



**U.S. Department of the Interior
Bureau of Reclamation
WaterSMART
Applied Science Grant
FOA No. BOR-DO-19-F012**



Pala Tribe Innovative Practices in Hydrologic Data Acquisition and Use for Water Management



Applicant:

Pala Band of Mission Indians

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October 30, 2019

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Section 1: Technical Proposal and Evaluation Criteria

1.1 Executive Summary

Date:	October 30, 2019
Applicant name:	Pala Band of Mission Indians
City, County and State	Pala, County of San Diego, California 92059
Project name:	Innovative Practices in Hydrologic Data Acquisition and Use for Water Management
Project length:	24 months
Estimated completion date:	December 30, 2021
Located on a Federal Facility:	No

The Pala Band of Mission Indians (Pala Tribe) is pleased to submit this application titled “Innovative Practices in Hydrologic Data Acquisition and Use for Water Management” to the United States Bureau of Reclamation (BOR) WaterSMART Applied Science grant program for Fiscal Year 2019. The Pala Tribe is applying for \$55,120.00 in federal funding assistance from the BOR. The proposed project accomplishes objectives described in the Funding Opportunity Announcement BOR-DO-19-F012, Applied Science Grant, under Category A. The main project goals are to acquire new hydrologic data to improve drought management on the reservation, prioritize water deliveries, monitor watershed health, and to develop a hydrologic-use water tool to support water resources management. The proposed project will be completed within two years of award of the grant, approximately by December 30, 2021.

The Pala Tribe understands the importance of applying innovative, science-based and advanced techniques to acquire reliable watershed data. Data are to be translated into actionable information to strengthen water security and resilience against hydrologic uncertainty due to extreme weather events, climate change and water scarcity. Methodology proposed for this project includes acquiring remote sensing imagery and applying geospatial techniques. The Pala Tribe recognizes the value of water resources data to improve decision-making by using the generated data to communicate the information to end-users, thus results of this project include development of a hydrologic-use data tool.

The proposed project supports grant objectives related to water supply reliability, drought management activities, watershed health, conservation, efficiency and management of water deliveries. Pala Tribe water resources are highly susceptible to agricultural water demands. Continuous aquifer withdrawals for crop irrigation could severely impact potable water availability on the Reservation. Agriculture has a long tradition in this region. The predominant crops cultivated are avocado, citrus, alfalfa and more recently vineyards. In order to ensure sustainable water-use on the reservation, the Pala Tribe

identifies the need to manage droughts at agricultural-field and watershed scale levels. In addition, the hydrologic-use water tool will assist water managers in providing readily available information to support decision-making related to water delivery.

Objectives:

Use remote sensing technology to obtain hydrologic data from unmanned aerial systems (drone) and satellite imagery to acquire hydrologic data related to land use coverage and vegetation health conditions on the Pala Reservation located in the Upper Pala sub-basin. Data obtained can be easily used to query and analyze data by Pala Tribe water managers to determine irrigation volumes, detect the onset and duration of droughts, and monitor post-wildfire vegetation response to assess watershed health. The implementation of this project will support Pala Tribe water reliability while building a sustainable climate and water resilient community.

1. Obtain continuous high-resolution satellite imagery for historical land coverage and climate time series records of Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High-Resolution Radiometer (NOAA-AVHRR) derived NDVI.
2. Obtain NDVI data at appropriate spatial and temporal scales using drone technology during four crop seasons for agricultural-field scale.
3. Use Geographic Information Systems (GIS) for macro and micro level mapping to process and integrate the remote sensing data to identify water resources wasting, estimate irrigation areas and watershed health impacts due to drought conditions.
4. Develop a GIS Hydrologic-Use data tool to support drought management and watershed health monitoring and conservation activities.

1.4 Technical Project Description and Milestones

Pala Tribe is a Category A applicant.

Water resources dynamic nature is affected by human activity, shifts in climate and extreme events can cause changes in water security and availability by the season. Given these realities, water managers need the right information at the right time to effectively address the Reservation's water resources challenges. The Pala Tribe understands the importance of applying innovative, science-based and advance techniques to acquire reliable data. Data are to be translated into actionable information to strengthen water security and resilience against hydrologic uncertainty due to extreme weather events, climate change and water scarcity.

On the Pala Reservation, approximately 320 acres are designated for irrigated agriculture. Farmers grow alfalfa, vineyards, citrus and avocado groves. During drought periods, groundwater extractions increase, and crop production is affected due to low yield. In addition, hydrologic conditions related to vegetation coverage vary throughout

the Reservation, and under drought conditions become susceptible to health decline impacting the watershed health and leading to an increase in groundwater extractions and wildfire risks. These issues affect water management related to drought, water reliability, water deliveries, watershed health, water efficiency and conservation.

The Pala Tribe does not have the necessary financial resources to address these water management problems and federal funding assistance becomes a necessary resource. Funding through this program will allow the Pala Tribe to acquire new hydrologic data and develop a hydrologic-use data tool to support water managers to query and analyze data to manage drought conditions, prioritize water deliveries and promote watershed health on the Reservation. Once the grant period ends, the Pala water managers in coordination with the Pala Environmental Department (PED) will retain and utilize the new data and management tool for a long-term period and will look for upgrades as applicable.

Project milestones

The Pala Tribe presents the following project milestones which will achieve the goals described in the WaterSMART Applied Science Projects Funding Opportunity Announcement No. BOR-DO-19-F012.

Milestone 1: Project management and environmental compliance.

- **Task 1: Project Management, Administration and Reporting**

Project management will be provided by appropriate Pala Tribe staff to ensure successful project implementation. Activities will include project oversight, securing contracts, managing consultants, and conducting meetings as necessary to discuss project progress. Grant administration will also be performed including activities to execute the grant agreement, ensure compliance with grant requirements, submit necessary project deliverables and supporting grant documents as well as prepare and submit regular invoice and progress report materials.

- **Task 2: Environmental Documentation**

Environmental impacts are not anticipated. National Environmental Policy Act (NEPA) related documentation will be addressed.

Milestone 2: New hydrologic data acquired with unmanned aerial systems and remote sensing imagery.

- **Task 3: New Data Acquisition**

The selected consultant in coordination with the PED will acquire data from two main sources: (a) Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Indices (MOD13Q1). This product provides a land cover/vegetation layer, the Normalized Difference Vegetation Index (NDVI), which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High-Resolution Radiometer (NOAA-AVHRR) derived NDVI; (b) Field

survey using drones with an attached NDVI sensor. The data obtained using drones will have a higher spatial resolution to complement and validate satellite data.

