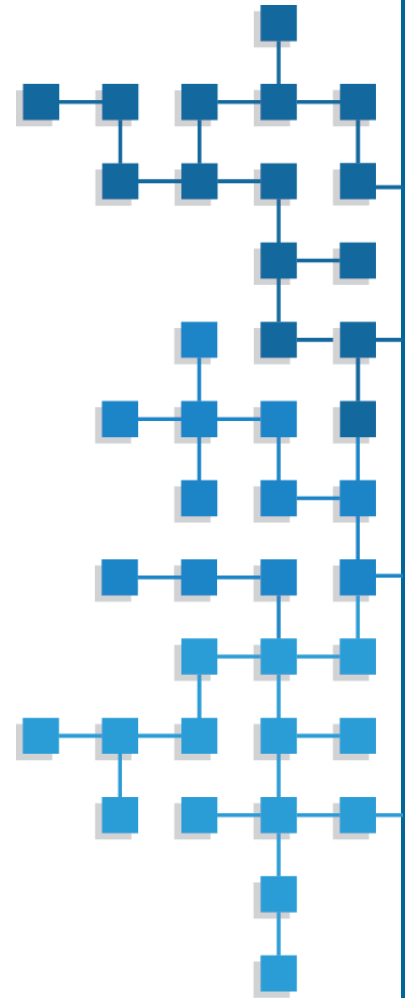# Methodology

Arctic Strategic Transportation and Resources
(ASTAR)

Developed by Resource Data

6/30/2019

Version 1.0

Version History

The following individuals have contributed to this document.

Version	Date	Author	Changes
1	01/10/2020	Resource Data Inc & ASRC Energy Services Alaska Inc	Initial Release

Table of Contents

Key Message

<u>Mission</u>: Identify, evaluate, and advance opportunities to enhance the quality of life and economic opportunities in North Slope communities through responsible infrastructure development.

<u>Goal</u>: Prioritize community needs and identify infrastructure opportunities that offer the most cumulative benefit and best enhance the quality of life for the region.

<u>Summary</u>

The Arctic Strategic Transportation and Resources (ASTAR) project is a collaborative effort initiated by the Department of Natural Resources (DNR) in partnership with the North Slope Borough. The planning area includes the entire North Slope region, including State lands, the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). The ASTAR team is working with communities and regional stakeholders to identify which projects and project areas may offer the most cumulative benefit to the region by prioritizing community and cultural connectivity, regional support, reduced cost of living, increased safety, and responsible infrastructure development. DNR team includes

- Office of Project Management and Permitting
- Division of Mining, Land, and Water's Resource Assessment and Development section
- Support Services Division's Information Resource Management section
- Division of Parks and Outdoor Recreation's Interpretation and Education unit
- Division of Geological and Geophysical Surveys
- Division of Oil and Gas

Other State of Alaska stakeholders include

- Department of Transportation and Public Facilities (DOTPF)
- Department of Health and Social Services (DHSS)
- Department of Commerce, Community, and Economic Development (DCCED)

This document describes the ASTAR process in terms of a framework so that it may be repeated in future partnerships between DNR and Alaska communities.

Resource Data

ASTAR Cumulative Benefits Analysis Framework

A cumulative benefits analysis (CBA) framework is a repeatable process that will help ASTAR identify the most beneficial infrastructure upgrade projects around the state. As the ASTAR process moves to further stages of refinement, those regions which offer the highest cumulative benefit will be identified and selected for further analysis and potential data collection.

To ensure objectivity, the CBA process must

- Be informed by stakeholder input
- Define a methodology to identify the best projects with greatest benefits
- Analyze projects for benefits while addressing impacts
- Be user friendly; it cannot be overly elaborate or complicated
- Allow for spatial and non-spatial inputs (e.g. important or sensitive cultural, social, environmental, and cost data) that define constraints, factors, and benefits of potential infrastructure projects
- Include input from subject matter experts
- Include factors to rank and weight evaluation criteria based on perceived degree of importance and stakeholder viewpoints

To meet these objectives, the ASTAR team conducted an initial study of literature and reviewed potential tools and processes for the CBA. ASTAR developed a report called "Assessment of Potential Tools for Cumulative Benefits Analysis" to present the results of the study. More than 20 different tools and decision-making processes were considered during the research, and 10 were considered potentially applicable to meet ASTAR project objectives. In addition, a four-stage project framework was established to define a methodical approach to project area evaluation.

Based on report feedback, meeting discussions, software demonstrations, and input from DNR and Esri, a major supplier of geographic information system (GIS) software, several tools were identified for supporting the ASTAR CBA within each stage of the project.

