National Telecommunications and Information Administration

Broadband Technology Opportunities Program

Evaluation Study

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Study Design

Deliverables A-B

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ASR Analytics, LLC
1389 Canterbury Way
Potomac, MD 20854

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Submitted to:

Tamia True, Contracting Officer
Brian Baker, Contract Specialist
Acquisition Services Directorate
National Business Center
Department of the Interior

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Section 1. Introduction

In September 2010, the National Telecommunications and Information Administration (NTIA) contracted with ASR Analytics, LLC (ASR) to conduct an evaluation of the economic and social impacts of its Broadband Technology Opportunities Program (BTOP) project grants. Over the past several months, a team consisting of ASR and Grant Thornton LLP developed a methodology that combines econometric analysis and case studies to estimate impacts of these grants, both quantitatively and qualitatively.

The culmination of this study will be the production of a Final Report that quantitatively and qualitatively measures the economic and social impact of BTOP grants (including CCI, SBA, and PCC). This report is intended to assess whether NTIA's implementation of BTOP has encouraged the fulfillment of the American Recovery and Reinvestment Act of 2009's (Recovery Act) goals. It will have sufficient methodological, theoretical, and pragmatic rigor to withstand critical scrutiny by technically proficient practitioners. The analytical work in the report will be of similar quality as that published in a peer-reviewed academic journal.

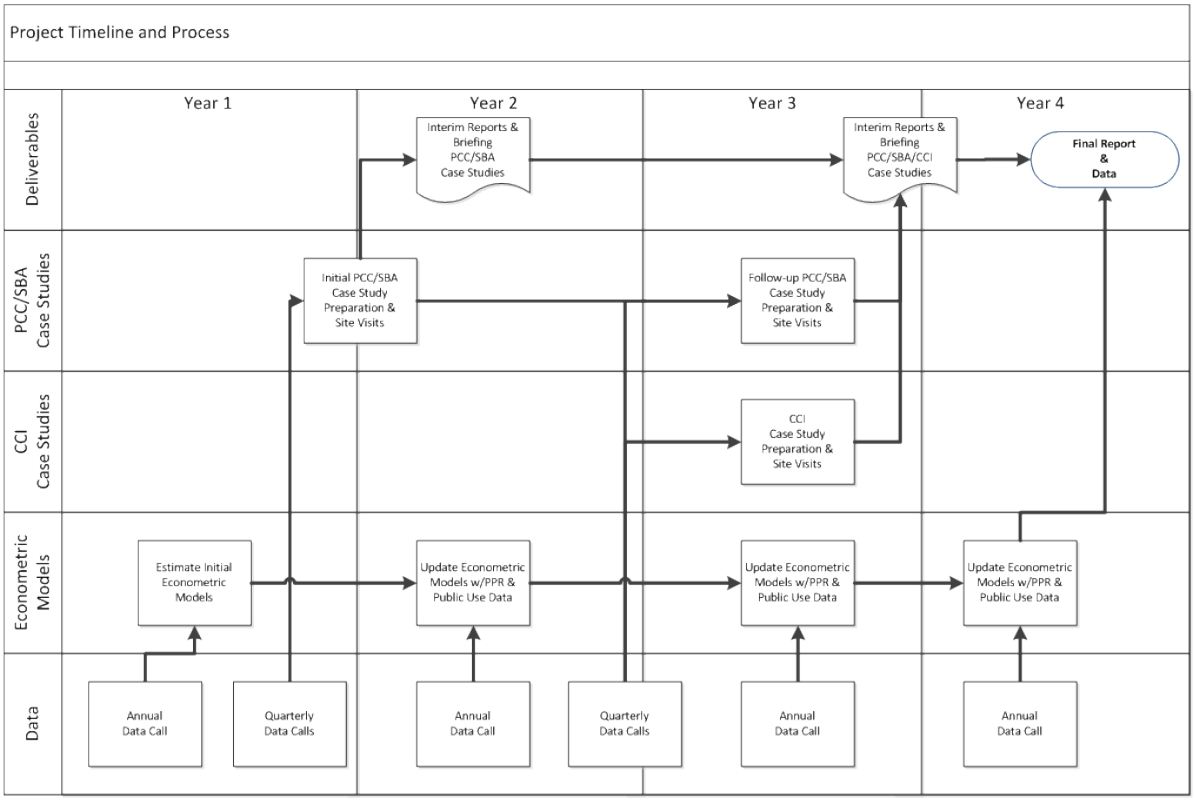
The centerpiece of the Final Report will be an assessment of the benefits that BTOP grant awards have on availability and adoption and in achieving economic and social benefits in areas served by the grantees. The economic impact analysis will examine the distribution of resources and value across groups and individuals as a result of BTOP grants. Social impacts will be measured, including incremental impact on social value and social welfare as a result of BTOP grant awards. The analysis of social impacts will include relative efficiency and cost effectiveness of policies and actions associated with the program.

The purpose of this Study Design deliverable is to present the research design that will be used to develop the Final Report. It provides a justification for the research design chosen to perform the economic and social impact assessments, including a detailed explanation of the study criteria, approaches, methodologies, data, and models to be used in the analyses.

1.1 Project Timeline

As shown in Figure 1 below, the results of these activities will be provided in two interim reports and a final report to be produced at the end of the study. We expect that after the production of each interim deliverable there will be an assessment of progress towards the goals of the project and an evaluation of actions to be taken to maintain or improve the quality of the final report. These interim reports (due in the second and third years of the project), will also provide the opportunity to discuss interim results with our Academic Advisory Committee and, to the extent desired by NTIA, with other stakeholders in the broadband community.

Figure 1: Final Report Deliverable Timeline



1.1.1 Ongoing Review

As we developed the research criteria, methodology, data, and sampling designs, we subjected our work to review by several highly regarded academics with experience in the areas of economic development and econometric estimation techniques. This Academic Advisory Committee operates on an independent basis. Although they worked on a subcontract to ASR, they were asked to provide impartial guidance on our study design. The evaluation study team briefed the Academic Advisory Committee throughout the iterative process of data discovery and our initial methodology, interpreting the significance of a variety of methodological factors, and revising the methodology. The evaluation study teams' Academic Advisory Committee includes Dr. Marvin Sirbu, Dr. Kingsley Haynes, and Dr. Roger Stough. We will continue to work with the Academic Advisory Committee throughout the project timeline.

1.1.2 Engaging Internal and External Stakeholders

A key component of our study design is the proactive engagement of stakeholders. Engaging internal and external stakeholders during the process of developing our study design will help to communicate the following to a wide audience:

- The objectives of the study
- The scope of the study
- The availability and comprehensiveness of existing data, including BTOP administrative data, public use data, and third party sources
- The technological and data limitations encountered to date

To that end, we conducted interviews with stakeholders in order to better understand NTIA and BTOP programmatic goals, as well as the underlying objectives for the evaluation study. During these meetings we obtained important feedback that we incorporated in the study design presented here.

Our team also invited several well-known academic researchers specializing in the areas of quantitative and qualitative assessment of broadband impacts to participate in a Methodology Conference that was held on April 1, 2011. Convening this Methodology Conference provided insight into the questions that the research community is likely to have regarding the evaluation study. It also provided input on the strengths and limitations of various data sources and quantitative and qualitative methods for measuring broadband impacts. This feedback was incorporated into this Study Design document.

1.2 Organization of this Document

This subsection presents the structure of the remainder of the document.

- Section 1 is the introduction to this document.
- Section 2 presents a brief overview intended to present the highlights of our methodology in a compact format. We do not discuss methodological details in this section and the reader is referred to Sections 4 and 5 for additional information.
- Section 3 presents a discussion of the data sources we will use for this project. During the first six months of this project, the evaluation study team, in consultation with the Academic Advisory Committee, telecommunications industry experts, and several BTOP grantees, gathered and assessed NTIA Program data as well as public and private data sources that were available to measure the economic and social impacts of BTOP. One driver of the evaluation study design was the assessment of data currently available, data that will be available through quarterly and annual updates, and data that can be gathered during our case studies.
- Section 4 presents the sample of PCC, SBA, and CCI grants that were selected as the basis for the study, the rationale for their selection, and descriptive statistics on each grant selected. The list of grants to be used as the basis for the study has not been finalized and may be changed in the future. This section discusses some areas of measurement complexity and the selection of geographic areas matching those selected for the purpose of comparisons over time.
- Section 5 presents our statistical methodology. This methodology was developed based on our findings from current scholarship on estimating the impacts of broadband presented in the literature review, as well as guidance from our Academic Advisory Committee. This section also describes our statistical methodology for estimating short-, intermediate-, and long-term impacts of BTOP grants. This analysis will produce interim results during the course of the study as well as material to be incorporated into the Final Report.
- Section 6 presents our case study methodology. We detail our methodology for how case studies will be conducted, data we will gather to support case study site visits, and the outputs of our analysis – the case study reports.
- Appendix A presents a short overview of the NTIA BTOP program. It is intended as a brief orientation and reference. This information informs the methodological choices included in the study design.
- Appendix B presents a review of the current literature. We have reviewed current state of the literature surrounding the economic and social impacts of broadband technologies. We have reviewed over 500 articles in academic literature, technical

publications, and other sources. The bibliography for this literature review concludes this document.

- Appendix C presents an analysis of the current research on data, measures, and findings studied for social impacts within the context of broadband adoption.
- Appendix D presents a glossary of commonly used terms and abbreviations.
- Appendix E presents our bibliography, which contains the sources reviewed in the creation of this study design.

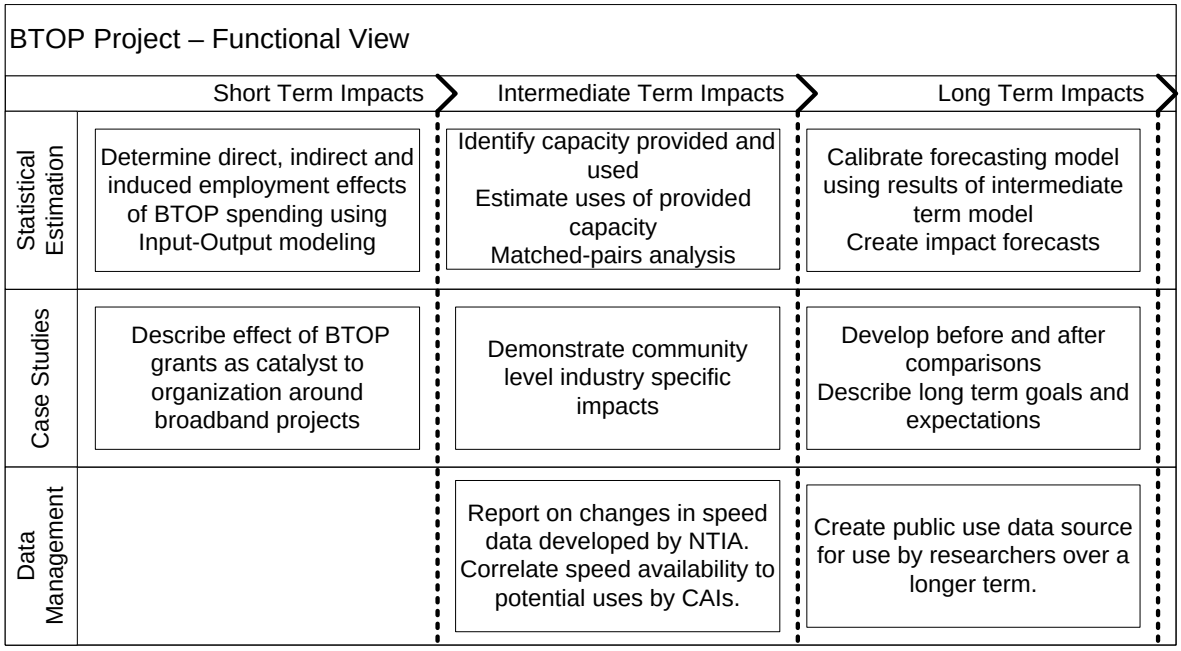
Section 2. Methodological Overview

2.1 Introduction

This section presents a brief overview intended to present the highlights of our methodology in a compact format. We have not discussed methodological details in this section and the reader is referred to Sections 4 and 5 for additional information.

As shown in Figure 2, our study methodology will include short-, intermediate-, and long-term impact assessments. In addition, the study will develop a source of public use data that may be used by researchers in the future who are seeking to better understand the impact of broadband on economic and social outcomes.

Figure 2: Methodology – Functional View



Our methodology includes three major task areas:

- Data Management
- Case Studies
- Statistical Estimation

Each of these will be described in more detail in the subsections below.

Based on previously reviewed research and the goals of this evaluation, we have defined the following outcome areas under which to categorize our potential impact measures or criteria:

- **Broadband Access in Unserved or Underserved Areas:** These are measures related to new broadband service provided, the types of broadband technologies implemented, the improvements to broadband speeds provided, and the types of outcomes that can be achieved with these various speeds and technologies.

- **Economic Impacts:** This area is primarily focused on jobs, but also includes other economic impacts such as wages, property values, and the number of firms in a region.
- **Educational Impacts (including focus on impacts to identified vulnerable populations):** These are measures, broken out by different levels of education, in changes to elements of educational content distribution and instruction.
- **Healthcare Impacts (including focus on impacts to identified vulnerable populations):** These are measures of changes in various elements of the provision and administration of the healthcare services including Health Information Technology (IT), e-Care, Electronic Health Record (EHR), Telehealth, and Mobile Health.
- **Public Safety Impacts:** These are measures related to both the provision and administration of public safety activities including those associated with law enforcement agencies, fire safety agencies, and emergency medical services.
- **Quality of Life Impacts:** These are measures related to various indicators of changes to standard of living associated with the uptake of broadband technologies such as community and civic participation (e.g., voter registration, volunteerism, and membership in civic associations), establishment of home businesses, time spent online, internet purchases, telecommuting rates, home schooling rates, increases in communications via email and other online channels.

2.2 Data Collection and Integration

The foundation of any empirical study is a collection of high-quality data. Our evaluation study will include both quantitative and qualitative data, gathered through a variety of modalities. Our data sources will include:

- NTIA Performance Progress Reports (PPR)
- American Community Survey (ACS) Data
- U.S. Census Zip Code Business Patterns (ZBP) Data
- U.S. Department of Agriculture (USDA) Economic Research Service (ERS) Data
- NTIA Broadband Mapping data
- Federal Communication Commission (FCC) Form 477 data
- Recovery Act reports
- Community Anchor Institution data
- Data obtained from case study participants

As part of our ongoing project activities will establish data quality routines and validate data we have received to ensure we are using accurate data for our analysis. Once data has been transformed into analysis data sets, we will perform preliminary analyses on those data to identify patterns, outliers, and generate summary statistics. While data gathering will only be complete at the end of the project, we will create ongoing documentation of database tables, database design, and data formats as data availability permits. We expect a substantial portion of the data gathering activities to be scheduled for Year 1. At the end of the project the data we have used, together with all relevant documentation will be packaged for use by future researchers.

2.3 Statistical Modeling

We will use a statistical estimation methodology to quantitatively assess the economic and social impacts of BTOP grants, especially infrastructure programs. The impacts of infrastructure programs are most amenable to quantitative analysis, and the methodology we present here is targeted toward the evaluation of these programs. Infrastructure projects have also received the majority of BTOP funding. In some cases PCC and SBA grants may have quantitatively measurable quantitative impacts, especially in the short-term. To the extent possible we will attempt to characterize these effects using quantitative methods.

2.4 Case Studies

We will perform case studies of selected CCI, PCC, and SBA grants to provide a window into the initial impacts of BTOP awards and provide ongoing snapshots of the Program's economic and social impacts, allowing for review and possible model adjustments for the longer-term, in-depth longitudinal study that will be a centerpiece of the Final Report.

The case studies will identify how the grantee maximized the impact of the BTOP investment; identify successful techniques, tools, materials and strategies used to implement the project; highlight best practices; and gather evidence from grantees, anchor institutions, and various publicly available data as to the impacts of the project in the community. The case studies will provide qualitative information; and, depending on the individual evaluation efforts of selected grantees, perhaps some quantitative data related to economic and social impacts of the activities resulting from the BTOP funded grant.

Section 3. Data

3.1 Introduction

During the first six months of this project, the evaluation study team, in consultation with the Academic Advisory Committee, telecommunications industry experts, and several BTOP grantees, gathered and assessed NTIA Program data as well as public and private data sources that were available to measure the economic and social impacts of BTOP. One driver of the evaluation study design is the assessment of data currently available, data that will be available through quarterly and annual updates, and data that can be gathered during our case studies site visits.

Given the scope, complexity, and implementation timelines of many of these grants, most of the projects are not expected to be complete for months or even years. Therefore, data on project outcomes, affected populations, connected anchor institutions, miles of fiber, number of towers, etc., will be evolving over the period of performance. It is also possible that grant projects could make changes to the approach described in their initial applications. Because the implementation of these projects is ongoing during the evaluation, the evaluation study team will evaluate grants as they evolve over their life cycle.

We will use a SharePoint portal as the technology for project metadata and document management. This secure environment is the central control point for all project materials and artifacts. The portal provides access to project artifacts that are planned, in process, and completed. This directly supports the corporate level and project level quality plan by retaining research data, case study workspaces, contact lists, literature review articles, background information, and controlled versions of all deliverables. This system provides the evaluation study team with the ability to automate data quality routines, as well as data integration tasks, so we can quickly reproduce statistical findings as the NTIA program data and public use data are being updated through quarterly and annual data calls. Data received during case studies can be easily added to our data sets and checked against any data previously submitted.

3.1.1 Geographical Unit of Analysis

NTIA awarded grants to applicants representing all states and territories of varying sizes, ranging from a single county to entire states, or even multiple states. Overall, grantees have reported that projects will connect or improve speeds at over 24,000 anchor institutions throughout the nation. Additionally, BTOP will fund over 35,000 new or upgraded workstations and more than 3,500 new or upgraded public computer centers. Grant recipients have also estimated that sustainable broadband adoption and awareness campaigns will reach a total of 40 million people.

The Final Report will examine the economic and social impacts of BTOP funded grants on communities, households, individuals, and anchor institutions. In order to assess impacts at these varied levels, data must be available at a variety of levels, including the county, ZIP Code Tabulation Areas (ZCTA), Census tract and Census block levels. The following describes the data we will seek to obtain at various levels of detail:

- County level data provides background on the areas that are served by BTOP projects. Public use data sources such as the Current Population Survey (CPS) provide a rich set of descriptive statistics on a county-by-county basis. While there is likely to be considerable variation within particular counties regarding social or economic conditions, county level analysis has been used to describe populations served by broadband and those who are excluded.

- A ZCTA comprises a group of census blocks that roughly maps to ZIP Codes. Older FCC 477 data is reported at the ZCTA level, which provides a source of broadband availability data in addition to the NTIA Broadband Mapping Data. In addition, broadband industry pricing and speed information is typically quoted in terms of ZIP Code. While matches between ZIP Codes and ZCTAs are not exact, with due care a ZIP Code may be found that corresponds to a particular ZCTA in most cases. The use of ZCTAs as one of the fundamental geographic units of analysis provides several benefits:
    - ZCTAs are contained in only one county.
    - Each census block is contained in only one ZCTA. This allows aggregation of NTIA Broadband Mapping data to the ZCTA level.
    - ZCTA is the lowest level of geographic aggregation available for some Census data.
    - Matches can be made between ZIP Codes and ZCTAs, although this must be done carefully. This allows for the incorporation of ZIP Code indexed data, such as pricing data into the analysis.
- Census tract data provides additional information on geographically smaller areas, although this information is available less frequently and for fewer measurements of interest when compared to higher levels of geographic aggregation such as county and ZCTA. Census tract data has the following benefits:
    - Each census block is contained in only one census tract. This allows for the aggregation of NTIA Broadband Mapping data to the Census tract level.
    - Detailed demographic data is available from the ACS.
    - More recent FCC 477 data is available at the census tract level, which provides additional information on broadband availability.
- Census block data is the lowest level of geographic aggregation available for use in this study. NTIA Broadband Mapping data is generally available at the census block level, although in some cases it is more detailed than that.
    - In general, census block data will be used as the basis of the measures we will develop to track broadband development over time.
    - Aggregation of census blocks to the census tract, ZCTA or county level will be necessary to interpret the implication of changes to broadband access, availability and adoption.
- Anchor institutions are expected to play a key role in the promotion of broadband use, and their activities and experiences will provide insight into key factors influencing access and adoption.
    - Anchor institutions will be identified by name in the Performance Progress Reports provided by NTIA infrastructure grant recipients. We will track these reports to identify anchor institutions affected by BTOP grants.
    - Anchor institutions are also identified in the NTIA Broadband Mapping data, which tracks information on broadband speed and availability. This information will be used to supplement the data provided in the PPRs.
    - Some anchor institutions may be included in the case study process, for both PCC/SBA case studies and for CCI case studies. Information from these anchor institutions will be collected during interviews and will be qualitative, rather than quantitative in nature.

3.2 Data Sources

Data will be integrated from a variety of data sources to create the analysis datasets. The major data sources we have identified include:

- NTIA PPRs
- American Community Survey Data
- U.S. Census ZBP Data
- USDA ERS Data
- NTIA Broadband Mapping data
- FCC Form 477 data
- Recovery Act reports
- Community Anchor Institution data
- Data obtained from case study participants

Each of these data sources is discussed below in more detail.

3.2.1 NTIA Performance Progress Reports

NTIA program data provides a valuable starting point for our analysis of the effects of BTOP grants. While our study is intended to present the social and economic impacts of the activities actually undertaken by grant recipients, as opposed to those actions described in applications or other plans, grant applications provide information that will assist the evaluation study team in early stages of the project. Our primary source of project information will be data reported by grantees through PPRs.

After discussions with NTIA, we believe we have assembled the most comprehensive set of program data currently possible, taking into account the proprietary nature of some data sources and inherent uncertainties in the implementation of longer-term projects. We plan to reassess these program data sources over time, including the incorporation of PPR information as it becomes available.

Quarterly and Annual PPRs are a requirement from each grantee and will summarize progress to date for each project. We will collect, integrate, and track updates to those data elements quarterly and annually in order to measure progress. These reports provide quantitative and qualitative descriptions of the project's status and specific grant funded activities. PPRs for all project types include an overall assessment for the current and upcoming quarters percent complete within different categories of project activities. Beyond this, however, the PPRs include more detailed information on activities specific to each grant type. This information will be useful in identifying potential project impacts specific to a particular location that can be verified and validated through the case study. This information will also be useful in identifying project specific areas of inquiry to pursue further with individual anchor institution contacts. This will help monitor accuracy and validate data we have at a given point, as well as data received from each grantee. As these updated data are collected, BTOP economic impact forecasts will be calculated to reflect the most up-to-date data.

The PAM database has been provided as one source of BTOP program data, including actual grant awards. This database provides quarterly information about grant location, amount, recipient information, and a set of measures and characteristics specific to the grant. As these data are updated, more information about the specific accomplishments at particular locations will become

available and will allow the evaluation study team to associate the BTOP grant award data with geographic areas and enhanced broadband availability. As such, it forms a core data source.

3.2.2 American Community Survey Data

As part of our analysis we will characterize the economic and demographic characteristics of areas and correlate these to broadband access, availability, and adoption. Most of our baseline socio-demographic data will be generated from the American Community Survey. As of the 2010 United States Census, the long form will not be used to collect detailed socio-demographic data. Instead, the American Community Survey has been focused on this data gathering effort.

Data for the ACS is produced from a random sample of households. Geographic areas are surveyed yearly, and data from successive years is aggregated into 3- or 5-year estimates. In order to preserve confidentiality, there is a built-in tradeoff between the level of geographic granularity at which data is available and the number of years of survey data that are aggregated in order to compute summary statistics. The data for this project will be drawn primarily at the census tract and ZBP level. This data is only available from an average of 5 successive ACS survey years. The data drawn from the ACS will be used to develop control variables that characterize the geographies included in the study. These characteristics are expected to be slowly changing variables, which makes for an acceptable tradeoff between the number of years used and the size of the area examined. Potential descriptive statistics include:

- Age
- Ethnicity
- Place of birth, citizenship, and year of entry
- Language spoken at home
- Educational attainment
- School enrollment
- Residence 1 year ago
- Veteran status and period of military service
- Disability
- Whether grandparents are caregivers
- Income
- Whether food stamp recipient
- Labor force status including industry, occupation, and class of worker
- Place of work and journey to work
- Work status last year
- Vehicles available
- Financial characteristics
- Tenure in current residence
- Value of current residence
- Rental rates
- Health insurance coverage

- Service-connected disability

3.2.3 U.S. Census Zip Code Business Patterns Data

On a yearly basis, the U.S. Census Bureau provides data on ZBPs. These data are currently available for 2009 and will be updated to 2010 by the end of calendar year 2011. This data includes statistics on the number of business establishments, the classification of these establishments by NAICS code, employment, and payroll. All of these statistics are available on a yearly basis at the ZIP Code level. We will use these data to characterize the areas affected by the grants we examine.

