stakeholder coalitions such as CADRE, and the Association of Bay Area Governments
- Tech companies with strong stakes in the region and a track record of community investment, including Google, Facebook, Twitter, and Cisco, for potential leadership, funding, and also to lend tech skills as part of a “day of service” or other volunteer opportunities

We emphasize that, ultimately, the development of a regional intermodal communications network—and especially a network of networks including different technologies—is a social process. Residents have to work and plan together, with and through accountable processes, to build community-supported technological systems and determine how to use them in different scenarios. One key finding from the experience of RHI Wi-Fi during Sandy was that the network was able to act as a fulcrum between the community’s offline and online worlds. While the network itself increased and added value to the Red Hook Initiative’s capacity to help the community persevere and prosper during and in the aftermath of the storm, this was due in large part to the organization’s reputation and existing social network.

Community rootedness will also help to create engagement and use of the network, especially during non-emergency times. For example, local organizations can run scavenger hunts or build walking tours using geotagged video and photo services—the same media sharing platform could then help critical responders and volunteers to rapidly understand and locate areas of need in an emergency. Networks and local servers could also be used to collect local data on an ongoing basis, including civic and municipal Internet of Things (IoT) data as well as emergency and recovery information.

Public, Education, and Government (PEG) media centers and libraries can contribute to the

development of everyday network applications, as they already offer many services with emergency uses, including streaming e-news, civic engagement kiosks, and mobile news vans, as well as media training and multi-language programming. They and local tech organizations can hold “net days” or other engagement opportunities for local residents and volunteer techies to become familiar with the networks. There are virtually unlimited day-to-day uses, services, and applications to make these networks relevant for their communities.

While technical systems alone will not lead to regional connectivity, we believe that such a system could have multiple benefits for the region beyond added response capacity. If the capacities and interests of all regional stakeholders align, this initiative could demonstrate a groundbreaking regional resilient communications model. Furthermore, as a national center of resilience innovation and capacity, Silicon Valley is poised to set an important example in how to conduct regional resilience planning. While building communications networks is only one part of creating a connected, healthy, and prepared region, if managed the process itself can link neighbors together across technological and social divides and preparing them for future risks while bringing benefits today.

Our guiding principle in these recommendations has been to provide an approach and tools that can be customized according to the needs and resources of communities, rather than prescribing a uniform approach. We believe this respects the variety of needs, assets, and strategies across the region, and allows local communities to share and compare methods and tools. We believe it is possible and productive to adopt a set of shared principles and draw from the same toolbox, thus developing a range of systems that work in harmony with each other. The recommendations in this report rely upon the creation of shared regional principles, platforms, and tools can help facilitate the goal of “resilience for all” and encourage the sharing of knowledge and resources before disaster strikes.

APPENDIX

Table 1 | Layer 1

Layer 1	Description	Benefits	Challenges	Cost ¹⁵	Resources
Regional High-Speed Backbone Network	A regional network linking all areas together using point-to-point digital wireless links and links maintained by Wireless Internet Services Providers, and potentially other experimental technologies such as TV White Space devices	Links together all hubs	Ongoing maintenance and updates	Hardware: \$175-250K. With installation fees, engineering studies, and carrier fees, up to \$350K	Altogether 15 links among 12 hub sites <ul style="list-style-type: none"> • Network hardware • Solar backup power • Installation labor • Engineering design

The High-Speed Backbone combines three technologies:

a. Point-to-Point Wireless Links	An independent network connecting regional community organizations in the Santa Clara Valley. It is designed to provide redundancies and could offer connectivity to the internet if network managers contract with an ISP for backhaul. Given our region, this option would enable a collection of small local network clusters that could link to this “regional backbone.”	Equipment is inexpensive and can be open-source to allow modifications & peering.	Some areas not reachable by line of sight—will require extensive engineering analysis.	Hardware: \$50-75K	<ul style="list-style-type: none"> • ~ 6 links • Network hardware • Solar backup power • Installation labor • Engineering design
b. WISP Managed Wireless Links	Wireless Internet Service Providers offer managed “point-to-point” networks connected to their existing network infrastructure. They could link community hub sites without direct line-of-sight. They are willing to host equipment on their towers to support power infrastructure needs. Quote includes backhaul or data service.	A managed service. Can reach very remote and isolated areas where they have towers (including potentially coastal San Mateo County).	Proprietary and managed—may not allow others to add on/peer, or only through negotiation.	Hardware: \$60K (+ \$50K/year for management and data services)	<ul style="list-style-type: none"> • ~ 5 links (each has 2 sets of equipment) • Network hardware • Solar backup power • Installation labor • Engineering design • Year-by-year WISP service fees
c. Experimental Wireless Technology	Non-line-of-sight wireless connections like TV White Spaces (TVWS) offer new technology solutions to the isolation experienced on the coastal or mountain communities.	Innovative and potentially groundbreaking use of important resilience technology.	Expensive and may require special licensing. Maintenance could be a challenge with early prototype devices.	Hardware: \$60K	<ul style="list-style-type: none"> • ~ 4 links (3 sites—coast + 1 tower east of 280) • TVWS equipment • Solar backup power • Installation labor • Engineering design