Milestone 3: Data processing and Hydrologic-Use data tool.

- **Task 4: Data Processing to Support Drought Management**
Drought management will be prioritized and strategized in two main perspectives: agricultural and the entire reservation. The new data will be acquired on temporal and spatial scales that the resource managers can apply to agricultural fields and at a watershed level.
- **Task 5: Hydrologic-Use Data Tool for Decision Support.**
A GIS-Hydrologic data use tool will be developed to query and analyze data by water resources managers in support of drought management, decision-making in water deliveries, watershed health monitoring and conservation activities.

Table 1 presents a proposed project schedule. The project has a duration of 24 months.

Table 1. Implementation schedule.

Task/Year	Timeline
Task 1: Project Management, Administration and Reporting	February 2020 – January 2022
Task 2: Environmental Documentation	February – March 2020
Task 3: New Data Acquisition <ul style="list-style-type: none"> • Remote sensing 16-day imagery products from MODIS satellite MOD13Q1, NDVI will be acquired for the period of record 2000–2019 (the imagery products are available from February 2000). • Unmanned aerial systems (drones) will be used to generate multispectral high-resolution digital elevation models and NDVI imagery for four seasons in a period of record of 24 months. 	March 2020 – December 2021
Task 4: Data Processing	March 2020 – December 2021
Task 5: Hydrologic-Use Data Tool for Decision Support.	September 2020 – December 2021

1.3 Project Location

The Pala Tribe is located in the northwestern portion of the San Diego County, California, at 33° 22' 2" north latitude and 117° 3' 15" west longitude, approximately 20 miles north of the City of Escondido via I-15 and State Highway 76. Figure 1 shows the reservation and the immediate vicinity.

The Reservation comprises over 12,000 acres and is occupied by the Pala Band, made up of the Cupeño and Luiseño Indians. The Reservation lies within the San Luis Rey River Basin, in the semiarid lands of Southern California where high interannual variability makes it challenging to quantify water volumes for capture. Higher temperatures and more intense rain patterns are projected in the future for this region, which could lead to more severe drought conditions and more frequent wild fires. The Pala Tribe believes that acquiring hydrologic data will help them to improve drought management and increase water efficiency and reliability in the reservation. The San Luis Rey River (River) intersects the Reservation just south of Highway 76. Most tribal residences are located north of

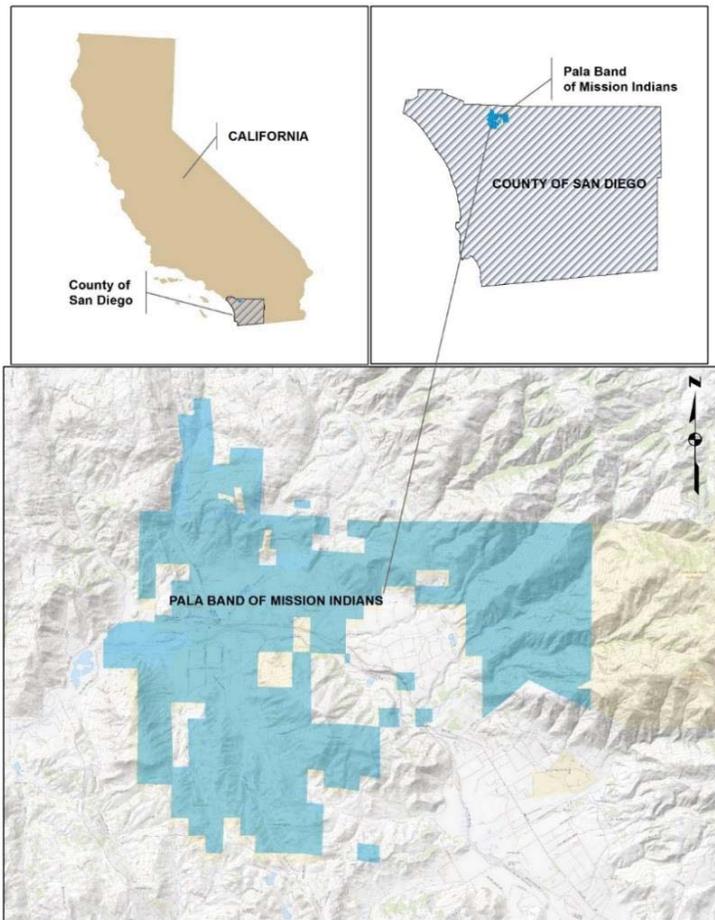


Figure 1. Location of Pala Band of Mission Indians.

Highway 76 although there are several residences on the south side as well. Approximately, 60% of the Tribal roads are paved. The Reservation ranges in elevation from a high of 3,977 feet at a mountain peak on its northeastern border to approximately 252 feet along the San Luis Rey River near the southern border. The terrain is primarily level or gently sloping land. In July, daily high temperatures average 95°F with overnight lows averaging 65°F. The Reservation receives no appreciable amount of snowfall and the average yearly precipitation is approximately 10.77 inches. Figure 2 shows the Reservation location within the Pala Sub-basin and the main agricultural lands. The predominant crops cultivated are avocado, citrus, alfalfa and more recently vineyards.