Resource Data

Table 1: Tools Identified to Support CBA within each Stage of Project

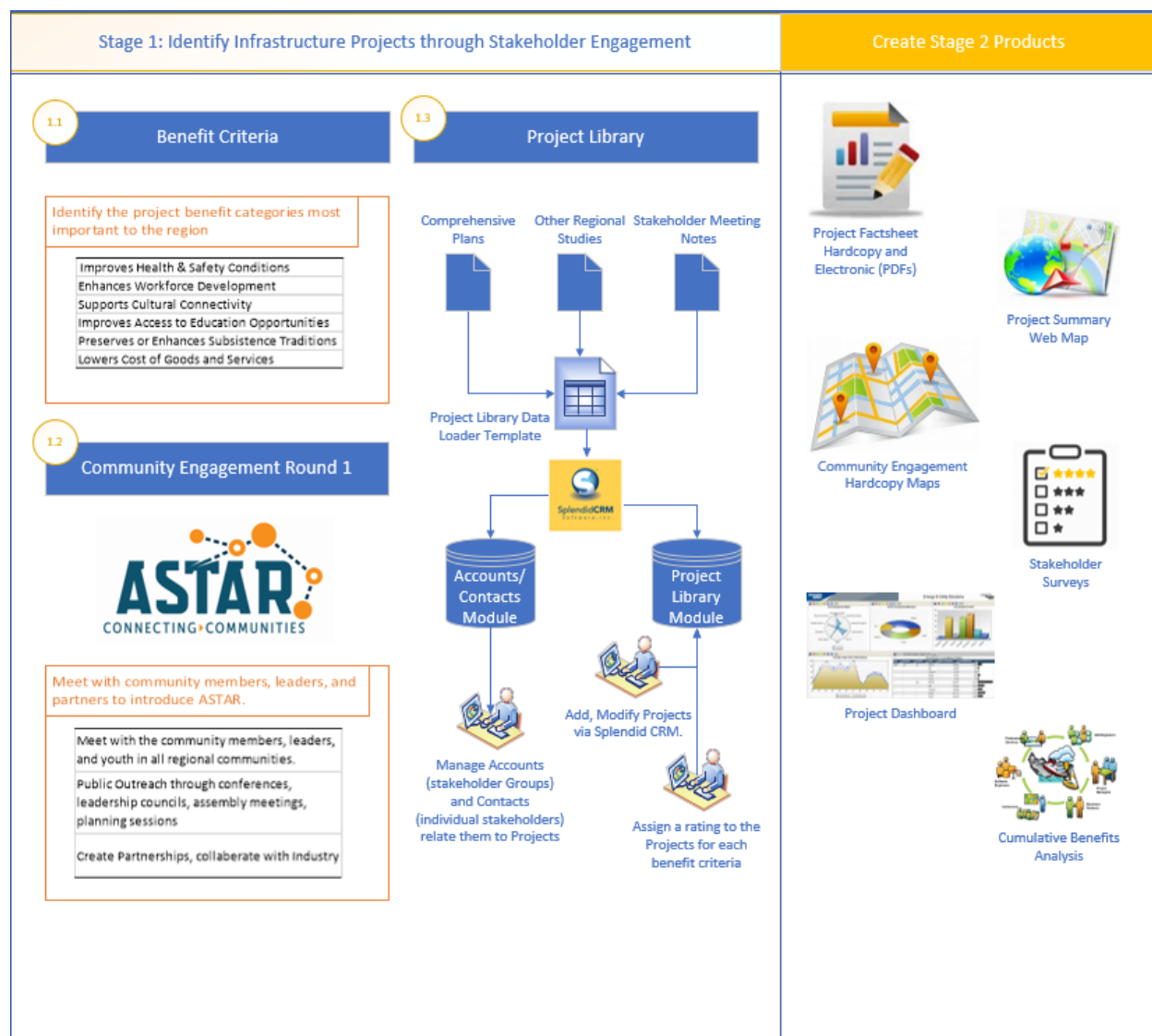| Tools Recommended for each Stage in Project |
| --- |
| **Stage 1: Identify Projects through Stakeholder Engagement** |
| Stakeholder Evaluation Survey

Stakeholder Engagement Database

Project Library |
| **Stage 2: Screen and Prioritize Projects** |
| Pairwise Comparison (PWC) of Benefit Criteria

Analysis of PWC using the Analytic Hierarchy Process (AHP)

Weighted Decision Matrix for Project Scoring using SME consultation

Benefit Assessment Reports |
| **Stage 3: Define and Analyze Priority Project Areas** |
| Multi-Criteria Decision Analysis MCDA using GIS methods

Decision matrices, as appropriate

SME consultation |
| **Stage 4: Collect Relevant Field Data for Priority Project Areas** |
| Collect relevant field data (e.g., gravel surveys, lake surveys, and LiDAR) |

Resource Data

Stage 1: Identify Projects Through Stakeholder Engagement

The initial stage of the project framework solicits stakeholder input and preferences for benefits criteria, identifies infrastructure projects to meet those preferences, and gathers information relevant for later project evaluation.

To accomplish this, the ASTAR team completed a literature review, identified benefit criteria required to meet the needs of the communities; created and implemented a survey to evaluate those benefits preferences; developed a community engagement database; participated in community outreach meetings; and created a project library from a variety of sources to facilitate the process of project analysis. Products for use in Stage 2 were also created during Stage 1 activities.

The ASTAR team compiled a document library of NSB community comprehensive plans, capital improvement plans, historical resource and transportation studies, and other reference material. They reviewed these documents to identify transportation and resource projects that would improve the quality of life and benefit the regional stakeholders.

Resource Data

Figure 1: Illustrated Stage 1 Process and Products

Stage 1: Identify Infrastructure Projects through Stakeholder Engagement

Create Stage 2 Products

1.1 Benefit Criteria

Identify the project benefit categories most important to the region

- Improves Health & Safety Conditions
- Enhances Workforce Development
- Supports Cultural Connectivity
- Improves Access to Education Opportunities
- Preserves or Enhances Subsistence Traditions
- Lowers Cost of Goods and Services

1.2 Community Engagement Round 1

ASTAR CONNECTING COMMUNITIES

Meet with community members, leaders, and partners to introduce ASTAR.

Meet with the community members, leaders, and youth in all regional communities.

Public Outreach through conferences, leadership councils, assembly meetings, planning sessions

Create Partnerships, collaborate with Industry

1.3 Project Library

Comprehensive Plans   Other Regional Studies   Stakeholder Meeting Notes

Project Library Data Loader Template

SplendidCRM

Accounts/ Contacts Module

Project Library Module

Manage Accounts (stakeholder Groups) and Contacts (individual stakeholders) relate them to Projects

Add, Modify Projects via Splendid CRM.

Assign a rating to the Projects for each benefit criteria

Project Factsheet Hardcopy and Electronic (PDFs)

Project Summary Web Map

Community Engagement Hardcopy Maps

Stakeholder Surveys

Project Dashboard

Cumulative Benefits Analysis

Resource Data

1.1 Benefits Criteria

The benefits criteria is a list of values which will help ASTAR determine which projects provide the most cumulative benefit to the region. The benefits selected produce helpful effects in the region, advance the well-being of the North Slope communities, and provide the most value to the members of those communities. The benefits criteria were chosen by the ASTAR team through review of the NSB and community comp plans (see page ES-3 of the NSB Comprehensive Plan 2019-2039) which include

- Improving Health and Safety Conditions
- Enhancing Workforce Development
- Supporting Community Connectivity
- Improving Access to Education Opportunities
- Preserving or Enhancing Subsistence Traditions
- Lowering Cost of Goods and Services

To select projects that most clearly meet ASTAR goals, it was necessary to evaluate the benefits preference of the North Slope communities. In other words, which benefits were viewed as most valuable in advancing the well-being of the region and communities?

