STAFF REPORT

DATE: April 3, 2018

TO: City Council

FROM: Broadband Advisory Task Force
Diane Parro, Chief Innovation Officer
Sarah Worley, Deputy Innovation Officer

SUBJECT: Broadband Feasibility Study

Recommendations

1. Receive presentation from staff, Broadband Advisory Task Force, and CCG Consulting on the Broadband Feasibility Study report
2. Accept the Broadband Feasibility Study as informational and provide feedback on study findings (Attachment 2).
3. Authorize work of Broadband Advisory Task Force to continue.
4. Provide direction on need for further studies (Attachments 1 & 2).

Fiscal Impact

Expenditure of $86,000 from Cable Franchise Fund, including $66,700 for consultant services to prepare the Feasibility Study, $5,000 for associated legal services, and $14,300 for costs to create a GIS map of the existing City conduit infrastructure. Indirect costs include staff time to provide Task Force and project support. Costs to implement any additional studies or recommended next steps are not yet determined.

Council Goal(s)

Council Goal 2: Drive a Diverse and Resilient Economy, Objective 1, Task D: Create awareness of infrastructure necessary to support business success and collaborate in activities to add capacity. Take steps to increase access to broadband by studying the feasibility of a citywide fiber optic network.

Background

Over the past three years the City Council has continued taking steps to explore options for improving community access to broadband, including:

2015 - Yolo Broadband Strategy, Davis Broadband Plan and formation of Broadband Advisory Task Force
2016 – Citywide Fiber Optic Network Feasibility Study RFP
2017 – CCG Consulting/Finley Engineering Inc. Consultant Services Agreement to prepare Broadband Feasibility Study

Task Force Recommendations

In presenting this Broadband Feasibility Study report the Task Force accomplishes many of the objectives the City Council established when creating the Task Force. These include establishing goals for broadband access, examining various models of broadband delivery, exploring funding options/mechanisms for financing, operating and maintaining a fiber network, and recommending next steps for implementation.

Considering the feasibility study an initial step, the Task Force recommends the City Council approve the Task Force continuing its work, and authorize further additional studies. These include taking next steps in three phases to refine accuracy of potential factors that can greatly affect project financing, construction, and operational costs. The Council is asked to provide direction on need for recommended additional studies (see Attachment 1).

Broadband Feasibility Study Approach, Findings and Next Steps

The Broadband Feasibility Study was conducted to understand the potential feasibility of creating a citywide fiber broadband network in Davis, bringing gigabit capable fiber broadband past every home and business in the community. The detailed technical analysis and modelling in the study identify construction costs, evaluate a range of business operation and financing options to determine potential success of different approaches for providing broadband services; and identify which implementation option is best suited for the City of Davis. Given the study's length and technical detail a Report Summary section was prepared to provide an overview of the study process, elements assessed, key findings and recommended next steps (see Attachment 3 for excerpts of the report Executive Summary page and Report Summary).

Study Approach

- A citywide broadband fiber network represents a significant major utility scale project to be undertaken with series of incremental steps and check points over a number of years.
- As a feasibility study, the assumptions used in the business model analyses are purposely conservative to avoid any overly optimistic results.
- The findings and estimated costs of the different business model options are to provide an order of magnitude and serve as bench marks bracketing a range of cost estimates used to inform next steps.
- The study models assume a 25-year time frame to reflect the repayment period for construction financing costs.
- The study modeling includes "sensitivity analysis," testing how changes in key variables affect economic viability (e.g. interest rates, market penetration rates, operation costs etc.).
    - For example, for the main business models analyzed, cost of living increases in operational costs were assumed over the 25-year period, but no parallel increases in price of internet services were assumed.
    - A Task Force request to see results of a less conservative "realistic case" scenario, that factored in some small increases in cost of internet service over time, showed revenues generated from small increases in service price could have a substantial positive impact on business viability.
- The City will retain the business models CCG Consulting created for the study as part of study deliverables.

Fiber Network Design

The proposed network design is to install fiber underground, running down both sides of City streets, connecting to a set of larger fiber rings that will provide network reliability and redundancy (see Attachment 4).

The high proportion of multifamily units in Davis (45% of 26,700+ dwelling units) present a connection challenge due to a variety of factors including: the distance required to make the

connections to each unit in a multifamily structure or in a complex of multifamily structures, costs of modifications necessary to provide fiber connections for the range of different building construction types and ages, and current internet provider contract restrictions.

Business Models Considered

- Single Provider: City pays for the Network and the City is also the Internet Service Provider (ISP), or contracts with a single partner to provide Internet Service.
- Open Access: City Pays for the Network and allows multiple Internet Service Providers (ISPs) to access the network.
- Public / Private Partnership: a private entity would pay for some of the network, but the City would likely still pay for most of it, and private partners would want most or all of the profit as Internet Service Providers.