3.2.4 USDA Economic Research Service Data

The USDA ERS, in cooperation with the U.S. Census, also categorizes areas as urban or rural, according to commuting and employment patterns. These data provide the evaluation study team with a convenient measure of an area's urban or rural character. The definition of rural depends in part on how the measure designed to capture rural characteristics is used. As part of our methodology we will examine measurements of "rurality" used in previous studies in order to develop a meaningful measure for our study.[1]

3.2.5 National Broadband Mapping Data

The centerpiece of our economic criteria are measures obtainable using the National Broadband Mapping Program Data. On February 17, 2011 the NTIA brought online the National Broadband Map (NBM), "the first public, searchable nationwide map of broadband Internet availability."[2] These data are provided by NTIA in cooperation with the FCC and the 50 states, territories, and District of Columbia. These data are based off of surveys of local broadband providers and has information on availability, technologies, and speed, by census block. The NBM project also makes available information about local community anchor institutions and their access to broadband services. This information can be used to create measures for broadband penetration in these core institutions.

Within the NBM Web site: "users can search by address to find the broadband providers and services available in the corresponding census block or road segment, view data on a map, or use other interactive tools to compare broadband across various geographies, such as states, counties, or congressional districts." In addition to specific searches, the site allows users to download entire data sets with information at the census block level. However, certain challenges have been brought to light surrounding the NBM. Ford states that measurement and sampling error are roots for the immediate issues with these data. It is anticipated that, over time, these "errors" will be resolved.[3]

3.2.6 FCC Form 477 Data

FCC 477 data refers to information submitted on the FCC's Form 477 by providers of broadband services, and comprising location, service levels, and speed. This allows the evaluation study team to measure broadband penetration on a ZCTA and census block level, forming a key component of our overall data store. Until recently, this was the most detailed data on broadband service provision available.

[1] "Rural and Suburban America: When One Definition is Not Enough." Last modified August 4, 2011. http://www.commerce.gov/blog/2011/08/04/rural-and-suburban-america-when-one-definition-not-enough.

[2] "Commerce's NTIA Unveils National Broadband Map and New Broadband Adoption Survey Results." Last modified February 17, 2011. http://www.ntia.doc.gov/press/2011/NationalBroadbandMap_02172011.html.

[3] Ford, George S. 2011. "Challenges in Using the National Broadband Map's Data." *Phoenix Center Policy Bulletin*, no. 27 (March). http://www.phoenix-center.org/PolicyBulletin/PCPB27Final.pdf.

A recent change in FCC Form 477 requirements now provides finer tracing on broadband supply penetration. This change should allow the evaluation study team to leverage biannual data around broadband bandwidth footprints and specific technologies at the grain of census tract. These data are available from March 2010 onwards.

3.2.7 Recovery Act Reports

To supplement our input/output analysis, we will make use of data submitted by grant recipients in their Quarterly and Annual PPRs. Since BTOP funding was provided by the Recovery Act, grantees must submit Quarterly PPRs throughout the duration of their projects. These quarterly reports are due no later than 10 days after the close of each quarter and are submitted to FederalReporting.gov. All of the reports are made available publicly after a federal agency performs a quality control and data validation. This process helps ensure transparency and accountability for Recovery Act award management.

The first report provided by each recipient will be used as a baseline report for comparative purposes. Recipients can use the Excel or XML report templates available on FederalReporting.gov for report submissions. The noteworthy variables included in the report templates are total amount of Recovery Act funds received, number of jobs, activity code (NAICS or NTEE-NPC), total federal amount of Recovery Act expenditure, and total federal Recovery Act infrastructure expenditure.

We are most interested in the data related to capital expenditures and job creation estimates and will use this data for a comparison with the results from our input/output analysis.

3.2.8 Community Anchor Institutions

Community anchor institutions play a key role in our analysis, both as sites for PCC or SBA activity and as proxies for CCI investment in particular geographic areas. NTIA estimates that infrastructure projects "propose to connect or improve speeds for approximately 24,000 community anchor institutions."[4] Understanding the location and type of anchor institutions that are connected by BTOP projects provide insight into geographic areas that should be considered for additional analysis as well as the types and locations of institutions that are likely to be affected by infrastructure projects.

3.2.9 Data Obtained from Case Study Participants

In addition to the data sources described above, we will solicit information from interview participants as part of our case study methodology. We do not anticipate having a set group of questions for each participant. Rather, qualitative information will be gleaned from the conversations we have regarding the projects included in the case studies. Case study interview guides will be targeted to the particular goals, intended outputs/outcomes, types of services provided, community conditions and anchor institution/service location types of each grant and, as such, will be highly customized for each grant location. The guides will be designed to collect information from grantees, anchor institution/service locations, local economic development professionals (where identified by grantees or anchor site contacts), last mile providers (for CCI grants) and individual users (when such access is available and appropriate.) Also, particular facts regarding a project may be confirmed during the interview process and we will make note of these as applicable in our project data.

[4] The Broadband Technology Opportunities Program. 2010. "Expanding Broadband Access and Adoption in Communities Across America, Overview of Grant Awards." Last modified December 14, 2010. http://www.ntia.doc.gov/reports/2010/NTIA_Report_on_BTOP_12142010.pdf.

Section 4. Sampling and Measurement

4.1 Introduction

This section presents the sample of CCI, PCC, and SBA projects that were selected as the basis for the study, the rationale for their selection, and descriptive statistics on each grant selected. The final list of grants to be used as the basis for the study has not been finalized and may be changed in the future. Finally, this section discusses some areas of measurement complexity and the selection of geographic areas matching those selected for the purpose of comparisons over time.

4.2 Grant Selection

In general, the selection of grants was purposeful and not meant to yield a statistical sample. The total number of selections was defined in our technical proposal and guided by the period of performance for the evaluation study, the logistics involved with conducting case study site visits, NTIA's requirements for the timing of interim reports, and the resources available for staffing the evaluation study team. NTIA and the evaluation study team worked collaboratively to develop a consistent set of criteria for the selection of grants. However, some differences in criteria exist due to the nature of CCI, PCC, and SBA projects. We discuss these differences below.

4.2.1 Process

The primary focus of the final report is to investigate and measure the economic and social impacts of BTOP grants at the community, individual, and anchor institution levels. Therefore, from a grant selection perspective, grants that have more focused outcome goals, a more targeted impact area, and/or identified anchor institutions lend themselves better to this analysis.

The diversity in types of grants, their objectives, target audiences, types of technology, timing of project milestones and completion schedules, and geographic scope are just some of the many factors that require a customized and specific approach for each of the selected grants. In addition, given the number of PCC and SBA selections are limited to 15, and the number of CCI selections are limited to 12, generalizations of findings across the grants requires careful interpretation. A further consideration is that many of these projects will be "in flight" at the same time we are conducting the case studies; therefore, we have suggested that NTIA consider grants that are likely to be closer to completion, especially since we will be conducting anchor visits. We discussed with NTIA several other considerations in the selection process, and they are listed below.

These considerations included:

- Is the grantee (or sub-recipient as the case may be) a willing participant that will be able to engage in a meaningful conversation about the impacts – both forecasted and actual – of their project?
- Is this a grant in which there is some high level of confidence that it will be completed without significant technical or financial obstacles? In other words, selected locations can represent grants of varying quality, but extremely troubled or returned grants should not be included.
- Is this a grant for which there is some reason to believe there will be anchor institutions that can be identified and will have been connected (or, in the case of SBA/PCC, are open and operating) by the time the evaluation study team will be conducting case study site visits?

The next level of consideration included various technical and administrative grant attributes including:

- Impact area or project focus with respect to the areas of analysis defined for the study, e.g., education, workforce development, healthcare, or public safety
- Urban versus rural location
- Grant size as measured by federal funding level
- Applicant Type, e.g., State Government, Non-Profit, For Profit, Small Business, Tribal
- Provision of service differentiators such as:
  - Types or style of training, outreach, or media engagement (in the case of PCC/SBAs)
  - Technology deployed, business model of applicant and/or sub-recipients, and/or middle mile versus last mile (in the case of CCIs)
- Type of population served
- Existence of a grant specific evaluation component being conducted by the grantee or a partner organization

Synergies across CCI, PCC, and SBA grant selections in a particular location were considered only if the first two levels of consideration kept the grants in the pool of potential selections. Finally, logistical considerations including budgetary and travel considerations were applied in making the final selection of grants.

4.2.2 Selected Grants

Table 1 presents a list of 15 selected PCC/SBA (7 PCC and 8 SBA) and 12 selected CCI grants along with a brief description of each project.

Table 1: Selected Grants

Recipient	Project Title	Description
CCI		
MCNC	North Carolina Rural Broadband Initiative	To construct over 1,300 more miles of fiber infrastructure to community colleges, libraries, schools, health and public safety facilities, and other community anchor institutions in 69 of the most economically disadvantaged rural counties.
South Dakota Network (SDN), LLC	Project Connect South Dakota	SDN, a partnership of 27 independent telecom providers, will add 140 miles of backbone network and 219 miles of middle mile spurs to SDN's 1,850-mile fiber-optic network.
Zayo Bandwidth, LLC	Indiana Middle Mile Fiber for Schools, Communities, and Anchor Institutions	Directly connect 21 Ivy Tech Community College campuses to the state's existing high-speed network for education and research, known as the I-Light network.

Recipient	Project Title	Description
Merit Network Inc.	REACH Michigan Middle Mile Collaborative	Build a 955-mile advanced fiber-optic network through underserved counties in Michigan's Lower Peninsula to serve institutions, businesses and households, the project will extend Merit's 1600 miles of existing network and intends to directly connect 44 anchor institutions.
Mid-Atlantic Broadband Cooperative	Middle Mile Expansion for Southern Virginia	Add 465 miles of new fiber to an existing 800-mile fiber network, focused on directly connecting 121 K-12 schools.
Executive Office State of West Virginia	West Virginia Statewide Broadband Infrastructure Project	Expand the state's existing microwave public safety network and add about 2,400 miles of fiber, expecting to directly connect more than 1,000 anchor institutions.
Massachusetts Technology Parks	The Massachusetts Broadband Institute: Mass Broadband 123	Link almost 1,400 community anchor institutions through a new middle mile fiber network by constructing over 1,300 miles of new fiber in areas.
OneCommunity	Transforming NE Ohio	Build 900 new miles of fiber, leveraging another 2,000 miles of existing network, across 20 counties.
University of Arkansas	The Arkansas Healthcare, Higher Education, Public Safety & Research Integrated Broadband Initiative	Deploy a new middle-mile fiber network across every county in the state that will extend, integrate, and enhance the capabilities of two major community-serving networks already in existence: the Arkansas Telehealth Oversight & Management (ATOM) Network and the Arkansas Research & Education Optical Network (ARE-ON).
Ocean State Higher Education Economic Development Administrative Network	BEACON 2.0	Construct a new fiber-optic backbone network to connect community anchor institutions and offer interconnection points for local broadband providers in all five counties in the state, as well as Bristol and Plymouth Counties in southeastern Massachusetts.
Delta Communications	Illinois Broadband Opportunities Partnership - Southern	Deploy a high-speed fiber middle mile network across a 23-county region of southern Illinois.
Lane Council of Governments	Oregon South Central Regional Fiber Consortium Lighting the Fiber Middle Mile Project	Enhance an existing fiber-optic backbone and deploy 124 miles of fiber-optic network to deliver broadband capabilities across three large, mostly rural counties -- Lane, Douglas, and Klamath.

Recipient	Project Title	Description
PCC		
Florida A&M University	The FAMU Center for Work Force Development	Establish a new Center for Public Computing and Workforce Development on the Florida A&M campus to serve the public of Tallahassee and surrounding Gadsden and Jefferson Counties. The center also plans to serve as a resource to other public computing centers in the region
Cambridge Housing Authority	Cambridge Housing Authority Community Computer Center	Re-open one computer center and expand the capacity of two public computer centers in public housing developments. The project will purchase 40 computers, replace 24 workstations, and add 16 new ones to serve approximately 384 new users per week. These centers will be located strategically across the city in the largest family public housing developments.
SC State Board for Technical and Comprehensive Education	SC Reach for Success	Expand the capacity of 51 public computer centers and create 19 new computer labs across the South Carolina Technical College System's 16 member colleges. Plan to conduct surveys and outreach to determine the types of additional continuing education courses students and the community need, including English as a Second Language, Internet and computer skills, and technical and healthcare training.
WorkForce West Virginia	One-Stop Public Computer Center Modernization	Enhance and expand public-use computers, connection speeds, and wireless capabilities at 20 WorkForce West Virginia One-Stop offices throughout the state. These offices provide referrals, career counseling, and other employment-related services. The AARP Foundation will provide training that focuses on job search assistance, life skills development and work-focused basic education to help individuals overcome barriers to successful employment.
Michigan State University	Evidence Based Computer Center Deployment II	Partner with 3 community colleges to add workstations at 169 PCCs and create 38 new PCCs throughout the State of Michigan. The PCCs will be located at libraries, community colleges, public housing, and other community support organizations. The State Library of Michigan and Community Outreach Services Corporation, a for-profit entity, will provide assistance at public housing sites and other low-income community centers.

Recipient	Project Title	Description
Technology For All, Inc	Texas Connects Coalition	Create 8 PCCs and upgrade 62 existing PCCs in libraries, workforce centers, public housing, government-operated community centers, and other community organizations. The PCCs will be located in urban and rural areas of southwest Texas.
Las Vegas-Clark County Urban League	Access to Computer Technology and Instruction in Online Networking (ACTION)	Expand capacity at 14 public computer centers and create 15 new public computer centers in public housing developments as well as community and senior centers throughout Clark County, Nevada. The 29 centers will offer computer classes, job training and certification programs, and community health programs through partner organizations. The project plans to hire at least 10 bilingual instructors capable of teaching courses in Spanish.
SBA		
California Emerging Technology Fund	Broadband Awareness and Adoption	Build awareness and understanding of broadband in vulnerable and low-income communities in Los Angeles, the Central Valley, Orange County, San Diego, and the Inland Empire using a targeted media campaign. Provide digital literacy training for low-income individuals, and partner with statewide organizations to coordinate an intensive media campaign, including multi-lingual outlets, and relevant online software applications targeting hard-to-reach, low-income communities, aided by outreach from trusted ambassadors and grassroots mobilization.
Foundation For California Community Colleges (FCCC)	California Connects	Provide outreach, training, and learning support to increase digital literacy skills and broadband usage in partnership with 33 California community colleges, 136 public libraries, public computing centers, and community-based organizations. Special emphasis placed on 18 Central Valley counties that contain a concentration of the target audience of low-income Hispanic residents.
Future Generations Graduate School	Equipping West Virginia's Fire and Rescue Squads with Technology and Training to Serve Communications	Community-based approach to stimulate broadband adoption, extend computer access, and provide training to low-income and predominantly rural communities across West Virginia by providing these services at 60 volunteer fire and emergency rescue stations. Project will include peer-to-peer outreach, newspaper and radio advertisements, signs to announce services, social networking, and a support Web site.

Recipient	Project Title	Description
Delaware Department of State	Delaware Library Job/Learning Labs	The project plans to serve residents by providing public access computers, assistive technology, videoconferencing capabilities, and wireless networking. The computer centers at the Dover, Georgetown, Seaford, and Wilmington libraries will become Job/Learning Labs focusing specifically on the needs of the unemployed, with specialized training for resume building, job search, and interview skills. This project will also upgrade public computer centers at all 32 public libraries statewide and deploy approximately 50 new computer workstations.
Greater Philadelphia Urban Affairs Coalition (GPUAC)	Freedom Rings: Sustainable Broadband Adoption	GPUAC, in partnership with 10 experienced organizations working with targeted vulnerable populations, proposes to increase broadband adoption by providing strategic outreach, broadband education, awareness, training, access, equipment and support to underserved populations in low-income communities throughout Philadelphia.
Connect Arkansas Inc.	Expanding Broadband Use in Arkansas Through Education	Implement a three-pronged program that will be piloted in the 15 poorest counties in Arkansas. Program focused on basic digital literacy training, entrepreneurship, and healthcare access. Upon successful completion of the training, families will receive a refurbished computer. A technology entrepreneurship program targeting low-income youth will also be developed and implemented. Working with the University of Arkansas Medical Services (UAMS), the project will also oversee a comprehensive broadband-based health awareness campaign.
City of Chicago	SmartChicago Sustainable Broadband Adoption	Spur economic development in five disadvantaged neighborhoods in Chicago by creating public computer centers at six community centers for working families and expand workstation capacity at four Business Resource Centers, as well as provide 1,500 residents and small businesses that complete a multi-session training course with laptops and netbooks. Project will also involve a citywide multilingual broadband awareness campaign including outreach by local community organizations in each neighborhood; and the creation of neighborhood-based Web portals.

Recipient	Project Title	Description
C. K. Blandin Foundation	Minnesota Intelligent Rural Communities	Reach each of Minnesota's 80 rural counties through education, training, technical assistance, and by removing barriers to broadband adoption. Training will be provided in computer literacy, online education, and workforce development, and 1,000 affordable refurbished computers will be distributed to low-income, rural Minnesota residents. Funding will also support the development of institutional broadband applications for schools and healthcare facilities to help increase broadband adoption. The U.S. Department of Commerce's Economic Development Administration (EDA) Center at the University of Minnesota, Crookston will help track the impact of the project, including the number of subscribers generated.

Table 2 presents coverage of the selected grants against the various attributes discussed above. The paragraphs that follow the table provide detail on how each of these categorizations were determined, what they mean for the case studies, and statistics on how the selected grants compare to the universe of grants in each area. Impact area is one of these attributes that benefits from some upfront explanation for context in viewing the table. The impact categories applied and their definitions include:

- Workforce Development – Projects that have explicitly linked their location or program to job search by providing training in job skills, or training in how to use the Internet specifically to find a job. Also includes projects that explicitly provide training or other resources geared towards small businesses or to business development skills in general.
- Healthcare – Projects that have explicit links to healthcare providers, training on how to use the Internet to find health information, or links to schools of medicine, public health or pharmacy.
- Education – Projects that are explicitly linked to GED training or to distance learning. These are projects that are linked to the provision of skills or learning other than how to use the technology itself and, which are tagged "digital literacy" as described below.
- Digital Literacy – Projects that include training for users on how broadband technology works and what they can do with it. This category should include most if not all PCCs and all SBAs. Most CCI projects do not have this component.
- Public Safety – Projects that have explicit links to public safety outcomes. Though those projects using the 700 MHz band for their deployment are excluded from this study, other projects might have explicit links to public safety outcomes.

Though general digital literacy is not one of the impact areas suggested in the project statement of work (SOW) as a focus for this study, this impact area was created because it was determined that a vast number of PCC and SBA grants in fact focus on general digital literacy, as opposed to other of the impact areas noted in the SOW as key areas of analysis.

For PCC and SBA projects, this determination was made through a review of the grant application and fact sheet and the description provided of the training and other services to be provided. Most CCI grants, on the other hand, do not have a particular impact area focus, but rather include the construction or provision of various types of broadband infrastructure over a specified geographic area. A number of different types of anchor institutions engaging in a variety of impact area

activities may end up being involved in the project. There are some CCI projects, however, that do include a particular impact area focus in that they explicitly intend to connect to an existing statewide health network or educational network or consortium or they are predominantly connecting to one type of anchor institution. These instances were identified through a review of CCI applications and a cross-check with identified anchor institutions in instances when anchor institution data was available. It is important to note that the impact area categorizations, as they are based primarily on a review of project fact sheets developed prior to actual project implementation and including any PPR information to date, could be subject to change as additional project activities are implemented. Reviews of PPR data over the course of the study period may result in updates to these designations. The statistics presented here are a snapshot of how the grants appear to fall out against the impact areas at the time of the development of this study design. No determination was made for those projects that cover numerous counties and/or multiple states.

Table 2: Attributes of Selected Grants

Selected Grants	Urban/ Rural	Award Amount	Applicant Type	Eval Program (Y/N)	Impact Area(s)
CCI					
MCNC	Rural	$75,757,289	Non-Profit		• Education
South Dakota Network (SDN), LLC	Urban	$ 20,572,242	For-Profit		
Zayo Bandwidth, LLC	Urban	$ 25,140,315	For-Profit		• Education
Merit Network Inc.	Urban	$33,289,221	Non-Profit		
Mid-Atlantic Broadband Cooperative	Rural	$16,044,290	Non-Profit		• Education
Executive Office State of West Virginia	Urban	$126,323,296	Government		
Massachusetts Technology Parks	Urban	$45,445,444	Government		
OneCommunity	Urban	$44,794,046	Non-Profit		
University of Arkansas	Rural	$102,131,393	Higher Education		• Healthcare
Ocean State Higher Education Economic Development Administrative Network	Urban	$21,739,183	Non-Profit		

Selected Grants	Urban/ Rural	Award Amount	Applicant Type	Eval Program (Y/N)	Impact Area(s)
Delta Communications	Rural	$31,515,253	For-Profit		
Lane Council of Governments	Urban	$8,325,530	Government		
PCC					
Florida A&M University	Urban	$1,477,722	Higher Education	Y	• Digital Literacy • Workforce Development • Healthcare • Education
Cambridge Housing Authority	Urban	$698,924	Government	N	• Workforce Development • Education
SC State Board for Technical and Comprehensive Education	Undetermined	$5,903,040	Government	N	• Workforce Development • Digital Literacy • Education
WorkForce West Virginia	Undetermined	$1,901,600	Government	N	• Workforce Development
Michigan State University	Undetermined	$6,056, 819	Higher Education	N	• Workforce Development • Education
Technology For All, Inc	Undetermined	$9,588,279	Non-Profit	N	• Workforce Development • Digital Literacy
Las Vegas-Clark County Urban League	Undetermined	$4,680,963	Non-Profit	N	• Workforce Development • Digital Literacy • Healthcare
SBA					
California Emerging Technology Fund	Undetermined	$7,251,295	Non-Profit	Y	• Digital Literacy
Foundation For California Community Colleges (FCCC)	Undetermined	$10,944,843	Non-Profit	Y	• Digital Literacy

Selected Grants	Urban/ Rural	Award Amount	Applicant Type	Eval Program (Y/N)	Impact Area(s)
Future Generations Graduate School	Rural	$4,461,874	Non-Profit	N	• Workforce Development • Digital Literacy • Healthcare
Delaware Department of State	Urban	$1,899,929	Government	N	• Workforce Development • Digital Literacy
Greater Philadelphia Urban Affairs Coalition (GPUAC)	Urban	$11,804,015	Non-Profit	Y	• Digital Literacy • Healthcare
Connect Arkansas Inc.	Undetermined	$3,702,738	Non-Profit	N	• Workforce Development • Digital Literacy • Healthcare
City of Chicago	Urban	$7,074,369	Government	Y	• Workforce Development • Digital Literacy
C. K. Blandin Foundation	Rural	$4,858,219	Non-Profit	Y	•Workforce Development •Healthcare •Education •Digital Literacy

None of the selected PCC grants are designated rural versus 29 percent urban and 71 percent undetermined; 25 percent of the selected SBA grants are rural versus 38 percent urban and 38 percent undetermined; and 33 percent of the selected CCI grants are rural versus 66 percent urban. Comparable statistics for all CCI, PCC, and SBA grants and the total universe of BTOP grants are presented in Table 3 below.

Table 3: BTOP Grant Rural / Urban Designations

Grant Type	Rural		Urban		Undetermined	
	#	%	#	%	#	%
CCI	39	34%	19	17%	56	49%
PCC	6	9%	18	28%	41	63%
SBA	9	20%	11	25%	24	55%
All Grants	54	24%	48	22%	121	54%

Designating BTOP grants as urban or rural, however, is a difficult and somewhat arbitrary exercise. The exact location(s) of the activities conducted under any given grant can be both numerous and, in some cases, hard to identify. For example, some of the selected grants can have tens or even hundreds of community anchor institutions at which their services are provided or to which their infrastructure are connected. Moreover, these anchor institutions can be located in geographically disparate locations, some of which may be rural and some of which may be urban. For purposes of this report, CCI grants were designated as rural or urban primarily based on the question in their application that asks whether "more than 75 percent of the grant will impact rural areas." If the answer was yes, the grant was classified as rural, if the answer was no, the grant was classified as urban. In instances where this question was not included in the application and/or no application was available, the project's fact sheet was reviewed and a judgment was made based on the description of the project provided. In the case of PCC and SBA grants, this question did not exist in the application. For these grants, review of the application (when available) and fact sheets was used to make a judgment on the urban or rural nature of the project on the whole.