Benefits Criteria Definitions

Enhances Workforce Development

Infrastructure projects that enhance workforce development are those that directly provide temporary or long-term jobs (e.g., short-term construction vs. long-term management or maintenance jobs); allow better access to existing places of employment (e.g., Prudhoe Bay oilfield); produce new business development opportunities (e.g., installation or upgrade of communication technology to support online businesses or remote-workplaces); identify and fill much-needed local and regional service gaps; provide skills training or workplace experience (e.g., vocational-technical training, internships, or apprenticeship programs); supply opportunities for low-skilled or entry-level workers in order to retain residency of younger workers in the communities; and seek to produce workforce equity among the North Slope communities (i.e., projects that provide jobs to more than one community).

Improves Access to Education Opportunities

Infrastructure projects that improve access to education and cultural opportunities are those that provide adequate learning spaces through new construction or upgrade, rehabilitation, or expansion of existing facilities; create physical access to education facilities; install or upgrade communications technology for classroom connectivity to outside resources; or facilitate attendance at schools, training centers, satellite campuses, and cultural centers/activities.

Resource Data

Examples of projects that improve access to education opportunities include inter-community roads, airports, facility constructions, and telecommunications development. Also considered are any projects that may enhance direct access to such existing resources such as Ilisaġvik College, the IHLC, or the Simon Paneak Museum.

Improves Health and Safety Conditions

Infrastructure projects that improve health and safety conditions are those that provide direct access to medical facilities and services for preventative, as well as urgent care, routine exams and treatments; allow for rapid response from emergency services, including search and rescue personnel and law enforcement; increase access to telemedicine; improve sanitary conditions (e.g., water/sewer/landfill development or enhancement projects); increase sustainability of necessary utilities, such as clean water supplies and reliable electric and heating sources; and increase the supply of fresh food. Consideration may be given to projects that either construct, upgrade, or rehabilitate existing health & safety facilities as well as those that improve or provide access to these facilities.

Lowers Cost of Goods and Services

Infrastructure projects that lower the costs of goods and services are those that lower associated costs of delivery through an enhanced supply chain or network (e.g., road construction, increased barge service, or less expensive freighting); provide a direct local source for goods and services (e.g., incentive to develop local providers rather than importing them from other communities); increase local storage capability to enable bulk purchases; directly supply fuel resources from North Slope oil & gas infrastructure; and those that include cost-sharing potential between communities and resource developers (e.g., shared infrastructure or coordination/splitting of shipping costs).

Preserves or Enhances Subsistence Traditions

Infrastructure projects that preserve or enhance subsistence traditions are those that improve local community access to subsistence resources while protecting those resources from outside pressure (e.g., gated, permitted, or restricted-access roads); enable safe and efficient deployment of harvesting implements such as boats and snowmachines (e.g., boat ramps, road pullouts, improvements at Cross Island, etc.); allow management or transfer/storage of harvest products (such as cold storage facilities); provide support for subsistence activities (small engine repair, boat repair, snowmachine sales & service, gunsmithing, etc.); mitigate encroachment within or in proximity to subsistence use areas; or provide environmental enhancements to improve the quality and quantity of subsistence resources.

Supports Community Connectivity

Infrastructure projects that support community connectivity are those that increase the quality of links or bonds among community members; create or enhance the capability to join together in

Resource Data

various activities; improve virtual or physical access among communities; and enable frequent cross-community communication and gathering.

Examples of projects that support community connectivity are improvement or marking of trails; road development or improvement; telecommunications installation or upgrades; establishment of safety facilities for travel (e.g., warming huts or restroom facilities at airstrips or along trails); and construction or expansion of community/cultural centers.

A Benefit Evaluation Survey was created to identify if any of the selected benefit criteria were outliers that should be removed from future analysis.

1.2 Community Engagement Round 1

In October of 2018, the ASTAR team introduced the project to the NSB communities in both tri-lateral leadership and public meetings. ASTAR held meet and greet gatherings with NSB departments, including North Slope Borough Department of Wildlife Management (NSBDWM) and IHLC, and presented to regional (i.e., Alaska Eskimo Whaling Commission tri-annual meeting) and state conferences (i.e., Alaska Waterways Safety Committee). Lastly, ASTAR team conducted the benefits evaluation survey in each community.

Technology/Tools

An ASTAR Stakeholder Engagement Database was created using SplendidCRM. This free tool provided an excellent database framework for logging the community meeting details by treating each community as a separate account. It offers a full-featured contact, account, meeting management system.

A Benefit Evaluation Survey was created in Esri's Survey 123®, a solution for creating online surveys, then storing and analyzing the results. The survey was used to collect stakeholder assessment of benefits criteria as well as participant contact information. The survey asked participants to assess the importance of each benefit criteria to their community using a Likert scale. The Likert scale is the most widely-used rating system for surveys and uses fixed choice responses (i.e., agree, moderately agree, strongly agree, moderately disagree, disagree, and strongly disagree) to gauge respondent attitudes or opinions.

The ASTAR Team analyzed the results and identified that the mode and count methods both identified that the communities expressed the greatest need to lower the costs of goods and services and to preserve or enhance subsistence traditions. All benefit criteria achieved greater than 60% marks of high to essential priority, without any outliers that would indicate a poorly chosen or worded benefit criteria. Thus, it was determined to keep the six original benefit criteria and proceed to the next stage.

Resource Data

1.3 Project Library

The Project Library is the catalog of potential resource and infrastructure projects being evaluated by the ASTAR team. These project ideas were collected during community engagement meetings, a review of community comprehensive plans, and a review of other regional infrastructure development studies. They were added to the project library data entry spreadsheet then uploaded to the project library database. A custom module for projects was added to the SplendidCRM Stakeholder Engagement Database. Within the website user interface, projects can be added, edited, or deleted.

The table below describes the information provided in the project library.