Estimated Project Costs

After evaluation of multiple business models, the "Single Provider" scenario was considered the best fit for Davis. This represents a scenario where there is one network operator (could be the city or somebody else); the business has a 50% penetration of homes, businesses and MDUs (multiple dwelling units) in the market. Estimated costs include (see also Attachment 3 pgs. 5-6):

$72.0 M	to construct the fiber network
$34.3 M	to provide network connections & and broadband service
$106.7 M	Total Cost

Study Findings

- Davis has the same kind of broadband as most cities – fast, but relatively expensive.
- There are a few broadband access gaps – e.g. some low income households, and downtown businesses.
- There are major benefits from fiber broadband including economic, safety, energy, climate preparedness, transportation, health, and education. There are also numerous risks such as low revenues requiring need for substantial ongoing public subsidies, and durability and longevity of long term partnerships.
- High cost of recommended underground, dual fiber construction, and high California wages make achieving a citywide fiber network a challenge.
- The City partnering with one internet service provider looks like the best financial scenario.
- Financing fiber will require some funding from tax revenues other than bonds.
- There are some intriguing scenarios for building fiber to everybody, e.g. increased tax financing could allow offer of a basic, low cost internet service citywide.
- Open Access looks difficult to justify because estimates of revenues generated will be insufficient to support multiple provider operation costs.
- The apartment market is already competitive and will be a challenge to penetrate.

Study Recommended Next Steps (see Attachment 3 pgs. 11-16 for greater description),

- Conducting a residential survey to understand market demand (potential number of subscribers).
- Additional MDU (apartment) analysis to understand the market better and reduce/remove potential connection constraints.
- Exploring funding options – using some tax revenues.
- Choosing the business model (identifying partner).

- Community education / buy-in.

Attachments

1. Broadband Advisory Task Force City Council Recommendations Letter
2. Executive Summary/Report Summary Excerpts from Final Draft Broadband Feasibility Study (pages 4-16)
3. Web link to full Final Draft Broadband Feasibility Study report http://documents.cityofdavis.org/Media/CityCouncil/Documents/PDF/CityCouncil/Broadband-Advisory-Task-Force/Documents/Broadband-Feasibility-Study-Final-Draft-2018-03-12.pdf
4. Map of the Study Areas Showing the Proposed Network Design and Fiber Ring

City of Davis
Broadband Advisory Task Force

February 28, 2018

Mayor Davis and Honorable City Council Members,

This letter provides an update on Broadband Advisory Task Force (BATF) progress, and conveys task force recommendations for the City Council to accept the enclosed Citywide Fiber Optic Network Feasibility Study Report, and support the task force in taking further steps to verify feasibility of implementing community broadband in Davis.

For nearly a year, the BATF has done its due diligence in working with CCG Consulting and Finley Engineering Inc. to assess the feasibility of implementing a Citywide Fiber Optic Network in the City of Davis, CA. While the consultant's report is available in its entirety for your review, the BATF would like to provide our comments and professional opinions, as well as detail what we recommend as appropriate next steps in this effort.

In an attempt to frame the overall initiative, we would like to begin by affirming the reasons that we believe the City of Davis should put forth the effort and expense of creating a citywide fiber network to provide better community access to broadband (high speed internet). These reasons range from significant economic development opportunities; educational and telemedicine enhancements; smart City initiatives like Police and Fire applications; utility meters, and various other civic applications. Additionally, the construction of a municipally owned fiber network not only has the potential to provide greater choice and level of service to residents of the community, but also takes a significant step towards dismantling the digital divide that the for-profit incumbent providers have created in our community.

It is with this mindset that we approached the project and as the chair, I can honestly say there were moments throughout the process where we would return to the charter set forth by the City to ensure we were capturing what we were tasked to capture. As a task force, nearly every meeting was embraced with extensive discussion and passion requiring our assumptions to be solid and well-reasoned. Additionally, we felt it was important to study other municipalities that were successful in deploying a fiber network, to better understand how they were successful and where they had struggles. In that exercise, it became clear that one business model does not fit all. What was successful for one City, may not have worked in another. Where one City may have leveraged a City-owned utility to build the network, another City may have had no utility presence. This led the task force to study not only several business models but economic models as well. Through this analysis, CCG and Finley Engineering were at our side to answer questions, provide examples and most importantly, challenge our thinking

After an extensive review of the detailed information and modeling that is contained in the report, one item surfaced repeatedly: cost. There is no way to sugar coat the facts in this case—it is going to take money to build this network. In the "one network provider" scenario studied, the cost to construct a citywide fiber network was estimated at $72 million (including 10 % contingency),

with $106.74 million projected as the full cost of assets needed to operate the network and provide service to 50% of homes, multiple family dwelling units and businesses in the market (50% penetration rate). While a small number of communities nationwide may in the long-run be able to break even or return positive revenue to their local governments that is probably not going to be the case in Davis. Based on the feasibility study, our community has higher costs and may have proportionally lower revenue per household than these communities. The report indicates that delivering municipal broadband in Davis is thus more likely to require a net expenditure of taxpayer dollars. We do not disagree with that general conclusion, but we think that much can be done to get a better estimate of the net cost and benefits to Davis as we feel they represent a very conservative look at the options. For example, analysis around such opportunities as reselling dark fiber and other revenue-generating possibilities were left to a minimum. While we will undoubtedly want to dive into significant levels of detail around the cost and opportunities, as an initial step in this analysis we believe we have achieved a relatively sound 'conservative look at what the range of costs an initiative of this scale this might represent over a 25-year window.