Table 2 | Layer 2

Layer 2	Description	Benefits	Challenges	Cost ¹⁵	Resources
Local Community Networks	High-speed regional backbone connects NGOs. Local community network pilots connect to neighbors.	Build awareness and use of the regional networks; community development and organizing platform.	Requires community ownership and intensive engagement from host CBO(s); takes time to achieve measurable outcomes.	\$30K or more (depending on network area) for equipment; labor may be part of the implementation plan (i.e., training, outreach, management)	<ul style="list-style-type: none"> • 5 anchor sites • 10 repeater sites • 50 client mesh sites • Wireless equipment and mounting hardware • Solar backup hardware • Electrical installation labor
<p align="center">RURAL EXPERIMENT Pescadero/La Honda</p> <ul style="list-style-type: none"> • Elevated vulnerability • Low broadband adoption • Puente • SVCF PQG • Willingness • Organizing experience • HAM/digital networks use • Has social and technical assets 			<p align="center">URBAN EXPERIMENT East San Jose</p> <ul style="list-style-type: none"> • High social vulnerability • High population density • Low broadband adoption • No SVCF PQG in the area • Somos Mayfair • Eager to work • Trusted and well-connected • Experimented with tech literacy • Digital justice organizing 		

Table 3 | Layer 3

Layer 3	Description	Benefits	Challenges	Cost ¹⁵	Resources
Broadcast and Amateur Radio Resources and Operators	With planning and coordination, amateur radio operators could participate in a system linking community-based organizations in addition to the official EOCs they already work with.	Inexpensive, hardy, resilient technology already used by many communities.	Barriers to learning and using this technology can be high with licensing requirements. Limited ability to share data with digital networks.	Social cost of recruiting, training, and coordinating with amateur operators and clubs	<ul style="list-style-type: none"> • Relationships • Training and coordination • Basic radio devices

WORKSHOP MODULE: RESILIENT COMMUNICATIONS PLANNING TOOL

Purpose:

Check geographic vulnerability assessment using CDC vulnerability index data against knowledge of local groups involved in planning for response.

- Do maps identifying areas with vulnerable populations match their understanding of their service areas?
- How are local CBOs planning to communicate with the most vulnerable people in their service areas?

Plan:

1. Pass out maps with vulnerable areas identified according to CDC index.

- Groups—5 minutes to discuss – pick a vulnerable area that you know most about and discuss what you know about that place.
- Facilitator ask for any responses—5 minutes

2. Introduce scenario (wildfire; earthquake; etc.)

- Instruction: find the others in the room who know your area well, form task force—5 minutes

3. Group task: Use the map to identify key places that need to be reached and think about how to reach them. Note your findings on the map. (30 minutes)

- Address three questions.
- Who needs to be reached and where are they? – highlighters, 5 minutes
- Where are people going to go for help and gather in your area? Libraries, churches, community orgs (yours and others)? sharpies, 5 minutes
- How do you reach these groups (at home or at gathering places)? What kinds of communication tools do you use? (think about languages, social networks – what media/tech/ approaches will these populations respond to?)—different color marker, 5 minutes; then
- 4–5 minutes to frame response plan to share back with the larger group