Table 2: Project Library

Title	Description
Project Name	The name of the project
Description	A brief description of the project
Communities	The communities in which this project will take place or who are direct recipients of the project benefits
Location Details	Any information about the project location that is pertinent to the project
Originator	Who provided project idea, who is the project proponent (could be person, company, or agency)
Contact	Point of contact for project, possibly at originator organization
Reference Information	Any relevant references for this project
Infrastructure Details	Explains more finite information related to the infrastructure dependencies and needs, also addresses interconnectivity
Benefit Categories	The types of benefits this project will provide
Benefit Comments	A description of specific project benefits

Resource Data

Community Support	Description, citations, or references of community support
Constraints	A description of potential constraints or limitations of this project
Infrastructure Categories	The categories and subcategories this project encompass
Project Status	The current status of the project
Status Comment	A description of the current status of the project
Notes	Any internal notes that should be captured about this project
Estimated Cost	The estimated cost range of this project
Latitude	The latitude of the point location of this project
Longitude	The longitude of the point location of this project
Project Dependencies	Reference any other projects that are related to this project, as a dependency, pre-requisite, sibling, etc.

After the project was identified, a general spatial location was created. The Project Library and spatial location were reviewed for quality and accuracy. The ASTAR Project Management Team reviewed the project library details and ensured it was of a high-quality for display in the project fact sheets. The spatial locations were reviewed to ensure they were correctly located and broad enough to capture potential alternatives.

The project library data was loaded into a custom project module in the same database as the stakeholder engagement database. This data was used to populate project fact sheets used in stakeholder engagement activities. The first use of the project fact sheets was to review them with community stakeholders and leaders to ensure the ASTAR group was on track with the type of projects and level of detail important to the stakeholder groups.

Technology/Tools

A project library data entry spreadsheet was created using Microsoft Excel. This was used to collect project details for the various resource and infrastructure projects collected from the stakeholder engagement meetings, community comprehensive plans, and other studies.

A project library module was created in SplendidCRM. The projects from the Excel data entry template can be loaded into the project library module in SplendidCRM where they are linked to the related community, contacts, etc. A custom user interface was created which gives ASTAR team members the ability to add or modify projects to the database.

Resource Data

Stage 2: Identify Priority Project Areas

A review of NSB specific documents resulted in more than 200 projects. Given ASTAR's goal of prioritizing project areas with the most benefits and support, priority project areas were identified based on areas with the greatest opportunities. Therefore, Stage 2 involves initial scoring and evaluating project inputs to identify areas which have the potential for greatest cumulative benefit for the region.

Project areas that have been identified to have the most potential cumulative benefit will receive additional analysis in Stage 3.

To accomplish the goal of identifying areas with highest potential for cumulative benefits, the ASTAR team participated in community outreach meetings; created a benefit criteria pairwise comparison (PWC) survey and collected results; analyzed PWC survey results using the analytic hierarchy process (AHP); completed project-benefits ratings using a weighted decision matrix (WDM); and created a benefits assessment report that is used to identify the projects with the most cumulative benefits by community, project area, and region.

Products developed in Stage 1 to support Stage 2 activities include the following:

- Stakeholder Surveys
- Stakeholder Engagement Database
- Project Library
- Project Fact Sheet: Hard Copies and Electronic PDFs
- Cumulative Benefits Analysis: Benefits Assessment Tool

Resource Data

Figure 2: Illustrated Stage 2 Process and Products

Resource Data
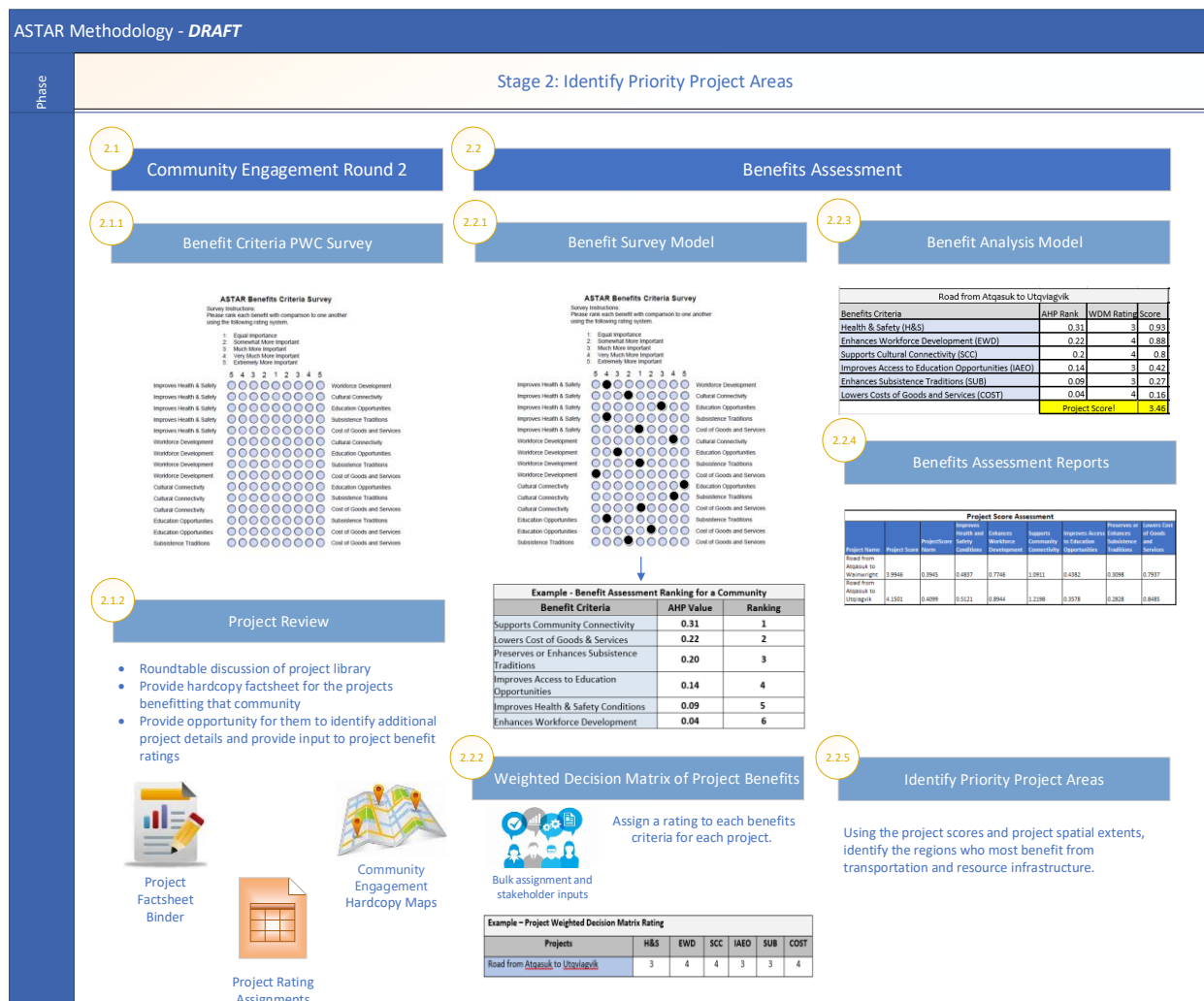
2.1 Community Engagement Round 2