With this study representing a first look at the project from a cost and therefore feasibility angle, it is the consensus of the BATF that it will be important to better understand the many variables and how they impact the overall practicality of the initiative. To accomplish this, the task force would like to ask the City for approval to remain intact and focus our efforts over a three-phased next-step plan as detailed below.

Phase 1 – Multi-family Dwelling/Business Study and Residential Penetration Survey

In phase one, the BATF would focus its attention on take rates (percentage of potential broadband subscribers who actually subscribe). As detailed in the feasibility report, knowing with a high degree of confidence how the population will react to the new service is critical to its success. As the City of Davis comprises a large percentage of multi-family housing units, knowing if those properties can and will allow another broadband carrier to serve their properties is critical information. Additionally, there are several large businesses throughout the city, including the University. Gaining an understanding of their appetite for moving services to a municipally owned fiber network is equally as critical to understand. Once an understanding is gained from the larger property owners, the task force would then prepare and manage a penetration survey that would focus on costs and current speeds. The combination of this data will help to fine tune the generic assumptions which were used to prepare the feasibility study. As a deliverable for phase one, the task force would be prepared to answer, with a relatively high degree of confidence, whether or not the large rental properties and businesses would switch from their current providers in favor of a municipally owned network. The task force considered including these tasks as part of the feasibility study, but chose to pursue them as recommended next steps instead, rather than delay completion of the study.

Phase 2 – Outreach to Targeted Key Stakeholders and Research Funding Options

As we move into Phase 2, the focus would shift slightly to outreach and more detailed financial analysis. The objective will be to work with the rental property owners, schools, public works and businesses to identify potential key stakeholders. Unlike the work that would be completed in Phase 1 around the probability of moving providers, Phase 2 would focus more on the service

model aspects, such as cost and data throughput requirements. These components will be essential to understand, as the rate a business is willing to pay for services must be understood in order to revisit the financial analysis models. Additionally, research into what other funding vehicles could be available, including federal and local funds would be investigated. As a deliverable for this phase, the task force would combine the knowledge and data gained in Phase 1 and Phase 2, and then revisit the models in the feasibility study. This will allow the BATF to fine-tune the conservative, high-level estimates that were used in the report with real world data and assumptions to better understand the true cost of ownership and return on investment.

Phase 3 – Identify Community Champions and Verify Construction Costs

Moving into Phase 3, the BATF will already have a good understanding of those businesses and land owners that are eager to move services and what they are willing to bear from a cost-per-month perspective. As such, the focus will shift to using those influential stakeholders to help champion the cause and excite others in the community. In parallel, the task force will work with equipment manufactures and engineering firms to develop rough order magnitude estimates of the engineering, construction and installation components of the project. With this data, the feasibility models that were fine-tuned at the end of phase two will be revisited once again. With the data from all three phases used in this iteration, the high level estimates from the feasibility report will start to portray a fairly realistic look at the business angle of successfully deploying and operating a municipally owned fiber network.

In summary, the task force is confident that with the additional time and financial backing needed to complete the three phases listed above, the conservative estimates and high level assumptions that are prevalent in the feasibility study will be fine-tuned to a point that the true return on investment will be significantly more realistic. As a testament to this, in a unanimous decision the taskforce has agreed to remain intact to complete the effort, should the council agree.

Sincerely,

Chris Clements, Chair
Broadband Advisory Task Force

Executive Summary

CCG Consulting (CCG) and Finley Engineering submit this report of our findings and recommendations from the feasibility study conducted to understand the potential for bringing a fiber broadband network to Davis. Our two firms looked at the feasibility from a number of different angles. Finley Engineering estimated the cost of building fiber everywhere in the city using two different fiber electronics technologies. CCG undertook research that told us more about the competitive landscape in the city that included a) research on existing competition and the incumbent broadband providers, b) discussions with key broadband stakeholders in the city, c) an analysis of actual customer broadband bills, and d) the results of speed tests taken by Davis citizens that measured their actual broadband speeds. Next, CCG created numerous financial projections that looked at different business plan scenarios for operating a broadband network in the city. Finally, the study answered various questions asked by the original RFP such as defining the benefits and risks of having a fiber network in the city.

The key finding from our analysis is that it doesn't look feasible to build and operate a fiber network and business in the city that would be 100% funded by a single bond issue. Instead, it looks like the only viable way to finance a fiber network would be to fund some portion of the new network with some other form of funding, such as tax revenues derived from sales taxes, property taxes, or some other source of municipal revenue.

There are a number of reasons for this finding. First, the cost of building a network in Davis is high for various reasons including: a) the condition of poles, which means that the network will have to all be buried; b) the high housing density in the city adds to the cost; and c) high wages in the area mean expensive fiber construction (which is primarily driven by labor costs). The high construction costs then create high debt costs if the project is 100% bond-funded. Operating costs also look to be high in the city, driven again by high labor rates. However, even with higher construction and operating costs, the rates that can be charged to customers are no higher than in other parts of the country, meaning that a fiber business in the city will achieve average revenues but will incur higher-than-average costs.

