Appendix B-8

LAKE TAHOE RESTORATION PROJECTS
ESTIMATED NECESSARY EXPENSES & KEY MILESTONE DATES

Project Name: LiDAR and Multi-spectral Geospatial Data Acquisition and Baseline Threshold Associated Product Development for the Lake Tahoe Basin: Impervious Surface coverage Analysis and Inputs for Fire Hazard, Water Quality, Forest Health, Wildlife, and Fisheries Habitat Models

Agency: USGS

Prepared by: Toby Welborn Phone: (775) 887-7671 EIP #: 10162

SNPLMA Project #: _____

Identify estimated costs of eligible reimbursement expenses:

1. Planning, Environmental Assessment and Research Costs (specialist surveys, reports, monitoring, data collection, analysis, NEPA, etc.)	$	300,000	75 %
2. FWS Consultation—Endangered Species Act	$		%
3. Direct Labor (Payroll) to Perform the Project	$		%
4. Project Equipment (tools, software, specialized equipment, etc.)	$	8,700	2 %
5. Travel (including per diem where official travel status required to carry out project, such as serve as COR, experts to review reports, etc.)	$	4,900	1 %
6. Official Vehicle Use (pro rata cost for use of Official Vehicles when required to carry out project)	$		%
7. **Cost of Contracts, Grants and/or Agreements to Perform the Project**	$	36,360	10 %
8. Other Direct and Contracted Labor: Agency payroll for the Contracting Officer to do project procurement, COR, Project Inspector, Sec. 106 Consultation if required, NEPA Lead, Project Manager, Project Supervisor, and subject experts to review contracted surveys, designs/drawings, plans, reports, etc.; Also covered is the cost to contract for a Project Manager and/or Project Supervisor if contracted separately from other project contracts)	$	50,000	13 %
9. **Other Necessary Expenses** (See Appendix B-11)	$		
TOTAL:	$	399,960	100 %

Estimated Key Milestone Dates:

Milestones/Deliverables:	Date:
Contract high-resolution LiDAR and Orthoimagery Collection	Spring 2009
Collect high-resolution LiDAR and Orthoimagery Data	Summer 2009
Collect QA/QC Control Points	Summer 2009
Perform QA/QC on LiDAR and Orthoimagery Data and Review Metadata	Late Summer – Fall 2009
Present and Release Initial LiDAR and Multi-spectral Data	Winter 2009
Create Derivative Datasets • Bare Earth Surface • Slope • Aspect • Intensity Classification • Canopy Cover • Shrub Cover • Stand Height • Stand Density • Stem Count • Stem DBH • Crown Drip Line • Vegetation Indices (NDVI, EVI, TCAP) • Structural Diversity • Hydrologically Enforced Bare Earth Surface • Micro-drainages • Impervious Surfaces	2010
Present and Release All Datasets	2010
Final Completion Date:	12/31/2010

COMMENTS: Contractual specifications will be accomplished by the Tahoe Regional Planning Agency, the U.S. Geological Survey will take the lead on QA/QC, the creation of derivative datasets will be led by the University of San Francisco, and workshops and presentations will be done by all involved parties.

ROUND 10 CAPITAL PROJECT NOMINATION FORM
LAKE TAHOE FEDERAL SHARE EIP CAPITAL PROJECTS
APPENDIX K

Project Name: LiDAR and Multi-spectral Geospatial Data Acquisition and Baseline Threshold Associated Product Development for the Lake Tahoe Basin: Impervious Surface Coverage Analysis and Inputs for Fire Hazard, Water Quality, Forest Health, Wildlife and Fisheries Habitat Models

Federal Agency Sponsor: USGS

Contact: Tim Rowe

Threshold: WQ, Soils, Veg, Wildlife, Fish

Phone Number: (775)887-7627

Threshold Standard: WQ5, SC1, SC2, V1, V2, V3, V4, F1, F2, W1, W2, SR1, SR2, SR3

Email Address: tgrowe@usgs.gov

Funding Requested in this Round: $399,960.00

Total Project Cost: $399,960.00

Federal Share EIP rationale (select and describe appropriate EIP criteria from 5 items below – projects must meet one or more of these 5 items) :

1. Does the project involve federal land?
   - If so, is the federal land involved important to successful implementation of the project?