A final consideration for grant selection was whether or not the grantee or an independent third party was conducting a formative or summative evaluation of the grant. Some grantees, in particular SBA grants, included an evaluation program as part of their grant application. Still others have recognized since award the value of collecting certain data on the outcomes and impacts of their projects. Some grantees have formed arrangements with other grantees in their state or other regional boundary in order to collect data on broadband access and adoption outcomes across projects. The existence of an evaluation program of this type was considered in terms of case study grant selection because such efforts will potentially yield data that the evaluation study team can incorporate into our analysis. These actions signal a willingness and understanding on the part of the grantees that certain measures of economic and social outcomes are only possible if they collect both baseline and ongoing data. These efforts by grantees will augment the information collected as part of the case study, and case study site visits.

Examples of evaluation efforts by case study grantees include those by Northern Illinois University (NIU) and the City of Chicago. NIU is attempting to evaluate issues such as:

- How did project impact access to households and businesses in the region?
- How did project impact use of broadband by households and businesses in the region?
- How did project impact employment in the region?
- How did project impact business vitality in the region?
- How are households and businesses using the increased bandwidth capacity?

They are doing this by collecting, amongst other things, baseline data on current use of broadband services, current price of broadband services, potential market for broadband services, regional wages, and regional domestic product through surveys of anchor institutions, households, and

businesses. We have engaged the NIU grant leadership to discuss ways the evaluation study team can assist in the development of data collection instruments, as well as analysis of the results derived from these efforts.

In the City of Chicago, the evaluation effort includes analysis of several elements through use of surveys and interviews including an evaluation of: (1) the implementation process (interviews); (2) programmatic outcomes for participants in various individual and business focused training initiatives (surveys and interviews); (3) organizational changes in capacity, leadership, collaboration, and resources for sustainability (interviews); (4) interpersonal and community-level outcomes including analysis of social networks and activities in such networks for FamilyNet participants (participant surveys); and (5) 2011 and 2013 city-wide survey tracking changes in technology use across community areas (including those communities involved in the BTOP grant). The city-wide survey will assist in the longitudinal assessment of the grant on residents by combining the results with a prior study of technology use in Chicago during the summer of 2008. The city-wide surveys will allow for comparison of changes in the grant recipient communities with other low-income community areas and with city averages.

Though not an explicit consideration for grant selection, the number and type of anchor institutions associated with case study grants will affect the manner in which the case study is conducted (see Subsection 4.3 below). Many of the selected case study grants have a large number, and in some cases wide variety, of anchor institutions at which their various services are targeted or will be located. As discussed in more detail in the Methodology sub-section below, this fact has implications on how the case study will be conducted and documented. The time and budget constraints of this project do not allow, for example, for a case study of the Michigan State University project to include a case study visit to each of the 207 institutions in which the project is placing PCCs, or to include a detailed analysis of the economic and/or social impacts of each of these PCCs on their individual communities. Rather, based on interviews with the grantee and the cost and logistical considerations associated with the exact location of the 207 PCCs, the evaluation study team will visit a small subset of these locations to observe, collect, and measure economic and social impacts. As a result, the case study reports will describe in detail only those specific locations visited, and where possible, generalizations will be made to the other locations. To the extent the grantee itself is collecting project-wide data, analysis of that data will be included in the case study, but the case study will focus on the observable outputs and outcomes of only the visited targeted anchor institutions and their associated communities or other defined areas of impact.

The selection of the locations the evaluation study team will visit will relate to the activities of the grantees at those locations. In situations where a grantee has demonstrated significant progress at several locations and/or types of community anchor institutions, the locations selected for case study site visits will be coordinated with the grantee and individuals in those locations knowledgeable of the association with BTOP.

4.3 Selecting the Sample for the Study

The statistical estimation and case study methodologies presented in this document will be performed on a sample of fifteen (15) PCC and SBA projects and twelve (12) CCI projects. These results will then be extrapolated to the BTOP as a whole to estimate the overall impact of BTOP. The grants selected for inclusion in the study are as follows:

PCC Grants

- Florida A&M University – The FAMU Center for Public Computing and Workforce Development
- Cambridge Housing Authority – Cambridge Housing Authority Community Computer Center
- SC State Board for Technical and Comprehensive Education – SC Reach for Success
- WorkForce West Virginia – One-Stop Public Computer Center Modernization
- Michigan State University – Evidence Based Computer Center Deployment II
- Technology For All, Inc. – Texas Connects Coalition
- Las Vegas-Clark County Urban League – Access to Computer Technology and Instruction in Online Networking (ACTION)

SBA Grants

- California Emerging Technology Fund – Broadband Awareness and Adoption
- Foundation For California Community Colleges (FCCC) – California Connects
- Future Generations Graduate School – Equipping West Virginia's Fire and Rescue Squads with Technology and Training to Serve Communications
- Delaware Department of State – Delaware Library Job/Learning Labs
- Greater Philadelphia Urban Affairs Coalition (GPUAC) – Freedom Rings: Sustainable Broadband Adoption
- Connect Arkansas Inc. – Expanding Broadband Use in Arkansas Through Education
- City of Chicago – SmartChicago Sustainable Broadband Adoption
- C. K. Blandin Foundation – Minnesota Intelligent Rural Communities

CCI Grants

- MCNC – North Carolina Rural Broadband Initiative
- South Dakota Network (SDN), LLC – Project Connect South Dakota
- Zayo Bandwidth, LLC – Indiana Middle Mile Fiber for Schools, Communities, and Anchor Institutions
- Merit Network Inc. – REACH Michigan Middle Mile Collaborative
- Mid-Atlantic Broadband Cooperative – Middle Mile Expansion for Southern Virginia
- Executive Office State of West Virginia – West Virginia Statewide Broadband Infrastructure Project
- Massachusetts Technology Parks – The Massachusetts Broadband Institute: Mass Broadband 123
- OneCommunity – Transforming NE Ohio
- University of Arkansas – The Arkansas Healthcare, Higher Education, Public Safety & Research Integrated Broadband Initiative
- Ocean State Higher Education Economic Development Administrative Network – BEACON 2.0

- Delta Communications – Illinois Broadband Opportunities Partnership
- Lane Council of Governments – Oregon South Central Regional Fiber Consortium Lighting the Fiber Middle Mile Project

Grants were selected by NTIA in order to provide geographic diversity and representation of diverse project types. A statistical sampling method such as simple random sampling was not used to create the selected lists.

Our approach to the selection of the grants was motivated by the following factors:

1. Identification of the impacts of the projects will require information that goes beyond grant applications, PPRs or other publicly available sources. Gathering additional information from grant recipients requires in depth interviewing and examination of specific project data. The cost of performing these activities for every grant recipient is prohibitive.
2. Participation in the study on the part of the grantees is voluntary. Although grantees are required to provide Recovery Act reports and PPRs as part of their participation in BTOP, participation in this study is not required. This makes assembling the sample of grant recipients an exercise in selection of those who are most likely to benefit from or show interest in the study.
3. Grant recipients have different levels of internal measurement and reporting planned as part of their projects. As an example, some grant recipients have included a survey or study as part of their projects, while others have not. To the extent that this type of data gathering activity is planned by the recipient, the inclusion of that recipient in the study improves the quantity of data available.

After developing estimates of project impacts for the selected samples, we will extrapolate the results to BTOP as a whole. To the extent that data sources are available, complete, and accurate we will use those sources. Some key pieces of information may be missing for some projects, either because of the project type or due to limitations in public data sources. In these cases we will impute data as required to develop overall program impact estimates. Variation surrounding these imputations will be included in our sensitivity analysis to determine the extent to which they might affect the overall conclusions of the study. Likewise, those areas selected as “controls” in the matched-pairs analysis (see below) might have more limited data availability versus the sampled projects.

4.4 Measuring Impacts -- Some Complexities

The methodology presented here is designed to address several practical difficulties that arise due to the structure of the BTOP program and the time available for completion of the study. Most of these practical considerations stem from the focus of BTOP investments on middle mile infrastructure and from the goals of the Recovery Act in general, which focus on wide-scale impacts on infrastructure investments that can be expected to provide benefits over an extended period of time.

- The primary hurdle to overcome is the long timescale of many BTOP infrastructure projects. While all projects are expected to expend their BTOP-provided funding during the same time period as this study, it is to be expected that larger infrastructure projects would be completed toward the end of the study period. This will limit the amount of time available during the study period for projects with longer durations.
- Public use data sources are expected to lag by at least a year and perhaps more both for variables that would be used to measure social or economic impacts and variables that might be used to identify co-occurring factors that would be used as control variables or for matching similar areas. While these delays are inevitable due to the necessity of

maintaining high-quality public use data sources, they will serve to push the real time at which a study using them will be feasible.

- There are likely to be delays between the availability of additional infrastructure due to projects funded by BTOP grants and adoption of technologies that will take advantage of that additional capacity. This is due to the remaining technological changes that must occur between the middle mile infrastructure backbone and the ultimate user of the technology. Limiting factors could include technological limitations at the last mile, required upgrades to hardware or software on the part of users, training or education of user communities, organizational planning delays, and contractual restrictions that might preclude the implementation of plans to take advantage of new infrastructure if agreements need to be renegotiated.
- Identification of the locations affected by most BTOP infrastructure projects is made more difficult due to distributed access to that infrastructure caused by the structure of the Internet itself. While projects have generalized areas that are targeted for improvement (generally identifiable at the county level) the effects of a large investment in middle mile infrastructure may not be felt equally throughout that county, and they might occur in other geographic regions depending on activities of last mile providers. Establishing the connection between middle mile infrastructure and users is difficult, as most broadband adopters do not know what middle mile infrastructure they are using, and last mile providers cannot be required to provide this information as part of our study design.

4.5 Matched Pairs Selection

An effective and well-established way to develop estimates of the effects of programs such as BTOP is the use of matched-pairs analysis. Geographies are selected that, to the extent possible, are similar to those where BTOP funding was received. These geographies are used as a "control" group, while those areas receiving BTOP funding are considered to be the "treatment" group. Comparison of the "treatment" and "control" groups will allow the evaluation study team to take factors into account that might be affecting broadband availability, access or adoption. In particular, we would be able to net out effects of national economic conditions, such as recovery from recession, which would presumably affect both "control" and "treatment" areas.

Matched-pairs analysis will be incorporated into our analysis of the intermediate-term impacts of infrastructure projects. Matching will take place at the county level, both because this provides a good set of matching parameters and can easily be incorporated into our analysis methodology. The key to this sort of estimator is the availability of geographic areas that are comparable, or nearly so, to areas receiving broadband investments, but which do not receive such investments themselves. Especially important is the identification of the fundamental economic base of each.

Following Gillett et al. we will use Stata's NNMATCH function to develop the control group for the matched-pairs samples of counties.[5] This function finds a control area (or groups) for each geographic area receiving BTOP funding. The procedure uses nearest-neighbor matching among the independent variables to identify similar observations. These independent variables could include the level of broadband service available at some time in the recent past. There are various options available using this procedure and an investigation of the data and the quality of the matches will form part of our control group selection methodology.

[5] Gillett, Sharron, William Lehr, Carlos Osorio, and Marvin Sirbu. 2006. "Measuring Broadband's Economic Impact." United States Department of Commerce, Economic Development Administration. http://web.si.umich.edu/tprc/papers/2005/475/TPRC2005_Gillett%20Lehr%20Sirbu%20Osorio%20submitted.pdf.

Section 5. Statistical Estimation Methodology

5.1 Introduction

This section describes our statistical methodology for estimating short-, intermediate-, and long-term impacts of BTOP grants. This analysis will produce interim results during the course of the study as well as material to be incorporated into the Final Report. The statistical estimation methodology presented here is primarily designed to characterize the economic impacts of BTOP infrastructure grants, although some of the social impacts will also be considered. After a short discussion of previous statistical work in this area, we present the methodologies we will use for short-, intermediate-, and long-term statistical analysis. The final portion of this section discusses matched pairs and sensitivity analysis.

5.2 Purpose of the Statistical Estimation Methodology

We will use the statistical estimation methodology described in this section to quantitatively estimate the economic and social impacts of BTOP grants, especially infrastructure programs. The impacts of infrastructure programs are most amenable to quantitative analysis, and the methodology provided here is targeted toward the evaluation of these programs. Infrastructure projects have also received the majority of BTOP funding. In some cases PCC and SBA grants may have measurable quantitative impacts, especially in the short-term. We anticipate that the case study methodology discussed in the following section will provide a substantial portion of the social and economic impact of these programs. However, the quantitative analysis presented here might supplement these case studies, especially for short-term effects of investments in PCCs.

Within each outcome area, various study criteria will include measurement of the impact of NTIA's implementation of BTOP on individuals, households, anchor institutions, and/or other community level units depending on the type of grant and specific grant activities undertaken. Again, some criteria will have an impact at multiple levels. Our methodology will be designed to report impacts at the levels deemed to be the most relevant for a given criterion.

Our study will examine both broadband availability and broadband adoption when considering how BTOP grants influence broadband use. While these factors have been conflated in many studies due to data limitations, the causes of each are different. The following definitions will be used in the study:

- **Availability:** According to the National Broadband Map (NBM), broadband service might be available to an area, but only if construction or other work is completed first. The NBM is not intended to include broadband service that is not available to a customer within a typical service interval (7 to 10 business days) and/or without an extraordinary commitment of resources.
- **Access:** Dependent on availability, access determines if the household / business have the tools/knowledge required to take advantage of the available technology.
- **Adoption**: The integration of these technologies into processes / daily life. "How do you behave differently now that you have broadband" / "How do you do business differently now that you have broadband"?

Broadband availability is more strongly driven by engineering limitations inherent in broadband technology and economic limitations on the types of projects that are profitable to undertake. Adoption is determined, in part, by the characteristics of the population that could be served and the area in which service is provided.

5.3 Estimating Short-Term Economic Impacts

When grants are distributed, they will have an immediate effect on economic activity within a particular region. In particular, construction activity, which is most closely related to CCI grants, will yield jobs in the short-term due to completion of the activities required by the project itself. To a certain extent, the PCC and SBA projects might exhibit similar results, but on a smaller scale.

We will define short-term economic impacts as those that occur due to the BTOP grant before other factors in the geography of interest have yet adjusted to the BTOP grant expenditure. Long-term economic impacts are observed when all factors may be adjusted. In the interim, some factors might remain fixed while others adjust, leading to intermediate-term impacts.

There exists a small body of well-developed literature surrounding short-term economic effects of broadband CCI grants. It primarily focuses on the use of input-output modeling to estimate the direct, indirect, and induced effects of broadband spending. Generally, input-output analysis examines how different industry sectors affect national or regional economies – that is, how a change in one industry can induce changes in other industries, as an output for one can become an input for another. Input-output analysis generates multipliers to account for these ripple effects. In order to facilitate comparison and aggregation of results, we will use national averages for input-output multipliers.

We will be using the IMPLAN software package to develop input-output estimates of the likely employment effects of BTOP grants in affected areas. Using data on total expenditures by industry sector, IMPLAN can derive the direct, indirect, and induced effects of work completed for BTOP grants on their respective regional economies. Specifically, IMPLAN can estimate industry-sector activity for final demand, final payments, industry output, and employment for each county in the U.S. along with state and national totals.

The basis for our analysis will be PPR data, which we will map to IMPLAN categories for the purpose of determining how various IMPLAN sectors would be affected by BTOP grant expenditures. Then, there are two possible approaches to mapping PAM expenditure data to their respective industries. First, we will assign each Cost Classification to a three-digit NAICS code. We will then follow one of two routes: 1) import the data to IMPLAN with an aggregation step which makes the three-digit NAICS code data IMPLAN-compatible; 2) map the three-digit NAICS codes to their respective IMPLAN 440 industry codes, which properly formats the data for IMPLAN software without an aggregation step. The mapping of NAICS codes to IMPLAN industry codes is show in Table 4 below.

Since PPR reports are due quarterly, it will be possible to update these analyses on a quarterly basis, allowing the evaluation study team to define short-, intermediate-, and long-term impacts. In addition to the methodologies used in the literature, BTOP also has reporting requirements that will produce more detailed information on the short-term effects of the project than would normally be obtainable from such an effort. In particular, Recovery Act reporting requirements include an estimate of the number of jobs that will be created as a result of grant expenditures. These numbers are publicly available and will be used to estimate the short-term job creation effects of BTOP projects. We will make comparisons between the IMPLAN results and the results from Recovery Act reporting.

Table 4: Mapping Cost Classifications to Three-Digit NAICS to IMPLAN 440

PAM Cost Classification	2007 NAICS	NAICS Title	2007 NAICS3	IMPLAN 440
ArchFee_Amt	5413	Architectural, Engineering, and Related Services	**541**	**369**
Benefits_Amt	523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	**523**	**356**
Constructn_Amt	23*	New Construction	**23***	**36**
Contract_Amt	5411	Legal Services	**541**	**367**
Demolitn_Amt	238910	Building demolition, Land clearing, Trenching	**238**	**39**
Equipmnt_Amt	5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	**532**	**365**
IndirCh_Conting_Amt	523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	**523**	**356**
LandApprsl_Amt	531320	Appraisal services, real estate	**531**	**360**
LegalExp_Amt	5411	Legal Services	**541**	**367**
OtherArchFee_Amt	5413	Architectural, Engineering, and Related Services	**541**	**369**
OtherMisc_Amt	523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	**523**	**356**
Personnel_Amt	561110	Administrative Management Services	**561**	**384**
ProjInspFee_Amt	541350	Architectural, Engineering, and Related Services - Building Inspection Services	**541**	**369**
RelocExp_Amt	484	Truck Transportation	**484**	**335**
SiteWork_Amt	23*	New construction, Repair and maintenance	**23***	**39**
Supplies_Amt	334210	Carrier equipment (i.e., analog, digital), telephone, manufacturing	**334**	**237**
Travel_Amt	5615	Travel Arrangement and Reservation Services	**561**	**383**

5.4 Estimating Intermediate-Term Impacts

By “intermediate-term” impacts, we mean an economic or social impact that will be observed during the study period within the geographic area designated for a particular grant. We distinguish between short-term effects, which are primarily due to expenditures on inputs, and intermediate-term effects, which are caused by the outputs of the projects, in this case increased infrastructure development.

A variety of econometric methodologies have been employed to estimate the effects of broadband availability and adoption on employment and other economic outcomes. For instance, Gillett et al. evaluate the effect of broadband investment on employment, wages, rents (a proxy for property values), and the number of business establishments in a region (a proxy for the number of firms in a region).[6] These authors perform a ZIP Code level analysis on two matched cross sections, the first as of December 1999 and the second four years later. They track changes in economic indicators over time in order to identify differentiated patterns of change based on broadband availability while controlling for community-level factors such as income, education, and urban/rural status. Gillett et al. find the presence of mass-market broadband is a significant factor in explaining growth in employment, the number of businesses in a ZIP Code and the number of IT businesses in a ZIP Code. Wages were not found to be affected by the presence of mass-market broadband, but property values appeared to be increased by broadband availability.

In a similar study, Crandall et al. estimated the effects of broadband penetration on both output and employment, in aggregate, and by sector, using state-level FCC data.[7] Economic performance captured by state-by-state estimates of output (GDP) data from the Bureau of Economic Analysis through 2005 and employment data from the Bureau of Labor Statistics through 2006. This study uses FCC data on broadband penetration for the lower 48 states over the 2003-2005 period, controlling for a variety of other factors that also could account for the growth in output and employment during this time. The authors find that nonfarm private employment and employment in several industries is positively associated with broadband use. For every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent per year.

Other authors have taken a more synthetic approach to the estimate of the effects of broadband technologies on specific areas. In their paper, "[t]he Economic Impact of Digital Exclusion," the Digital Impact Group and Econsult Corporation develop a taxonomy of potential deficits in social or economic outcomes and use studies of specific effects of broadband to estimate the effect on each component.[8] The sum total of these effects is then computed to present an assessment of broadband's overall impact. This paper presents an annual estimate of $55 billion for the cost of exclusion of 100 million individuals and 40 million households from broadband access in the United States.

This type of study has several benefits, including:

- The general-purpose nature of broadband technology may be captured by a sufficiently broad and diverse taxonomy of potential effects.
- Estimates of broadband technology in areas where the technology has not been widely deployed, or where broadband technology has been newly adapted for use may be included in the estimation methodology.

The drawbacks of this approach may include:

- Potential for double-counting or undercounting of the same benefit. As an example, education and economic opportunity are potentially overlapping categories with respect to vocational education. Since statistics on the impact of broadband on each of these components may be computed separately by different authors, some educational activities may be counted in both places.

[6] Gillett, Sharron, William Lehr, Carlos Osorio, and Marvin Sirbu. 2006. "Measuring Broadband's Economic Impact." U.S. Department of Commerce, Economic Development Administration. http://web.si.umich.edu/tprc/papers/2005/475/TPRC2005_Gillett%20Lehr%20Sirbu%20Osorio%20submitted.pdf.

[7] Crandall, Robert, William Lehr, and Robert Litan. 2007. "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data." *The Brookings Institution: Issues in Economic Policy*, no. 6 (July). http://www.brookings.edu/views/papers/crandall/200706litan.pdf.

[8] Digital Impact Group and Econsult Corporation. 2010. "The Economic Impact of Digital Exclusion." Article published March 5. http://www.econsult.com/articles/030810_costofexclusion.pdf

- Lack of clarity on definitions of access, availability and adoption, and the factors that influence each. That is, the character of each particular benefit will likely have an impact on the reason why broadband is not in wider use. For example, personal financial management, which requires lower speed than personal entertainment might be more influenced by access, while personal entertainment would be influenced by availability of higher speed connections.

Notwithstanding these potential drawbacks, we will follow a similar methodology to obtain estimates of the economic and social benefits of broadband use as part of our methodology.

5.4.1 Characteristics of BTOP Infrastructure Projects

The particular characteristics of BTOP Infrastructure projects must be carefully considered in the creation of the statistical estimation methodology. NTIA made the strategic decision to provide grant funding to “middle mile” projects. In contrast to “last mile” infrastructure, which serves households or businesses, middle mile projects provide service to last mile broadband service providers themselves. This has important implications for the measurement of the benefits of BTOP broadband infrastructure projects.

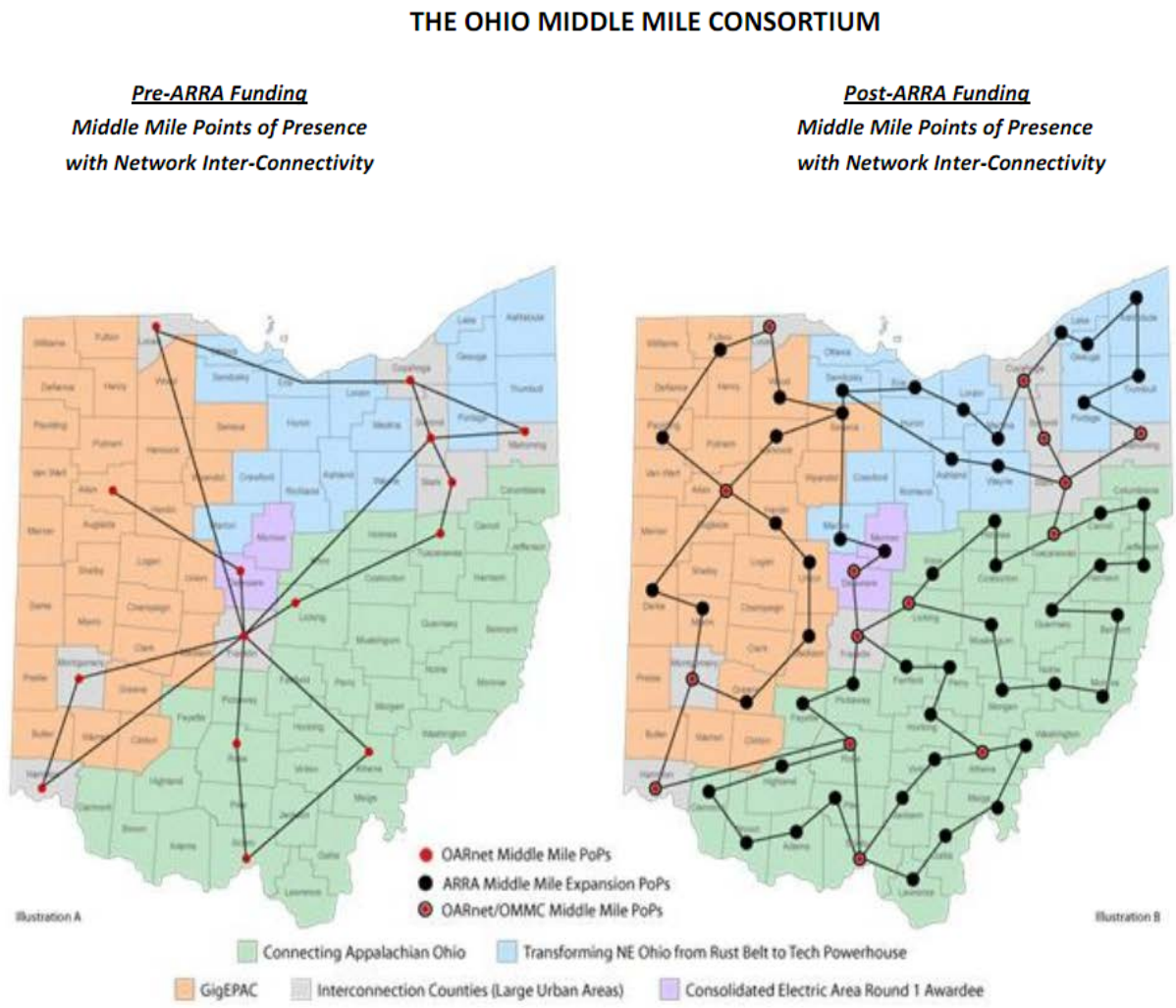
In the case of middle mile projects, the situation is more complex. A single middle mile project may serve multiple last mile providers. The middle mile grant recipient is unlikely to know the full extent of the area served by the last mile providers who use the middle mile network built or activated using BTOP funding. Furthermore, the last mile provider may have no relationship at all with NTIA, other than as a consumer of the services provided by a grant recipient. The delineation of the areas served by the last mile providers is also likely to be sensitive financial information. This raises the possibility that little information would be provided on the locations served by last mile providers using connections to middle mile BTOP projects.