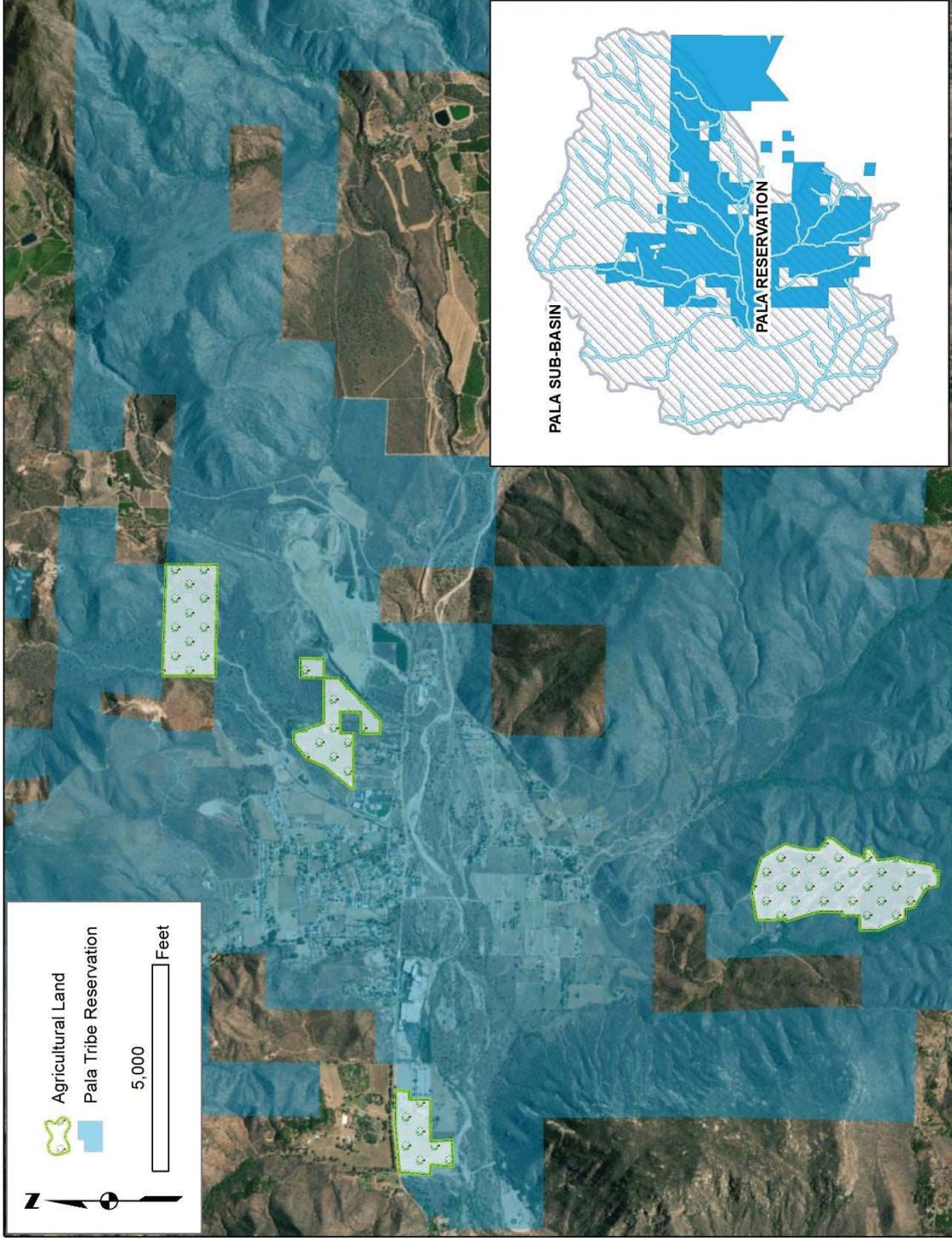


Figure 2. Pala Sub-basin and agricultural areas on the Pala Reservation.

1.5 Data Management Practices

Pala Tribe has hydrologic data available developed by their PED, GIS, and Public Works Departments. LiDAR imagery provided from the United States Geological Survey (USGS). Additional data has been downloaded from local sources such as the San Diego Geographic Information Source (SANGIS). Table 2 presents a summary of the hydrologic related data currently available to the Pala Tribe.

Table 2. Hydrologic data available on the reservation.

Hydrologic Data	Type/Coverage	Source
Flooding Areas	Point, Reservation	Pala GIS Department
Wells	Point, Reservation	Pala GIS Department
Water distribution system	Polyline, Reservation	Pala GIS Department
Water quality sampling	Point, Reservation	Pala GIS Department
Hydrologic Basins	Polygon	SANGIS
Geology	Polygon, Reservation	SANGIS
Soil type	Polygon, Reservation	SANGIS
Floodplain	Polygon, Reservation	SANGIS
LiDAR	Satellite Image, Reservation	USGS

Water resources data is managed by the PED. Practices include storing data in files (i.e. shapefiles, raster), and this activity is performed by one primary person in the Pala GIS department. Databases using Excel spreadsheets are used for storing information and to monitor water resources conditions such as, water table depth, water quality sampling results, irrigation volumes. At this moment, there are no tools to assist water managers and the PED with real-time decision-making to manage water deliveries during drought conditions. Obtaining new data is necessary to enhance accurate and reservation-scale databases that serve as a basis to hydrologic-use data tools for accurate resources management. Project deliverables will follow standard formats compatible with GIS platforms.

1.6 Evaluation Criteria

Evaluation Criterion A: Benefits to Water Supply Reliability

The Pala Tribe will use funds to acquire new hydrologic data and develop a hydrologic-data use tool. The project is expected to benefit water and drought management on the reservation by providing water managers in the Tribe with access to a tool built with accurate data to improve decisions on water deliveries and drought management.

Describe how your project will benefit water supply reliability:

- 1. Describe the water management issue(s) that your project will address. For example, will your project address water supply shortfalls or uncertainties, the need to meet competing demands for water, complications arising from drought, conflicts over water, or other water management issues? Describe the**

severity of the water management issues to be addressed through your project.

The proposed project directly addresses water management issues related to water supply uncertainties, complications arising from drought, management of water deliveries and water availability. Indirectly, the proposed project will assist on decision-making for water supply shortfalls. The water management issues detected on the Reservation can be classified as severe. Pala Tribe water supply depends on groundwater availability. Water extractions for agricultural irrigation imply significant volumes dedicated to this activity. Domestic Water use can be severely impacted by water shortages if water levels in the groundwater system decline. Reliable and timely hydrologic information on the location and area of major agricultural lands has significant economic and environmental implications. In addition, the new data to be acquired and the developed hydrologic data use tool will be applied to the entire reservation for drought management purposes. New data at the proper spatial and temporal scales is vital. While all dimensions of remotely sensed data are relevant, for practical purposes it is the temporal information that has been most useful for monitoring agricultural lands and semi-arid regions with remote sensing.