Nevertheless, there are significant benefits from fiber that make it worthwhile to explore if there are feasible ways to move forward. As DSL broadband on the AT&T telco network continues to decline in the market, Comcast will become more of a monopoly broadband provider in the city. There is ample national evidence that having a second fiber network provides customers with choice and holds down prices compared to communities without a competitive fiber network. The study found some intriguing options for a city network that might enable the city to find ways to address the digital divide and bring broadband to all households in the city. The study explored numerous business operating structures and, since the city doesn't want to be a retail ISP, the best option looks to be partnering with a single operating ISP to operate the business. The option of open access—allowing multiple ISPs to operate on the network—doesn't look to be financially viable.

This report makes a number of specific recommendations on next steps for the city to consider if it wants to further explore fiber broadband options.

Report Summary

Project Overview

Project Description. Finley Engineering and CCG Consulting were hired to do a feasibility study for bringing fiber broadband past every home and business in the community. The project included a number of components including 1) a market analysis of the current products and prices offered in the market, 2) an engineering analysis and estimate of the cost of building and lighting a fiber network, 3) a discussion of the possible operating models to be considered to operate a government-sponsored fiber business; 4) the development of various financial business models to quantify the operating costs and potential profitability of the various operating models, 5) a sensitivity analysis to quantify the impact of varying the most important assumptions and variables supporting the financial models, 6) a discussion on possible funding mechanisms that can be used to fund fiber, 7) an analysis of the likely competitive response of the incumbent providers, 8) the benefits to the community from operating a citywide fiber network, and the financial and execution risks that must be considered. The study culminated in this report which describes the steps taken to meet those goals, a description of the significant facts we found that will influence a decision to pursue fiber, and a list of specific recommended next steps to take next after completion of this report.

Fiber Network Design. Finley Engineering considered several designs before designing a reasonably efficient network for bringing fiber to the whole community. The network consists of a series of huts that house electronics that are connected to a fiber ring to provide redundancy and to protect the network from failure in the case of a fiber cut (see map on page 142). Finley considered both passive optical technology (PON) and active Ethernet technology (AON) – the two primary technologies used to serve fiber to a community. The base analysis is based upon active Ethernet. The network built from the neighborhood huts to reach customers is designed for flexibility and each customer has a separate fiber connection back to a hut. This means that today either of the core technologies can be used to serve any individual customer and this design makes the network ready for future fiber technologies as they are developed.

The full cost of the assets need to operate the network are as follows. This represent a scenario where there is one network operator (could be the city or somebody else), and the business has a 50% penetration of homes, businesses and MDUs (multiple dwelling units) in the market. These figures represent the assets in place by the end of the fourth year after launching the business – the date by which all of the customers will have been connected to the network:

	50% Penetration
Vehicles	$ 231,800
Tools	$ 80,000
Buildings	$ 2,181,440
Furniture	$ 25,500
Computers	$ 55,265
Voice Gateways	$ 245,940
Data Servers	$ 102,500

Cable TV	$ 1,053,926
FTTH Electronics	$ 11,946,563
ONTs	$ 6,650,091
Fiber Drops	$ 10,584,956
Fiber Network	$ 65,864,087
Fiber Contingency	$ 6,566,409
Elect. Contingency	$ 406,775
Inventory	$ 350,000
Capitalized Software	$ 395,670
Total	$106,742,422

Note that the required assets vary according to the number of customers connected the network as well as by the number of employees required for the various scenarios that were studied.

Business Models Considered. We considered several different operating models:

- Single Provider. This model looks at the cost of operating the business by a single entity. This could be the city or an operating partner chosen by the city.
- Open Access. This operating model would open the network to multiple service providers to use the network to provide products and services to customers.
- Public / Private Partnership. In this operating model the city would partner with a commercial entity which would provide some of the capital needed to build the network.

Our Approach to the Financial Analysis.

- A base model was created for each operating model. We arbitrarily chose a 50% market penetration (the percentage of customers using the network) at 50% for each base model. We don't have any idea how many customers a new fiber business might win and chose the 50% penetration as typical of other municipal and similar commercial fiber overbuilders.
- All projections were built to reflect a 25-year period in order to match the expected time frame for financing with bonds.
- All projections include projected financing costs for borrowing the money needed to build and launch the network. The base studies anticipated financing with revenue bonds that are backed by the full faith and credit of the city.
- The engineering estimates are conservatively high. As an example, we added a 10% construction contingency to the cost of building a fiber network as well as a 5% contingency for the cost of electronics. But the underlying costs estimates of the network are based upon our best estimate that considers the local market conditions in Davis and of California.
- All studies also include an estimate of future asset costs that are needed to either connect future customers or to maintain and upgrade the network over time. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.
- The models all offer the triple play of broadband, cable TV and telephone service. The assumption is that most people buy broadband and far fewer buy the other products. We also project that the customers buying telephone and cable TV will drop over time. The projections also predict a modest amount of margin from other unspecified future

products that might include such things as security, smart home, managed WiFi and others.

- Products were priced at a modest discount from the existing prices of products sold in the market today. The expectation is that the internet speeds offered on the network will be significantly faster than the speeds offered by competitors. The projections include no future price increases.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Again, we based these costs on local Davis conditions including such things as typical salaries and benefit costs in the area.
- Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Study Results

A summary of the financial results of the various scenarios studied is included in Appendix VI, on page 175. That appendix includes a table showing key facts such the cost of building the network under each scenario, the cost and method of financing the scenario and the amount of cash generated by the scenario over 25 years. After the table is a description of the key assumptions made for each scenario studied.

