Grand Canyon Monitoring and Research Center

Managing Data Resources and Online Content for GCMRC & GCDAMP

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Project K: Geospatial Science and Technology

Project Elements

- Geospatial Data Analysis
- Data Management / Data Science
- Access to Data Resources

Support Other Projects

- Support science projects with specific tasks
- Align this support with the goal of modernizing and improving data management, analysis, and data access strategies
- Often leveraging newer technologies to achieve these goals
- Center-wide support through the development of systems and resources

Geospatial Data Analysis – Support to Science Projects

Geospatial Data Analysis

- Provide geospatial expertise to science projects on:

  - Field mapping methods

  - Development of customized field maps

  - Sample site unit definition and selection

  - GIS layer development

  - GIS tool development and support.

- Oversight and support for various GIS-related tasks including:

  - Spatial analysis, including use of Python programming

  - Training for staff and cooperators in GIS data entry

  - Database management and Geospatial data set concepts

  - Data processing techniques

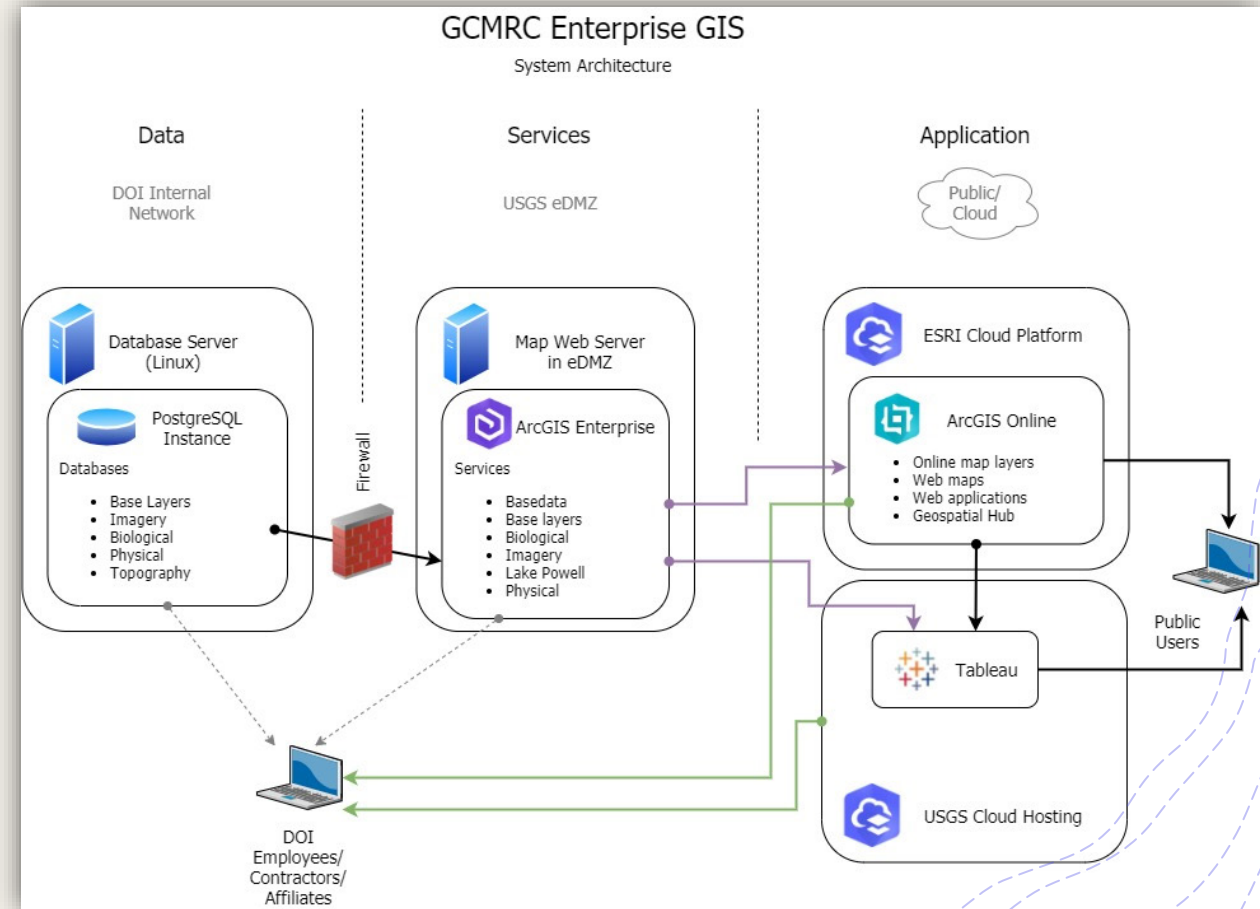 - Production of printed maps and online map products
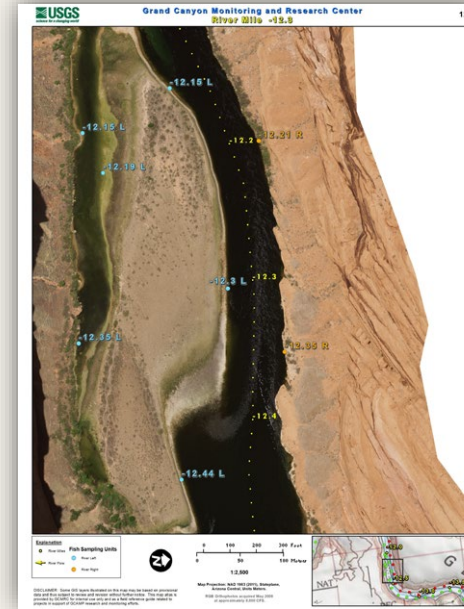
Geospatial Data Management – Support to GCMRC