2. Explain how your project will address the water management issues identified in your response to the preceding bullet. In your response, please explain how your project will contribute to one or more of the following water management objectives and provide support for your response:

a. water supply reliability: The proposed project will benefit this objective as water use for irrigation would be tracked more effectively, and decisions can be made to improve water use efficiency. The proposed project can help to stabilize the water available from the ground water aquifer and improve reliability.

b. management of water deliveries: The proposed project will benefit this objective as the Pala Tribe will have tools based on certain timely data to support decisions on water deliveries for agricultural uses. The new data to be generated is related to hydrologic conditions on the reservation that indicate land cover density and vegetation health affecting runoff and treatment on infiltration. Cover type addresses vegetation, bare soil and impervious surfaces and is used to describe the management of cultivated agricultural lands. A recommended method to obtain these hydrologic components is through unmanned aerial systems.

c. water marketing activities: Not Applicable.

d. drought management activities: The proposed project will support drought management throughout the reservation. The new data and tool to be generated will support detecting the onset and duration of a drought period at watershed and agricultural field scales allowing water managers to make appropriate decisions on water deliveries and implementing mitigation actions. The innovative approach includes the use of satellite data to monitor the health of vegetation in relation to historic and ongoing drought episodes. Historic data to be obtained will be used as

baseline when analyzing current conditions. Data obtained with drones will be used to manage current conditions on the reservation. The NDVI has been used to improve predictions and impact assessments of disturbances such as droughts.

- e. **conjunctive use of ground and surface water:** Not Applicable.
- f. **water rights administration:** Not Applicable.
- g. **ability to meet endangered species requirements:** Not Applicable.
- h. **watershed health:** This project will benefit watershed health. Datasets and analysis performed with NDVI will provide information on hydrologic conditions at watershed scale. In this context, hydrologic conditions refer to density of lawns, crops, or other vegetative areas and amount of year-round cover. This index has been used to assess ecosystem health. In addition, it supports the evaluation of dynamic fire risk relying on the sensitivity of the index to vegetation dryness, also, a major predisposing factor for drought occurrence.
- i. **conservation and efficiency:** Pala Tribe expects to enhance water efficiency by improving agricultural irrigation management while promoting aquifer water levels conservation.
- j. **other improvements to water supply reliability:** Not Applicable.

3. Describe to what extent your project will benefit one of the water management objectives listed in the preceding bullets. In other words, describe the significance or magnitude of the benefits of your project, either quantitatively or qualitatively, in meeting one or more of the listed objectives.

The proposed project benefits the water management objectives selected in the preceding section. Drought management and watershed health will be supported quantitatively. New data acquired will allow the Pala Tribe to quantitatively assign a scale of drought and vegetation conditions on the reservation. The new data will have high resolution and spatial coverage. The vegetation dynamics and local climate are intrinsically linked and hence vegetation dynamics could provide information about climatic events, such as drought conditions. By comparing to historical data, Pala water managers will be able to determine onset and duration of droughts. Drought management activities will be supported with accurate and timely information generated with this project. The Hydrologic-Use data tool for decision support will include processed data discerned to be appropriately communicated to resource managers in a GIS format. Watershed health based on coverage type will also be visualized using the tool. This will allow resource managers to identify wildfire risk areas, which can assist in prevention of impacts to water quality conditions after rain events due to post-fire runoff and sediment transport.

Management of water deliveries and conservation and efficiency will be supported qualitatively. The Hydrologic-Use data tool for decision support will assist water managers on decisions for water deliveries during drought conditions. Agricultural

managers can also use the tool to decide on irrigation volumes, improving efficiency and promoting water conservation.

4. **Explain how your project complements other similar applicable to the area where the project is located. Will your project complement or add value to other, similar efforts in the area, rather than duplicate or complicate those efforts? Applicant should make a reasonable effort to explore and briefly describe related ongoing projects.**

The project is located in Tribal lands. Pala Tribe has not previously collected this type of hydrologic data to support the previously mentioned water management goals. Hydrologic data have typically been provided by local and federal sources. Spatial and temporal scales on these data need to be improved to obtain reliable information on the Pala water resources specific to the Reservation.

Evaluation Criterion B: Need for Project and Applicability of Project Results

Explain how your project will result in readily useful applied science tools that meet an existing need:

1. **Does your project meet an existing need identified by a water resource manager(s) within the 17 Western States?**

Yes. Multi-year drought conditions have affected the State of California. The project meets needs related to accurate drought management, water deliveries and water efficiency. The tasks executed during this project are necessary to improve drought management at a Reservation scale. Assessing crop health will support water usage optimization for irrigation on the Reservation. This issue has been detected by water managers as large volumes of groundwater are required for agricultural lands and excess usage can seriously impact water availability. Additionally, excess agricultural runoff impacts water quality on the Reservation due to fertilizers and pesticides applied on agricultural lands. The Pala Tribe recognizes the importance of drought management, water delivery prioritization, conservation, and efficiency on the Reservation as groundwater is the sole source of potable water for all uses. In addition, the Pala Tribe is currently participating with County of San Diego in the Sustainable Groundwater Management Act (SGMA) process and, has joined the local Groundwater Sustainability Agency (GSA) in order to further protect and use their water resources in a responsible and sustainable manner.

- a. **Explain who has expressed the need and describe how and where the need for the project was identified (even if the applicant is the primary beneficiary of the project). For example, was the need identified as part of a prior water resources planning effort, through the course of normal operations, or raised by stakeholders? Provide support for your response (e.g., identify the entities that have expressed a need or cite planning or other documents expressing a need for the project).**

The Pala Tribe identified the need of new and reliable water resources data to support planning efforts and improve water availability forecasts. The Pala Tribe has previously experienced drought conditions, wildfires and groundwater aquifer

depletion. The Pala Tribe has collaborated with other stakeholders in the San Luis Rey River Basin and with the SGMA for appropriate management and use of groundwater in a manner that can be maintained bringing groundwater basins into balanced levels of pumping and recharge.

- b. Provide letters of support from any resource managers, stakeholders or partners that have stated that they will benefit from the project, or, for Category B applicants, letters of participation from partners who have committed to participate in the proposed project. Identify any contribution (e.g., cost share, staff time, or other resources) by partners other than the applicant to the non-Federal cost share requirement for the project.**

Letters of support are included in Section 5.

- 2. Will the project result in an applied science tool(s) or information that is readily applicable, and highly likely to be used by water resource managers in the West?**

- a. How will the project results be used?**

The Pala Tribe will use project results to support drought management and water deliveries on the Reservation. Results of this project include datasets and development of a Hydrologic-use data tool to be built on a GIS platform that can easily allow water managers to query and visualize maps. GIS maps will include a database related to conditions of interest to facilitate information query. This tool will support the detection of healthy conditions in the crops during a season expected to positively impact water resources by diminishing groundwater extraction for agricultural irrigation. Temporal and spatial scales are an important factor to this tool, as it is important to understand that changes to the vegetation index vary locally and regionally as it depends on water availability, drought conditions, and the ecosystem. Another benefit is to track changes to the ecosystem over time due to climate change, wildfires and drought conditions.