   The data that will be obtained for this project will include all land (a majority of which is federal land) within the Lake Tahoe basin.
2. Does the EIP identify the federal funding for the EIP project (project #)?

   EIP Project # 10162 – Remote Sensing Impervious Coverage Analysis and applicable to the planning of other EIP capital projects.
3. Does the project involve the conservation of a federal or regional threatened, rare, endangered or special interest species?

   The data that will be purchased and derivative products, such as canopy cover, stand height, structural diversity, created under this request could be used at a later date to produce suitable habitat maps for Threatened, Endangered and/or Sensitive species including change detection of aerial distribution of suitable habitat if data is collected again at a future date.
4. Does the project involve an identified federal interest such as the detection and eradication of noxious aquatic or terrestrial invasive species?

   This data can be used to map the current distribution of certain noxious species of interest, and if this same data is obtained in the preferred 5 year timeframe, the extent of spread or decrease can be mapped, quantified and reported with relative efficiency.
5. Does the project otherwise directly support federal implementation of capital projects in the EIP (e.g. technical assistance, data management, resource inventories, etc.)?

   This project would directly support a broad range of capital projects including reducing cost for EIP projects, such as planning fuels reduction

projects, fire risk assessments, forest health/diversity evaluations, wildlife habitat suitability assessment, planning purposes for urban stormwater/erosion control projects, river restoration projects, and a host of other potential applications.

List Capital Focus Area(s) (as described in the 2006 Federal Vision):

This proposal targets both the Forest Health Focus Area and Watershed and the Habitat Improvement Focus Area although the data may be applicable for planning actions within other EIP Focus Areas.

Circle all that apply (must meet a minimum of one category):

1. Continued emphasis on forest ecosystem health/fuels reduction projects considering the LTBMU Stewardship Fireshed Assessment and Lake Tahoe Basin Multi-Jurisdictional Fuel Reduction and Wildfire Prevention Strategy.

2. Continued implementation of projects approved in Rounds 5 through 9 which implement the EIP. Project proposal should identify the applicable project(s) from Rounds 5 through 9 and clearly describe the phase/product being produced along with the consequence of not completing the project phase proposed for Round 10.

3. Project is consistent with and contributes toward TMDL pollutant reductions within the four source categories (atmospheric, urban & groundwater, forested uplands, and stream channel). List source category being addressed and integrate into the project nomination the following TMDL considerations (*see attached TMDL references – page 6). Source Category: **Urban & Groundwater, Forested Uplands, and Stream Channel**

a) Describe whether, and how, the project demonstrates advanced, alternative, or innovative practices.

b) If project includes project level monitoring, describe ability of proposed monitoring strategy to contribute to the state of TMDL knowledge. Also describe if purpose of the capital project is to conduct data collection and/or analysis related to Lake Tahoe clarity.

This data would be integrated with modeling tools currently under development (i.e. Pollutant Load Reduction Model) for use in estimating the annual fine sediment load reduction for different projects by incorporating a better topography layer. Additional analysis may be conducted in the future utilizing this data related to Lake Tahoe clarity.

c) Describe treatment approach for reducing pollutants, and/or measures to address connectivity between pollutant sources and Lake Tahoe or its tributaries. Identify target pollutants, and, to the degree feasible, provide quantitative estimates of project effectiveness at reducing pollutant loads (and/or a commitment to provide post-project estimates).

d) If appropriate, describe whether, and how, the project can be combined or coordinated with other TMDL implementation projects.

The refined topography data that will be generated will be used in the PLRM to assist the urban jurisdictions in prioritizing projects that will achieve the largest fine sediment load reductions.