Base Study. The results of the financial projections for building fiber within the city were not as good as the city had hoped for. For example, the cash losses range from $34.1 million over 25 years at a 60% customer penetration to $81.4 million at a 40% customer penetration (page 64).

There are several primary reasons for these losses:

- The fiber network is more expensive to build in Davis due to the fact that the network is going to have to be almost entirely buried. The existing utility poles in the city mostly run through yards and it looks to be too expensive to string fiber on most poles.
- Any construction done by the city must be done at 'prevailing wages'. This means at the wages for similar work in the major cities in California. It would be possible to find contractors that pay a lower wage rate – but that is prohibited by law to help ensure that most construction work goes to California companies.
- Much of Davis has a residential density (how close homes are together) like larger cities. In many cases it will be cheaper to build fiber on both sides of residential streets than to bore under the streets to reach homes if there was fiber on only one side. This adds to the construction cost of the network.
- The salaries and benefits for the employees of the business are set at levels reasonable for Davis. But these costs are higher than might be experienced by a fiber network built in another state with lower salaries.

Funding with Tax Revenues. We show that it is possible for a fiber network to be profitable if some portion of the network is built using tax revenues. That might be some external funding source such as revenue from increasing sales tax. Our study doesn't make any assumption about the type of tax revenue used. We calculated the amount of tax revenue needed to reach cash breakeven - that is a scenario where the business always has enough cash to operate during the whole 25-year window of the bond financing. The amount of needed tax revenues varies with the

customer penetration rates and range from $33 million at 60% penetration rate to $59.7 million at a 40% customer penetration rate. These results are shown on pages 65-66.

Reasonable Case Study. Many of the assumptions used in the base study were conservative. This is always done in feasibility studies to make certain that the projected costs of entering the business are high enough so that if the project was financed with bonds there would be sufficient cash.

We looked at a 'reasonable case' scenario that softened some of the most conservative assumptions. The most significant assumption change was that the construction contingency wouldn't be needed. Making that kind of change in bond financing would mean doing enough extra engineering before funding to more precisely estimate the cost of the network. The results of this analysis are shown on pages 66-68 of the report.

Compared to the base case described above with a 50% customer penetration, the reasonable case assumptions reduced the amount of external tax financing required from $37 million to $24 million.

Open Access. We also explored an open access scenario. This is a scenario where the city builds the network and then allows multiple ISPs onto the network. This network costs the same in an open access network and the big financial difference is that the city collects 'access fees' from the ISPs for using the network, while the retail revenues instead go to the ISPs. The other big change is that the city would have only a few employees under this scenario. Staff that supports customers would be hired by the various ISPs.

The losses in an open access scenario are significantly larger than the one-provider scenario shown above. Losses range from $102.3 million over 25 years at a 60% customer penetration to $128.5 million at a 40% customer penetration. This is because the lost revenues in this scenario are greater than the efficiencies from having the ISPs pay for the staffing. This scenario is summarized on pages 68-70 of the report.

Public / Private Partnership. A public / Private Partnership (PPP) is a scenario where the ISPs cover some of the cost of the network. There are nearly endless possibilities of how a PPP might be structured. The studies looked at the simplest scenario where the operating ISP funds the assets needed to support employees (trucks, computers, furniture, etc.) as well as the assets at the customer premise including the electronics (ONT) and anything inside customer premises like settop boxes.

This scenario has a significantly beneficial impact on the city's cash position. The loss at a 50% customer penetration reduces over 25 years from $53.9 million to $3.4 million. However, this scenario would be unattractive to an ISP partner which must fund $11.5 million of the project, with projected losses over 25 years at $23.2 million. This scenario is summarized on pages 71-72 of the report.

Again, there are many other potential PPP models. But any model that reduces the capital outlay of the ISP operator would shift costs and losses back to the city.

Digital Divide Scenarios. Finally, we considered digital divide scenarios. These scenarios look at the cost to build the network to everybody in the city. They also offer lower prices in order to get more homes and businesses onto the fiber network.

For example, we looked at a scenario where the city would offer a $10 broadband connection to homes that qualify. That qualification could be done any ways, such as allowing the low-cost connection for the elderly or for homes that qualify for some subsidy program such as food stamps or reduced-price school lunches.

This scenario increased losses over 25 years, but not drastically so. For example, the losses at a 50% customer penetration for unsubsidized broadband customers increased from $53.9 million in the one ISP partner scenario to $60.6 million. With a substantial amount of external tax financing this scenario could be cash positive. This scenario is summarized on pages 73-74.

Key Findings

Customers in Davis Have Broadband Options Today. We asked existing customers to take speed tests to see how their achieved broadband speeds compare to what they are purchasing. Speeds on AT&T's DSL network have a maximum speed of 50 Mbps. A significant percentage of AT&T customers are getting less speed than they are paying for. We did find one AT&T customer that was buying and receiving a gigabit broadband connection on fiber.

However, there are customers in the city buying speeds today as fast as 300 Mbps on Comcast. And, unlike with AT&T, customers using Comcast mostly receive the speeds they are subscribing to, and sometimes a little bit more. Comcast says they will be increasing download speeds in the city and that customers will have speeds up to 1 Gbps by the end of 2018. For both providers upload speeds are significantly slower than download speeds.