- b. Will the results of your project inform water resource management actions and decisions immediately upon completion of the project, or will additional work be required?**

Pala water resources managers are collaborating on this project and maintain communication throughout the execution of all tasks. Once the Hydrologic-Use data tool for decision support is set up, managers will be trained to properly use it in their daily activities.

- c. Will the results of your project be transferrable to other users and locations?**

Yes. The methodology and results of this projects can be transferable to the neighboring Tribes located in the San Luis Rey River Basin.

- d. If the applicant is not the primary beneficiary of the project (e.g., if the applicant is a university or research institute), describe how the project beneficiaries have been or will be involved in planning and implementing the project?**

The applicant is the primary beneficiary of this project.

Evaluation Criterion C: Project Implementation.

Describe your project implementation plan:

1. Describe the objectives of the project and the methodology and approach that will be undertaken. Provide support for your methodology and approach.

Through an effective methodology, the Pala Tribe will acquire new hydrologic data to develop a Hydrologic-Use data tool that supports drought management, monitoring irrigation activity, managing unregulated irrigation, and optimizing water resources using satellite imagery and unmanned aerial systems. Some factors to consider in estimating the effect of land use cover on hydrologic components such as infiltration and runoff are density of lawns, crops, or other vegetative areas and amount of year-round cover. The methodology to be implemented include acquisition of new data of NDVI satellite imagery and NDVI in situ collection using drones. Satellite imagery and drone imagery will be combined to create a full dataset that allows the Pala Tribe to manage water resources during drought conditions. This combination is a substitute to traditional scouting. A GIS Hydrologic-Use data tool will be developed to support drought management and watershed health monitoring. Pala water managers would be able to quickly detect areas of concern on the Reservation and agricultural fields based on regions with low NDVI values instead of relying on time-consuming practices that are also prone to human error. New data and the Hydrologic-Use data tool will allow resource managers to:

- Manage drought conditions by monitoring vegetation health changes and coverage at watershed and agricultural-field scales to prioritize water deliveries.
- Monitor crop dynamics at seasonal scale to assist on optimizing irrigation volumes and water efficiency.
- Monitor watershed vegetation land coverage health to assist on forecasting fire-hazardous areas to promote watershed health, water quality, and conservation.

Specific objectives include:

- Obtain continuous high-resolution satellite imagery for historical land coverage and climate time series records of NDVI which is referred to as the continuity index to the existing NOAA-AVHRR derived NDVI.
- Obtain NDVI data at appropriate spatial and temporal scales using drone technology during four crop seasons for agricultural-field scale.
- Use GIS for macro and micro level mapping to process and integrate the remote sensing data to identify water resources wasting, estimate irrigation areas and watershed health impacts due to drought.
- Develop a GIS Hydrologic-Use data tool to support drought management and watershed health monitoring.

The new data will be acquired from MODIS and is validated by NOAA. The methodology has been implemented worldwide for different purposes related to droughts, detection of wildfire prone areas, agriculture, ecosystem management. For instance, in California NDVI assisted on monitoring vegetable crop evapotranspiration in San Joaquin Valley. In

addition, NDVI has been applied to monitor and evaluate protected ecosystems prone to drought and fires in southern California.

References:

- Gillespie, T.W., Ostermann-Kelm, S., Dong, C., Willis, K.S., Okin, G.S. and MacDonald, G.M., 2018. Monitoring changes of NDVI in protected areas of southern California. *Ecological indicators*, 88, pp.485-494.
- Johnson, Lee F.; Trout, Thomas J. 2012. "Satellite NDVI Assisted Monitoring of Vegetable Crop Evapotranspiration in California's San Joaquin Valley." *Remote Sens.* 4, no. 2: 439-455.

2. Describe the work plan for the project. Include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

Milestone 1: Project Management and Environmental compliance.

• **Task 1: Project Management, Administration and Reporting**

Project management will be provided by appropriate Pala Tribe staff to ensure successful project implementation. Activities will include project oversight, securing contracts, managing consultants, and conducting meetings as necessary to discuss project progress. Grant administration will also be performed including activities to execute the grant agreement, ensure compliance with grant requirements, submit necessary project deliverables and supporting grant documents as well as prepare and submit regular invoice and progress report materials.

• **Task 2: Environmental Documentation**

Based on the project nature, no environmental impacts are anticipated. NEPA related documentation will be addressed.

Milestone 2: New hydrologic data acquired with unmanned aerial systems and remote sensing imagery.

• **Task 3: New Data Acquisition**

The selected consultant in coordination with the PED will acquire data from two main sources: (a) Terra MODIS Vegetation Indices (MOD13Q1). This product provides a land cover/vegetation layer, the NDVI) which is referred to as the continuity index to the existing NOAA-AVHRR derived NDVI; (b) Field survey using drones with an attached NDVI sensor. Data obtained using drones will have a seasonal time scale high spatial resolution.

Milestone 3: Drought management and Hydrologic data use tool.

• **Task 4: Data Processing and Water management**

Drought management will be strategized in two main perspectives: agricultural and the entire reservation. The new data will be acquired in a time scale that the resource managers can apply to small scale fields and at a watershed scale.

- **Task 5: Hydrologic-Use data tool for decision support.**
Develop a GIS-Hydrologic data use tool to query and analyze data by resource managers in support to drought management, decision-making in water deliveries, evaluating watershed health and promoting conservation activities.

Table 3. Activities and duration of the proposed work.

Activity/Year	2020												2021											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
MILESTONE 1: Project Management and Environmental compliance.																								
Task 3: Activity 1: Compile MODIS Satellite Imagery at a 16-day temporal scale for the entire Reservation.																								
Task 3: Activity 2: Field survey using drones with an attached NDVI sensor at seasonal time scale.																								
Task 4: Activity 1: Process and Integrate data to develop NDVI maps at agricultural field scale.																								
Task 4: Activity 2: Process and Integrate data to develop NDVI maps to manage drought conditions and evaluate watershed health at a Reservation scale.																								
Task 5: Activity 1: Develop a GIS based Hydrologic data use tool integrating NDVI mapping, historical and ongoing records.																								