2.1.1 Benefits Criteria PWC Survey

The initial benefit evaluation survey conducted during Stage 1 was necessary to gauge overall community opinion to vet the chosen benefits criteria. However, to ascertain more useful benefits criteria rankings for project area identification, it was necessary to enlist a smaller group of informed community members and leaders to perform a more robust comparison of all benefits criteria.

This was accomplished by using pairwise comparisons, which allows individuals or groups, through consensus building, to compare the benefits in pairs and make judgements as to which of the two is more important and by how much. All possible 15 pairs were evaluated, and the results analyzed using the analytical hierarchy process (AHP).

The stakeholder engagement team met with groups of community members to complete the benefit criteria PWC survey to provide the inputs necessary to rank the benefits for each community. The community results were aggregated to discover additional preferences on project area and regional levels. A single benefits criteria PWC survey was collected from each community and input to the benefit survey models as one of two primary inputs to create the benefits assessment reports. See Appendix A: Sub-Processes on page 23 for details on how these surveys were collected.

2.1.2 Project Review

During the second round of community meetings, the stakeholder engagement team reviewed community-specific projects as well as the regional projects with each community. Attendees were provided an opportunity to validate the current list and collect additional details or potential revisions. A list of projects and benefit ratings assigned to each project was shared with the community members then comments and revisions to the project ratings were collected. Additionally, feedback was solicited for improvements for the project ratings assigned by reviewing the project ratings spreadsheet.

Technology/Tools

A project factsheet binder was created by pulling information out of the project library and placing it into the project fact sheet template using Esri ArcMap, Python, and .NET technology.

Community maps were created for community engagement meetings.

A project rating spreadsheet was shared with the stakeholders and feedback was solicited on suggested improvements to the ratings.

Resource Data

2.2 Benefits Assessment

The benefits assessment is how the community benefit preferences were used to identify the areas most beneficial for infrastructure development. The benefit criteria PWC surveys use a pairwise comparison format that are be input into the AHP process. The resulting AHP scores are combined with a rating of the benefits for each project. The result is a list of scored projects that identify which are the most beneficial from the stakeholder perspective.

The qualitative benefits assessment tool includes the following:

- Pair Wise Comparison Matrix of Benefit Criteria
- Analytic Hierarchy Process
- Weighted Decision Matrix of Project Benefits
- Qualitative Benefits Assessment Reports

2.2.1 Benefit Survey Model

The benefit survey model was developed for ASTAR. It uses the benefit criteria PWC surveys as inputs and computes the AHP value for each community using a simplified version of the AHP. This provides a method for transforming a problem into a hierarchy composed of an overall objective, criteria for analysis, and the evaluation of alternatives. In the case of ASTAR, the objective is the stated program goal to "identify and promote North Slope infrastructure projects that have the most cumulative benefits", the criteria are the benefits, and the alternatives could be projects or project areas if AHP is to do a pairwise comparison of project alternatives. This decision-making process is both mathematically and psychologically-based in that it uses matrices and formulas to derive numerical values from inputs, whether discrete data or those based on human judgement. AHP accomplishes this using pairwise comparisons that sift out preferences among criteria and alternatives which can ultimately be used to rank and identify the decision that best suits the objective and understanding of the problem.

The ASTAR team used PWC for benefit criteria but determined not to use PWC to evaluate alternatives. Some communities had nearly 60 projects to evaluate and doing a pairwise comparison was too large an effort to solicit from community members. As an alternative, we used a weighted decision matrix to relate benefits to projects. For more information, see 2.2.2 Weighted Decision Matrix of Project Benefits on page 16.

A simplified version of the AHP method was employed to analyze the results of the benefits criteria PWC survey described in section 2.1.1 Benefits Criteria PWC Survey. The individual benefits of pairwise comparisons were put into a tool and subjected to mathematical processes designed to resolve the outputs to ranking values as exhibited in the figure below. The result of the AHP analysis is a list of benefit criteria, ranked by importance to that community. Results based on a single PWC survey could be considered to reflect a percentage value. However, if using the geometric mean of products, aggregation of multiple surveys can rank in unitless

values if more than one survey is conducted per community or if the community results are aggregated to derive regional rankings. For this reason, AHP outputs are best considered as relative rankings, rather than percentages or other common nomenclature.

Table 3: Example of a Benefit Assessment for a Community

Benefit Criteria	AHP Value
Improves Health and Safety Conditions	0.2847
Preserves or Enhances Subsistence Traditions	0.1837
Improves Access to Education Opportunities	0.1686
Supports Community Connectivity	0.1686
Enhances Workforce Development	0.1494
Lowers Cost of Goods and Services	0.0451

The table above demonstrates that a project that improves health and safety conditions provides more benefit to this community than a project that preserves or enhances subsistence traditions.

The PWC AHP results can be evaluated for each community or can be aggregated to determine preferences across a broader spectrum. For example, results for all eight North Slope communities can be multiplied to derive the geometric mean and return a ranking of benefits across the entire region. Likewise, community results for a specific area, say the Chukchi coastal communities, could be aggregated in the same manner to discern preferences among this distinct group. In other words, once a single, group-consensus PWC survey is acquired for each community, the results can be used in numerous permutations and should provide value throughout the life of the ASTAR project.