Recently AT&T has slowed promotions for DSL and many industry analysts think they are now starting the slow process of withdrawing from that business line. The company is instead putting effort into selectively building fiber and there are some AT&T fiber customers in the city today. Over time as the AT&T DSL product diminishes in the city many customers will only have the choice of using Comcast for fast broadband, making them a virtual monopoly.

There Are Some Broadband Gaps in the City. There were several businesses in downtown Davis that were not able to buy the broadband speeds they want, or that are being quoted high prices to build broadband to their location.

The university also identified locations where they would like faster broadband. For example, they buy space in apartments throughout the city for about 600 underclass students and have also located a number of administrative functions in the city. The University says that both of these groups do not share the same broadband experience as the rest of the campus.

Fiber Construction Costs Are High. The most expensive component of building a fiber network is the cost of the fiber that would be built on each street of the city to reach potential customers.

The fiber network is estimated to cost more than $72 million. The overall costs of building fiber are higher than what we see in some other cities, for the following reasons:

- Because of the nature and location of existing poles it looks like the best design is to bury the entire network. Buried fiber is the most expensive kind of construction; burying the entire network drives up the cost of the network.
- The housing density in Davis adds to the cost of the network. Fiber construction is most efficient in suburban and small towns where there is 'moderate' housing density. In Davis some parts of the city are as dense as what we see in larger cities and this adds to the construction cost. For example, there are streets in Davis where it will be necessary to build fiber on both sides of the street to most affordably reach homes.

In general, wages in California are higher than in much of the rest of the country. Since the cost of fiber construction is primary from labor costs this adds to the costs of building fiber.

The Best Network Design Should Be Flexible. The city asked us to provide a network design that would have capacity to provide 1 Gbps broadband speeds to all customers. The base electronics design uses active Ethernet (AON) technology that delivers at least 1 Gbps to each customer location. But the outside fiber network was designed to accommodate both PON electronics and AON electronics for any customer (these technologies are described in detail later in the report). This would allow for delivery of shared or dedicated bandwidth to any customer, as needed.

There are Significant Benefits to Building a Citywide Fiber Network. These include: expanding customer choice; extending opportunity to connect to the University network where needed in the city; offering a chance to address the digital divide issue; provide affordable broadband options; enhance economic development opportunities; and support smart city initiatives. Examples of these initiatives include use of a citywide network of connected devices, smart sensors, and big data analytics to implement new solutions in safety, energy, climate preparedness, transportation, health, and education (see pages 104-108). A citywide network could also enable better outdoor WiFi, reduced city telecom expenditures, and prepare the city for better future cellular networks.[1]

But There Are Also Risks. The primary risk is in not performing financially with a city-owned fiber network and creating a situation where the city would have to subsidize the broadband network. There is also a risk that other broadband technologies become available during the long time period required to pay for the network. Finally, there are the risks involved in working with an operating partner and maintaining that relationship for the life of a potential 25+ year bond issue, or other long-term partnership

Partnering with One Service Provider is the Best Option. The financial analysis shows that operating a retail network by partnering with one service provider produces the best financial results. This could be a nonprofit such Davis Gig or a commercial ISP. It would also be possible to partner with a newly-formed cooperative, although a coop would need to find much of their own funding.

[1] https://obamawhitehouse.archives.gov/the-press-office/2015/09/14/fact-sheet-administration-announces-new-smart-cities-initiative-help

Financing the Network Will Require Tax Revenues. In the financial analysis we did not find a financial model that could be funded solely with bonds. The only feasible-looking scenarios use some other source of city tax revenues to fund some portion of the cost of the network. For example, if the network was expected to get a 50% customer penetration rate, then $36.5 million of the funding would have to come from some source other than the revenues of the business.

There are Intriguing Digital Divide Scenarios. There are scenarios where the city could extend fiber to low-income homes and neighborhoods. For example, a scenario that is funded with equal amounts of bond and other tax revenues would be able to provide a $10 broadband product to low-income homes in the city.

Probably even more intriguing is the idea of lowering the cost of broadband for everybody. For example, we looked at a scenario similar to what has been proposed in San Francisco. This scenario would provide $50 gigabit product, a $20 100 Mbps product, and a free low-speed broadband connection to anybody that wants it. This scenario requires significant tax funding and would be feasible with a $43 M bond supported by the broadband business and $89 M of other tax funding.

Open Access Looks Hard to Justify. It looks hard to justify an open-access network. This is a network that allows access to multiple ISPs and provides more options for customers. The operating losses for the scenario are much greater than if one ISP operates the network because it splits the potential revenue. This scenario could only be made to work with significant funding ($80 M) or more from tax revenues.

MDU Penetration Rates Are Challenging to Forecast. The report looks in depth at the issues associated with providing broadband to multi-dwelling units (MDUs). There are a number of challenges that must be overcome to make sure that all MDUs have fast fiber broadband. First, it's the property owner's choice to allow connection to a city-owned fiber network. Many MDU owners will elect to connect instead to Comcast, AT&T, or other providers that specialize in serving MDUs. The cost to wire and distribute fiber in MDUs also varies significantly in MDUs depending upon a number of factors which are described in more detail on pages 37-39.

Timing of Network Launch. It should be reasonable to build a citywide fiber network within three years from the date of funding, with the first customers on the network after 18 months.