Last mile projects in theory will have a defined service area that may be defined by the locations of connection points, and descriptions of distribution infrastructure, which is known to the last mile providers. For mixed middle-mile/last-mile projects some mixture of these situations is likely to obtain, with some last mile activity being known to the grant recipient, with other last mile activity being potentially unavailable. This will depend on the characteristics of the project and the relationships between the last and middle mile providers.

First, most studies of the impact of broadband availability and adoption have focused on whether broadband was available in a certain area and how economic or social measures changed after broadband came online in areas that had not previously had it. Implicit in this form of analysis is the assumption that the "last mile" is the goal of broadband policy. While this is true for some NTIA infrastructure grants, the majority of BTOP infrastructure projects and funding are addressed toward "middle mile" projects. Middle-mile projects were funded by NTIA in part because they have widely-distributed benefits. An example of this is OneCommunity Ohio, which has provided maps and other documentation of their project indicating the extent of the infrastructure improvements planned for that project. In order to provide more context for the discussion of our intermediate- and long-term impacts, we present some background information on the OneCommunity project below.

The OneCommunity Ohio infrastructure project is slated to build 900 miles of fiber, connect 2,000 miles of existing fiber, connect 20 counties and 800 anchor institution and provide users with broadband with speeds between 10 to 40 Gbps. The geographic area covered by OneCommunity is a 20-county area in NE Ohio plus Franklin County, representing ½ the State’s population (5.4 million), over 200,000 businesses and nearly 9000 community anchor institutions. Figure 3 below shows before-and-after middle mile connectivity.

Figure 3: OneCommunity Ohio infrastructure Project



Analysis of infrastructure projects of this size and geographic scope presents several research challenges. First, while NTIA Broadband Mapping data allows for the identification of broadband service parameters down to the Census block level, the determination of whether a middle mile project has contributed to the provision of service to a particular Census block or other location depends on the identification of the last mile connections from the middle mile infrastructure to that location. These connections are most often made by entities other than NTIA and the middle mile grant recipient, which means information on specific connections is not generally available. Second, given that the particular geographic area served by a middle mile project cannot be exactly identified, the development of control variables, such as the level of infrastructure investment activity by non-recipient providers, is difficult or impossible to obtain.

5.5 Proposed Methodology

In order to overcome these hurdles, we have developed a multipart statistical estimation methodology. These steps are:

1. Establish the increased level of service provided by middle mile projects receiving BTOP funds. These are the only measures in our statistical estimation methodology that require obtaining additional information from BTOP grant recipients. While there are numerous measures of the capacity of broadband infrastructure, in general we are interested in the number of additional customers that could be served at particular speed levels. This points to the use of a measure like TB/month transmitted as a measure of capacity.

2. Identify the counties that are likely to be affected by each BTOP CCI grant. The primary sources for this identification will be publicly-released grant application data, press releases, and studies published by the grant recipients. For those CCI grants selected for analysis as part of the CCI case studies, we will confirm this information as part of the case study process. The goal of this step is not to make a definitive list of the areas affected by the grant, but to set some general areas where results would be expected, acknowledging that the final areas benefitting from the infrastructure are likely to differ from the county-level results.

3. Develop a list of census blocks in each identified county, and compare broadband service over time. The goal is to develop a measure of broadband development progress in each census block that incorporates information on available broadband speeds and adoption rates. This information is available from the NTIA National Broadband mapping data and is updated twice yearly.

4. Develop a list of anchor institutions in the identified counties and compare broadband service over time. These data should be available as part of the NTIA National Broadband Map. The goal for this step is similar to #3, above. Information on available broadband speeds and adoption rates will be captured in relevant statistics. These data are expected to be updated twice each year.

5. Assemble benchmark usage statistics for bandwidth use by households and anchor institutions. We will consult with industry experts and trade organizations as well as perform background research to develop expected up and download volumes for different types of users with different types of service. The goal of this step is to develop a methodology for estimating the amount of middle mile infrastructure required to serve a particular identified county and to obtain a measure of the increase (or decrease) in required bandwidth over time.

6. Based on the results of #5, we will estimate the volume of middle mile service required to support broadband use in areas that have been targeted for improvement by specific projects. This amount of transport capacity will be stated in the same terms as the amount of capacity provided by BTOP projects (i.e., TB/month).

7. We will develop an estimate of the fraction of additional required capacity provided by BTOP grant recipients. This is a simple ratio of the result obtained in #1 to the result obtained in #6. This ratio will be below to apportion likely benefits to BTOP grant recipients.

8. Based on the results observed in #3 and #4, above, we will identify potential uses of broadband technology in the various census blocks and at the observed anchor institutions in the affected counties. For instance, lower broadband speeds might be appropriate for streaming of recorded audio material, while streaming of video content or videoconferencing would require higher speeds. Anchor institutions might use broadband at lower speeds for transmission of documents and records, while higher speed connections might facilitate videoconferencing. The end result of this step will be a table of likely uses of the additional broadband capacity provided by the BTOP recipient.

9. Perform a demographic analysis on the areas experiencing increases in availability, adoption or speed, and present a summary of the characteristics of the beneficiaries of increased broadband service. Although it will not be possible to say specifically which households or individuals benefitted from the increased availability of infrastructure, the

characteristics of the population of benefit recipients will be assumed to be the same as those in the areas where broadband access and availability increased.

10. Measures of significant social outcome variables will be obtained in the affected areas targeted by infrastructure programs and these will be compared to national averages. The main idea of this step is not to make the claim that these indicators would be immediately affected by the broadband infrastructure project, but that the scope for possible improvements is bounded by the extent of the issues observed in the first place. In other words, areas with high crime rates have a greater capacity for improvement in public safety than areas with very low crime rates. Likewise, areas with poor indicators of public health or civic participation would be expected to improve more overall than areas with better indicators of these things, when the effects of broadband technology are measured by future researchers.
11. For those projects for which we are performing a case study, additional steps will be taken to integrate the results of both methodologies. We will first present the results of our study to grant recipient personnel, including the assumptions we have made about the areas served, bandwidth usage, and other factors. We will then explore the implications of the increased bandwidth provided by the project, with special attention to areas of focus specified by each infrastructure grant.

5.5.1 Strengths and Weaknesses of this Approach

As is the case with every methodology for impact estimation, the methodology we propose has relative strengths and weaknesses. One of the strengths of the methodology is that it allows for less-than-perfect identification of the specific geographic areas that are affected by the projects receiving BTOP grants, although some idea of where these projects are having their effects is required. Second, the incorporation of NTIA Broadband Mapping data provides much more specific measurements on the changes to broadband usage in potentially unserved or underserved areas than has been developed to date. Finally, the examination of anchor institutions provides insight into key participants in the community's use of broadband.

Drawbacks to this methodology include a lack of empirically-testable hypotheses, such as the extent to which broadband technology facilitates productivity growth. The absence of a mathematical formulation of the effects of broadband limits the use of the mathematical results for forecasting, although our methodology does produce ratio estimates that could be used for the same purpose. Finally, econometric estimation strategies have well-understood error bounds on the results they produce, while the estimates produced by the methodology we propose do not have the same statistical properties. We will, however, perform sensitivity analysis on key parameters to alleviate some of this concern.

5.6 Estimating Longer-Term Impacts

The effects of BTOP infrastructure investments are likely to be felt years in the future. However, this study will be completed before these effects have had a chance to completely play out. As a result, measuring longer-term impacts of BTOP investments will require forecasting of the likely changes in broadband over an extended period of time. We believe that an examination of the results of earlier phases of the project, case study results, and a critical analysis of other research in this area will yield insights as to prospective outcomes where grants were made. The following presents a description of the steps that we will take to estimate the longer-term impacts of BTOP infrastructure projects. Our longer-term impact analysis will be based on the results we obtain from the analysis of several key questions:

1. What proportion of the capacity provided by BTOP infrastructure grant recipients has been utilized and what remaining capacity is available for allocation to additional broadband service provision?
2. What is the level of broadband usage observed in the areas targeted by BTOP infrastructure grant recipients, and what is the potential for usage to be increased those areas?
3. What are the social and economic conditions in the areas targeted by BTOP infrastructure grant recipients, and what is the potential for improvement in those conditions due to broadband.

As is the case with all forecasting exercises, the results will be determined by the selection of assumptions used to create the forecast scenarios. We will perform sensitivity analysis on the forecast assumptions to illustrate the range of results that could be expected for longer-term impacts.

5.7 Sensitivity Analysis

We will undertake sensitivity analysis of our results in order to better understand how the underlying assumptions of our models affect the conclusions we draw. Our sensitivity analysis will consider the composition of the areas affected by the BTOP grants we intend to study. In the case that some of the areas affected by grants are unclear, we will examine different methodologies for designating affected census blocks or ZIP Codes. We will then perform the analysis using these different geographic designations to determine if uncertainty about the boundaries of project grants causes changes in the estimated results.

The sensitivity analysis will be incorporated into our forecast analysis of the likely future effects of BTOP programs. These forecasts will provide a range around the expected future outcomes, based in part on the results of the sensitivity analysis. Additional factors might be included, such as expected changes to technologies or infrastructure not captured in the statistical models.

Section 6. Case Studies

6.1 Introduction

This section presents our case study methodology. We describe the purpose of case studies, our methodology for how case studies will be conducted, data we will gather to support case study site visits, and the outputs of our analysis – the case study reports.

6.2 Purpose of Case Studies

We will perform case studies of selected CCI, PCC, and SBA grants in order to supplement and, in some areas of inquiry, to support the quantitative analysis. The case studies will provide a window into the initial impacts of BTOP awards and provide ongoing snapshots of the Program's economic and social impacts, allowing for review and possible adjustments for the longer-term, in-depth longitudinal study that will be a centerpiece of the Final Report.

The case studies will identify how the grantee maximized the impact of the BTOP investment; identify successful techniques, tools, materials and strategies used to implement the project; identify any best practices; and gather evidence from grantees, anchor institutions, and various publicly available data as to the impacts of the project in the community. The case studies will provide qualitative information; and, depending on the individual evaluation efforts of selected grantees, perhaps some quantitative data related to economic and social impacts of the activities resulting from the BTOP funded grant.

The case study effort will have three components and result in two sets of interim impact reports. The first set of interim reports will be delivered in April 2012. Due to the nature of BTOP, and the CCI projects in particular, this first set of case studies will focus exclusively on 15 selected PCC and SBA projects because CCI projects will not be far enough along in their development to be able to measure impacts. In September 2013, a second set of interim impact reports will be delivered. These reports will include an update on the same 15 PCC and SBA projects analyzed in the first set of case studies and include a set of case studies on 12 selected CCI grants as well. This methodology allows for both a cross-sectional analysis to measure impacts at a point in time and information to feed the longitudinal analysis of the impacts of the BTOP PCC and SBA grants over time.

6.3 Methodology

The development of the case studies will include a number of steps including various communications with the selected grantees, a number of data collection efforts, and development of case study reports. Our approach to each of these steps is described below.

6.3.1 Grantee Notification and Communication

The point of contact of record for each grant will receive initial notification of their selection as a case study grant through their assigned Federal Program Officer. The evaluation study team will then contact each grantee for an initial introduction and description of the effort.

This will be the first of many interactions between the evaluation study team and the grantee over the course of the case study period. Additional communications will occur to establish case study visit logistics and to gather information related to the project. Specifically, the evaluation team will

rely on the grantee to provide any background material on the grant not available from NTIA. We will also rely on the grantees to provide recommendations on the specific location(s) of their various anchor institutions or service delivery locations that we should visit and to provide contact information for the individuals at those locations. Communication with those individuals will be used to plan and conduct case study visits and to collect any available data specific to those locations.

6.3.2 Data Collection

Various data will support the development of the case studies. This includes community level public use economic, demographic and broadband specific data; information specific to each grant as collected from their grant applications; quarterly and annual performance progress reports; and more detailed grant-specific information as collected through visits to anchor institutions and service delivery locations. This information will provide generally for analysis on potential changes in economic conditions, provision of healthcare and/or public safety services, educational opportunities, quality of life or standard of living, and other social goods resulting from BTOP investments. In addition, to the extent possible and where data are available, the case studies might explore important economic concepts that may otherwise be difficult to quantify, such as innovation and entrepreneurship. Though the thrust of the case studies is not to evaluate implementation of the projects against their originally stated goals (but rather to document impacts), project implementation issues such as the grantee's organizational type, business model, and staffing will be explored to the extent they appear to influence the ability of the grant to have an impact on its community and in order to contributed to the discussion of best practices and lessons learned.

6.3.2.1 Economic, Social, Demographic, and Broadband Specific Statistics

Various economic, social, and demographic statistics will be collected through public use data and grant applications in order to characterize the area impacted by the grant. Close review of the grant application and conversations with the grantee will be utilized in order to determine the impacted area or “the community” to be considered for each grant. Economic/demographic statistics collected and described (when available) will include, but not be limited to:

- Population, by age, gender and race,
- Personal income,
- Housing values,
- Educational attainment and graduation rates,
- Local economic environment characteristics including economic development efforts,
- Employment,
- Voter registration and participation,
- Volunteerism,
- Mortality rates,
- Suicide rates,
- Membership in civic associations,
- Homelessness,
- Telecommuting rates,
- Establishment of home businesses

- Communications via email, chat, webcam, etc.
- Home schooling rates, and
- Crime statistics.

The impacted area will also be characterized in terms of its baseline or existing level and type of broadband service. Broadband related statistics collected, if available, will include, but not be limited to:

- List of existing broadband providers, including advertised speeds and rates,
- Market share of existing broadband providers, and
- Examples of broadband use by local industries.

For PCC and SBA grants, these data will be collected at the time of the first round of case studies (2011) to represent the pre-BTOP situation. The same data will be collected again at the time of the second round of case studies (2013) and represent the post-BTOP situation. For CCI grants, the case study report developed towards the end of 2013 will include data from 2010 or 2011 as appropriate and available to represent the before BTOP picture, and data from the time of the case study to represent the post-BTOP picture.

Under the NTIA's State Broadband Data Development Program (SBDD), most states have formed a broadband authority. These entities have engaged to varying degrees in local adoption and impact studies. On a case by case basis, these existing studies will also be used as a data source for the case studies. To the extent possible, information from last mile providers and local businesses regarding their degree of adoption of services related to BTOP middle miles CCI projects will be collected as well. These data may come from state broadband authority studies. If not, conversations with grantees and/or the NTIA Broadband mapping data will be used to identify last mile providers or businesses with whom to speak.

In addition, there are on occasion outside influences such as changes in the state or local level political, legal, or regulatory climate that can affect the ability of BTOP grants to have an impact in a certain area. Therefore, efforts will also be made to investigate and report on state or local level broadband or other relevant public infrastructure-related conditions, laws, statutes, or other elements of the local political climate that could have an influence on the ability of the selected grant to achieve its stated objectives.

6.3.2.2 Grantee Quarterly Performance Progress Reports

Grantees are required to submit Quarterly PPRs to NTIA describing their grant funded activities. These reports provide quantitative and qualitative descriptions of project status and specific grant funded activities. The portion of the PPRs that includes detailed information on activities specific to each grant type will be useful in identifying potential project impacts specific to a particular location that can be verified and validated through the case study effort. This information will also be useful in identifying project specific areas of inquiry to pursue further with individual anchor institution contacts during the case study site visits.

Specific to SBA projects, the PPR data most relevant to the case study effort includes:

- Name, location, and description of the SBA activity(ies) undertaken in the current quarter,
- Size of target audience,
- Actual number of participants,
- New subscribers (households and businesses),

- Number of households and businesses receiving discounted broadband service as a result of BTOP,
- General description of activities planned for the upcoming quarter, and
- Description of method used to define attributed subscribership (i.e. adoption).

For PCC projects, the PPR data most relevant to the case study effort includes:

- Description of significant project accomplishments,
- New workstations installed and available to the public,
- Average users per week,
- Upgraded broadband connectivity at PCC,
- Established broadband wireless connectivity at PCC,
- Number of additional hours per week existing PCC is open to public as result of BTOP funds, and
- Name, length, number of participants and number of training hours for all training programs.

The data relevant to the case study effort from the CCI PPRs includes:

- New network miles deployed,
- New network miles leased,
- Existing network miles upgraded,
- Existing network miles leased,
- Number of miles of new fiber (aerial or underground),
- Number of new wireless links,
- Number of new towers,
- Number of interconnection points,
- Number of signed agreements with broadband wholesalers or last mile providers,
- Number of agreements currently being negotiated with broadband wholesalers or last mile providers,
- Average term of signed agreements,
- Numbers of businesses, households, anchor institutions, and last mile providers receiving new and/or improved access, and
- Name, service area and type of anchor institutions connected and description of how the anchor is using the BTOP funded infrastructure.

It is these last two pieces of information from the PPRs that will be of particular importance to the CCI case study activities because they will help to define the case study site visit specific locations and areas of inquiry.

6.3.2.3 Service Delivery Locations/Anchor Institution Visits

Each case study will include an in-person visit to targeted anchor institutions (CCI grants) or service delivery locations (PCC/SBA grants.) This visit will include a face-to-face visit with the

grantee as well, if possible, depending on their location relative to the selected anchor/other location(s). Case study visits will normally consist of a two-day trip. An interview guide and data collection checklist targeted to the particular goals, intended outputs/outcomes, types of services provided, community conditions, and anchor institution/service location types of each grant will be developed to provide the structure for each case study visit. These questions and lists will be developed in close coordination with NTIA and will consider data collected from the initial contacts with the grantees, our review of all available grant award and post-award documents and the economic, demographic, and broadband specific statistics compiled for each grant location. The guides and checklists will be broken out into sections to identify appropriate areas of inquiry specific to grantees, anchor institution/service locations, local economic development professionals (where identified by grantees or anchor site contacts), last mile providers (for CCI grants), and individual users.[9]

Generally, the case study visit interview guide and data collection checklist will be designed to gather the following types of information:

- Validation of background information on grant purpose, scope, services, and goals
- Description of anchor institutions, if applicable
- Description of grantee type, business model, and staffing issues
- Validation and clarification of reported project activity outputs and outcomes
- An assessment of the broadband adoption readiness of anchor institutions/service locations and the community
- Current/baseline broadband (and/or Internet) operations/uses at targeted anchor institutions/service locations
- Planned operational changes and uses of broadband (and/or Internet) as result of BTOP grant at targeted anchor institutions/service locations
- Observed changes resulting from BTOP funded activities to-date (if any) at targeted anchor institutions/service locations
- Observed economic and/or social outcomes at the anchor institution/service location, community, and/or individual level (if any), and
- An assessment of the sustainability of project activities beyond the term of the BTOP grant, if applicable

The collection of data on impacts at the individual level will depend largely on the degree to which the individual grantees are collecting data and/or conducting evaluation efforts related to their BTOP funded activities. We will also work with the anchor site/service location contacts to identify, where possible, opportunities to speak to individual users.

A case study visit travel and logistics plan along with the targeted, location specific interview guides and data collection checklists will be provided to NTIA for review prior to the start of the case study period. Given the diversity of projects selected for case studies, these guides will be highly customized and specific to each grant.

6.3.3 Case Study Report

Each case study will result in an individual case study report. A case study report template will be developed, although each report will differ based on details of the subject grant. The first round of PCC and SBA grant case studies will result in a set of 15 interim impact reports. As discussed

[9] Case study visits will be conducted in compliance with 15 CFR Part 27 Protection of Human Subjects.

above, these reports will provide detailed information on the baselines against which future analysis will be compared. The second round of case studies will result in another set of interim impact reports – updates of the 15 PCC and SBA case studies previously developed and 12 CCI grant case studies. At contract closing, the case study reports, along with all other quantitative and qualitative impact assessment efforts detailed throughout this document, will be combined to develop the final report assessing the economic and social impacts of the BTOP grants.

The unit of analysis for each case study will be unique and will depend on the definition of the impacted area and the granularity of the economic, demographic, and broadband specific data available. Some grants, such as the City of Chicago, include activities that are community specific. Most, however, will likely have to be defined at the county level. Most of the public use data will likely only be available at the county level, but some localities may have data available by community. Further, in terms of the discussion of findings, i.e. outcomes or impacts, the affected community may have to be defined in something other than geographic terms. For example, impacts may be discussed in terms of an industry or other topical area.

Each case study report will generally include the following sections:

- Description of grant. This will include a discussion of the grant's purpose, area of impact, and services offered,
- Characterization of the impacted area/community. This will include presentation and discussion of various economic, demographic, and Internet/broadband specific statistics of the community(ies) affected by the BTOP grant, including local economic development efforts,
- Summary of data provided by grantees through their PPRs, and
- Summary of anchor/service location visits and findings. This will include a description of anchor institutions/service locations and overall findings in terms of:
    - Broadband adoption readiness (primarily for infrastructure projects),
    - Current/baseline broadband (or Internet) operations/uses (primarily for infrastructure projects),
    - Planned operational changes and uses of Internet as result BTOP grant (primarily for infrastructure projects),
    - Observed changes resulting from BTOP funded activities to-date (if any),
    - Observed economic and/or social outcomes at the anchor institution/service location, community, and/or individual level (if any),
    - Sustainability of project activities, as determined through review of grantee business plans,
    - Best practices (if any identified), and
    - Lessons learned.

In addition, in order to make a comparison to other communities that did not receive BTOP funding, each case study report will include, to the extent possible, a review of NTIA's BTOP application database to identify if there were any other applications in a similar geography (based on the economic and demographic statistics collected as explained in section 6.3.2.1). If so, we will inquire if any of those initiatives were undertaken, in whole or in part, without BTOP funding and include a description of that effort in the case study report. As grantees complete and submit additional PPRs, the evaluation study team will validate the geographic locations of impacted communities and anchor institutions providing the evaluation study team the ability to associate grantee reported data with BTOP impact areas. By definition, we will be able to identify the communities and anchor institutions that are outside the BTOP impact areas. Consequently, we can include in the second

set of interim case study reports statistics on the economic conditions of areas that were similar at the inception of BTOP, but not directly associated with BTOP initiatives and funding. This comparison will be included in the second round of PCC/SBA case study reports.

Appendix A. BTOP Overview

The Recovery Act provided NTIA with $4.7 billion to support the deployment of broadband infrastructure, enhance and expand public computer centers, encourage sustainable adoption of broadband service, and develop and maintain a nationwide public map of broadband service capability and availability. The Recovery Act instructed NTIA to implement BTOP to promote five core purposes:

- To provide access to broadband service to consumers residing in unserved areas of the country;
- To provide improved access to broadband service to consumers residing in underserved areas of the country;
- To provide broadband education, awareness, training, access, equipment, and support to:
  - Schools, libraries, medical and healthcare providers, community colleges and other institutions of higher learning, and other community support organizations;
  - Organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband services by vulnerable populations (e.g., low-income, unemployed, aged); or
  - Job-creating strategic facilities located in state- or federally-designated economic development zones.
- To improve access to, and use of, broadband service by public safety agencies; and
- To stimulate the demand for broadband, economic growth, and job creation.

In facilitating the expansion of broadband infrastructure and adoption of broadband services, NTIA aims to advance the objectives of the Recovery Act to spur job creation and stimulate economic growth and opportunity. Additionally, NTIA funded projects with the expectation that they will provide long-term economic and social benefits, including improvements to healthcare delivery, education, innovation, and the nation's global competitive position. NTIA administers BTOP within three project categories:

- Comprehensive Community Infrastructure (CCI): Projects to deploy new or improved broadband Internet facilities (e.g., laying new fiber-optic cables, upgrading wireless towers) to connect households, businesses, and Community Anchor Institutions (CAI) such as schools, libraries, hospitals, and public safety facilities. CCI projects funded by BTOP are predominantly middle mile projects, although a small number of last-mile projects were awarded.
- Public Computer Centers (PCC): Projects to establish new public computer facilities or upgrade existing facilities that provide broadband access to the general public or to specific vulnerable populations, such as low-income individuals, the unemployed, seniors, children, minorities, and people with disabilities.
- Sustainable Broadband Adoption (SBA): Projects to provide a focus on increasing broadband Internet usage and adoption, including projects among vulnerable populations where broadband technology traditionally has been underutilized. Many projects include digital literacy training and outreach campaigns to increase the relevance of broadband in the public's everyday lives.