4. Control of aquatic invasive species and prevention and/or detection of new aquatic invasive species.

Provide an overall Project Summary (maximum 200 words): (describe ONLY this Round 10 project):

The primary purpose of this project is to collect and make available high-resolution Light Detection and Ranging (LiDAR) and multi-spectral imagery covering the entire Lake Tahoe Basin. The spatial data set would be collected using proven new remote sensing technologies to provide an extremely accurate and analytically-rich source of geospatial information that will benefit an extensive user group, including EIP project planners. Applications for this data include, but are not limited to, fuel treatment planning, fire behavior modeling, habitat restoration planning and evaluation, hydrologic modeling, accurate mapping of vegetation height, density, size, distribution and heterogeneity, terrain visualization, landform extraction, surface feature extraction, watershed and water quality evaluations, community planning, engineering surveys and planning, and natural resource monitoring and evaluation.

The project proposes to deliver: 1) current LiDAR and multi-spectral geospatial datasets, 2) an analysis of the datasets to derive estimates of impervious hard and soft coverage for the entire basin, and 3) an analysis of the datasets to derive vegetation, terrain, and hydrologic attributes needed as inputs for fire hazard and water quality models. The effort will be coordinated with Basin GIS administrators and other staff to ensure wide use, understanding, and application of products.

Please provide clear and concise written responses to each of the items below. Please state "not applicable" if you believe the item or question is not applicable to your project.

Is this project proposed as a multi-round project (previous or future)? (If yes, for previous or future projects describe in the Detailed Project Description below number of years or phases and which year the requested funding will cover).

No, this proposal is only requesting funding for SNPLMA Round 10.

Detailed Project Description (focuses on what Round 10 is funding; list the number of years the requested funding will cover; briefly describe how this project links into previous and future projects).

LiDAR (Light Detection and Ranging) is similar to radar technology in that the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal. This allows the end user to create three-dimensional construction of targeted features such as buildings, infrastructure, vegetation communities, and topographic features (Figure 1). Radar accomplishes this using radio waves while LiDAR uses light. This technology has been widely applied to forestry, urban planning, archaeology, geography, geology, geomorphology, seismology, remote sensing and atmospheric physics.

Figure 1. LiDAR data collected in Lewis County, Washington for the Puget Sound LiDAR Consortium showing "highest hit" and "bare earth" data (Watershed Sciences Inc., 2008). This data will provide agencies with a similar capability of measuring terrain characteristics of the Lake Tahoe Basin (note the clarity of terrain features such as roads and flood plane details that would go unnoticed using traditional aerial photography or satellite imagery).

Compared to classical aerial photography, multi-spectral imaging captures light from multiple places in the light spectrum with some being located beyond the visible light range, such as infrared. This allows extraction of additional information that the human eye fails to capture with its receptors for red, green and blue. These additional bands allow for the creation of spectral signatures specific to features such as vegetation vigor, bare earth, and potential moisture. Fusing multi-spectral data with LiDAR data allows for the integration and convergence of structural and spectral features which opens up a vast number of applied analysis opportunities (Figure 2).