2.2.2 Weighted Decision Matrix of Project Benefits

A weighted decision matrix (WDM) process was used to assign a rating of each benefit criteria to each project. Project rating definitions were written so consistent metrics could be used when assigning the ratings. Initially, ratings were assigned to each project by the kind of infrastructure assigned to each project. The example below shows the rating assignments for projects that were gravel roads. See Appendix A: Sub-Processes on page 23 for more information the rating process.

Resource Data

Table 4: Arbitrary Gravel Road Rating Assignments

Benefit Criteria of Gravel Roads	Rating
Improves Health and Safety Conditions	3
Enhances Workforce Development	4
Supports Community Connectivity	5
Improves Access to Education Opportunities	2
Preserves or Enhances Subsistence Traditions	2
Lowers Cost of Goods and Services	3

Next, a list of all projects with blank ratings for all 6 benefit criteria was shared at the second round of community engagement meetings. Stakeholder feedback was collected on how to assign the ratings based on specific characteristics for each project. Each participant had access to project fact sheets and time to familiarize themselves with project parameters, goals, and requirements. This exercise provided for a well-informed group for project benefit rating.

WDM ratings were assigned via group consensus discussions or by individual matrices aggregated to a total rating. In this case, since the rating values was along a common scale (0-5), the simple mean of values provided a good overall rating from all inputs. Each project in the project library has a column for each benefit criteria (see the table below).

Table 5: Example of a Project Weighted Decision Matrix Rating

Gravel Road from Atqasuk to Utqviagvik	Rating
Improves Health and Safety Conditions	5
Enhances Workforce Development	4
Supports Community Connectivity	5
Improves Access to Education Opportunities	3
Preserves or Enhances Subsistence Traditions	4
Lowers Cost of Goods and Services	5

Resource Data

2.2.3 Benefits Analysis Model

The benefits analysis model is a custom tool in the ASTAR database that calculates project scores. The AHP score from the benefit criteria PWC survey and the project rating for the weighted decision matrix (WMD) are used as inputs to the model. Project scores are calculated by summing the products (AHP value of the community) x (WMD rating of the project) for each project/community combination. An example of this is shown in the table below.

Table 6: Example of a Road Project Score

Road from Atqasuk to Utqiagvik (Using Atqasuk PWC Survey)			
Benefit Criteria	**AHP Value**	**WMD Rating**	**Product**
Supports Community Connectivity	0.1686	5	0.843
Lowers Cost of Goods and Services	0.0451	5	0.2255
Preserves or Enhances Subsistence Traditions	0.1837	4	0.7348
Improves Access to Education Opportunities	0.1686	3	0.5058
Improves Health and Safety Conditions	0.2847	5	1.4235
Enhances Workforce Development	0.1494	4	0.5976
		Project Score	**4.3302**

2.2.4 Benefits Assessment Reports

A series of reports were generated from the results of the benefits analysis model that include the project scores and reports for each community's scores (Appendix C: Reports).

The **Benefit Analysis Results** page in splendid high level results for each individual analysis. Alternately the results can be exported to excel to include additional columns of data related to the analysis:

- Several project information columns (project description, references etc)
- Analysis Name & ID
- Communities included in the analysis
- Product for each benefit criteria for each project (shown in Table 6)
- Project Score for each project included in that analysis (shown in Table 6)
- Normalized project score using three methods:

Resource Data

- normalized by mean of all projects
- normalized by sum of all projects
- normalized by sum of all projects multiplied by 10.

In this report you will get more than one set of results per project if the project was included in more than one analysis.

The **Project Account Scores Report** is similar however there is only one row per project. It combines all AHP Surveys and Projects associated to the accounts for those surveys. Project scores for multiple communities were grouped and aggregated by geometric mean to derive a single overall score for the project under consideration.

Community scores for specific projects can be aggregated for project areas or for the entire region to acquire an overall score for the project. This is done by linking more than one community to an analysis. A tally of projects and their scores grouped by areas can then be used to define project areas where cumulative benefits may be the greatest. The results are determined by computation of the geometric mean of the inputs (i.e., the product of project score for the area). The result is the ability to sort the project lists by the project score to see the ranking of the projects that provide the most cumulative benefits for the communities or across the entire region.

Table 7: Example of Project Score Assessment for Two Projects

Benefit Criteria	Regional - Point Lay Atqasuk Wainwright Connection	Road from Atqasuk to Utqiagvik
Supports Community Connectivity	0.843	0.843
Lowers Cost of Goods and Services	0.2255	0.2255
Preserves or Enhances Subsistence Traditions	0.7348	0.7348
Improves Access to Education Opportunities	0.843	0.5058
Improves Health and Safety Conditions	1.4235	1.4235
Enhances Workforce Development	0.747	0.5976
Project Scores	**4.8168**	**4.3302**

Resource Data

2.2.5 Define Priority Project Areas

Using the project scores and GIS locations, we identified the projects that provide the highest cumulative benefits to regional stakeholders. Groupings of projects further defined the regions that most benefit from transportation and resource infrastructure.

Technology/Tools

The benefits assessment tool was created by adding two analysis modules to the SplendidCRM ASTAR database. An AHP.NET code pack was tested and configured to consume benefit criteria survey results, process those results using the AHP PWC method, and copy the results on a SQL Server database. This tool has an additional analytic interface that processes the weighted decision matrix for the project benefits ratings. Two reports are generated, one is a project list for each community with a score assigned to each project. The second is a single list where the geometric mean is calculated for projects that benefit more than one community, thus providing a regional score across all projects.

A series of Python scripts were written to join the analytic data to the spatial data and publish the results to ArcGIS Online shared with the ASTAR group for further analysis.

Stage 3: Define and Analyze Priority Project Areas

Those areas passed forward to Stage 3 are determined to best meet needs, goals, and objectives; have local support; and demonstrate that they will provide benefits to a wide spectrum of stakeholders.

Project areas advanced to Stage 3 are exposed to more rigorous desktop analysis by subject matter experts (SMEs) to characterize the project; describe or quantify expected benefits; and identify feasible alternatives, important constraints, data gaps, and other key factors affecting project success. This involves analyzing the priority projects in detail to adopt an analysis strategy; further define factors and constraints; select scoring criteria and weighting methods; and perform alternatives analysis.