In essence, the purposes described in the two Notice of Funds Availability (NOFA) indicate that BTOP grants are targeted to:

- Provide new or improved broadband access to unserved or underserved areas;
- Affect positive change in the areas of education, healthcare, employment, and public safety through access to various broadband related services and equipment;
- Increase the usage of broadband related services and equipment by vulnerable populations; and/or
- Stimulate overall demand for broadband and economic growth, in particular job creation.

PCC and SBA grants serve a different purpose than CCI grants, and in some cases intended to be complementary to them. While CCI grants address issues of broadband availability, PCC and SBA grants are more focused on broadband access and adoption. Availability, access, and adoption are required for broadband use.

NTIA awarded BTOP grants in two funding rounds. In both funding rounds, NTIA received more than 2,800 applications requesting in excess of $36 billion. This BTOP portfolio of projects initially included:

- 123 infrastructure projects totaling $3.5 billion in Federal grant funds to construct broadband networks;
- 66 Public Computer Center (PCC) projects totaling $201 million in Federal grant funds to provide access to broadband, computer equipment, computer training, job training, and educational resources to the public and vulnerable populations; and
- 44 Sustainable Broadband Adoption (SBA) projects totaling nearly $251 million in Federal grant funds to support innovative projects that promote broadband adoption, especially among vulnerable population groups where broadband technology traditionally has been underutilized.[10]

[10] National Telecommunications and Information Administration. 2011. "Broadband Technology Opportunities Program Quarterly Status Report." Last modified December 22. http://www.ntia.doc.gov/files/ntia/publications/btop-quarterly-congressional-report-dec-2011.pdf.

Appendix B. Literature Review

This section describes selected articles drawn from the literature, in addition to policy responses that have resulted from them. Given the truly enormous volume of research that has been done in the area of the role of broadband on the economy and society, there is no way to present a concise summary of every paper and conclusion. Instead, we seek to provide the reader with a summary of work in this area that is most significant in relation to this study of the economic and social impacts of BTOP grants.

The literature on government-funded plans to stimulate economic activity is distinguished by both its sheer size and the number of issues that have been raised as part of the decade-long debate into what broadband strategies can be expected to achieve on both a local and an economy-wide level. Much of this research has been focused on the effects broadband has on incentives for firms and individuals to relocate to (or remain in) particular areas. Overall, the literature presents few examples of crystal clear conclusions or hard-and-fast rules that may be used to guide the development of policy.

B.1 Information Technology, Information and Communication Technology, and Broadband Impacts on the Economy

The Bureau of Economic Analysis estimates that for each $1 invested in broadband, the economy benefits nearly $3.[11] Gillett et al. find that after controlling for community-level factors known to influence broadband availability and economic activity between 1998 and 2002, communities in which mass-market broadband was available by December 1999 experienced more rapid growth in (1) employment, (2) the number of businesses overall, and (3) businesses in IT-intensive sectors. In addition, the effect of broadband availability by 1999 can be observed in higher market rates for rental housing in 2000. These impacts will be revealed after a certain amount of "time lag," as noted by Gillett et al., because broadband has to be 1) available, 2) adopted, and then 3) used in order to enhance productivity and economic activity.[12] Research by Atkinson, Castro, and Ezell tie these ideas together, stating that broadband (a necessary foundation for the adoption of information communication technology (ICT)) "encourages upstream investment in industries creating new and innovative applications and services such as telemedicine, Internet search, e-commerce, online education (distance learning), and social networking."[13]

B.1.1 Community Impacts

The benefits of broadband have been found to differ in urban versus rural communities. Kolko reports that the benefits realized by the introduction of broadband in rural communities will be greater when compared to urban communities.[14] Prior research by the Columbia Telecommunications Corporation has quantified that rural small businesses get less service when compared to metro small businesses, holding prices constant; and rural small businesses paid

[11] Ford, G.S., and T.M. Koutsky. 2005. "Broadband and Economic Development: a Municipal Case Study from Florida." *Applied Economic Studies* 1. http://www.designnine.com/library/docs/other_papers/BroadbandFactFiction.pdf.

[12] Gillett, Sharron, William Lehr, Carlos Osorio, and Martin A. Sirbu. 2006. "Measuring Broadband's Economic Impact." United States Department of Commerce, Economic Development Administration. http://web.si.umich.edu/tprc/papers/2005/475/TPRC2005 _Gillett%20Lehr%20Sirbu%20Osorio%20submitted.pdf.

[13] Atkinson, Robert D., Daniel Castro, and Stephen Ezell. 2009. "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America." *Information Technology and Innovation Foundation*, January 7. http://www.itif.org/files/roadtorecovery.pdf.

[14] Kolko, Jed. 2010. "Does Broadband Boost Local Economic Development?" *Public Policy Institute of California*. Article published January. http://www.ppic.org/content/pubs/report/R_110JKR.pdf.

higher prices than metro small businesses, holding services constant.[15] Kolko reports a positive relationship between broadband expansion and economic growth, but that relationship is stronger in areas with lower population densities.[16] This is consistent with the theory that smaller or more isolated areas may benefit more from high-speed connections, giving businesses in these areas access to larger markets. However, even for most high density areas, the relationship between broadband and growth remains positive on balance.[17] The positive relationship is especially large for utilities; information; finance and insurance; professional, scientific, and technical services; management of companies and enterprises; and administrative and business support services. The relationship in these sectors is much larger than the relationship for overall employment.[18]

Ford and Koutsky offer a real-world example of this magnified "rural" impact. In 2001, Lake County – a small county in central Florida – began offering private businesses and municipal institutions access to one of Florida's most extensive, municipally-owned broadband networks, including fiber optic connections to hospitals, doctor offices, private businesses, and 44 schools. Their econometric model showed that Lake County has experienced approximately 100 percent greater growth in economic activity relative to comparable Florida counties since making its municipal broadband network generally available to businesses and municipal institutions in the county.[19]

B.1.2 Employment Impacts

Most economic impact studies will include an analysis of job creation, and our study will be no different. Employment impacts of various kinds have been discussed in the literature, including job creation, job search, telecommuting, and job displacement.

Broadband expansion efforts create jobs both directly and indirectly. Infrastructure investments such as broadband infrastructure create direct, indirect and induced changes to employment. Direct jobs are those created specifically by spending on the project itself. Indirect jobs are those created to supply the materials and other inputs to production. Induced jobs are those created by newly employed workers spending their earnings.[20] In addition to these employment effects, broadband will also cause changes to the structure of the economy in general. All public infrastructure projects can be expected to induce some structural change, but the introduction of a general-purpose technology such as broadband increases the possibility of new forms of economic activity in a way that typical infrastructure projects do not. A Darby, Fuhr, and Pociask study calculated the sum of all of the effects of broadband, including jobs lost because of capital for labor substitution, productivity improvements, and from possible outsourcing. Even with these negative impacts, the number of jobs created was shown to be substantial.[21] Darby, Fuhr, and Pociask also estimate that the wide-spread availability of broadband can add over 1 percent to the employment growth rate in a typical community.[22] These changes are attributed to network effects.

"A network effect is the effect that one user of a good or service has on the value of that product to other users. The value of the network increases logarithmically with each new user added to the

[15] Columbia Telecommunications Corporation. 2010. "The Impact of Broadband Speed and Price on Small Business." Report for SBA under contract number SBAHQ-09-C-0050. Report released November. http://archive.sba.gov/advo/research/rs373tot.pdf.

[16] Kolko, Jed. 2010. "Does Broadband Boost Local Economic Development?" *Public Policy Institute of California*. Article published January. http://www.ppic.org/content/pubs/report/R_110JKR.pdf.

[17] *Ibid.*

[18] *Ibid.*

[19] Ford, G.S., and T.M. Koutsky. 2005. "Broadband and Economic Development: a Municipal Case Study from Florida." *Applied Economic Studies* 1. http://www.designnine.com/library/docs/other_papers/BroadbandFactFiction.pdf.

[20] Atkinson, Robert D., Daniel Castro, and Stephen Ezell. 2009. "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America." *Information Technology and Innovation Foundation*, January 7. http://www.itif.org/files/roadtorecovery.pdf.

[21] Darby, Larry F., Jospeh P. Fuhr Jr., and Stephen B. Pociask. 2010. "The Internet Ecosystem: Employment Impacts of National Broadband Policy". *The American Consumer Institute*. http://www.theamericanconsumer.org/wp-content/uploads/2010/01/aci-jobs-study-final1.pdf.

[22] *Ibid.*

network. The classic example is the telephone; the more people own telephones, the more valuable the telephone is to each owner."[23]

This network effect leads to new consumer and business behaviors, new functionalities, and new downstream industries enabled by the ICT infrastructure. This possibility arises because digital infrastructure acts as a platform that serves as the foundation for a multitude of innovative products and services."[24] Note that not all of the changes caused by network effects create jobs. It is possible that outsourcing or increases in productivity will cause decreases in employment. As a result, the sum of the effects of broadband investment on employment can be positive or negative.

Relating this to broadband in particular, the short-term job creation can be as simple as the jobs created to develop and deploy the infrastructure necessary for broadband technology. The labor intensive nature of broadband deployment ensures that the construction jobs created are significant and, despite the highly technological nature of the ultimate product, broadband is to be seen as being similarly economically meaningful as conventional infrastructure investments such as roads and bridges.[25]

Long-term jobs are created or enhanced as a result of the availability of that broadband technology. Having this leading-edge technology, buyers can help IT companies gain a competitive advantage and boost IT jobs.[26] Atkinson, Castro, and Ezell go on to explain that the long-term job growth results in enhancing America's competitiveness and expand to higher value-added U.S. jobs.[27] This is quantified by Fuhr and Pociask, who found that for every worker employed in manufacturing and constructing a broadband network, 4.1 additional downstream jobs are created elsewhere in the economy.[28]

Not only do IT infrastructure projects create more jobs than traditional infrastructure investments, in part because of the network multiplier, they also might also create more high-skilled, high-paying jobs.[29] Jobs involved in the building and expansion of broadband networks typically pay about 42 percent more than the average for manufacturing jobs.[30] Crandall et al. found that for every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent per year.[31]

The development of improved broadband infrastructure might also improve job matching. Atkinson et al. state that Internet-based job sites enable superior matching between employers and employees, making the process cheaper and faster and providing both employers and employees with more information on which to base their decisions.[32] Improved job matches are beneficial to the employee and to the employer. The lower cost associated with Internet-based applicant

[23] Atkinson, Robert D., Daniel Castro, and Stephen Ezell. 2009. "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America." *Information Technology and Innovation Foundation*, January 7. http://www.itif.org/files/roadtorecovery.pdf.

[24] *Ibid.*

[25] Katz, Raul L., Stephan Vaterlaus, Patrick Zenhäusern, and Stephan Suter. 2010. "The Impact of Broadband on Jobs and the German Economy." *Intereconomics*. http://www.teleadvs.com/images/Katz,_final.pdf

[26] Atkinson, Robert D. 2009. "The Role of Competition in a National Broadband Policy." *Journal on Telecommunications and High Technology Law* 7. http://www.itif.org/files/JTHTL.pdf.

[27] Atkinson, Robert D., Daniel Castro, and Stephen Ezell. 2009. "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America." *Information Technology and Innovation Foundation*, January 7. http://www.itif.org/files/roadtorecovery.pdf.

[28] Fuhr, Joseph J. and Stephen B. Pociask. 2007. "Broadband Services: Economic and Environmental Benefits." *American Consumer Institute*. http://www.nederlandbreedbandland.nl/uploaded/FILES/Final_Green_Benefits.pdf.

[29] Atkinson, Robert D., Daniel Castro, and Stephen Ezell. 2009. "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America." *Information Technology and Innovation Foundation*, January 7. http://www.itif.org/files/roadtorecovery.pdf.

[30] *Ibid.*

[31] Crandall, Robert, William Lehr and Robert Litan. 2007. "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data." *The Brookings Institution: Issues in Economic Policy*, no. 6 (July). http://www.brookings.edu/views/papers/crandall/200706litan.pdf.

[32] Atkinson, Robert D., Stephen Ezell, Scott M. Andes, Daniel Castro, and Richard Bennett. 2010. "The Internet Economy 25 Years After .com." *Information Technology and Innovation Foundation*. http://www.itif.org/files/2010-25-years.pdf.

searches as a result of broadband means that higher quality matches are possible (which raises labor productivity as well).[33]

A third, and more recent, employment-related impact of ICT and broadband deployment and expansion is the practice of telecommuting. Benefits of telecommuting impact both the business and the employee. As a result of telecommuting, firms will need less equipment, office space, parking spaces, office equipment, supplies, and other amenities.[34] Atkinson finds that broadband facilitates work from home. Telecommuting frees employees from, on average, an hour of commuting each day.[35] This translates into greater output (benefit to the employer) and less time and money spent commuting (benefit to the employee).[36] Lehr et al. note that these benefits are difficult to quantify, but do extend employment opportunities to candidates with disabilities.[37] This extension can reduce unemployment among disabled individuals.[38] Telecommuting allows employers to search in a larger geographic area to find employees with rare skill sets.

Broadband technology accompanied with telecommuting could also discourage some of the migration to offshore jobs and encouraging what is called "homeshoring."[39] Katz and Suter clarify that the displacement of employment ("offshoring" or "homeshoring") from one targeted area to another should not be viewed as incremental employment, but rather viewed as mutually beneficial employment, matching the right candidate/employee with the right position unencumbered by geographic boundaries.[40]

B.1.3 Business and Productivity Impacts

An analysis of the relationship between broadband availability and productivity suggests that many commercial subscribers are currently realizing productivity gains because of their broadband access.[41] LECG reports that almost half of the projected increase in U.S. productivity growth between 2001 and 2011 could be accounted for by firms adopting Internet business solutions. The increment to U.S. productivity due to broadband has been about 0.25 percentage points per year between 1999 and 2007. During this period, average annual productivity growth in the U.S. has been about 2.1 percent per year, implying that the "broadband effect" is one-eighth of all productivity growth.[42] Additional research differentiates companies' adoption rates based on size. Large enterprises are three times more likely to have intranet, extranet, and mobile access to the Internet than small enterprises.[43] Jayakar, Schejter, and Taylor go on to point out the impacts associated with small firms' lower adoption rates – "as a consequence they (small firms) miss out

[33] Atkinson, Robert D., Stephen Ezell, Scott M. Andes, Daniel Castro, and Richard Bennett. 2010. "The Internet Economy 25 Years After .com." *Information Technology and Innovation Foundation*. http://www.itif.org/files/2010-25-years.pdf.

[34] Fuhr, Joseph J. and Stephen B. Pociask. 2007. "Broadband Services: Economic and Environmental Benefits." *American Consumer Institute.* http://www.nederlandbreedbandland.nl/uploaded/FILES/Final_Green_Benefits.pdf.

[35] Atkinson, Robert D. 2009. "Policies to Increase Broadband Adoption at Home." *Information Technology and Innovation Foundation*. http://www.itif.org/files/2009-demand-side-policies.pdf.

[36] *Ibid.*

[37] Crandall, Robert W., and Charles L. Jackson. 2003. "The $500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access." In *Down to the Wire: Studies in the Diffusion and Regulation of Telecommunications Technologies*, edited by Allan L. Shampine. Haupaugge, NY: Nova Science Press.

[38] Atkinson, Robert D. and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." *Information Technology and Information Foundation*. http://www.itif.org/files/DQOL.pdf.

[39] Fuhr, Joseph J., and Stephen B. Pociask. 2007. "Broadband Services: Economic and Environmental Benefits." *American Consumer Institute*. http://www.nederlandbreedbandland.nl/uploaded/FILES/Final_Green_Benefits.pdf.

[40] Katz, Raul, and Stephan Suter. 2009. "Estimating the Economic Impact of the Broadband Stimulus Plan." Working paper, Columbia Institute for Tele-Information.

[41] Burton, M.L., and M.J. Hicks. 2005. "The Residential and Commercial Benefits of Rural Broadband: Evidence from Central Appalachia." Center for Business and Economic Research, Marshall University. Article published August 1. www.marshall.edu/cber/research/broadband/Final%20Rural%20Broadband%20July%202005.pdf.

[42] LECG Ltd. 2009. *Economic Impact of Broadband: An Empirical Stu*dy. London: LECG. http://www.connectivityscorecard.org/images/uploads/media/Report_BroadbandStudy_LECG_March6.pdf

[43] Smihly, Maria, and Hendrikus Storm. 2010. "ICT Usage in Enterprises 2009." *Data in Focus, Eurostat*. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-QA-10-001/EN/KS-QA-10-001-EN.PDF.

on ICT-enabled productivity gains, further widening the economic gap between large and small firms."[44]

Atkinson et al. state that taking a business online gives companies a potential customer base 20 to 30 times larger than those enjoyed by stores in even the largest metropolitan areas.[45] They also claim that Internet solutions available as a result of broadband help firms boost productivity and cut costs, thereby enabling them to cut prices and expand output. More specifically, Atkinson states that even larger savings accrue to firms from creating Internet-enabled supply chains. The ability to track shipments online allows firms to better time production and to anticipate bottlenecks in supplies, while up-to-the-minute information about inventories tells suppliers when fresh deliveries are needed.[46] Broadband can reduce transaction costs by making it easier to conduct business and commerce online.[47]

B.2 Broadband Access and Adoption

Our study will examine both broadband availability and broadband adoption when considering how BTOP grants influence broadband use. While these factors have been conflated in many studies due to data limitations, the causes of each are different. The following definitions will be used in the study:

- Availability: According to the National Broadband Map (NBM), broadband service might be available to an area, but only if construction or other work is completed first. The NBM is not intended to include broadband service that is not available to a customer within a typical service interval (7 to 10 business days) and/or without an extraordinary commitment of resources.
- Access: Dependent on availability, access determines if the household / business have the tools/knowledge required to take advantage of the available technology.
- Adoption: The integration of these technologies into processes / daily life. "How do you behave differently now that you have broadband" / "How do you do business differently now that you have broadband"?

Broadband availability is more strongly driven by engineering limitations inherent in broadband technology and economic limitations on the types of projects that are profitable to undertake. Adoption is determined, in part, by the characteristics of the population that could be served and the area in which service is provided.

Evaluating non-Internet users (which as of 2010 was approximately 28.9 percent of adults), 3.1 percent cite lack of availability as their reason for not adopting while 25.3 percent state that it is too expensive.[48] Citing "not available" as reason for not subscribing to home broadband services is a much more prevalent in rural America than in urban areas. In fact, "not available" accounts for 9.4 percent of the main reasons for non-use in rural areas but accounts for only about a 1 percent factor in urban areas.[49] Smaller market sizes and low population densities are less attractive to service providers. Additionally, several industries (banking, finance, insurance, real estate, and

[44] Jayakar, Krishna, Amit Schejter, and Richard Taylor. 2010. "Small Businesses and Broadband: Key Drivers for Economic Recovery." Working paper, Institute for Information Policy at Pennsylvania State University. http://comm.psu.edu/about/centers/institute-for-information-policy/smallbusiness.pdf.

[45] Atkinson, Robert D., Stephen Ezell, Scott M. Andes, Daniel Castro, and Richard Bennett. 2010. "The Internet Economy 25 Years After .com." *Information Technology and Innovation Foundation*. http://www.itif.org/files/2010-25-years.pdf.

[46] *Ibid.*

[47] Atkinson, Robert D. 2007. "The Case for a National Broadband Policy." *Information Technology and Innovation Foundation*. www.itif.org/files/CaseForNationalBroadbandPolicy.pdf

[48] National Telecommunications and Information Administration. 2011. "DIGITAL NATION: Expanding Internet Usage." United Sates Department of Commerce. Article published February. http://www.ntia.doc.gov/files/ntia/publications/ntia_internet_use_report_february_2011.pdf

[49] *Ibid*.

business services) are more intensive users of advanced IT and digital communication technology. Variation in industry concentration causes the level of information infrastructure to be "unevenly distributed across the country, agglomerating in densely populated urban areas and in regions with large populations of certain types of users."[50]

B.2.1 Factors Affecting Broadband Availability

Service providers ultimately determine the supply of services to underserved and unserved regions. Chaudhuri and Flamm suggest that broadband services may not be available in certain geographical areas "not because the residents are not interested, but because service providers find the economics of small and sparsely populated markets unattractive."[51] Greenstein notes the enhanced profitability of operating in dense regions relative to those sparsely populated due to construction and operating costs.[52] NTIA further emphasizes the economic reason for slow deployment to rural areas by stating, "the cost to serve a customer increases the greater the distance among customers."

Broadband service over cable and DSL is also limited by technical problems incurred with distance and service to a smaller number of customers."[53]

From an engineering standpoint, there exists several barriers to broadband deployment and adoption. The key factors in the economics of broadband deployment are the radius of service from a single terminal note and the population density of the area that might be served. For example, DSL technology can only extend at most 18,000 feet from the central office switch.[54] This shrinks to 12,000 feet for high-quality, low-interruption service. The population density within the served radius limits the number of broadband users, with denser areas being more profitable, at least until the capacity of the central office switch is used up. Likewise, cable systems are more profitable in high-density areas for the same reasons. The cost of deployment for a fixed number of subscribers increases dramatically for providers in sparsely populated areas. This will deter the development of information infrastructure in those areas.

A second engineering barrier is that, with the exception of satellite and some fiber-optic networks, the provision of broadband services is essentially an overlay on top of existing telecommunications networks. These networks evolved to provide voice service, not broadband access. The extent to which the existing telecommunications network is capable of providing broadband service at all depends on the extent to which it has any remaining capacity after providing voice service to existing customers. In rural areas, provision of advanced services is correlated with the population density per route mile. As described by the NTIA and the USDA's Rural Utilities Service (RUS), "low density equates to long loops. When loops are long, they are frequently loaded, which

[50] Greenstein, Shane, and Mercedes Lizardo. 1999. "Determinants of the Regional Distribution of Information Technology Infrastructure in U.S." In *The Electronic Village: Public Policy Issues of the Information Economy*, edited by Dale Orr and Tom Wilson. Toronto: C.D. Howe Institute. http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/chapters/Determinants%20of%20the%20Regional%20Distribution%20of%20Information%20Technology%20Infrastructure%20in%20U.S..pdf.

[51] Chaudhuri, Anindya, and Kenneth Flamm. 2005. "An Analysis of the Determinants of Broadband Access." Presented at the Telecommunications Policy Research Conference, Washington, DC, September 24. http://web.si.umich.edu/tprc/papers/2005/485/Broadband.pdf.

[52] Greenstein, Shane. 2005. "The Economic Geography of Internet Infrastructure in the United States." In *The Handbook of Telecommunications Economics Volume II,* edited by Martin Cave, Sumit Majumdar, and Ingo Vogelstang, 289-364. New York: Elsevier. http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/articles/geography.pdf.

[53] National Telecommunications and Information Administration and United States Department of Agriculture's Rural Utilities Service. 2000. "Advanced Telecommunications in Rural America, The Challenge of Bringing Broadband Service to All Americans." Accessed November 15, 2010. http://www.ntia.doc.gov/reports/ruralbb42600.pdf.

[54] Greenstein, Shane. 2005. "The Economic Geography of Internet Infrastructure in the United States." In *The Handbook of Telecommunications Economics Volume II,* edited by Martin Cave, Sumit Majumdar, and Ingo Vogelstang, 289-364. New York: Elsevier. http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/articles/geography.pdf.

prevents DSL operation."[55] The result of this can be slow, unreliable, or unavailable broadband service in rural areas with minimally-built telecommunications networks. Low population density can also result in a limited number of providers and limited competition among them, resulting in higher costs for broadband versus more densely populated areas. Some sparsely populated areas of the country have yet to obtain access to broadband services at all.[56]

Americans in rural areas tend to have lower broadband adoption rates than their demographic counterparts in urban areas. This applies across race (African-Americans and Hispanics in rural areas exhibited much lower levels of broadband use than their urban counterparts), and employment levels (employed and unemployed persons in rural America had significantly lower broadband use than those living in urban areas). Although overall adoption rates are lower for rural areas, these rates are increasing. NTIA reports that the gap decreased from 11.8 percentage points in 2009 to 10.1 percentage points in 2010. Three years earlier, in 2007, the gap was 15.0 percentage points (53.8 percent versus 38.8 percent).[57]

Comparing rural areas across the country, the NTIA reports, "the likelihood of offering advanced services in rural service areas is highest in the Southeast and Northeast, lower in the Midwest, and lowest in the Southwest."[58] Further emphasized in another recent report, they point out that Internet usage is lowest in the South and Midwest.[59] This discrepancy indicates there are additional factors influencing broadband availability and adoption in underserved and unserved regions, aside from only the urban- rural distinction.