Recommended Next Steps

Residential Survey. Our analysis shows that the most important variable affecting the financial feasibility of building fiber is the potential number of customers. For example, getting 40% rather than 50% of residents on the network makes a big difference in expected future revenues.

We recommend that the city undertake a residential survey to understand interest in a fiber network. CCG Consulting has found that a well-designed random residential survey is a good predictor of the number of residential customers that might be interested in using city-provided fiber. We've been able to see a significant correlation when comparing the results of initial surveys to the actual customer penetration rates.

Since the study results show that some amount of tax financing is likely going to be needed to fund a fiber network such that it will be cash flow positive, it's vital to predict the percentage of households that might be interested in fiber. Knowing the range of possible customer penetration rates will allow the city to then better quantify the amount of tax revenues that are needed to fund each scenario.

MDU Analysis. The report looks in detail at the issues associated with providing service to MDUs. Since MDUs represent a big percentage of the living units in the city, understanding the potential for serving MDUs is needed to fully assess potential revenues of a fiber business. The city might want to undertake a deeper analysis of the MDU market. The more you know about that market the more you will be able to understand how a Davis-owned fiber network might benefit this market.

Ideally the city might want to know the following things about the larger MDUs in the city:

- Census of MDUs. Identify the owners, local managers, and decision makers at each MDU that might be involved in making the decision to connect to a city fiber network.
- Cost to Wire with Fiber. The report describes the many factors that are involved with distributing fast bandwidth within an apartment building or complex. The city might want to ask MDU owners of differently sized MDUs to allow the city (with the help of engineers) to make an on-site estimate of the cost to upgrade their MDU to fiber. This report looks at some theoretical costs to wire MDUs of various sizes and technologies, but we also discuss the various factors that can affect the specific costs of upgrades. If the city were able to examine MDUs of various sizes you would be able to better estimate the cost of providing fiber broadband to the MDUs.
- Survey of MDU Owner Interest / Penetration Rates. It would be useful to understand the broadband intentions of MDU owners. Ideally the city would like to know how many MDUs already are connected to fiber and the intentions or goals of those that are not connected. It might be difficult to collect this information since many MDU owners would not want their intentions to be discoverable through a public information request. But we know other cities that have gathered this information through an anonymous questionnaire that doesn't identify responses with specific MDU owners. But since MDUs represent such a significant percentage of the housing units in the city, an effort should be made to better estimate penetration rates.

Understanding the Funding Options. The analysis shows that financing costs are a major cost component for any of the fiber business models. It is essential for the city to understand its financing options in more detail. This might include steps like:

Assessing the Use of Revenue Bonds. Probably the predominant portion of funding would come from revenue bonds that are backed by city tax revenues. The city should talk to bond advisors to understand the possibility of using this kind of bonding as well to understand any nuances

Investigate the Possibility of Using Tax Revenues. The financial analysis shows that it will be necessary to finance at least some of the cost of building a network using tax revenues. Tax revenues could come from a variety of city cash flows such as sales taxes, property

taxes, or some sort of utility fee. If the city wants to proceed after this study then it's going to be necessary to understand the possibility of using tax revenues. There are a number of steps needed to understand the potential for this kind of funding. This might include:

- An analysis of the various types of such funding that might be available;
- A legal and financial analysis of any issues with using such financing to pay for a fiber network;
- Public outreach to understand the public's willingness to use these kinds of financing for fiber. This probably would entail a large public education campaign and probably eventually result in a ballot measure – so it's a major undertaking.
- Consideration of other City infrastructure needs.

Investigate Other Revenue Sources. The vast majority of a fiber network will have to be financed by the above two kinds of financing. But there are often opportunities to get some funding from other sources. For example, we've seen cities get transportation grants for smart traffic signals that can be used partially for fiber. We've seen public safety grants that were able to fund some fiber. We've seen homeland security grants that were able to fund some fiber. It's hard to know what might be available in Davis since these kinds of grants vary from year to year – but there might be grant opportunities if you are willing to explore all of the grants available. Such funding would not likely cover more than a few percent of the cost of the network, but even that would lower financing costs significantly.

Choose a Business Model. The business plan that looks to be the most promising from a financial perspective is for the city to build the network and to partner with a nonprofit or commercial entity to operate the triple-play business. There are two options for that operating model. One is to build only to customers that buy a product on the network. A second option to build to everybody also looks intriguing. A larger build would allow the city to tackle the digital divide and other social goals for the network.

But there are other possible operating models and the city should first narrow down the options. There are four basic business models to consider:

- The city becomes the ISP and hires staff and operates the business.
- The city hires an operating partner that operates the business on behalf of the city. This partner would be a vendor and all of the revenues of the city would belong to the city.
- The city builds the network and charge one or more ISPs to use the network (open access). There is one nuance of this model which would be to start with one partner to jump-start the business with the ultimate goal of having multiple ISPs in an open access environment. For example, this is how Huntsville. AL (Google Fiber) and Westminster, MD (Ting Broadband) have launched.
- Finally the city can partner with an ISP that is willing to make a significant investment into the network, a model that's referred to generically as a public private partnership.

One of the early next steps needs to be to have the policy discussions to pin down the potential operating model, hopefully to just one of the above options, but to no more than two. Each business model is unique and it would be difficult to explore all of them at the same time.