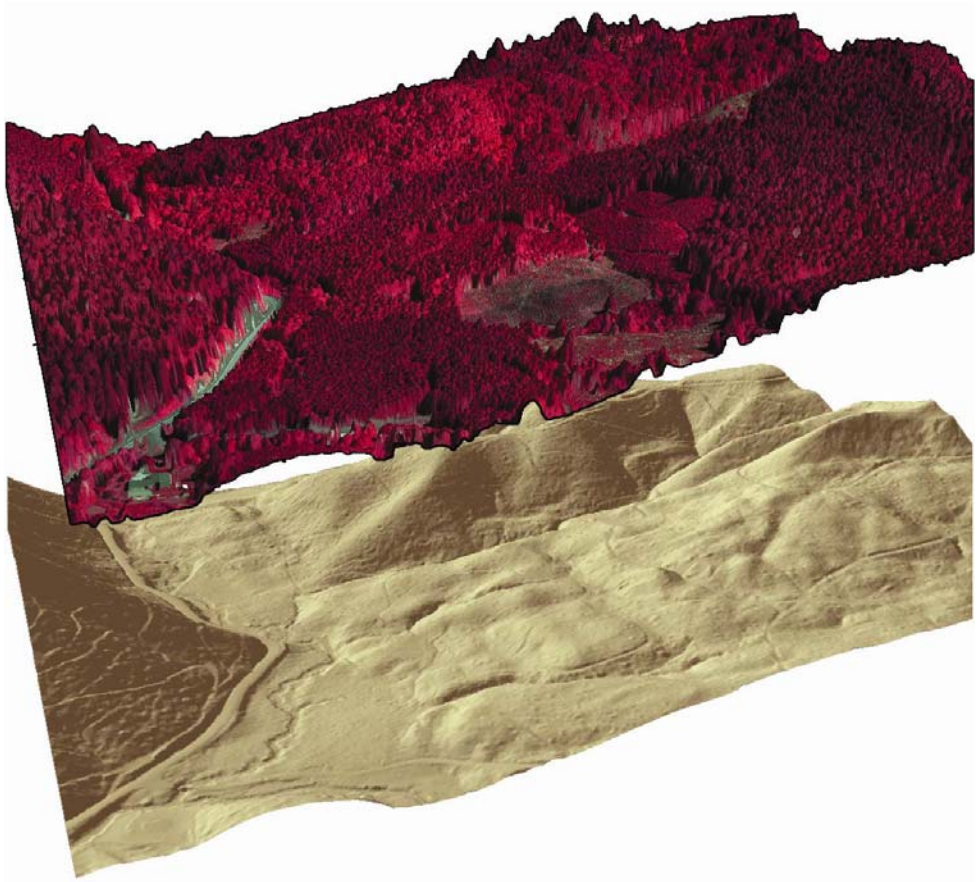

Figure 2. Incorporating multi-spectral near infrared (NIR) with LiDAR highest hit and LiDAR bare earth data in the Siuslaw National Forest in Oregon (Watershed Sciences Inc., 2008). This figure illustrates the integration of micro-topography with vegetation structure (tree heights) and vegetation vigor (color, red is healthier).

Much of the current data used for geospatial analysis and modeling in the Lake Tahoe Basin have spatial and temporal limitations that make accurate estimates and conclusions difficult. For example, many models use the National Elevation Dataset (NED) 10-meter Digital Elevation Model (DEM) that were derived from the 7.5 minute USGS quadrangles. Structures, anthropogenic landscape alterations, and natural change that occurred after the creation of the 7.5 minute quadrangle are not featured in the data. While these data are valuable to provide general estimates, they do not provide the level of spatial or temporal refinement necessary to make decisions about current conditions in the basin.

This project proposes to improve upon existing information products such as terrain mapping and create new base information products in the Lake Tahoe Basin by using SNPLMA Round 10 funding to collect high-resolution LiDAR and multi-spectral imagery data, conduct quality assurance/quality control (QA/QC) analyses, conduct an analysis of the datasets to estimate impervious surface coverage throughout the basin, provide specific products applicable to characterizing water quality pollutant loading, forest vegetation and wildfire hazard, and present and disseminate these data to agencies and entities with interests in the basin. The project area covers the entire Lake Tahoe Basin (200,952 acres, Figure 3).

This project will begin in 2009 when funding becomes available and continue through the end of 2010. LiDAR and multi-spectral imagery will be collected either simultaneously or near concurrent in the summer of 2009. QA/QC data collection

and evaluation will begin two weeks before LiDAR and multi-spectral imagery collection and continue through the fall of 2009. Initial data products will then be presented and released following QA/QC of the data at the end of 2009. Data analysis and derivatives will begin in the winter of 2009 and continue through the fall of 2010. Workshops will be coordinated and conducted with end users to present finalized LiDAR and multi-spectral datasets, and analysis methodologies and limitations of geospatial data derivative products (GIS layers) and analysis results as they become available.