B.2.2 Factors Affecting Adoption

Certain social and demographic factors aid in defining unserved and underserved regions. Noted in many studies, and specifically in reports published by the NTIA, is the correlation between race, age, and levels of both income and education, and broadband access. These factors establish what is widely recognized as the "digital divide."[60] These factors play a key role in the phenomenon known as the "digital divide."[61]

The term "digital divide" initially signified the gap in ownership of computers between demographic groups.[62] This definition was later extended to include the gap between people with effective access to digital and information technology, including broadband, and those with very limited or no access. This included the imbalance both in physical access to technology and the resources and skills needed to effectively participate as a digital citizen. In 1995 the NTIA published, "Falling through the Net: Toward Digital Inclusion".[63] This report outlined the growing disparity in Internet

[55] National Telecommunications and Information Administration and United States Department of Agriculture's Rural Utilities Service. 2000. "Advanced Telecommunications in Rural America, The Challenge of Bringing Broadband Service to All Americans." Accessed November 15, 2010. http://www.ntia.doc.gov/reports/ruralbb42600.pdf

[56] National Telecommunications and Information Administration. 2010. "Digital Nation: 21st Century America's Progress Towards Universal Broadband Internet Access." United States Department of Commerce. http://www.ntia.doc.gov/reports/2010/NTIA_internet_use_report_Feb2010.pdf.

[57] National Telecommunications and Information Administration. 2011. "Digital Nation: Expanding Internet Usage." United States Department of Commerce. Article published February. http://www.ntia.doc.gov/files/ntia/publications/ntia_internet_use_report_february_2011.pdf

[58] National Telecommunications and Information Administration and United States Department of Agriculture's Rural Utilities Service. 2000. "Advanced Telecommunications in Rural America, The Challenge of Bringing Broadband Service to All Americans." Accessed November 15, 2010. http://www.ntia.doc.gov/reports/ruralbb42600.pdf

[59] National Telecommunications and Information Administration. 2010. "Digital Nation: 21st Century America's Progress Towards Universal Broadband Internet Access." United States Department of Commerce. http://www.ntia.doc.gov/reports/2010/NTIA_internet_use_report_Feb2010.pdf.

[60] Chaudhuri, Anindya, and Kenneth Flamm. 2005. "An Analysis of the Determinants of Broadband Access." Presented at the Telecommunications Policy Research Conference, Washington, DC, September 24. http://web.si.umich.edu/tprc/papers/2005/485/Broadband.pdf.

[61] *Ibid.*

[62] Compaine, Benjamin M, ed. 2001. *The Digital Divide: Facing a Crisis or Creating a Myth?* Massachusetts: MIT Press.

[63] National Telecommunications and Information Administration. 1995. "Falling Through the Net: A Survey of the 'Have Nots' in Rural and Urban America." Accessed January 27, 2012. http://www.ntia.doc.gov/ntiahome/fallingthru.html.

access, broadband in particular, between different demographically defined groups and not just on the availability of the necessary hardware, and more on the disparity of access.

Today the term "digital divide" is also associated with differences by gender, income, race, and location. Results from the FCC Broadband Adoption & Use in America survey indicate that the main dividing factors for broadband adoption are education, income, age, and people with disabilities.[64] Servon argues that the digital divide is a symptom of a larger and more complex problem – that of persistent poverty and inequality.[65] Mehra identifies socioeconomic status, income, educational level, and race among other factors associated with technological attainment, or the potential of the Internet to improve everyday life for those on the margins of society and to achieve greater social equity and empowerment.[66] To the extent that access to broadband technology could help with economic advancement, for instance through improved educational or job search opportunities, the digital divide could represent a self-perpetuating form of social and economic inequality.

Characteristics of broadband adopters give some indications of who is more likely to be in the population of broadband adopters, and who is not. For example, there is a substantial discrepancy in Internet usage comparing those over 25 years old without high school diplomas (28 percent) to college graduates (84 percent).[67] This suggests that for areas in which low levels of education are characteristic, broadband adoption rates and availability may be lower. It is also possible that those with higher levels of education are more aware of, or more able to afford the benefits of broadband, and therefore settle in areas that have, or will soon have, broadband access. Doms notes, "metropolitan areas with highly educated workforces are those that are likely to become more computer intensive, and these are also areas that enjoy faster real wage growth."[68] Such areas appear more attractive to service providers. Higher wages suggest greater demand, in addition to broadband adoption being correlated with higher levels of education. Greenstein points out, "the wealth and income of the area's residential population is key to understanding demand."[69]

Similar reasoning can be applied to income differentials across regions of the country. The highest broadband use at home was by those with household incomes greater than $150,000 annually (89 percent) and the lowest use was by those persons living in households with $15,000 annual family income or less (28 percent).[70] An area's per capita income not only influences the population's broadband adoption (based on affordability), but also determines suppliers' entry decisions. As Greenstein and Lizardo note, "real per capita income and the density of large-scale computer users in the region have become important explainers of the distribution of infrastructure."[71]

[64] Horrigan, John B. 2010. "Broadband Adoption and Use in America." OBI Working Paper Series No. 1. Federal Communications Commission. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296442A1.pdf.

[65] Servon, Lisa. 2002. *Bridging the Digital Divide: Technology, Community, and Public Policy.* Massachusetts: Blackwell Publishers Ltd.

[66] Mehra, Bharat, Cecelia Merkel, and Ann P. Bishop. 2004. "The Internet for Empowerment of Minority and Marginalized Users", *New Media and Society,* 781–802. doi:10.1177/146144804047513.

[67] National Telecommunications and Information Administration. 2010. "Digital Nation: 21st Century America's Progress Towards Universal Broadband Internet Access." United States Department of Commerce. http://www.ntia.doc.gov/reports/2010/NTIA_internet_use_report_Feb2010.pdf.

[68] Doms, Mark. 2005. "The Diffusion of Personal Computers across the U.S." *The Federal Reserve Bank of San Francisco Economic Letter* 2005-37. http://www.frbsf.org/publications/economics/letter/2005/el2005-37.pdf.

[69] Greenstein, Shane. 2005. "The Economic Geography of Internet Infrastructure in the United States." In *The Handbook of Telecommunications Economics Volume II,* edited by Martin Cave, Sumit Majumdar, and Ingo Vogelstang, 289-364. New York: Elsevier. http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/articles/geography.pdf.

[70] National Telecommunications and Information Administration. 2010. "Digital Nation: 21st Century America's Progress Towards Universal Broadband Internet Access." Washington DC: US Department of Commerce. Last modified February. http://www.ntia.doc.gov/reports/2010/NTIA_internet_use_report_Feb2010.pdf.

[71] Greenstein, Shane, and Mercedes Lizardo. 1999. "Determinants of the Regional Distribution of Information Technology Infrastructure in U.S." In *The Electronic Village: Public Policy Issues of the Information Economy*, edited by Dale Orr and Tom Wilson. Toronto: C.D. Howe Institute. http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/chapters/Determinants%20of%20the%20Regional%20Distribution%20of%20Information%20Technology%20Infrastructure%20in%20U.S..pdf.

Age is also negatively correlated with broadband adoption. However, broadband usage among adults ages 65 or older grew from 19 percent in May, 2008 to 30 percent in April, 2009.[72] The same discrepancies exist, albeit less severe, when comparing the portion of the population using dial-up to broadband users. On average, dial-up users are "older, have lower incomes, have lower levels of educational attainment, are more likely to be African American, and more likely to live in rural areas."[73] The supply of broadband service and the willingness of the population in the service area to pay for broadband determine the price at which the service is provided. This cost to consumers can be another reason cited for non-adoption by underserved populations. Broadband service is notably more expensive than dial-up, thus cost can be assumed to be highly influential on low-income populations (which comprise a substantial portion of underserved regions). Chaudhuri and Flamm note that a report from the Office of Technology Policy of the Department of Commerce identifies cost as "the most obvious factor limiting broadband demand."[74] In his study of broadband adoption policies, Robert Atkinson recognizes the price elasticity of demand in broadband adoption, and suggests, "efforts to reduce costs can play a role in spurring demand, particularly among lower income households."[75]

[72] Horrigan, John. 2009. "Home Broadband Adoption 2009: Broadband Adoption Increases, But Monthly Prices Do Too." *Pew Research Center*. http://www.pewinternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf.

[73] Horrigan, John. 2009. "Home Broadband Adoption 2009: Broadband Adoption Increases, But Monthly Prices Do Too." *Pew Research Center*. http://www.pewinternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf.

[74] Chaudhuri, Anindya, and Kenneth Flamm. 2005. "An Analysis of the Determinants of Broadband Access." Presented at the Telecommunications Policy Research Conference, Washington, DC, September 24. http://web.si.umich.edu/tprc/papers/2005/485/Broadband.pdf.

[75] Atkinson, Robert D. 2009. "Policies to Increase Broadband Adoption at Home." *Information Technology and Innovation Foundation*. http://www.itif.org/files/2009-demand-side-policies.pdf.

Appendix C. Social Impacts

C.1 Introduction

This section presents background information on data sources that will be used in our study for the purpose of benchmarking projects in the following key impact areas: education, healthcare, public safety, and quality of life. In part due to the construction of the BTOP programs, the impacts of BTOP grants in these areas will affect numerous and diverse issues and types of institutions. For instance, educational impacts could be observed at K-12 institutions, community colleges, 4-year institutions, universities, or other education providers. Likewise, healthcare impacts might be observed at primary care physicians' offices, hospitals, or in areas served by nurse practitioners. Finally, public safety impacts might be observed in emergency response entities, civil defense groups, or police forces. As a result of the multitude of potential impacts and impact areas of a general purpose technology like broadband, it is not feasible to use a standardized instrument to collect data on these topics. Further, there is a quite limited set of public use data available covering indicators of social impacts. We have therefore included these areas in our case study methodology in order to develop in depth data on the particular impacts on education, healthcare, and public safety caused by BTOP grants. To the extent possible, however, we will conduct statistical analyses on the public use data sets identified as sources for the identified social impact criteria discussed in each of the sub-sections below in an attempt to detect correlation and/or causality between BTOP grant funding and changes in these data.

C.2 Data Availability

Various social measures will be collected through public use data and grant applications in order to characterize the area impacted by the grant. Close review of the grant application and conversations with the grantee will be utilized in order to determine the impacted area or "the community" to be considered for each grant.

We assume that data sources outlined below will be available for key variables on an ongoing basis throughout the study, and that the quality of these data is sufficient for use in the study. Our data is assembled from subject-specific sources which cover: Education, Healthcare, Public Safety and Quality of Life / Standard of Living. In the event of discontinuance of or large changes in a data source, data collection may have to be reassessed in order to achieve the study goals. Table 5 below illustrates the types of variables we propose to obtain and data sources from which we will be able to obtain them. The same data may be available from multiple sources; in this case, we list the most reliable or extensive source we have found. Descriptions of these data sets are provided in the following subsections.

Table 5. Potential Data Sources and Variables

Category	Variable(s)	Source	Level of Granularity
Education	Drop-out / Graduation Rates	Local Education Agency Universe Survey Dropout Data	State
	Student Factors, Instructional Content and Practice, Teacher Factors, School Factors, Community Factors, Factors Beyond School, and Government Factors	The National Assessment of Educational Progress (NAEP)	State
	Instituational Characteristics, Institutional Prices, Enrollment, Student Financial Aid, Degrees and Certificates Conferred (Completions), Student Persistence and Success, and Institutional Resources	Integrated Postsecondary Education Data System (IPEDS)	College Level
Healthcare	Variables covering: E-Care, Electronic Health Records, Telehealth, and Mobile Health	American Hospital Associations (AHA) annual survey (electronic health records data)	Hospital Level
Public Safety	Variables covering: Crime, Justice and Socio-demographics	Crime & Justice Electronic Data (Bureau of Justice Statistics)	State Level
	- Number of: computers in the field, vehicle mounted computers and other computers - Digital: fingerprints, mugshots and suspect composites used	Law Enforcement Management and Administrative Statistics (LEMA)	State / Local agency Level
	- The nature and types of specific offenses in the incident, - Characteristics of the victim(s) and offender(s), - Types and value of property stolen and recovered, and - Characteristics of persons arrested in connection with a crime incident.	National Incident-Based Reporting System (NIBRS)	City Level
Quality of Life / Standard of Living	- Use the Internet at any location? - Connect to the Internet from home? - Do you currently access the Internet at home using - What is the main reason that you do not have high-speed Internet access at home?	Schooling and Computer / Internet Usage Supplement - Current Population Survey (CPS) - Census	County Level
	- Were you registered, - Did you vote, - Main reason not registered, - Main reason did not vote	Voter registration and participation supplement - Current Population Survey (CPS) - Census	County Level
	- Contacted a public official, - Bought or boycotted based on political views, - Type of group joined, - How often did you communicate via email or internet	Membership in civic associations supplement - Current Population Survey (CPS) - Census	County Level
	- Volunteer activities for an organizations, including time spent, types of organizations, and types of volunteer activities, and location of volunteer activities - Volunteer activities for children's school or youth organizations, including time spent and types of volunteer activities and location of volunteer activities - Charitable donations	Volunteer Workers Supplement - Current Population Survey (CPS) - Census	County Level
	- Type of telecommuting, e.g. employer-sponsored telework vs. home business telework - Frequency per week (days and hours) of telework - Computer use while working from home	Telecommuting Supplement - Current Population Survey (CPS) - Census	County Level
	Variables covering: working from home	American Community Survey (ACS) - Census	County Level

C.3 Measuring Impacts on Education

Broadband technologies have been discussed as a key tool in the work that needs to be done to maintain and improve educational outcomes in the United States. Home broadband users are more likely than non-users to plan further education.[76] The ongoing integration of IT into the activities of workers in most fields is no longer a subject for debate or consideration, but a reality that is forcing

[76] LaRose, Robert, Jennifer L. Gregg, Sharon Stover, Joseph Straubhaar, and Nobuya Inagaki. 2008. "Closing the Rural Broadband Gap." Final Technical Report, Michigan State University. Report published November 30. https://www.msu.edu/~larose/ruralbb/.

both employers and educators to determine what steps are necessary to ensure a well trained and well educated population. There are two major challenges facing our educational system that must be addressed:

- Not everyone who starts in the educational system today successfully exits. An incomplete education can be a lifelong stumbling block. By providing alternatives to existing forms of education, broadband-based technologies could play a role in reducing dropping out.
- The demography of the United States is shifting so that substantially all of the growth in population is projected to come from minority groups, primarily from Hispanics. The extent to which these populations are unserved or underserved with respect to broadband could have an effect on the availability of educational opportunities and potentially on educational attainment for these groups.

Prior Internet use is positively correlated to learning and adapting new methods of computer and Internet methods.[77] Also, the use of "distance learning" in the higher education space is more cost-effective and breaks down the physical barriers apparent for some students.[78] The potential benefits of such development are encouraging for the future of our education system. In a study on technology and student achievement, Protheroe reports that: "when properly implemented, computer technology had a significant effect on student achievement, as measured by test scores across subject areas and with students at all levels."[79] This positive impact transcends many demographic and socio-economic groups. For example, "a study by the American Psychological Association found that low-income children who used the Internet on a regular basis performed better on standardized tests of reading achievement and had higher grade point averages than did children who used it less."[80] Additionally, "a study of the Computers for Youth model, which provides low-income families with discounted laptops and Internet connections, also found a positive correlation between increased computer and Internet use and improved test scores."[81]

Internet and ICT applications are prevalent in elementary and secondary schools across the country. Cleary noted that by 2003, 95 percent of all public schools with Internet access used broadband.[82] Survey findings indicate that online learning has been growing in K–12 schools and that this growth will continue for the foreseeable future.[83] Research shows that home use of computers and broadband technologies for learning can be a significant factor in boosting math and reading achievement.[84] Use of computers and broadband at home for educational purposes has also been shown to motivate students and to increase the relevance of content during school hours, ultimately improving student achievement.[85,86,87,88]

[77] Eastin, Matthew S., and Robert LaRose. 2000. "Internet Self-Efficacy and the Psychology of the Digital Divide." *Journal of Computer-Mediated Communication* 6, no. 1. http://jcmc.indiana.edu/vol6/issue1/eastin.html#abstract.

[78] Hulbert, Linda Ann, and Regina C. McBride. 2004. "Utilizing Videoconferencing in Library Education: A Team Teaching Approach." Working paper, Journal of Education for Library and Information Services, Association for Library and Information Science Education.

[79] Protheroe, Nancy. 2005. "Technology and Student Achievement." *Principal*, November-December. http://www.naesp.org/resources/2/Principal/2005/N-Dp46.pdf.

[80] Davidson, Charles, and Michael J. Santorelli. 2010. "The Impact of Broadband on Education." Working paper, Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[81] *Ibid.*

[82] Cleary, Paul. 2009. "The Impact of Broadband on Education in the USA," In *Encyclopedia of Multimedia Technology and Networking Second Edition*, edited by Margherita Pagani. IGI Global. http://www.igi-global.com/Bookstore/Chapter.aspx?TitleId=17461.

[83] Picciano, Anthony G., and Jeff Seaman. 2007. "K–12 Online Learning: A Survey of U.S. School District Administrators." *Sloan Consortium*. http://sloanconsortium.org/sites/default/files/K-12_Online_Learning_1.pdf.

[84] Texas Center for Education Research. 2009. "Evaluation of the Texas Technology Immersion Pilot: Final Outcomes for a Four–Year Study (2004–05 to 2007–08)." http://www.etxtip.info/y4_etxtip_final.pdf.

[85] Valentine, Gill, Jackie Marsh, Charles Pattie, and BMRB. 2005. "Children and Young People's Home Use of ICT for Educational. Purposes: The Impact on Attainment at Key Stages." http://www.dcsf.gov.uk/research/data/uploadfiles/RR672.pdf.

C.3.1 Online Learning

In 2007, the Sloan Consortium issued a report on the extent and nature of online learning in K-12 schools. Entitled, K-12 Online Learning: A Survey of U.S. School District Administrators, it was based on a national survey of school district administrators during the 2007-2008 academic year.[89] It was one of the first studies to collect data on and compare fully online and blended learning (part online and part traditional face-to-face instruction) in K-12 schools. Of particular importance, the study found that three-quarters of the responding public school districts are offering online or blended courses:

- 75 percent had one or more students enrolled in a fully online or blended course.
- 70 percent had one or more students enrolled in a fully online course.
- 41 percent had one or more students enrolled in a blended course.

These percentages represent an increase of approximately 10 percent in school districts offering online or blended courses since 2005-2006. Sixty-six percent of school districts with students enrolled in online or blended courses anticipate their online enrollments will grow. The overall number of K-12 students engaged in online courses in 2007-2008 is estimated at 1,030,000. This represents a 47 percent increase since 2005-2006.

Infrastructure (CCI) grants have the potential to have by far the largest educational impact. Based on data gathered by NTIA shortly after the award phase, over 8,000 educational anchor institutions will be affected.

Online learning has also been implemented at community anchor institutions, but its applicability appears to be anchor type specific. For example, interviews with library patrons as part of one study revealed in that instance library "public access is not suitable for online courses owing to limited hours of operation, short duration appointments for library computers, and overcrowding. Improved broadband access for educational purposes is thus in need of further attention."[90]

C.3.2 K-12 Institutions

K-12 institutions are by far the majority of institutions affected by BTOP grants. NTIA has identified 6,882 K-12 anchor institutions potentially affected by CCI grants, exclusive of the effects of PCC and SBA grants.

We will be able to obtain a list of the K-12 anchor institutions affected by the CCI grants based on Quarterly and Annual PPRs by the grantees and information provided to NTIA. We will use data from the multiple sources (described below) to compile a list of anchor institutions that are receiving BTOP funding. Access will be measured by matching this list to the list of anchor institutions provided in the NTIA broadband mapping data.

[86] Ito, Mizuko, Heather Horst, Matteo Brittanit, Danah Boyd, Becky Herr-Stephenson, Patricia G. Lange, C.J. Pascoe, and Laura Robinson. 2008. "Living and Learning with New Media Summary of Findings from the Digital Youth Project." Article published November. http://digitalyouth.ischool.berkeley.edu/files/report/digitalyouth-WhitePaper.pdf.

[87] Passey, Don, Colin Rogers, Joan Machell, and Gilly McHugh. 2004. "The Motivational Effect of ICT on Pupils." http://www.dcsf.gov.uk/research/data/uploadfiles/RR523new.pdf.

[88] Becta, Minister. 2008. "Minister's Taskforce on Home Access to Tech." *Extending Opportunity* 4. http://partners.becta.org.uk/upload-dir/downloads/page_documents/partners/home_access_report.pdf.

[89] Picciano, Anthony, and Jeff Seaman. 2009. "K–12 Online Learning: A 2008 Follow-up of the Survey of U.S. School District Administrators." *Sloan Consortium*. http://sloanconsortium.org/sites/default/files/k-12_online_learning_2008.pdf

[90] LaRose, Robert, Jennifer L. Gregg, Sharon Stover, Joseph Straubhaar, and Nobuya Inagaki. 2008. "Closing the Rural Broadband Gap." Final Technical Report, Michigan State University. Report published November 30. https://www.msu.edu/~larose/ruralbb/.

Limited information is available on educational outcomes on a school-by-school basis. The National Assessment of Educational Progress (NAEP) is the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas. Assessments are conducted periodically in mathematics, reading, science, writing, the arts, civics, economics, geography, and U.S. history. NAEP assessments are administered uniformly using the same sets of test booklets across the nation. NAEP results serve as a common metric for all states and selected urban districts. The assessment stays essentially the same from year to year, with only carefully documented changes. This permits NAEP to provide a clear picture of student academic progress over time.

NAEP, also known as The Nation's Report Card, is the only nationally representative and continuing assessment of what America's students know and can do in various subject areas. Since 1969, assessments have been conducted periodically in reading, mathematics, science, writing, U.S. history, civics, geography, and the arts. The NAEP budget supports the following program components:

- National NAEP—National NAEP reports information for the nation and specific geographic regions of the country, includes students drawn from both public and nonpublic schools, and reports results for student achievement in grades 4, 8, and 12;
- State NAEP—These assessments provide reliable state-level student achievement data in reading, mathematics, science, and writing;
- NAEP Trial Urban District Assessment—Federal appropriations authorized for the No Child Left Behind Act supported a multiyear study of the feasibility of a Trial Urban District Assessment of Educational Progress, with the first assessment occurring in reading and writing in 2002 for five urban districts, and 2003 reading and mathematics assessment results available for 10 such districts; and
- Long-Term Trend (LTT)—NAEP LTT assessments, designed to give information on the changes in the basic achievement of America's youths, are administered nationally and report student performance at ages 9, 13, and 17 in reading and mathematics.

Based on the review of the literature and the availability of data from the NAEP data set, the following categories contain measures that could be applied at the anchor institution level to measure the education-related impacts of BTOP grants:

- Major Reporting Groups (includes subcategories Student Factors, School Factors, and Community Factors)
    - Generally seen as the most important and popular data in NAEP. Consisting of more than a dozen variables, their availability depends on the assessment and criteria selected. (For more information, see the glossary on their Web site or search their Web site for "reporting groups.")
- Student Factors (includes subcategories Demographics, Affective disposition, Academic record and school experience)
    - Data about students, their parents, students' level of interest and activity in school, student opinions about the subject being assessed, absenteeism, academic record, and school experience.
- Instructional Content and Practice (includes subcategories Curriculum, Course offerings, Classroom management, Grouping, Modes of instruction/classroom activities)
    - Course offerings, emphasis and time spent on topic matter, role of parents and guests in teaching, students' ability levels, modes of instruction, classroom activity, and computer use (not available in LTT).
- Teacher Factors

- Teacher race, teacher education and background, attitudes, expectations, availability of support for teachers, and teacher satisfaction. Teacher variables are not a part of LTT, and are not generally part of grade 12 assessments.

- School Factors
  - Demographics, percentage of students taking particular classes or coursework, average class size and duration, school type, assignment of coursework by ability, governance, resources (computers, field trips, tech support, summer programs), test requirements for students, school climate, parental involvement, teacher morale, student attitudes, enrollment, safety, absenteeism, cheating, and extracurricular activities (not available in LTT).
- Community Factors
  - Region of the country or school location.
- Factors Beyond School
  - Home environment, media at home, students' use of time outside school, homework, parents and homework, and more.
- Government Factors
  - State and district requirements for students (not in LTT).

We will use measures from NAEP, where comparable, to illustrate the differences or similarities between results obtained at K-12 institutions receiving BTOP funds and their counterparts elsewhere. Statistical analyses will be applied to determine if causality or correlation can be detected between BTOP grant funding and student achievement scores as reported in NAEP.