3. Describe the availability and quality of existing data and models applicable to the project.

The selected consultant in coordination with the PED will acquire data from two main sources: (a) Terra MODIS Vegetation Indices (MOD13Q1). This product provides a land cover/vegetation layer, the NDVI, which is referred to as the continuity index to the existing NOAA-AVHRR derived NDVI; (b) Field survey using drones with an attached NDVI sensor. Data obtained using drones will have a seasonal time scale high spatial resolution.

4. Identify staff with appropriate credentials and experience and describe their qualifications. Describe the process and criteria that will be used to select appropriate staff members for any positions that have not yet been filled. Describe any plans to request additional technical assistance from Reclamation or via a contract.

Pala Tribe has identified a qualified consultant to assist with activities related to this project. The qualified consultant firm has experience with NDVI analysis, satellite imagery, and GIS analysis and web applications. In addition, they have extensive experience with drone data collection.

a. Have the project team members accomplished projects similar in scope to the proposed project in the past either as a lead or team member?

Yes, the qualified consultant has proven experience acquiring data with unmanned aerial vehicles (UAV). Members of the team have also performed NDVI analysis using remote sensing imagery and GIS. In addition, the consultant has proven experience on developing GIS tools to support water resources data management and decision-making processes.

b. Is the project team capable of proceeding with tasks within the proposed project immediately upon entering into a financial assistance agreement? If not, please explain the reason for any anticipated delay.

Yes. Pala Tribe will contract with a consulting firm with experience in data acquisition using UAV technology. In addition, Pala PED staff will be available to support the proper implementation of this project immediately upon obtaining the requested financial assistance.

5. Provide a summary description of the products that are anticipated to result from the project. These may include data, metadata, digital or electronic products, reports and publications.

Products to obtain with the execution of this project include:

1. Historic dataset of NDVI satellite imagery.
2. Drone NDVI imagery.
3. GIS Maps at agricultural-field and Reservation scales.
4. Hydrologic-use data tool (GIS platform).

Evaluation Criterion D: Dissemination of Results.

Explain how project results will be disseminated, including:

- 1. Describe how the tools, frameworks, or analyses being developed will be disseminated, communicated, or made available to water resources managers who may be interested in the results.**

The Pala Water and Agricultural Managers will be involved in this project. The Hydrologic-use data tool will be developed in a user-friendly platform that can easily allow water managers to query and visualize maps. GIS maps will include a database related to condition of interest to facilitate information query.

- a. If the applicant is the primary beneficiary of the project, explain how the project results will be communicated internally, and to interested stakeholders and interested water resources managers in the area, if appropriate.**

The Pala Water and Agricultural Managers will be involved in this project as a team. Both departments will coordinate and communicate internally to approve the Hydrologic-use data tool to present the data in the most beneficial and useful arrangement for resource managers.

- b. If the applicant is not the primary beneficiary of the project (e.g., universities or research institutes) describe how project results will be communicated to project partners and interested water resources managers in the area.**

Not Applicable.

- c. Explain why the chosen approach is the most effective way to disseminate the information to end users in a usable manner.**

The Pala Tribe has chosen this approach based on the identified need to have access to user-friendly platforms that support water resources management on the Reservation. Developing this tool with accurate, new and local data will allow them to respond to drought conditions, water deliveries, evaluate watershed health, and promote efficiency and conservation in an effective and faster time frame.

Evaluation Criterion F: Department of the Interior Priorities.

The applicable Department of the Interior Priorities are discussed below.

- 1. Creating a conservation stewardship legacy second only to Teddy Roosevelt**
 - a. utilize science to identify best practices to manage land and water resources and adapt to changes in the environment;**

The Pala Tribe is utilizing science to identify best practices to manage their land and water resources to adapt to changes in the environment. The proposed project implements strategies to acquire satellite data administered by NASA and utilizes GIS to process and manage water resources data. The Pala Tribe is committed to become a sustainable community in a changing climate.

- 3 Restoring trust with local communities.**

The Pala Tribe has been environmentally conscious; working towards sustainable and long-term management of their water through actively engaging with other Tribes located in the San Luis River Basin. The Pala Tribe's Chairman declared the La Jolla, Pala, Pauma, Rincon and the San Pasqual Bands of Mission Indians have come together as one body to be a political advocate for the Tribes – to fight for water rights, address Tribes' water needs, and help Tribes develop and use their water appropriately and efficiently. As all of the tribes work together to seek their fair share of water allocation, they must consider what continued opportunities are available as owners of this valuable resource. The most basic responsibility of tribal leaders is to provide a variety of social, governmental, administrative, educational, health and welfare services for tribal members – Over the years Native Americans have made progress in these areas, but there is much more to be done. They continue to dedicate themselves to improving the quality of life for all of the Tribe's members.

Section 2: Project Budget

2.1 Funding Plan and Letters of Commitment

The funding plan proposed by the Pala Tribe is shown below:

FUNDING SOURCES	AMOUNT
Non-Federal Entities	
Cash contributed by Pala Tribe	\$55,891.00
Non-Federal Subtotal	\$0.00
Other Federal Subtotal	None
REQUESTED RECLAMATION FUNDING	\$55,120.00

The cost contributed by the Pala Tribe includes:

Pala Tribe staff salaries (hourly rate) for their support during the execution of all aspects of the project (\$55,391.00). Pala Staff salaries for this project are directly paid by Pala Tribe. Environmental compliance cost is also included as 50% cost-share (\$500.00). The cost contributed by the Pala Tribe is \$55,891.00.

The cost contributed by the BOR includes:

Equipment, materials and supplies, 50% environmental compliance cost, and contractual work. The cost to be contributed by the BOR is \$55,120.00.

No letters of commitment are required as no other funding source has been requested or included. No other project costs will be incurred prior the award.

2.2 Budget Proposal

The total project cost including all required cost sharing and voluntary committed cost sharing is shown in the following table.

SOURCE	AMOUNT
Requested Reclamation funding	\$ 55,120.00
Costs to be paid by the applicant	\$ 55,891.00
TOTAL PROJECT COST	\$ 111,011.00

2.3 Budget Narrative

The following budget proposal includes detailed information on all items of cost involved in the proposed project. Quotations of materials, labor and equipment included in this budget can be found in Appendix B: Letters of Support.