The collection of high-resolution LiDAR and multi-spectral imagery directly ties into several current and future projects in the Lake Tahoe Basin. For example, fire hazard is typically modeled using a program such as FlamMap. This project will produce the following inputs to FlamMap: elevation, slope, aspect, canopy cover, and stand height. FlamMap additional inputs could be derived from the data collected in this project including: fuel model characterization, crown bulk density, height to live crown. Additional models that could benefit from the data and data derivative products include:

- **Ecosystem Models**
  - **Vegetation Dynamics Development Tool (VDDT);**
- **Fire Models**
  - **Fire Effects and Monitoring Protocol (FIREMON)/Fire Ecology Assessment Tool (FEAT) Integrated (FFI),**
  - **Fire Behavior Mapping and Analysis Program (FlamMap),**
  - **Fire Area Simulator (FARSITE)**
- **Hydrological Models**
  - **Coupled Ground-Water and Surface-Water Flow Model (GSFLOW),**
  - **Modular 3D Finite-Difference Ground-Water Flow Model (MODFLOW),**
  - **Precipitation-Runoff Modeling System (PRMS)**
  - **Hydrologic Engineering Centers River Analysis System (HEC-RAS)**
  - **Hydrologic Modeling System (HMS)**
- **Erosion/Sedimentation Models**
  - **Water Erosion Prediction Project (WEPP)**
- **Urban Dynamics Models**
  - **Land Use Simulation Model (LUSM)**
  - **Pollutant Load Reduction Model (PLRM)**

For a list of specific deliverables see Table 1, which includes a listing of other future analysis that could be carried out by agency GIS staff or contracted under a separate funding arrangement.

Describe the specific goals and objectives of the project and describe how fulfilling those objectives will contribute to the achievement of one more environmental thresholds (air quality, water quality, soil conservation, vegetation, fisheries, wildlife, scenic, noise, recreation).

The goal of this project is to provide basin agencies with an accurate, high resolution vertical and horizontal spatial datasets that can be used: 1) to improve

the planning of EIP projects, 2) as model inputs for fire hazard and water quality assessments, and 3) to characterize current forest and urban conditions.

The objectives to accomplish the goals of this project are:

1. **Data Collection**
   LiDAR and multi-spectral imagery collection is the primary focus of the proposal. Specifications for the LiDAR data collection include a bare earth surface model, raw full width LAS files, a minimum of 1-meter post spacing, the ability to create 1-foot contours, the use of a sensor that is capable of ≥4 returns, hydrographic breaklines, and a hydrologically enforced bare earth surface. Specifications for the multi-spectral imagery will be four band (red, blue, green, and near infrared) and rectified to ground differential GPS surveyed ground control points. These data will be the base for product deliverables described in Table 1.

2. **Quality Assurance / Quality Control (QA/QC)**
   The USGS will conduct the QA/QC analysis. The QA/QC analysis will include the collection of independent elevation points from differential GPS surveys conducted by the USGS and other agencies in the basin. These points will be used to validate data in the raw LAS files and develop a non-partisan root mean square error (RMSE). Raw LAS files will then be used to evaluate the bare earth surface, breaklines, and hydrologically enforced bare earth surfaces. Metadata will be reviewed for completeness. This objective is a necessary step as it will verify the accuracy and precision of the data for its contribution to various threshold-related analyses.

3. **Release of Post-processed Data Products**
   After QA/QC, the initial LiDAR and multispectral imagery data products will be made available to interested basin agencies and researchers.

4. **Development of Derivative Data Products**
   The University of San Francisco will create derivative products (GIS layers) identified in Table 1. These produces will be useful as inputs to water quality and fire hazard models as well as for assessing other threshold-related conditions.

5. **Presentation and Dissemination of Derivative Data Products**
   Workshops and presentations will be scheduled to present the data and derivative products and disseminate these data to agencies and interested parties within the Tahoe Basin. Additional products that can be derived from this data beyond the scope of this project will be a topic for discussion after data is initially released and during the presentation of analysis products.

Table 1. Specific deliverables and future data derivatives from the proposed project (X = Data Derivative Product, p = Future Potential Data Derivative Product).