Another potential source of data that could be used in our assessment of the impact of broadband on education is Local Education Agency Universe Survey Dropout and Completion annual data. [91] These data are available at the county level for the 2002-2003 and 2005-2006 school years, while more recent years are available at the state level.

We will match these dropout data to Quarterly / Annual PPRs collected by NTIA from grantees. This could provide a measure of dropout rates in areas impacted by BTOP, and those rates could potentially be compared historically or against areas not impacted by BTOP grant funding, although, the evaluation study team does not anticipate being able to observe any direct impacts from BTOP grant activity at the state level.

We will further examine these dropout data sources, and, where possible, use these to compare anchor institutions based on broadband availability and adoption. Statistical analysis will be applied to determine causality or correlation between these statistics and BTOP funding.

C.3.3 Community College & Four Year Institutions

As in the case of K-12 institutions, community colleges and four-year institutions will receive broadband service as a result of BTOP grants, although these institutions are not as numerous as K-12 institutions.

The Integrated Postsecondary Education Data System (IPEDS) provides a detailed look at postsecondary institutions in the United States. IPEDS data reports are available online from the U.S. Department of Education, Institute of Education Sciences. We will identify the community colleges affected by BTOP grants and assemble their IPEDS data on an ongoing basis. We will

[91] National Center for Education Statistics. *Local Education Agency Universe Survey Dropout and Completion Annual Data,* 1997 – 2008. Accessed January 27, 2012. http://nces.ed.gov/ccd/drpagency.asp.

then look for differences in IPEDS results between those institutions receiving BTOP funds and those receiving no such funding.

Based on the review of the literature and the availability of data from the IPEDS data set, the following categories contain measures that could be applied at the anchor institution level to measure the education-related impacts of BTOP grants:

- **Institutional Characteristics:** These include basic institutional contact information, tuition and fees, room and board charges, control or affiliation, type of calendar system, levels of awards offered, types of programs, and admissions requirements.
- **Institutional Prices:** This includes tuition and fee data as well as information on the estimated student budgets for students based on living situations (on-campus or off-campus).
- **Enrollment:** This includes Fall Enrollment, Residence of First-Time Students, Age Data, Head Count, Instructional Activity, and Total entering class.
- **Student Financial Aid:** This includes the number of full-time, first-time degree/certificate-seeking undergraduate students who receive different types of student financial aid, including grants and loans, from different sources at each institution. IPEDS also collects data to show the average dollar amount of aid received by these students.
- **Degrees and Certificates Conferred (Completions):** This section includes data on the number of students who complete a postsecondary education program by type of program and level of award (certificate or degree).
- **Student Persistence and Success:** This includes data on First-Year Retention Rates and Graduation Rates.
- **Institutional Resources:** This includes Human Resources and Finance related data.

While IPEDS will provide a valuable source of information for outcomes such as graduation rates, the specific impacts of broadband on the institution might not be evident. Also, depending on the size of the broadband investment versus the size of the institution, the overall size of the impact might be too small to be captured in an aggregate measure of institution performance.

The National Broadband Mapping data may be used to identify institutions that are similar to those selected for BTOP CCI grants in terms of broadband access. In addition, we can further improve the match between comparable institutions by examining key IPEDS variables available for both. This could include class size, class composition, and graduation rates. We will develop a list of comparable institutions that will be used to serve as a control for the analysis. Statistical analysis will be applied to IPEDS data elements such as graduation rates, in order to determine the degree of causality or correlation with BTOP grant funding.

C.4 Measuring Impacts on Healthcare

Hospitals, clinics, and physicians deliver quality care on a daily basis, but they are faced with an aging population and rising healthcare costs. Improving Americans' health is one of the most important tasks for the nation. Healthcare already accounts for 17 percent of U.S. gross domestic product (GDP); by 2020, it will top 20 percent. America is aging and by 2040 there will be twice as many Americans older than 65 as there are today, and healthcare costs will likely increase as a consequence.[92]

[92] Center for Medicare & Medicaid Services. 2008. "National Health Expenditure Projections 2008–2018." Accessed January 27, 2012. http://www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2008.pdf.

Though the United States spends more annually on healthcare than any other nation (nearly $2 trillion), the system has not overcome some issues of quality, access, and affordability.[93] Daniel Castro, in his Information Technology and Innovation Foundation report on healthcare, explicitly notes, "[s]ome individuals do not receive the proper amount of care. Those who receive too much care or the wrong kind of care waste resources, while those who receive insufficient care may develop additional health problems. In many instances, the healthcare that people receive is not based on the best available scientific evidence."[94] It is this disparate level of healthcare access that has slowed the improvement of healthcare quality.[95] The services available and the care received are influenced in part by geographic location. Those in densely populated metropolitan areas have access to a wider variety of services, providers, and specialists. As Stenberg and Low point out, "[r]ural residents often face challenges accessing a full range of healthcare services. Today, due to the availability of broadband Internet, rural healthcare providers can more easily link with urban providers through the use of health IT."[96]

In 1999, the FCC noted that broadband access to the Internet was in a position to "meaningfully improve [the Nation's]…healthcare services."[97] Broadband enhances healthcare efficiency via strengthened connectivity, driving innovation, and cutting-edge approaches to healthcare that are expected to lead to "vast individual and national cost savings and to an increase in the availability of quality health solutions."[98] Though its benefits are clear, access to broadband service is not identically available across the nation. In addition, from the fact that availability is not ubiquitous, the United States currently invests very little in healthcare IT relative to the other nations. Atkinson points out that total investment in healthcare IT by the United States government in 2005 was only $0.43 per capita, which is extremely low when compared to the United Kingdom's per capita investment of $192.79.[99]

Healthcare IT includes several components, including:

- **Health IT:** Information driven health practices and the technologies that enable them. It includes billing and scheduling systems, e-care, electronic health records, telehealth, and mobile health.[100]
- **E-Care:** The electronic exchange of information (e.g., data, images, and video) to aid in the practice of medicine and advanced analytics. It encompasses technologies that enable video consultation, remote monitoring, and image transmission over fixed and mobile networks.[101]
- **Electronic Health Record (EHR):** An electronic health record is a digital record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, diagnoses,

[93] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." *Information Technology and Information Foundation*. Article published October. http://www.itif.org/index.php?id=179.

[94] Castro, Daniel. 2007. "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered." *Information Technology and Information Foundation*, October 25. http://www.itif.org/index.php?id=88.

[95] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[96] Low, Sarah and Peter Stenberg. 2009. "Rural Broadband at a Glance." Working paper, United States Department of Agriculture. http://www.ers.usda.gov/publications/eib47/eib47.pdf.

[97] Davidson, Charles M., and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[98] *Ibid.*

[99] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." *Information Technology and Information Foundation.* http://www.itif.org/index.php?id=179.

[100] Federal Communications Commission. "National Broadband Plan: Connecting America." Accessed January 27, 2012. http://www.broadband.gov/plan/10-healthcare/.

[101] *Ibid.*

medications, vital signs, medical history, immunizations, laboratory data, and radiology reports.[102]

- **Telehealth:** Often used as a synonym for e-care, but includes non-clinical practices such as continuing medical education and nursing call centers.[103]
- **Mobile Health:** The use of mobile networks and devices in supporting e-care. Emphasizes leveraging health-focused applications on general-purpose tools such as smart phones and Short Message Service (SMS) messaging to drive active health participation by consumers and clinicians.[104]

To improve its functionality, it has been widely recommended the United States healthcare adopt a system of EHRs, which contain a complete listing of patients' medical histories. The absence of single, individualized, consolidated healthcare records makes it difficult for patients to actively manage their healthcare. Healthcare providers often receive incomplete information when they treat their patients, which can result in medical errors.[105] A study of radiologists found that 62 percent cite a "[lack of consistent] access to patient medical records as an impediment to their work," and stating that 96 percent agreed or strongly agreed that this problem poses medical risks for patients.[106] The ability to create an EHR system is dependent on healthcare providers' having broadband connectivity.[107] Though the benefits of EHRs are widely recognized, cost is a substantial barrier to implementing such a system. Castro goes on to emphasize that the overwhelming majority of hospitals find the initial cost of EHR adoption as a "significant barrier or somewhat of a barrier."[108] Cost is a more significant issue for individual and smaller medical practices. Approximately two-thirds of U.S. physicians work in this type of practice, which Castro notes results in a major impediment in the development of healthcare IT.[109]

Currently, an estimated 61 percent of adults use the Internet to obtain health information (a portion of the population Pew refers to as "e-patient"). Additionally, Pew reports 42 percent of all adults say they or someone they know has been helped by following medical advice or health information found on the Internet. This represents a significant increase from 2006 when this figure was 25 percent of all adults.[110] More specifically, Pew reports the percentage of American adults getting exercise and fitness information online has jumped from 21 percent in 2002 to 38 percent now – an 88 percent increase.[111] Broadband service enables the population to combat and prevent health issues with easy access to such information. Ackerman argues that patient demand, as a market force, will drive adoption of telemedicine.[112] This demand is self-evident in many arenas, including the cell phone market:[113]

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[102] *Federal Communications Commission. "National Broadband Plan: Connecting America." Accessed January 27, 2012. http://www.broadband.gov/plan/10-healthcare*

[103] *Ibid.*

[104] *Ibid.*

[105] Castro, Daniel D. 2007. "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered." Working paper, Information Technology and Innovation Foundation.

[106] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[107] Low, Sarah and Peter Stenberg. 2009. "Rural Broadband at a Glance." Working paper, United States Department of Agriculture. http://www.ers.usda.gov/publications/eib47/eib47.pdf.

[108] Castro, Daniel D. 2007. "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered." Working paper, Information Technology and Innovation Foundation.

[109] Castro, Daniel D. 2007. "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered." Working paper, Information Technology and Innovation Foundation.

[110] Fox, Susannah. 2009. "The Social Life of Health Information: Americans' Pursuit of Health Takes Place within a Widening Network of both Online and Offline Sources." *Pew Research Center: Pew Internet & American Life Project*, June 11. http://www.pewinternet.org/Reports/2009/8-The-Social-Life-of-Health-Information.aspx.

[111] *Ibid.*

[112] Ackerman, Michael J. 2010. "Telemedicine: Networks in the Service of Healthcare." Presentation, National Library of Medicine. Accessed January 27, 2012. http://courses.mbl.edu/mi/2010/presentations_spring/Telemed.ppt.

[113] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the United States Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

- Verizon phones contain a "Pill Phone" option with dosage, facts, side effects, and notifications on more than 1,800 common drugs.
- T-Mobile provides download options for personal healthcare applications, including a Health Tracker that files a consumers health notes.
- AT&T's iPhone allows physicians and patients to view medical images remotely.

It is this access to technology and innovation that will shift the focus from disease treatment towards personal wellness and preventative care, which in turn will improve both individual and country-wide economies.

Though notable adoption progress has been made, there exists a division among the population in terms of Internet use for healthcare services. The Pew study reports that 85 percent of college graduates compared with only 25 percent of those without high school diplomas are e-patients; and 82 percent of adults with household incomes greater than $75,000 are e-patients compared with 44 percent of those with household income lower than $30,000.[114] The need to expand such service capabilities to reach all households is evident given the potential benefits.

The advancement of healthcare IT may prove remarkably beneficial to consumers and providers alike. Perhaps the most notable improvements to the system are the cost savings from keeping patients and providers local, and the reduction in administrative workloads. Often, especially in less populated regions, it is necessary that patients leave the community to receive healthcare, requiring travel expenses and, in some cases, time taken off work. One study estimates that healthcare IT "could save the U.S. healthcare system $4.28 billion [annually] from just reducing transfers of patients from one location, such as a nursing home for medical exams at hospitals, physicians' offices, or other caregiver locations."[115] In addition to any financial and time burdens, in this case consumer purchasing dollars also go with them to the urban community.[116] This scenario is less than ideal for small, rural economies and burdensome for low-income patients. Additionally, because much of healthcare involves generating, processing, and transmitting information, implementing a system of EHRs and other electronic administrative management has potential to substantially reduce costs.[117] Atkinson reports that overall, societal cost savings from implementing and using healthcare IT in the United States has been estimated (by two studies) at approximately $80 billion per year.[118]

In addition to lowering costs, enhanced healthcare IT allows consumers access to better quality information. Atkinson points out that by providing such information, IT empowers patients to make more sound healthcare decisions. Individuals are able to access not only higher quality information regarding conditions and treatments, but also information pertaining to the quality of services available through different providers.[119] Internet health resources enhance information available to patients and consumers by establishing online communities and social networks as knowledge exchange forums. Consumers can share with one another thoughts and experiences, aiding in the decision making process. The Internet also creates an opportunity for individuals to communicate with specialists and experts located anywhere in the world. This lessens the influence of

[114] Ackerman, Michael J. 2010. "Telemedicine: Networks in the Service of Healthcare." Presentation, National Library of Medicine. Accessed January 27, 2012. http://courses.mbl.edu/mi/2010/presentations_spring/Telemed.ppt.
[115] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.
[116] Ackerman, Michael J. 2010. "Telemedicine: Networks in the Service of Healthcare." Presentation, National Library of Medicine. Accessed January 27, 2012. http://courses.mbl.edu/mi/2010/presentations_spring/Telemed.ppt.
[117] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.
[118] *Ibid.*
[119] *Ibid.*

geographic proximity on availability and quality of care. A few examples of the cost and health savings associated are outlined below: [120]

- A telemedicine network in Alaska has provided the ability for doctors to communicate with expecting mothers upwards of 200 miles away, providing prenatal care and assistance to safely deliver babies.
- A 2002 study by the Veterans Association found in-home chronic disease management tools, including teleconsulations and remote monitoring, resulted in "40 percent fewer emergency room visits and a 63 percent reduction in hospital admissions."
- In-home monitoring systems are being tested to detect the early onset of cognitive diseases, including Alzheimer's. It is estimated that the early "interventions that could delay the onset of Alzheimer's disease by as little as one year would reduce prevalence of the disease by 12 million fewer cases in 2050," which could lead to dramatic cost savings for this disease alone.

Internet health resources create opportunities for providers to increase service provision and offer higher quality care. Previously, Atkinson notes, it was generally accepted that, "[i]f you want access to the best healthcare in the world, you should live close to a major world-class research hospital, usually located in an urban area…if you do not live near such a facility, you may not get the best treatment." Atkinson notes "that IT is helping to break down geographical barriers to healthcare by enabling patients to have access to top-quality care without necessarily being physically close to it."[121] Often sparsely populated and economically depressed areas lack a full spectrum of healthcare options. Generalists may be unwilling to practice in areas without specialty backup.[122] A 2005 study furthers this point, finding that only three percent of medical students expressed interest in working in a rural area.[123] Telemedicine addresses the issue of doctor or specialist shortages in rural communities with low population densities.[124] Additionally, the increase in quality and availability of information will aide in reducing medical errors. For example, Atkinson points out that in the United States adverse drug events account for 19 percent of injuries in hospitalized patients and cost hospitals over $2 billion per year, not including malpractice costs or the costs of injuries to patients. One study found that health IT, including such elements as e-prescribing, could improve physician accuracy and eliminate around 200,000 adverse drug events in the U.S., resulting in an annual savings of $1 billion.[125]

Broadband will play an invaluable role in transforming healthcare for seniors and people with disabilities. Seniors currently account for 12 percent of the population and are set to double by 2050.[126] Additionally, there are currently over 50 million people with disabilities in the U.S., many of whom are older. Healthcare costs are going to drastically increase in the coming years, and broadband can help manage and contain these costs. It is estimated that broadband-based health resources can save around $927 billion in healthcare costs for seniors and people with disabilities between 2005 and 2030.[127] Services such as in-home monitoring will allow seniors to stay in place,

[120] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[121] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.

[122] Ackerman, Michael J. 2010. "Telemedicine: Networks in the Service of Healthcare." Presentation, National Library of Medicine. Accessed January 27, 2012. http://courses.mbl.edu/mi/2010/presentations_spring/Telemed.ppt.

[123] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[124] Low, Sarah and Peter Stenberg. 2009. "Rural Broadband at a Glance." Working paper, United States Department of Agriculture. http://www.ers.usda.gov/publications/eib47/eib47.pdf.

[125] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.

[126] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[127] *Ibid.*

stay connected, and take advantage of lifesaving applications, while decreasing dependency on nursing homes and care givers. In addition to providing access to health Web sites, broadband "facilitates efforts by seniors and people with disabilities to stay in touch with family, friends, and community, and to participate in an array of activities, all of which may decrease debilitating symptoms of depression and sustain mental acuity."[128] Many seniors are working past retirement and many of these jobs require computer skills. Additionally, seniors are increasingly enrolling in computer courses and Internet training classes, with top Internet uses being searching for health information and keeping in touch with loved ones. This sets the stage for successfully bringing more seniors into broadband. In fact, the largest increase in broadband adoption from 2005-2008 fell in the 65+ age group.[129]

Implementing a new, widely adopted healthcare IT system has the potential to create substantial consumer surplus and save the country billions of dollars. Much of the estimated national savings comes from increases in efficiency including shorter hospital stays and less frequent visits, improved nurse productivity, and more efficient drug utilization. EHRs provide doctors with more complete information about their patients, which reduces the need for duplicative and unnecessary medical tests.[130] Patients would be equipped with access to more information aiding them in managing their health and making more informed decisions. Atkinson explains, "by increasing patients' access to their own medical records and to a plethora of information to help patients make better decisions, the Internet has the potential to improve healthcare."[131] IBM has observed that in making consumers more directly accountable for their own health and healthcare choices, "they can also become wiser, more value-based purchasers, improving their health through better choices, and at the same time exert pressure to keep system costs in line."[132] As stated in the National Broadband Plan, "[t]hese [broadband-enabled] solutions…offer the potential to improve healthcare outcomes while simultaneously controlling costs and extending the reach of the limited pool of healthcare professionals. Furthermore, as a major area of innovation and entrepreneurial activity, the health IT industry can serve as an engine for job creation and global competitiveness."[133] One study, for example, estimates that an investment of $10 billion in health IT in one year has the ability to create or retain 212,000 U.S. jobs for a year.[134] The National Broadband Plan aims to improve quality of life by providing better healthcare at lower costs, to a greater portion of the population, while simultaneously creating jobs to aid in recovery.

Many communities lack sufficient numbers of primary care clinicians.[135] Limited research suggests that family physicians, nurse practitioners, and physician assistants are especially likely to practice in rural communities.[136,137,138] They are also more likely to care for low-income patients.[139,140] Other

[128] *Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.*

[129] *Ibid.*

[130] Castro, Daniel D. 2007. "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered." Working paper, Information Technology and Innovation Foundation.

[131] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.

[132] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[133] Federal Communications Commission. 2010. "Connecting America: The National Broadband Plan." http://www.broadband.gov/plan/10-healthcare/.

[134] Davidson, Charles M. and Michael J. Santorelli. 2009. "The Impact of Broadband on Telemedicine: A Study Commissioned by the U.S. Chamber of Commerce." Working paper, The Advanced Communications Law & Policy Institute at New York Law School. http://www.uschamber.com/sites/default/files/about/0904Broadband_and_Telemedicine.pdf.

[135] Council on Graduate Medical Education. 1998. "Tenth Report: Physician Distribution and Health Care Challenges in Rural and Inner-City Areas." Washington DC: Government Printing Office.

[136] *Ibid.*

[137] Fryer GE, LA Green, SM Dovey, and RI Phillips Jr. 2001. "The United States Relies on Family Physicians Unlike any other Specialty." *American Family Physician* 63:1669–1703.

[138] Larson, EH, LG Hart, and J Hummel. 1994. "Rural Physician Assistants: a Survey of Graduates of MEDEX Northwest." *Public Health Reports* 266–274.

[139] Moody, NB, PL Smith, and LL Glenn. 1999. "Client Characteristics and Practice Patterns of Nurse Practitioners and Physicians." *Nurse Practitioners* 24: 94–96, 99–100, 102–103.

studies restricted to analyses of physician distribution have indicated that family physicians are more likely than other primary care physicians to work in rural and underserved communities.[141,142] The conclusions that can be drawn from the available research indicate that non-physician primary care clinicians and family physicians have a greater propensity to care for underserved populations than do primary care physicians in other specialties.[143] No study, however, has comprehensively compared the geographic distribution and patient populations of clinicians across the different primary care disciplines. But these are the very individuals that would benefit the most from health IT applications.

The Office of the National Coordinator for Health IT (ONC) supports two national health IT adoption surveys: one of physician offices and one of hospitals.

Summarized in Table 6, the surveys:

- Assess the current state of health IT adoption;
- Specify measurable goals and methods for evaluating strategies; and,
- Determine approaches that can accelerate health IT adoption in a cost-effective manner

Table 6: Adoption Rates[144]

Setting	2006	2007	2008	2009*
Physicians offices (basic**)	11%	13%	17%	21%
Physicians offices (full**)	3%	4%	4%	6%
Hospitals (basic**)	N/A	N/A	8%	N/A
Hospitals (full**)	N/A	N/A	2%	N/A

*2009 statistics are preliminary.

Efforts to quantify health IT benefits are underdeveloped. Researchers have tried to measure the success, but many "focus on only one metric of their success – such as user acceptance, economic benefits, usefulness, or improvement in patient safety – rather than conducting a comprehensive evaluation."[145] One of the primary sources of data that will be used in our assessment of the impact of broadband on healthcare is the American Hospital Associations (AHA) annual survey. This survey effort has been in annual circulation since 1980 and is designed to assess many factors at over 6,500 hospitals nationwide. The survey covers over 1,000 data items, which touch on areas such as organization of hospitals, facilities and services, community benefits the hospitals may fulfill, and general facility items (e.g., bed count, utilization, revenue).

Our evaluation study will use Quarterly / Annual PPRs collected by NTIA from grantees and match that data to the AHA data. This will provide a sample of hospitals that are affected by BTOP grant awards. An additional sample of hospitals that are deemed statistically similar (based on size,

[140] Mainous, Ag, JG Bertolino, and PL Harrell. 1992. "Physician Extenders: Who is Using Them?" *Family Medicine* 24:201–204.
[141] Council on Graduate Medical Education. 1998. *Tenth Report: Physician Distribution and Health Care Challenges in Rural and Inner-City Areas.* Washington DC: Government Printing Office.
[142] Burnett, WH, DH Mark, JE Midtling, and BB Zellner. 1995. "Primary Care Physicians in Underserved Areas: Family Physicians Dominate." *Western Journal of Medicine* 163:532–536.
[143] Grumbach, Kevin, Gary L. Hart, Elizabeth Mertz, Janet Coffman, and Lorella Palazzo. 2003. "Who is Caring for the Underserved? A Comparison of Primary Care Physicians and Nonphysician Clinicians in California and Washington." *Annals of Family Medicine* 1, no.2 (July): 97-104. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1466573/.
[144] The Office of the National Coordinator for Health Information Technology. 2010. "Health IT adoption." Last modified May 25. http://healthit.hhs.gov/portal/server.pt?open=512&objID=1152&parentname=CommunityPage&parentid=28&mode=2&in_hi_userid=11113&cached=true.
[145] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.

demographics, surrounding area's population) will be drawn that have not been affected by BTOP grant awards, and the difference/similarities will be statistically analyzed.

Based on this review of the literature and the availability of data from the AHA survey described above, the following measures could be analyzed at the anchor institution level to measure the healthcare-related impacts of BTOP grants:

- Broadband technology infrastructure available to healthcare organizations and practitioners
- Access to Health IT care products and services
- Type of Health IT applications sought
- Type of Health IT applications utilized
- Notable changes in the quality of healthcare services before and after introduction of broadband service/improvements
- Notable changes in the cost of healthcare services before and after introduction of broadband service/improvements

More specifically, looking at the AHA survey in terms of E-Care, Electronic Health Records, Telehealth, and Mobile Health, we will investigate causality or correlation through statistical analysis of the following statistics and BTOP funding:

- Availability of E-Care:
    - Home health services
    - Electronic consultant reports
    - Electronic laboratory reports
    - Electronic radiology reports
    - Electronic radiology images
    - Electronic diagnostic test results
    - Electronic diagnostic test images
    - Sharing of electronic patient-level clinical data through an electronic health information exchange or a regional health information organization
    - Level of participation in a regional health information exchange or regional health information organization
    - Electronic exchange of patient data (e.g., patient demographics, clinical care record, laboratory results, medication history, radiology reports)
    - Electronic checks of insurance eligibility
    - Electronic claims submission to both public and private payers
    - Use of electronic reminders to patients for pre-admission and/or follow-up care
    - Electronic capture of patient consents or authorizations
    - Capability to provide patients with an electronic copy of their health record
- Availability of Electronic Health Record:
    - EHRs
    - Electronic patient demographics

- Electronic physician notes
- Electronic nursing notes
- Electronic problem lists
- Electronic medication lists
- Electronic discharge summaries
- Electronic advanced directives
- Electronic laboratory reports
- Electronic radiology reports
- Electronic radiology images
- Electronic diagnostic test results
- Electronic diagnostic test images

- Availability of Telehealth:
  - Electronic clinical guidelines
  - Electronic clinical reminders
  - Electronic drug allergy alerts
  - Electronic drug-drug interaction alerts
  - Electronic drug-lab interaction alerts
  - Electronic drug dosing support
  - Telemedicine
- Availability of Mobile Health:
  - Mobile health devices
  - Physician use of personal data assistant

C.5 Measuring Impacts on Public Safety

For the purposes of this project, we have defined public safety agencies to include law enforcement agencies, fire safety agencies, and emergency medical services. The aim of this review is to provide an overview of the current impact and future impact potential of broadband ICT on law enforcement, public safety, and emergency medical services. Broadband technology can potentially affect public safety in two ways. First, dedicated broadband network resources have the potential to improve communication between disparate public safety institutions. Several of the BTOP grants, particularly the 700MHz grants, address this type of initiative. These grants are not included in the scope of this study. A second benefit of broadband ICT on public safety occurs when public safety institutions are connected to broadband communications and community members. We investigate the extent of these benefits as part of this study and present more information on this type of benefit below.