4. Small groups share out what they’ve learned (10-15 minutes)

5. Facilitator wrap up, Q&A and next steps (10 minutes)

SPECIAL THANKS

- Mauricio Palma
- Manuel Santamaria
- Sarah Davison
- Jeremy Hay, EPA Now
- Susan Mernit, Hack the Hood
- Mike McCarthy, San Francisco Community Broadband Network
- Ralf Muehlen, Internet Archive
- Sean McLaughlin, Access Humboldt
- Jeremy Horan, Red Cross
- Henrietta J. Borroughs, East Palo Alto Today
- Douglas Schenk, Santa Clara County
- Allan Baez, Mobile for All/Community Technology Alliance
- Stu Jeffrey, Wifi 101 EPA & Computers for Everyone
- Shannon Farley, FFWD
- Ken Sadamasa, Etheric Networks
- Camille Fontanilla, Somos Mayfair
- Karl Garcia, WiFi Evangelist, Google
- Mike McCarthy, Community Broadband Manager, City of San Francisco
- Tim Pozar, Network Architect for the Community Broadband Network (CBN), City of San Francisco
- Shelley Wolfe, former Executive Director (KMTV)
- Annie Folger, Executive Director, MidPen Media Center
- Chris Pearce, IT Director, MidPen Media Center
- Suzanne St. John-Crane, former Executive Director, CreaTV San Jose
- Charise McHugh, President/CEO, Half Moon Bay Chamber of Commerce and Chair, Coastside Emergency Action Program (CEAP)
- Nick Gottuso, Coastside Emergency Response Coordinator, San Mateo County Sheriff's Office
- Pilar Furlong, the Bill Wilson Center
- Justin Cowgill, CTO, CreaTV San Jose
- Anna Swardenski, Collaborating Agencies Disaster Relief Effort (CADRE), Santa Clara County

Notes

¹ Statement of Daisy Snipes, Sept. 22, 1966, cited in Rhonda Y. Williams, *The Politics of Public Housing: Black Women's Struggles Against Urban Inequality* (Oxford University Press, 2004), p. 192-193.

¹ Joshua Eaton, "Flooding the system: Climate change could knock the Internet offline" Al Jazeera America, October 12, 2015. <http://america.aljazeera.com/articles/2015/10/12/climate-change-internet-offline.html>

² Noam Cohen, "Red Hook's Cutting-Edge Wireless Network," *New York Times*, August 22, 2014. <http://www.nytimes.com/2014/08/24/nyregion/red-hooks-cutting-edge-wireless-network.html>

³ Rick Carr, "Low-Power FM Radio," Bill Moyers Journal, PBS, August 24, 2007. http://www.pbs.org/moyers/journal/blog/2007/08/_lowpower_fm_radio_share_it_wi.html

⁴ Case Study: Red Hook Initiative WiFi, in *Wireless Networking in the Developing World* (2013), http://wndw.net/CaseStudies/Open_Technology_Institute.html

⁵ All statistics taken from the Joint Venture Silicon Valley Index, <http://siliconvalleyindicators.org/>

⁶ <http://svi.cdc.gov>

⁷ Mountain View Voice, *Homeless Population Doubles in Mountain View*, 2015 (<http://www.mv-voice.com/news/2015/06/30/homeless-population-doubles-in-mountain-view>)

⁸ Rhinesmith, Colin (2016). Digital Inclusion and Meaningful Broadband Adoption Initiatives. <https://www.benton.org/inclusion-adoption-report>

⁹ Matt Hamilton, "FBI investigating vandalism of Bay Area fiber-optic cables," *Los Angeles Times*, June 30, 2015 <http://www.latimes.com/local/lanow/la-me-ln-sacramento-cables-vandalized-20150630-story.html>

¹⁰ Goetzel, Johanna. "Tweeting the Way to Community Resilience: Frances Medina." *City Atlas*, September 3, 2013. [http://newyork.thecityatlas.org/lifestyle/tweeting-community-rebuilding-resilience-interview-red-hook-initiatives-frances-](http://newyork.thecityatlas.org/lifestyle/tweeting-community-rebuilding-resilience-interview-red-hook-initiatives-frances-medina/)

[medina/](#)

¹¹ Homeland Security Studies and Analysis Institute, "The Resilient Social Network." Department of Homeland Security Science and Technology Directorate, 2013. http://www.anser.org/Resilient_Social_Network2

¹² a not-for-profit United States computer networking consortium led by members from the research and education communities, industry, and government.

¹³ New America's Resilient Communities program is currently co-designing networks with six community-based organizations in Sandy-impacted communities of NYC, and providing curriculum to train 40-50 Digital Stewards citywide, through the New York City Economic Development Corporation's RISE : NYC program.

¹⁴ "Why Silicon Valley Wi-Fi Fizzled," *Palo Alto Online*, July 8, 2008. <http://www.paloaltoonline.com/news/2008/07/08/into-thin-air-8212-why-silicon-valley-wifi-fizzled>

¹⁵ Estimates include only capital expenditures (equip + labor) NOT operating costs.



This report carries a Creative Commons Attribution 4.0 International license, which permits re-use of New America content when proper attribution is provided. This means you are free to share and adapt New America’s work, or include our content in derivative works, under the following conditions:

- **Attribution.** You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

For the full legal code of this Creative Commons license, please visit creativecommons.org.

If you have any questions about citing or reusing New America content, please visit www.newamerica.org.

All photos in this report are supplied by, and licensed to, [shutterstock.com](https://www.shutterstock.com) unless otherwise stated. Photos from federal government sources are used under section 105 of the Copyright Act.