LiDAR/Multispectral Imagery Data Products	Geospatial Data Derivatives (GIS Layers)
Terrain	
Bare Earth Surface	X
Slope	X
Aspect	X
Hillslope Units	p
Shaded Relief	p
View Shed Analysis	p
Vegetation	
Intensity Classification	X
Canopy Cover	X
Shrub Cover	X
Stand Height	X
Stand Density	X
Stem Count	X
Stem DBH	X
Crown Drip Line	X
Vegetation Indices (NDVI, EVI, TCAP)	X
Structural Diversity	X
Vegetation Cover	p
Crown Bulk Density	p
Height to Live Crown	p
Multi-Scale Vegetation Classification	p
Vegetation Clustering	p
Fire Fuel Model Classification	p
Potential Biomass	p
Potential Decomposition Rates	p
Potential Carbon Sequestration Rates	p
Potential Carbon Emissions	p
Noxious weed/ Invasive mapping	p
Insect/disease outbreaks	p
Aspen abundance and distribution	p
Land Cover / Land Use	p
Hydrology	
Hydrologically Enforced Bare Earth Surface	X
Micro-drainages	X
Hydrology Networks	p
Aquatic Vegetation Classification	p
Basin Delineation	p
Urban	
Impervious Surfaces	X
Urbanized Areas	p
Roof Composition	p
Defensible Space	p
Wildlife	
Habitat Classification	p
Habitat Suitability Analysis	p
Habitat fragmentation assessment	p

Describe the anticipated project accomplishments **(i.e. products or identifiable environmental benefits being produced or implemented under this project):**

This project will provide the following products and deliverables:

1) **A QA/QC'd Multispectral Geodataset from Summer 2009 – High-resolution (<1m), 4-band (red, blue, green, and near-infrared, plus pan-chromatic band), multispectral imagery for the entire Lake Tahoe Basin.**
2) **A QA/QC'd LiDAR Geodataset from Summer 2009 for the entire Lake Tahoe Basin – Including:**
   - **LiDAR points in .LAS and ASCII formats**
     - **Final calibrated to control**
   - **LiDAR-derived bare earth elevation(1-meter resolution, stripped of ≥ 90% of vegetation/features)**
   - **LiDAR-derived bare earth hydrologically-enforced elevation model**
   - **LiDAR highest hit model (1-meter resolution)**
   - **Intensity images (0.5-meter pixel)**
   - **Breaklines delivered in the geodatabase format with separate feature classes for each defined breakline feature type.**
3) **Analysis of acquired geodatasets to provide an accurate calculation of hard and soft impervious coverage for the entire basin.**
4) **Analysis of the acquired geodataset to derive the following GIS map layer and spatial attribute products:**
   - **Vegetation:**
     - **Canopy cover**
     - **Vegetation Intensity Classification**
     - **Shrub cover**
     - **Stand height**
     - **Stand density**
     - **Stand height**
     - **Stem count**
     - **Stem (tree) DBH**
     - **Crown drip line**
     - **Vegetation indices (NDVI, EVI, TCAP)**
     - **Structural diversity**
   - **Terrain**
     - **Bare earth surface**
     - **Slope**
     - **Aspect**
   - **Hydrology**
     - **Enforced bare earth surface**
     - **Micro-drainage**
5) **Up to 5 user-group and interested party workshops will be conducted to present information generated by the project.**

Describe the "readiness" of this project to move forward **(urgency, capacity, capability, environmental documentation, interagency agreements, etc.):**

Prior to the SNPLMA round 10 proposal process, a number of public agencies representatives working in the Lake Tahoe Basin have been consulted through the Tahoe Science Agency Coordination Committee (TSACC) to identify remote sensing analysis needs including GIS administrator not affiliated with the TSACC. TSACC identified that this data acquisition could benefit EIP project planning and evaluation, research and modeling, monitoring and evaluation that could benefit a number of planning, monitoring, and risk assessment projects. There have also been