The presence of broadband and advanced IT systems amplifies the protection officials are able to provide. In a recent report, Atkinson explains, "by using IT, a police force can be more productive, solve more crimes, and better protect the lives and property of the public."[146] Law enforcement

[146] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.

agencies need public safety IT to understand the community and the nature of criminal activity within the jurisdiction. As technology advances, systems designed to enhance public safety are becoming more accurate and sophisticated. For example, Atkinson points out, "GPS devices can similarly be used to enforce restraining orders… if domestic violence offenders violate restrictions on visiting their spouse at their home or place of work, the police will be notified in real time."[147] Such systems not only improve the efficiency of law enforcement, but also provide comfort and reassurance to citizens. Similar advanced IT systems exist which notify victims of an offender's release or escape from custody, enabling affected parties to take proper precautions.[148]

In addition to IT enabling greater protection services, it also works to prevent and prepare communities for instances of accidents and crime. Atkinson mentions, "[g]overnments and nongovernmental organizations are using IT to predict, respond to, and manage accidents at dangerous facilities, as well as natural phenomena such as hurricanes, wildfires, tsunamis, and landslides." He explains that through satellite and aerial images, as well as first hand ground inspections, organizations can locate at-risk populations and unstable locations and determine how to respond after or amidst a disaster.[149] Broadband and public safety IT can also boost efficiency through cost and time savings. Advanced technologies "automate many of the time-consuming tasks associated with police work and free police resources to be used on other effective programs." At the most basic level, efficiency gains are realized as less time needs to be devoted to paper work and administrative tasks. A more complex example, Atkinson, points out, "[u]sing GPS devices for remote monitoring can reduce expenses and improve outcomes for the criminal justice system.... [r]ather than being put in jail, some low-risk offenders can be required to stay at home…incarceration can cost a state approximately $25,000 per inmate per year, whereas the cost of remotely monitoring an inmate can cost less than $5,000 per year."[150] By incorporating advanced technologies, public safety agencies are able to devote more efficient use of their time and resources.

Developing broadband and IT systems improves information sharing between citizens and public safety entities. Atkinson notes one of the primary benefits of advanced mobile technologies in combating crime, "with so many cell phones now equipped with digital cameras, when a crime occurs witnesses are more likely to be able to provide digital evidence."[151] It therefore is important that both the public and law enforcement agencies have access to, and the means of integrating, such information. Additionally, IT systems enhance the transparency of public safety agencies. Atkinson explains, "[p]olice departments that have computerized their incident and arrest reports can more easily share their data with nonprofit organizations and journalists. Using these data, researchers can monitor police performance and analyze the data for evidence of impropriety."[152] Greater transparency implies more efficient agency operations.

The adoption of broadband and advanced IT systems has notable benefits for the country's public safety. However, according to the NTIA there are significant barriers to such realization. They state, "the public safety community must overcome a number of practical hurdles, ranging from the technical to the financial and regulatory."[153] To improve public safety it is necessary that all areas of the country have access to broadband services. NTIA emphasized, "[f]ederal agencies will require ubiquitous broadband coverage to support a variety of voice, video, and data requirements. In many instances, these mission-critical capabilities will be needed in regions that are unlikely to be served by commercial providers."[154] As a result, government must directly support or create the

[147] *Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.*
[148] *Ibid.*
[149] *Ibid.*
[150] Atkinson, Robert D., and Daniel Castro. 2008. "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution." Working paper, Information Technology and Information Foundation.
[151] *Ibid.*
[152] *Ibid.*
[153] National Telecommunications and Information Administration. 2009. "Executive Branch Views on Public Safety, Homeland Security and Cybersecurity Elements of a National Broadband Plan." United States Department of Commerce.
[154] *Ibid.*

appropriate incentives for the deployment of services and communication infrastructure that public safety agencies require.

Finally, the National Broadband Plan seeks to increase availability, adoption, and the use of broadband for "national purposes, such as economic development, healthcare, education, public safety, and government transparency. Public safety is also included in two of the long-term goals of the National Broadband Plan:[155]

- Every American community should have affordable access to at least one gigabit per second broadband service to anchor institutions such as schools, hospitals, and government buildings.
- To ensure the safety of the American people, every first responder should have access to a nationwide, wireless, interoperable broadband public safety network.

Potential sources of data that could be used in our assessment of the impact of broadband on public safety are: Crime & Justice Electronic Data (Bureau of Justice Statistics), Law Enforcement Management and Administrative Statistics (LEMA), and the National Incident-Based Reporting System (NIBRS).[156,157,158]

The Bureau of Justice Statistics reports are available from 1977 – 2008 and are collected on a yearly basis. It is aggregated data from a wide variety of published sources and intended for analytic uses. These measures cover topics such as crime, justice, and socio-demographics. These data are available nationwide at the state level and more granularly for specific areas of the country. Given the level of analysis of these data, we feel it could be best used while performing certain case studies.

LEMA is available every 3-4 years from 1987 – 2007 and collects data from over 3,000 state and local law enforcement agencies, including all those that employ 100 or more sworn officers and a nationally representative sample of smaller agencies. Data are obtained on the organization and administration of police and sheriffs' departments, including agency responsibilities, operating expenditures, job functions of sworn and civilian employees, officer salaries and special pay, demographic characteristics of officers, weapons and armor policies, education and training requirements, computers and information systems, vehicles, special units, and community policing activities. Specific items of interest are:

- Number of computers in the field
- Number of vehicle mounted computers
- Number of other computers
- Digital fingerprints used
- Digital mug shots used
- Digital suspect composites used, etc

The evaluation study could track these data in areas known to be impacted by BTOP compared to statistically similar areas that are not impacted by BTOP. This could provide a measure of

[155] Federal Communications Commission. 2010. "Connecting America: The National Broadband Plan." http://www.broadband.gov/plan/10-healthcare/.
[156] Bureau of Justice Statistics. *Crime & Justice Electronic Data*, 1977-2008. http://bjs.ojp.usdoj.gov/content/dtdata.cfm#index. Last modified January 27, 2012.
[157] Bureau of Justice Statistics. *Law Enforcement Management and Administrative Statistics*: 1987, 1990, 1993, 1997, 1999, 2000, 2003, 2007. Last modified April 19, 2010. http://bjs.ojp.usdoj.gov/index.cfm?ty=dcdetail&iid=248#Documentation.
[158] Federal Bureau of Investigation. "National Incident-Based Reporting System, 1991 – 2008." Uniform Crime Reporting Program. Accessed January 27, 2012. http://www.icpsr.umich.edu/icpsrweb/ICPSR/series/00128/studies?archive=ICPSR&sortBy=7.

digitalization of law enforcement agencies. Given the level of these data, it could potentially be a viable measure of the impact of BTOP on public safety via law enforcement agencies.

NIBRS is an incident-based reporting system for crimes known to the police. For each crime incident coming to the attention of law enforcement, variety of data are collected about the incident. These data include:

- The nature and types of specific offenses in the incident
- Characteristics of the victim(s) and offender(s)
- Types and value of property stolen and recovered
- Characteristics of persons arrested in connection with a crime incident

These data are available from 1991 – 2008 and published yearly at the city level. The evaluation study could track these data in areas known to be impacted by BTOP compared to statistically similar areas that are not impacted by BTOP. This could provide a measure of criminal activity. Given the level of these data, it could potentially be a viable measure of the impact of BTOP on public safety via crime rates.

C.6 Measuring Impacts Quality of Life/Standard of Living and Civic Engagement

As discussed in their paper, *The Social Impact of Broadband Household Internet Access*, Anderson and Raban point out the relative lack of research on the social impacts of broadband as compared to the economic impacts.[159] Anderson and Raban note that, "[i]ndeed recent authors have noted that few academic publications focus on the impact of broadband on social and personal issues in contrast to the developmental and macro-economic issues."[160] Early studies on impacts of broadband computer networks on society mainly focus on offering expert opinions, forecasting future trends, and speculating about the potential of the technology. More recent studies attempted to assess the penetration rate of broadband by focusing on specific types of applications requiring high speed connections.[161,162,163,164] These studies also attempted to quantify the subscriber volume, which stands for the number and percent of customers purchasing the service.[165]

Moreover, research has found that it is difficult to discern social outcomes specifically attributable to broadband (as opposed to narrowband Internet use). Beyond this, when actual outcomes have been identified, some research has shown that the outcome or change is correlated more to the previous behavior of the individual, as opposed to the switch from narrow-band to broadband.[166] Anderson and Raban, for example, looked at Internet time, TV time, amount of money spent online, and out-of-home social leisure activities as a result of a switch to broadband, and found that the greatest effect on time spent online is not moving to broadband, although this was significant, but the previous behavior of an individual. Similarly, regarding the amount of money individuals spend online, Anderson and Raban found, "a steady progression of online spend driven largely by experience not only in terms of years spent online but in terms of breadth of Internet use."[167] Similarly, with respect to time spent watching TV, Anderson and Raban found that, contrary to previous findings using longitudinal data that getting household Internet access had a negative effect on television use, switching from narrowband to broadband Internet at home did not have a similar effect.[168] Their results, instead, demonstrated the resilience of time spent watching TV to a range of life transitions including switching to broadband. Anderson and Raban's research was based on surveys conducted in 2001 and 2002 and, as such, represent results gleaned from very early adopters of broadband. More recent adopters may exhibit different behavioral change.[169]

Other studies that have attempted to measure social impacts related to broadband use have noted difficulties in identifying appropriate indicators and/or data sources to support those indicators. When discussing IT productivity in terms of broadband at home, Gillett, Lehr, Osorio, and Sirbu, for example, note that, "home-based access may improve quality of life, for example by enabling more participation in community and civic activities, making a locale more attractive to potential

[159] Anderson, Ben., and Yoel Raban. 2005. "The Social Impact of Broadband Household Internet Access." Chimera Working Paper 2005-2006, Colchester, University of Essex.
[160] *Ibid.*
[161] Chang, S., Lee, H., and C. Middleton. 2004. "The Deployment of Broadband Internet in Australia: Areas for Attention and Implications from Canada and Korea." Retrieved from www.ryerson.ca/~cmiddlet/pubs/bband_aus.pdf.
[162] Cohill, A.M. 2005. "Community Web Portals and Economic Development". Presented at the 9th Annual Rural Telecommunications Congress Annual Meeting, Lexington, Kentucky, October 9-12.
[163] Cohill, A.M. 2005. "Broadband Policy for Rural Communities." Presented to the Canadian Government Telecommunications Policy Group, Whitehorse, Yukon Territory, Canada, September 9.
[164] Lee, H., O'Keefe, R., and K. Yun. 2003. "The Growth of Broadband and Electronic Commerce in South Korea: Contributing Factors." *The Information Society*, 19(1): 81-93.
[165] Chang, S., Lee, H., and C. Middleton. 2004. "The Deployment of Broadband Internet in Australia: Areas for Attention and Implications from Canada and Korea." Retrieved from www.ryerson.ca/~cmiddlet/pubs/bband_aus.pdf.
[166] Anderson, Ben, and Yoel Raban. 2005. "The Social Impact of Broadband Household Internet Access." Chimera Working Paper 2005-2006, Colchester, University of Essex.
[167] *Ibid.*
[168] *Ibid.*
[169] Anderson, Ben, and Yoel Raban. 2005. "The Social Impact of Broadband Household Internet Access." Chimera Working Paper 2005-2006. Colchester, University of Essex.

residents."[170] However, Gillett, Lehr, Osorio, and Sirbu found that most of these hypothesized impacts of home-based Internet are not directly measurable, so they focused instead on how broadband is likely to change other indicators that describe local economies, including community participation and quality of life as measured by voting participation, mortality rates, or local prices.[171] However, as Gillett, Lehr, Osorio, and Sirbu found, the ability to test some of these indicators is limited by the collection frequency for different types of Census data, and geographic unit limitations for other types of data (for example, voting participation is not tallied by ZIP Code).[172] In addition, for most indicators, it is reasonable to expect that broadband's impacts will be felt only after some time lag – broadband has to be not only available, but adopted, and then used.

Others have also noted difficulties in measuring quality of life impacts. In "How the Public Perceives Community Information Systems," the Pew Internet and American Life Project and the Monitor Institute noted that several of the indicators for measuring a citizens' sense of how their community information system is performing and their overall satisfaction with their community are difficult to measure and assess independently without complicated and expensive methodologies.[173] Specific areas noted as difficult to measure, among others, were the effectiveness of technology programs at schools, the availability of "quality of life" information from community organizations, and "effective opportunities" for citizens to have their voices heard.[174]

Despite this, several studies have attempted to develop quality of life or standard of living indicators to measure broadband's social impacts. In their article, "Closing the Rural Broadband Gap" LaRose, Gregg, Strover, Straubhaar and Inagaki note that, "[b]roadband development may produce social benefits as well as economic ones."[175] They summarize the literature addressing the impacts of rural broadband networks, stating that, "[r]ural broadband networks could improve some of the conditions of rural life that lead to depopulation and despair, including access to healthcare and education."[176] In their survey and case study research, LaRoase, Gregg, Strover, Straubhaar, and Inagaki look at community attachment, perceived social support, relocations intentions, number of voluntary members, and Internet self-efficacy as measures of broadband's social impacts in rural communities.[177] They find that the precursors of broadband adoption were the perceived benefits of high speed Internet connections, the ability to experience those benefits for oneself, and a sense of efficacy when using the Internet, noting that, "[these are factors amendable to community-based, self development interventions that can close the broadband gap despite the challenging demographics of rural communities." LaRose, Gregg, Strover, Straubhaar and, Inagaki also found that, "social uses of the Internet increased the social support experienced by rural residents, leading to higher levels of community satisfaction and attachment, and ultimately lower intentions to relocate away from rural communities."[178] Those impacts were counterbalanced, however, by the development of social connections and interests beyond the local community increasing intentions to relocate. This led to the conclusion that the development of local web content and a focus on local social networks, "is important to sustain rural populations."[179]

[170] Gillett, Sharron, William Lehr, Carlos Osorio, and Marvin Sirbu. 2006. "Measuring Broadband's Economic Impact." U.S. Department of Commerce, Economic Development Administration. http://web.si.umich.edu/tprc/papers/2005/475/TPRC2005_Gillett%20Lehr%20Sirbu%20Osorio%20submitted.pdf.
[171] *Ibid.*
[172] *Ibid.*
[173] Rainie, Lee, Kristen Purcell, Tony Siesfeld, and Mayur Patel. 2011. "How the Public Perceives Community Information Systems." *Pew Internet and American Life Project*, March 11. http://pewinternet.org/Reports/2011/Community-Information-Systems.aspx.
[174] *Ibid.*
[175] LaRose, Robert, Jennifer L. Gregg, Sharon Stover, Joseph Straubhaar, and Nobuya Inagaki. 2008. "Closing the Rural Broadband Gap." Final Technical Report, Michigan State University. Report published November 30. https://www.msu.edu/~larose/ruralbb/.
[176] *Ibid.*
[177] LaRose, Robert, Jennifer L. Gregg, Sharon Stover, Joseph Straubhaar, and Nobuya Inagaki. 2008. "Closing the Rural Broadband Gap." Final Technical Report, Michigan State University. Report published November 30. https://www.msu.edu/~larose/ruralbb/.
[178] *Ibid.*
[179] *Ibid.*

Other case study research has tried to identify and measure, where possible, the social transformational changes that can be attributed to the uptake of broadband technologies within communities. In their case study of the Shippagan area, a rural area on the Acadian Peninsula in North-eastern New Brunswick Canada, Sid-Ahmed Selouani, and Habib Hamam surveyed individuals throughout the Shippangan area, which had obtained broadband access at different times over the six years prior to their survey.[180] In terms of transformational changes, Selouani and Hamam looked at use of communications and informational tools; changes in leisure time activities and community involvement, such as time together as a family and participation in community meetings or activities; mobility and migration; changes in uses of the Internet at home; changes in online purchases; establishment and/or expansion of home-based businesses; and the financial impacts on home based businesses.[181]

In summary, Selouani and Hamam found in terms of transformational change and community impacts that the introduction of broadband services to households does not diminish the time that the family spends together, allows for daily online banking, and increases the household purchases of electronic devices.[182] Moreover, household users reported positive impacts, generally in the areas of:

- Facilitating communication with friends
- Making education projects easier
- Improving the quality of life since it allows the payment of bills from home

Selouani and Hamam note that the identified positive changes are closely related to the broadband connection as opposed to access to the Internet in general, as many of the tasks are very difficult or quite impossible to do with a dial-up connection.[183] In addition, respondents' indication that in the near future a proportion of surveyed persons plan to use their high-speed connection to get access to e-learning, to find information about real estate values and purchasing, stock trading/tracking, investment purchases, and local government services.

Volunteerism is another quality of life indicator utilized by some researchers in looking at the social impacts the Internet in general. The Pew Research Center's Internet & American Life Project has found that 75 percent of all American adults are active in some kind of voluntary group or organization and Internet users are more likely than others to be active: 80 percent of Internet users participate in groups, compared with 56 percent of non-Internet users.[184] The Pew survey found that use of the Internet is having a wide-ranging impact on users' engagement with civic, social, and religious groups. Moreover, the Pew research found that Internet users are more active participants in their groups than other adults, and are more likely to feel pride and a sense of accomplishment.

Some research has found that found that broadband users are sometimes less satisfied than others with community life, which raises the possibility that upgrades in local information systems might produce more critical, activist citizens. Research suggests that social media like Facebook and Twitter are emerging as key parts of the civic landscape and mobile connectivity is beginning to affect people's interactions with civic life.[185]

[180] Habib, Haman, and Sid-Ahmed Selouani. 2007. "Social Impact of Broadband Internet: A Case Study in the Shippagan Area, a Rural Zone in Atlantic Canada." *Journal of Information, Information Technology, and Organizations*, Vol. 2: 79-94.
[181] *Ibid.*
[182] *Ibid.*
[183] *Ibid.*
[184] Rainie, Lee, Kristen Purcell, and Aaron Smith. 2011. "The Social Side of the Internet." *Pew Internet and American Life Project*, January 18. http://pewinternet.org/Reports/2011/The-Social-Side-of-the-Internet.aspx.
[185] Rainie, Lee, Kristen Purcell, Tony Siesfeld, and Mayur Patel. 2011. "How the Public Perceives Community Information Systems." *Pew Internet and American Life Project*, March 11. http://pewinternet.org/Reports/2011/Community-Information-Systems.aspx.

Based on a review of the literature, potential measures for quality of life impacts of broadband could include:

- Civic engagement, including voter registration and/or participation and membership in civic associations
- Homelessness
- Volunteerism
- Telecommuting rates
- Establishment of home businesses
- Home schooling rates
- Time spent online
- Internet purchases

Potential sources of data that could be used to support some of these measures are the CPS and ACS.[186,187]

The CPS is a monthly survey of about 50,000 households conducted by the Bureau of the Census for the Bureau of Labor Statistics. This survey covers Employment, Unemployment, Earnings, Educational Attainment, Income, Poverty, Health Insurance coverage, Job Experience and Tenure, School Enrollment, Voting and Registration, Computer Usage, and Internet Usage. These data are available at the county level, and there are four specific supplements to this monthly survey that would be of particular value to the study:

1. Schooling and Computer / Internet usage supplement (1998, 2000, 2001, 2003, 2005, 2010, 2011) – a nationwide supplement to the CPS, which covers items such as:
    a. (Do you/Does anyone in this household) use the Internet at any location?
    b. (Do you/Does anyone in this household) connect to the Internet from home?
    c. Do you currently access the Internet at home using…?
    d. What is the main reason that you do not have high-speed (that is, faster than dial-up) Internet access at home?
2. Voter registration and participation supplement (1996, 1998, 2000, 2002, 2004, 2006, 2008) – a nationwide supplement to the CPS, which covers items such as:
    a. Were you registered?
    b. Did you vote?
    c. Main reason not registered?
    d. Main reason did not vote?
3. Membership in civic associations supplement (2008, 2009, 2010, 2011) – a nationwide supplement to the CPS, which covers items such as:
    a. Contacted a public official?
    b. Bought or boycotted based on political views?
    c. Type of group joined?

[186] United States Census Bureau. *Current Population Survey,* 1996 – 2010 Accessed January 27, 2012. http://dataferrett.census.gov/.
[187] United States Census Bureau. *The American Community Survey,* 2005-2009. Accessed January 27, 2012. http://dataferrett.census.gov/.

d. How often did you communicate via email or internet?

4. Volunteer Workers Supplement (2002-2011) – a nationwide supplement to the CPS, which covers items such as:
    a. Volunteer activities for an organizations, including time spent, types of organizations, and types of volunteer activities, and location of volunteer activities (state)
    b. Volunteer activities for children's school or youth organizations, including time spent and types of volunteer activities and location of volunteer activities (state)
    c. Charitable donations
5. Telecommuting rates (1997, 2001, 2004) – a nationwide supplement to the CPS, which covers items such as:
    a. Type of telecommuting, e.g. employer-sponsored telework vs. home business telework
    b. Frequency per week (days and hours) of telework
    c. Computer use while working from home

The ACS is a nationwide survey designed to provide communities a fresh look at how they are changing. It is a critical element in the Census Bureau's decennial census program. The ACS collects information such as age, race, income, commute time to work, home value, veteran status, and other important data. These data are available yearly at the county level, and a specific point of interest to the evaluation study is the "Means of Transportation to Work" section, which contains a question that address "working from home."

These data will be tracked in areas known to be impacted by BTOP and compared to statistically similar areas that are not impacted by BTOP. Correlation and causality of these measures will be tested with respect to BTOP funding.

For identified measures that are not supported through these two data sources, we will attempt to collect data from state and local level government sources for particular geographies, perhaps those associated with our case study locations. To the extent possible, statistically significant causation or correlation findings for these limited geographic-specific instances will be extrapolated to other similar areas or nationwide, as appropriate.

Appendix D. Glossary

ACS – American Community Survey

ACTION – Access to Computer Technology and Instruction in Online Networking

AHA – American Hospital Association

ARE-ON – Arkansas Research & Education Optical Network

ASR – ASR Analytics, LLC

ATOM – Arkansas Telehealth Oversight & Management

BAA – Broadband Awareness and Adoption

BTOP – Broadband Technology Opportunities Program

CAI – Community Anchor Institutions

CCI – Comprehensive Community Infrastructure

CETF – California Emerging Technology Fund

CPS – Current Population Survey

EDA – Economic Development Administration

EHR – Electronic health records

ERS – Economic Research Service

ESOL – English as a Second Language

FCC – Federal Communication Commission

FCCC – Foundation for California Community Colleges

GDP – Gross domestic product

GPUAC – Greater Philadelphia Urban Affairs Coalition

ICN – Illinois Century Network

ICT – Information communication technology

IPEDS – Integrated Postsecondary Education Data System

IT – Information Technology

LEMA – Law Enforcement Management and Administrative Statistics

LTT – Long-term trend

MESA – Mathematics, Engineering, Science Achievement

NAEP – National Assessment of Educational Progress

NBM – National Broadband Map

NIBRS – National Incident–Based Reporting System

NIU – Northern Illinois University

NOFA – Notice of Funds Availability

NTIA – National Telecommunications and Information

ONC – Office of the National Coordinator for Health IT

OSHEAN – Ocean State Higher Education Economic Development Administration Network

PAM – Post-Award Monitoring

PCC – Public Computer Centers

PPR – Performance Progress Report

Recovery Act – American Recovery and Reinvestment Act of 2009

RUS – Rural Utilities Service

SBA – Sustainable Broadband Adoption

SBDD – State Broadband Data Development

SDB – Socially and Economically Disadvantaged Business

SDN – South Dakota Network

SMS – Short message service

SOW – Statement of work

UAMS – University of Arkansas Medical Services

USDA – U.S. Department of Agriculture

ZBP – ZIP Code Business Pattern

ZCTA – ZIP Code Tabulation Areas

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