Identify Potential Partners.

If the city chooses an option other than the city acting as the ISP, then a natural next step is to talk to potential partners.

Some cities have engaged in this process by issuing an RFI or other similar document that asks potential partners to describe their interest. We don't like this approach because we know that many ISPs will not put their intentions into writing and thus many potential partners might not respond to an RFI. The alternative process is to open direct discussions with potential partners that you know. Another alternative is to mix the two processes—issue a short RFI that asks for potential partners to identify themselves but then leave the more detailed discussion to be done on a one-on-one basis with each respondent.

The steps needed to reach an agreement with a partner are fairly well defined in the industry. It would include such steps as:

- Identify the Specific Roles of Both Parties. There are a number of ways that a city can work with an operating partner. For example, it is possible for the city to operate the network and a partner to provide services to customers. However, a partner could also do everything including operating the fiber network. We've found that the best way to define roles is to create a detailed checklist of functions and responsibilities so that the two sides clearly understand their specific roles.
- Define the Financial Relationship. There are also multiple possible financial arrangements. We would expect, for instance, that the financial arrangements would be different for a nonprofit partner like Davis Gig versus a commercial partner. Financial arrangements can vary widely and might include management fees, profit sharing, or leasing the network to a partner.
- Define Operating Metrics. It is essential to establish the expectation for operating the business and this is usually defined through the use of metrics. There might be metrics to cover a range of operating parameters such as network performance, customer installation times, sales goals, customer service response times, etc.
- Negotiate an Operating Agreement. Once the roles, the financial relationship, and the operating metrics have been negotiated, the end result is generally some kind of operating agreement that encapsulates the relationship.

Community Education/Buy-in. If the city decides to continue with investigating the fiber business then a step that most cities take is to undertake a community education process to get feedback and gain buy-in of the concept.

Cities go about this in different ways. Making this report public is a good first step. Communities often hold workshops or other kinds of public presentations to answer the public's questions. It's common to build a web site that discusses the fiber initiative and which can be used to answer the typical questions citizens have about fiber.

Consider Implementation of Fiber Network in Phases. One of the ideas mentioned in the report is to look at undertaking the network in phases. For example, the city might want to consider first building fiber for the purpose of providing additional connections between city facilities. That idea

could be expanded further to build to better connect the city and the University. Another phase could be building fiber to a few key business districts such as University Research Park, Second Street research and development/light industrial area, Downtown and perhaps to some large MDU complexes.

It's worth noting that many of the existing municipal fiber networks were built in phases. For example, both the Chattanooga, TN and the Lafayette, LA network began with a fiber network to serve city locations, then expanded to serve key business districts and finally expanded to serve everybody. Also, while there are less than 150 cities that have built fiber to everybody, there are many hundreds of cities that have built networks to serve city facilities or to reach business districts – this is a common municipal fiber model. As part of looking at a phased approach the city might want to talk to cities of similar size that have undertaken the phased approach.

This study was intended to quantify the opportunity for building fiber everywhere. A separate study would be required to quantify the option to build something less than that. For example, if the goal was to look at a network that served larger business and MDUs on a wholesale basis, an analysis and design would need to be determined of the layout of the fiber network to accomplish that goal. This requires a bit deeper engineering analysis than was done in this high-level feasibility study. Such a study should also be done in conjunction with the next step identified above of better understanding the MDU market.

In-Depth Review of City Practices (that affect fiber). Like every city, there are practices and processes in the city that impact the initial cost of building a fiber network. This would include such things as permitting, franchise requirements, traffic control, construction inspection, etc. Cities often review all of these practices before tackling a fiber network to see if any practices can be streamlined.

Any changes in these practices would also impact existing telecom providers as well as a potential city fiber network, and so the city would want to invite the existing ISPs and incumbents into the discussion.

There are a number of ways to go about this. One approach is to hold workshops with affected stakeholders to get input. Another approach would be to instead get an external review by engineers or others who can compare the city's current practices with what's found in other cities. A third approach would be to find out what cities that have built fiber networks have done (or wish they had done after they went through the process of constructing the fiber network).

Keep an Eye on Broadband Prices. There is speculation in the industry and Wall Street that Comcast and the other big cable companies are going to significantly increase broadband prices over the next few years. The sensitivity analysis shows that prices are among the most important and sensitive variables in the business plan, and the projected financial performance would improve with higher prices. However, this also has to be tempered with a policy question of whether a city-owned network would charge a lot more than today just because Comcast does.

Our base analysis does not suppose any broadband price increases. But we looked at several scenarios that increase prices over time and found that higher prices can significantly improve the

cash flow of any of the operating models. But we caution strongly against building a business plan that requires significant price increases to succeed. While there is a general expectation that Comcast and other large ISPs are going to raise broadband prices over time, this does not mean that they would raise prices in a market where they are competing against a competitive fiber network. For example, we've seen big ISPs drop rates in markets where Google Fiber or other municipal fiber networks have been built and it's not a far-fetched scenario to think that the ISPs will suffer with lower rates in the handful of competitive markets and make up for it with higher prices everywhere else.

Appendix IV: Map of the Study Areas Showing the Proposed Network Design and Fiber Ring