3.1 Subject Matter Expert Consultation

Consultation with SMEs was necessary to identify inputs to analyses and inform the weights of various factors identified as critical to these analyses through pairwise comparison of the analysis layers. SME consultation enables analysts to select appropriate spatial and non-spatial data as well as help decide the best approach for codifying value judgments about these data. SMEs were consulted to ascertain this input and composed a series of technical memos each analysis layer.

3.2 Analysis Strategy

The analysis strategy varies depending on the type of project(s) being evaluated. A route analysis uses tools such as the Path-Distance and rasterize tools. A facility siting project would use distance and suitable areas tools. Some analyses may require socioeconomic analysis and use little or no geospatial data. For the purposes of ASTAR most alternatives analyses will use the reclassify and weighted overlay tools to assign suitability on a common scale and varied weights across the analysis layers.

3.3 Data Gap Findings

Each analysis strategy requires input data and criteria to inform the analysis. Once the necessary data inputs are assembled in a geodatabase, the various sources are evaluated for data gaps against the area of interest. The area of interest, the North Slope Borough, is 90,000 square miles. We can refine this process by using the ASTAR Projects GIS layer to prioritize data gaps. As you recall the ASTAR Projects layer identifies the regional corridors that provide the highest benefits for regional development.

Resource Data

Stage 4: Field Data Collection for Priority Data Gaps

Collect relevant field data (e.g., gravel surveys, Lidar, and lake surveys) to help communities better understand the opportunities and constraints of future infrastructure development. Data collected from these efforts should live long beyond the ASTAR project.

Resource Data

Appendix A: Sub-Processes

Benefits Criteria PWC Survey

These are best practice instructions for how to collect pairwise comparison data in agroup setting.

1. **Plot a large poster of the benefits pairwise comparison (PWC) survey.**
   a. Can be laminated for multiple uses or just plot one for each community.
   b. Each poster will include community, date, stakeholder categories represented (i.e., tribal, community member, QIT, NSB, etc.), number of participants, and facilitator(s).
2. **Assemble representative group of community members.**
   a. The number of group participants should be large enough to get a clear decision but small enough to be effective, such as 7-10 people.
   b. This group would have to be solicited beforehand by invitation or nomination.
   c. The group should approximate the community makeup.
   d. Individuals selected should be obvious and acceptable choices for participation by the community-at-large.
3. **Provide a group briefing on the PWC survey process.**
   a. Discuss the meaning of each benefit so it is clear what it is trying to capture (e.g., "Projects that enhance workforce development are those that provide new business development or job opportunities, better access to existing places of employment, etc.").
   b. Explain that for each line in the survey, only the two benefits on that line are being compared to one another (e.g. "Which is more important for your community: projects that improve health and safety or those that provide more employment opportunities?").
   c. It is okay if these are hard choices. Recommend that the group focus on the one at hand and the AHP process will sort out the distinction between them all.
4. **It should be explained that this is a "democratic process" where the majority will rule on each line of the survey.**
   a. Hopefully this sets the stage, in the event of spirited discussion, for the clear aim of an accepted majority decision for each benefits comparison.
   b. This will be important to establish so the process can remain moving forward positively even when a vote does not go a participant's way.
5. **A facilitator will work down through each line of the survey.**
   a. Ask participants to vote by show of hands or by group discussion to consensus on which of the two benefits being compared on each line is more important than the other

Resource Data

      b.   Majority wins.

6. **Once a choice has been made by simple vote, the discussion turns to how important the chosen benefit is compared to the other by selecting a number on the winning side of the scale (left or right of "1").**
   a. A show of hands by pointing to each number on the scale might be enough.
   b. Majority wins on the scale choice as well.

7. **The number is circled and that line is complete.**
   a. A split vote or one lacking a clear majority can be given a value of "1" (Equal) if no consensus can be reached.
   b. "1" or "Equal" is a valid result and there is no reason to belabor the process to try and get a consensus in such a case.

8. **The same process is repeated for each line of the survey.**

9. The completed survey should be done in dry erase marker and photographed, and the results recorded on a smaller copy to ensure they are not lost during travel.

10. The process is complete and the survey ready to be delivered to Group 2 for analysis using AHP.

This process will take a little over an hour if each line takes 5 minutes; limiting discussion to 3-4 minutes for each will keep the process engaging and moving forward. The pre-survey briefing should give everyone an opportunity to form opinions about their feelings on each benefit and make selection for each line faster.

Resource Data

Figure 3: Example of Benefits Criteria PWC Survey

Purpose: This exercise helps identify types of projects viewed as more beneficial to your community by comparing the following six benefits categories. Your answers will be used as inputs for ranking the categories.

- Improves Health & Safety Conditions
- Enhances Workforce Development
- Supports Cultural Connectivity
- Improves Access to Education Opportunities
- Preserves or Enhances Subsistence Traditions
- Lowers Cost of Goods and Services

Instructions: For each row below, first decide if you prefer Benefits Criteria 1 or Benefits Criteria 2. Then indicate how important that Benefit Criteria is to you by circling a choice on that side of the page.

Example: For row 1,
- If you think the benefit of Enhancing Workforce Development in your community is *Very Strongly More Important* than the benefit of Improving Health & Safety Conditions, circle "7" on the right side.
- OR, if you think the benefit of Improving Health & Safety Conditions in your community is *Strongly More Important* than the benefit of Enhancing Workforce Development, circle "5" on the left side.
- OR, if you think both are *Equally Important*, circle "1" in the center.

Benefits Comparison

	Benefits Criteria 1	Extremely More Important	Very Strongly More Important	Strongly More Important	Moderately More Important	Equally Important	Moderately More Important	Strongly More Important	Very Strongly More Important	Extremely More Important	Benefits Criteria 2
1	Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Enhances Workforce Development
2	Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Supports Cultural Connectivity
3	Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Improves Access to Education Opportunities
4	Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
5	Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
6	Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Supports Cultural Connectivity
7	Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Improves Access to Education Opportunities
8	Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
9	Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
10	Supports Cultural Connectivity	9	7	5	3	1	3	5	7	9	Improves Access to Education Opportunities
11	Supports Cultural Connectivity	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
12	Supports Cultural Connectivity	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
13	Improves Access to Education Opportunities	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
14	Improves Access to Education Opportunities	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
15	Preserves or Enhances Subsistence Traditions	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services

Project Rating Guidelines

Enhances Workforce Development*

0 = Provides no benefit.