conference calls and emails exchanged with J. LaRue Smith and Toby Welborn of the USGS Nevada Water Science Center, Christopher Soulard and William Forney of the USGS Western Geographic Science Center, Dr. David Saah of the University of San Francisco, Dr. John Reuter of the University of California Davis, Hannah Schembri of the LRWQCB, Shane Romsos of the TRPA, and Karl Heidemann of the USGS Center for LiDAR Information Coordination and Knowledge (CLICK) to identify data specifications, evaluate data options, and address short and long-term needs. The information gathered from these contacts has been used to finalize data specifications and field estimates from seven contractors. These estimates have defined the framework for the budget of the project. The partnering agencies and institution (USGS, TRPA, University of San Francisco, and Lahontan) collectively have the technological and human capacity to carry out the work at the release of funding. USGS, University of San Francisco and TRPA currently have the personnel and computer/server capacity to manage and store the acquired datasets and resulting products.

Describe partnerships for this project. (if applicable, project should identify committed/secured partner funding and/or other partner contributions (describe) and how it is integrated into the project):

This proposal is being submitted as a partnership between the U.S. Geological Survey (USGS), the Tahoe Regional Planning Agency (TRPA), the Lahontan Regional Water Quality Board and the University of San Francisco. We anticipate broadening agency interest and participation after data have been acquired to include: USFS-LTBMU, Nevada State Lands, EPA, USACE, BOR, California State Parks, California Tahoe Conservancy, and other interest EIP implementing agencies and groups.

Describe the estimated environmental risks from unintended consequences of the proposed project:

Not Applicable – No environmental risk will be introduced as a result of this project

Describe the project monitoring that will be implemented as part of this project including:

1) **The questions the monitoring program is designed to answer**

The data that will be acquired can be analyzed to answer regional status and trends (change detection) and project effectiveness questions. However, these analyses are beyond the scope of the proposed project. This data would be valuable for establishing baseline conditions that could at a later date (preferably 5 years) be compared to similar datasets to detect changing conditions at the regional or project scale.

2) **Describe the methods and strategies (i.e. monitoring, research, or both) that will be used to verify whether the project goals and objectives have been met? (Note, a detailed monitoring plan and/or research plan is not required, however, enough detail must be provided to allow someone that is unfamiliar with the project to understand and evaluate the proposed methods and strategies)**

The completion of analyses and the delivery of products to end-users will be used to judge the success of this project.

3) **Describe whether the monitoring or research associated with this project fits into or is part of a larger monitoring or research program.**

As stated in item 1 above, this data would be valuable for regional status and trend monitoring for a number of valued natural resources and applicable to project-scale effectiveness monitoring if data are re-acquired at a later date and compared.

4) **Describe how information from the monitoring and/or research will be used to improve the continued performance of the proposed project or future similar projects**

Researchers and managers working in the Lake Tahoe Basin have a long history of monitoring, measuring, and modeling. This data will be useful in updating models used in the Tahoe Basin with better topography and land features that will assist in improved performance over the long-term. Additionally this information in combination with other monitoring information may improve the current state of knowledge in the Tahoe Basin.

Describe how the project results will be communicated and made available to the public.

Communicating LiDAR and multi-spectral imagery availability, data structure and usability basin-wide to agencies, interested parties, and the public is one of the major accomplishments of the project. After data collection, project staff will be responsible for working with all partner agencies and interested parties to insure project data and information is disseminated. Meetings and workshops will be scheduled to provide support, gain feedback, and distribute the LiDAR and multi-spectral imagery data and their data derivatives. For the continued development of more data derivatives and model applications, regular conference calls and email communications will be maintained between the USGS, TRPA, LRWQCB, and University of San Francisco points of contacts, as well as other interested parties. As requested, presentations will be made at relevant Lake Tahoe meetings such as the Tahoe Science Agency Coordination Committee (TSACC), Lake Tahoe Science Consortium, LTIMP, and others. Point data will also be made available through the USGS Center for LiDAR Information Coordination and Knowledge (CLICK) group at http://lidar.cr.usgs.gov and the TIIMS website.