BUDGET ITEM DESCRIPTION	Computation		Quantity Type	TOTAL COST
	\$/Unit	Quantity		
Salaries and Wages				
Shasta Gaughen, Director PED	\$70.50	80	Hour	\$5,640.00
Heidi Brow, Water Resource Specialist	\$58.00	416	Hour	\$24,128.00
Matthew Deveney, GIS Specialist	\$40.50	376	Hour	\$15,228.00
Agricultural Manager	\$49.50	210	Hour	\$10,395.00
			SUBTOTAL	\$ 55,391.00
Travel				
Trip 1: NDVI field survey: three trips dry season per year	\$0.59	500	Mileage	\$ 292.50
Trip 1: NDVI field survey: three trips wet season per year	\$0.59	500	Mileage	\$ 292.50
			SUBTOTAL	\$ 585.00
Equipment				
			SUBTOTAL	\$ 0.00
Materials and Supplies				
NDVI Sensor	\$6,563.75	1	each	\$7,455.00
			SUBTOTAL	\$ 7,455.00
Contractual				
Consultants:				
Data collection, data processing and developing hydrologic-use data tool	\$46,580.00	1	Task	\$ 46,580.00
			SUBTOTAL	\$ 46,580.00
Environmental Compliance				
			SUBTOTAL	\$ 1,000.00
			TOTAL COST	\$ 111,011.00

Salaries and wages:

The PED Director will be involved in overview of the execution of the complete project. Hourly rate for the Director is \$70.5/hour. The PED Director will be paid at the specified hourly rate directly from the Pala Tribe to oversee this project. A total of forty hours for the entire project duration (24 months) is being included as cost share from the Pala Tribe.

The Pala Tribe Project Manager (Pala PM) will be involved during the execution of all tasks. The Pala PM is the Water Resource Specialist and will collaborate providing data, supervising field work in the reservation, creating reports, and overseeing the

development of the hydrologic database water-use tool. Hourly rate for the Project Manager is \$58/hour. The Pala PM will be paid at the specified hourly rate directly from the Pala Tribe to manage this project. It is estimated an average of four hours a week will be dedicated to this project.

The Pala Tribe GIS specialist will be collaborating throughout the project storing data in Tribal secured systems. In addition, collaboration during the development of the Hydrologic database Water-Use Tool includes facilitating GIS data, LiDAR Imagery, soil types, floodplain areas. Hourly rate for the GIS specialist is \$40.50/hour. The Pala GIS Specialist will be paid at the specified hourly rate directly from the Pala Tribe to collaborate on this project. It is estimated an average of three-four hours a week will be dedicated to this project.

The Pala Tribe Agricultural Manager will be collaborating providing data and with field work throughout the reservation. Hourly rate for the Agricultural Manager is \$49.50/hour. The Pala Agricultural Manager will be paid at the specified hourly rate directly from the Pala Tribe to collaborate on this project. It is estimated an average of three hours a week will be dedicated to this project.

Milestone 1: Project Management and Environmental Compliance

The Pala Environmental Director will dedicate 60 hours for the total duration of the project. Activities include securing contracts, updates to Tribal Chairman and Council, and conducting meetings as necessary to discuss project progress. The Pala Environmental Director budget for this milestone corresponds to a total of \$4,230.00, cost paid by Pala Tribe.

The Pala PM will dedicate two hours per week per 104 weeks in two years. Activities will include project oversight, securing contracts, managing consultants, and conducting meetings as necessary to discuss project progress. Grant administration will also be performed including activities to execute the grant agreement, ensure compliance with grant requirements, submit necessary project deliverables and supporting grant documents as well as prepare and submit regular invoice and progress report materials. The Pala PM budget for this milestone corresponds to a total of \$12,064.00, cost paid by Pala Tribe.

Milestone 2: New hydrologic data acquired with unmanned aerial systems and remote sensing imagery.

Task 3: New Data Acquisition

The Pala GIS specialist will dedicate in average two hours per week per 72 weeks. Activities include storing new data in secured Tribal system. The Pala GIS Specialist budget for this task corresponds to a total of \$5,832.00, cost paid by Pala Tribe.

The agricultural manager will dedicate in average three hours per week per 70 weeks in two years. Activities include providing access to agricultural lands during field surveys, providing relevant data for validation purposes. The Pala Agricultural Manager budget for this task corresponds to a total of \$10,395.00, cost paid by Pala Tribe.

Milestone 3: Drought management strategy and Hydrologic data use tool.

Task 4: Data Processing and Water management

The Pala PM will dedicate in average one hour per week per 88 weeks. Activities include drought management strategy review, and hydrologic data use tool review and approval process. The Pala PM budget for this task corresponds to a total of \$5,104.00, cost paid by Pala Tribe.

The Pala GIS specialist will dedicate an average of two hours per week per 52 weeks. Activities include validating and storing NDVI maps in Tribal secured system, and hydrologic data upgrades. The Pala GIS Specialist budget for this task corresponds to a total of \$4,212.00, cost paid by Pala Tribe.

Task 5: Hydrologic-Use data tool for decision support.

The Pala Environmental Director will dedicate two hours per week per 10 weeks. Activities include final presentation to Tribal Chairman and Council and conducting meetings as necessary with water users. The Pala Environmental Director budget for this milestone corresponds to a total of \$1,410.00, cost paid by Pala Tribe.

The Pala PM will dedicate two hours in average per week per 60 weeks. Activities include Hydrologic data use tool overseen and conducting meetings with all water users. The Pala PM budget for this task corresponds to a total of \$6,960.00, cost paid by Pala Tribe.

The Pala GIS specialist will dedicate an average of two hours per week per 64 weeks. Activities include storing Hydrologic data use tool in secured Tribal system, setting up and testing tool in internal system, uploading existing hydrologic data, and providing training to water users. The Pala GIS Specialist budget for this task corresponds to a total of \$5,184.00, cost paid by Pala Tribe.

Travel:

Trips are dedicated to data collection activities. Trip one includes three visits for a total of approximately 500 miles to acquire data with drone (3 days: San Diego-Pala Tribe-San Diego). Trip two includes three visits for a total of approximately 500 miles to acquire data with drone (3 days: San Diego-Pala Tribe-San Diego). Each roundtrip cost is \$97.50.

Equipment:

Not Applicable. The consultant will provide drone services for data collection.

Materials and supplies:

One NDVI sensor will be acquired for a total of \$7,455.00.