1 = Provides very few jobs to the local community.

2 = Provides a few jobs to the local community and may lead to other economic activity for local residents.

3 = Provides many jobs but will benefit only one community. May also enable other projects to move forward.

4 = Provides many jobs and may benefit more than one community. May also enable other projects to move forward or may lead to other economic activity within a region[1] or across the North Slope.

5 = Provides very many jobs and benefits to more than one community. Will enable other projects to move forward or will lead to other economic activity within a region or across the North Slope.

Resource Data

Improves Access to Education Opportunities

0 = Provides no benefit.

1 = Slightly[1] improves access to education opportunities to the local community.

2 = Moderately[2] improves access to education opportunities to the local community.

3 = Significantly[3] improves access to education opportunities to the local community and/or slightly improves access to education opportunities to more than one community.

4 = Significantly improves access to education opportunities to more than one community.

5 = Significantly improves access to education opportunities within a region or across the North Slope.

[1] *"Slightly" signifies that measurable indicators of improvement (such as number of students affected or the range of resources provided) are expected to be small in number compared to the overall student population. Students may include adults seeking continuing education.*

[2] *"Moderately" signifies that measurable indicators of improvement (such as number of students affected or the range of resources provided) are expected to be midrange in number compared to the overall student population. Students may include adults seeking continuing education.*

[3] *"Significantly" signifies that measurable indicators of improvement (such as number of students affected or the range of resources provided) are expected to be large in number compared to the overall student population. Students may include adults seeking continuing education.*

Improves Health and Safety Conditions

0 = Provides no benefit.

1 = Provides occasional[1] health and safety benefits to the local community.

2 = Provides continuous[2] health and safety benefits to the local community.

3 = Provides occasional health and safety benefits to more than one community.

4 = Provides continuous health and safety benefits to more than one community.

5 = Provides continuous health and safety benefits within a region or across the North Slope.

[1] *"Occasional" indicates health and safety benefits that may be limited in scope or frequency, such as providing itinerant staffing of clinics or seasonal access to resources.*

[2] *"Continuous" indicates provision of permanently deployed resources, such as full time staffing or access to resources.*

Resource Data

Lowers Cost of Goods and Services

0 = Provides no benefit.

1 = Slightly[1] lowers the cost of goods and services within the local community.

2 = Moderately[2] lowers the cost of goods and services within the local community.

3 = Significantly[3] lowers the cost of goods and services within the local community and/or slightly lowers the cost of goods and services to more than one community.

4 = Significantly lowers the cost of goods and services to more than one community.

5 = Significantly lowers the cost of goods and services within a region or across the North Slope.

[1] *"Slightly" indicates that any lowering of costs of goods and services are expected to be limited in range or in the percentage of the population that may be impacted.*

[2] *"Moderately" indicates that any lowering of costs of goods and services are expected to be in the middle of the range or in the percentage of the population that may be impacted.*

[3] *"Significantly" indicates that any lowering of costs of goods and services are expected to be wide in range or in the percentage of the population that may be impacted.*

Preserves or Enhances Subsistence Traditions

0 = Provides no benefit.

1 = Preserves or enhances subsistence traditions for the local community.

2 = Preserves or enhances subsistence traditions across the community area of influence.

3 = Preserves or enhances subsistence traditions within more than one community area of influence.

4 = Preserves or enhances subsistence traditions across a region.

5 = Preserves or enhances subsistence traditions across the North Slope.

Supports Community Connectivity

0 = Provides no benefit.

1 = Slightly[1] supports connectivity in the local community.

2 = Significantly[2] supports connectivity in the local community.

3 = Slightly supports connectivity in more than one community.

4 = Significantly supports connectivity in more than one community.

Resource Data

5 = Significantly supports connectivity within a subregion, region, or across the North Slope.

[1] *"Slightly" signifies that measurable indicators of improved connectivity (such as number of residents affected or the range of resources provided) are expected to be small in number compared to the overall student population. Students may include adults seeking continuing education.*

[2] *"Significantly" signifies that measurable indicators of improved connectivity (such as number of residents affected or the range of resources provided) are expected to be large in number compared to the overall student population. Students may include adults seeking continuing education.*

Appendix B: Templates

Create a Project Form in Splendid

** After creating each project it must be linked to at least one Community or Stakeholder Group

Create Survey Form in Splendid

BENEFIT SURVEYS »

SAVE   CANCEL

* Required.

Help Wiki

Name:*

Description

Include In Analyses: ☐   Date Collected: 📅 MM/DD/YY

Facilitator(s):   Number of Participants:

Benefit Criteria 1	Extremely More Important	Very Strongly More Important	Strongly More Important	Moderately More Important	Equally Important	Moderately More Important	Strongly More Important	Very Strongly More Important	Extremely More Important	Benefit Criteria 2
Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Enhances Workforce Development
Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Supports Community Connectivity
Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Improves Access to Education Opportunities
Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
Improves Health & Safety Conditions	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
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Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
Enhances Workforce Development	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
Supports Community Connectivity	9	7	5	3	1	3	5	7	9	Improves Access to Education Opportunities
Supports Community Connectivity	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
Supports Community Connectivity	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
Improves Access to Education Opportunities	9	7	5	3	1	3	5	7	9	Preserves or Enhances Subsistence Traditions
Improves Access to Education Opportunities	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services
Preserves or Enhances Subsistence Traditions	9	7	5	3	1	3	5	7	9	Lowers Cost of Goods and Services

** After creating each survey it must be linked to at least one Community or Stakeholder Group

Resource Data

Benefit Analysis Grid in Splendid

Project Factsheets

Projects Feature Service in ArcGIS Online

Legend

Project Accounts Scores

Point Lay - Nomalized by Mean

— 0.181000 - 0.556320
— 0.556321 - 0.931640
— 0.931641 - 1.306960
— 1.306961 - 1.682280
— 1.682281 - 2.057600

Legend

Project Scores

Point Lay

— 0.367600 - 1.130080
— 1.130081 - 1.892560
— 1.892561 - 2.655040
— 2.655041 - 3.417520
— 3.417521 - 4.180000

Resource Data