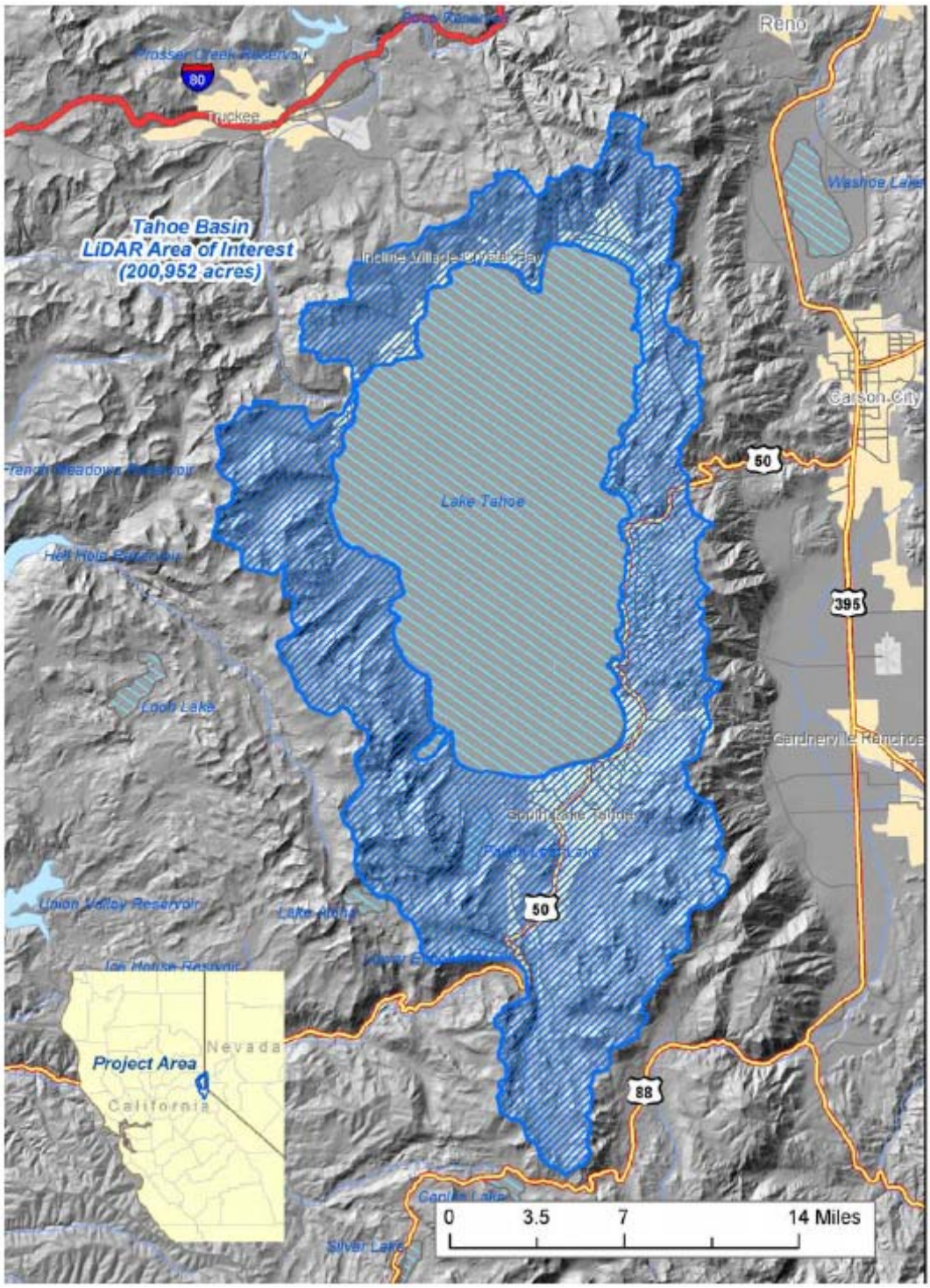

Figure 3. Proposed high-resolution LiDAR and multi-spectral imagery collection area, Lake Tahoe Basin, California and Nevada (Watershed Sciences Inc., 2008).