Contractual:

The Pala Tribe has identified the work that will be accomplished by consultants. Procurement methods for all activities have not been identified at this time. The information provided by the consultant and vendors were used to build the budget. The Pala Tribe understands that if the proposed project is selected procurement methods indicated by the BOR will be followed.

The project will require contracted services with the selected consultant for acquiring and processing data and developing the Hydrologic-Use data tool. Total amount for the 24 months of work will be \$46,580.00.

Environmental and regulatory compliance costs:

The estimated environmental and regulatory compliance cost is \$1,000. The cost was estimated based on information provided from the local Reclamation Office. It is the Pala Tribe's understanding that if the proposed project is selected, the local Reclamation office will send an environmental specialist to review and to provide the final estimate. The Pala Tribe will cover costs on the final estimate accordingly.

Total costs:

The total project cost is \$111,011, with \$55,891 to be contributed by the Pala Tribe, and \$55,120 to be covered by Reclamation.

Section 3: Environmental and Cultural Resources Compliance

The Pala Band of Mission Indians has complied with all NEPA regulations when conducting any work that is projected to be done on tribal lands. This regulation covers any work that may affect tribal lands, resources, or areas of historic significance on the reservation. Carrying out NEPA compliance helps continue the trust responsibility of the U.S. Government and protects tribal sovereignty.

- **Will the proposed project impact the surrounding environment? No. Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area.**
No earth-disturbing work that could affect the surrounding environment will be done. **Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.**
The project will not have impacts on the surrounding environment.

- **Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area?**

The Pala Tribe lands are within the San Luis Rey Watershed, a watershed that serves more than just humans. It consists of a variety of unique and diverse ecosystems that act as critical habitat for several species of concern, including the orange-throated whiptail, western skink, the California pocket mouse, the arroyo toad, coastal California gnatcatcher, least bell's vireo, southwestern willow, flycatcher, and the western yellow billed cuckoo.

If so, would they be affected by any activities associated with the proposed project?

The activities proposed in this project will not affect endangered species or the watershed ecosystem.

- **Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as “Waters of the United States?”**

The main water body in the watershed is the San Luis Rey River.

If so, please describe and estimate any impacts the proposed project may have.

This project will not have impacts to the San Luis Rey River.

- **When was the water delivery system constructed?** The ten supply wells were constructed during different years: 1977, 2001, 2002, 2003, 2008, 2015 and, 2018.

Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? No.

If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously. No modifications to the irrigation systems will occur during this project.

- **Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.** Yes.
- **Are there any known archeological sites in the proposed project area?** Yes.
- **Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?**

No. This project will help the Pala Tribe to improve water management in their community.

- **Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?**

The proposed project is in Tribal lands, as the Pala Tribe is the applicant. The project will not disturb Indian sacred sites.

- **Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?** No.

Section 4: Required Permits or Approvals

There are no required permits or approvals for the implementation of the proposed project.

Section 5: Letters of Project Support

Letters of support are included in Appendix B.



Section 7: Unique Entity Identifier and System for Award Number

The Pala Tribe's Unique Entity Identifier and System for Award Management mandatory requirements are listed below:

- Pala Tribe Unique Entity Identifier: 177146362
- Pala Tribe System for Award Management (SAM): 4UY61

The Pala Tribe will continue to maintain an active SAM registration, with current information at all times during which it has an active application, plan under consideration by a Federal awarding agency, or an active Federal award.

Section 8: Appendices

Appendix A: Quotations for equipment, materials and supplies included in the Budget

ENTERPRISE UAS



Micasense AG Sensor for Matrice 200 Series - Aerial Kit

Prepared by:

James Coloso

enterpriseuas.com

sales@enterpriseuas.com

Date Created: Oct 16, 2019

Prepared for:

Mehak Gupta

Altaenviron

Long Beach

Quote ID: VA3MF-8RZAC-WV7FQ-DCSKC

Pricing valid for 7 days after date received

Payment Options

[Financing Available](#)

[Purchase Orders](#)

[Wire Transfer Method](#)

Signatures

Name	Price	QTY	SKU	Subtotal
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General Section					
<input checked="" type="checkbox"/> Micasense RedEdge-MX <ul style="list-style-type: none"> • Compact Size • Easily integrates with wide range of drones • Five spectral bands • Global shutter for distortion free images • Updated aluminum design for improved ruggedness and heat dissipation 	\$5,500.00	1	S-MICA-REMX	\$5,500.00	
<input type="checkbox"/> Micasense Altum <ul style="list-style-type: none"> • Simultaneous capture of 5 discrete bands + thermal • High-resolution multispectral images • 2.5x higher resolution than RedEdge-M • Brand-new DLS 2 for unparalleled calibration accuracy • Radiometric spectral and thermal imagers • Mount on any larger drone • Rugged design with no moving parts 	\$9,950.00	1	S-MICA-ALT	\$9,950.00	
Micasense RedEdge & Altum - Matrice 200 Mounting Kit <ul style="list-style-type: none"> • Exclusive Micasense Matrice 200 Integration Kit • Easily mount & power a Micasense sensor with Matrice 200 	\$599.00	1	B-MICA-M200-REM-INT	\$599.00	

- All necessary items to mount and power sensor



Shipping and Handling

Free Shipping	\$0.00	1	\$0.00
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*****Add 3% Convenience Fee if NOT Paying by Check or Wire*****

*****Shipping fees will be determined upon order completion*****

***** Sales tax applicable if shipping inside CA or WA *****

We are first tier authorized FLIR dealers and will match competitive pricing quotes upon request

Subtotal	\$6,099.00
Long Beach Current Tax Rate (10.25%)	\$625.15
Total	\$6,724.15

Payment Options

Financing Available

Affirm financing provides innovative, technology-powered finance solutions for America's businesses as well as individuals. Basically – we're here for you so let's succeed together.

Purchase Orders

We support and welcome purchase order requisitions from local county, state and federal agencies as well as academic institutions.

Wire Transfer Method

We only recommend wire transfers for amounts over \$2,000 USD.

Please contact us for information on how to complete the wire transfer to place your order.

Signatures

Again, we want to thank you for purchasing your equipment or services with enterpriseuas.com. By signing below you agree to our terms and conditions and have read and understand the pricing provided. You also agree not to share the information & pricing provided in this document to anyone outside of your organization. <https://www.dronefly.com/terms-of-use>

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Signature	Date
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Name	Title

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Signature	Date
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Name	Title