Enterprise GIS Administration

- Storing and serving geospatial data in an enterprise environment

- Involves maintaining on-premise servers, system configurations

- Testing and migration of systems to newer versions of software

- Database administrative tasks

- Code development for automating the upload of data and publishing geospatial services online

GCMRC Enterprise GIS
System Architecture

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Data Management – Support to Science Projects
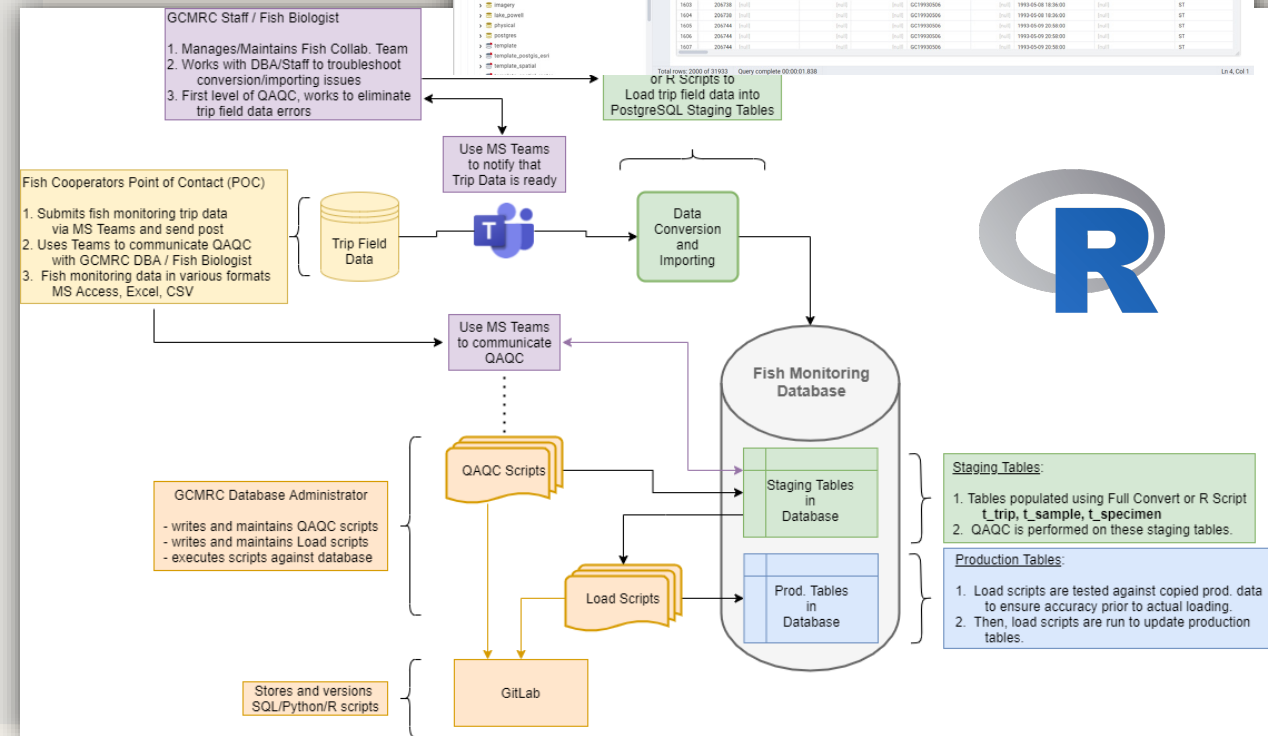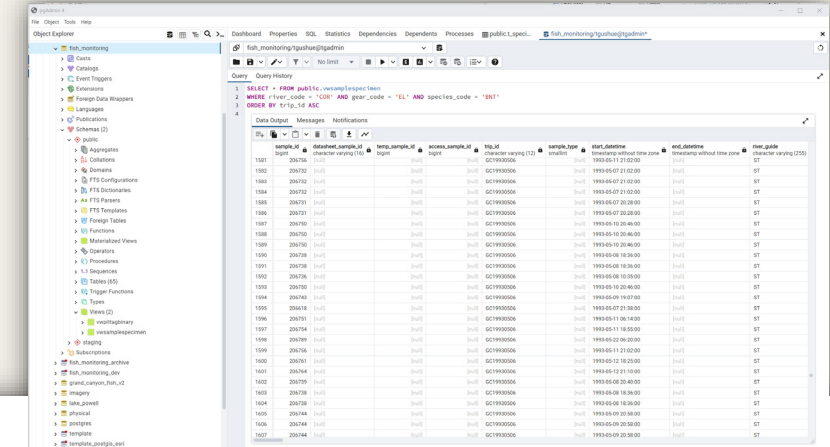

- **Fish Monitoring Database**
  - Migration from Oracle to PostgreSQL (2021)
  - Updated Workflow for Data Staging and QAQC (2022-23)
  - Leveraging tools such as Microsoft Teams & SharePoint to collaborate with fish cooperators across the GCDAMP.

- **Lake Powell Water Quality**
  - Published release of WQ database (2022)
  - Development of online tools (2023-24)

- **On-premise Data Resources**
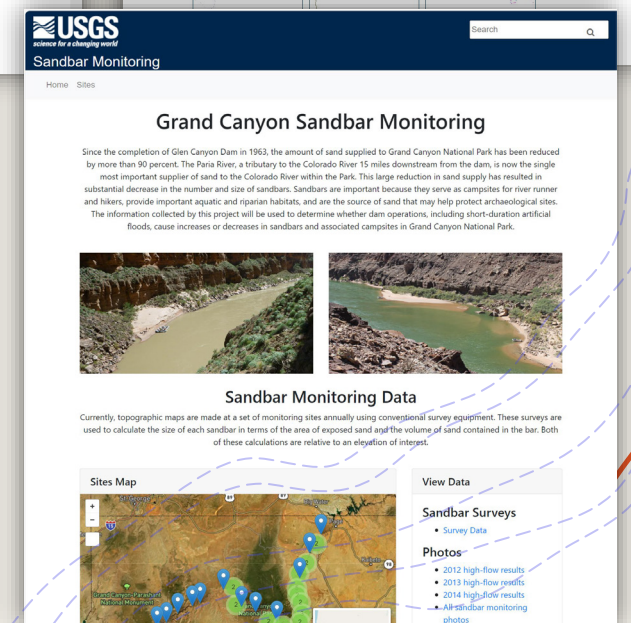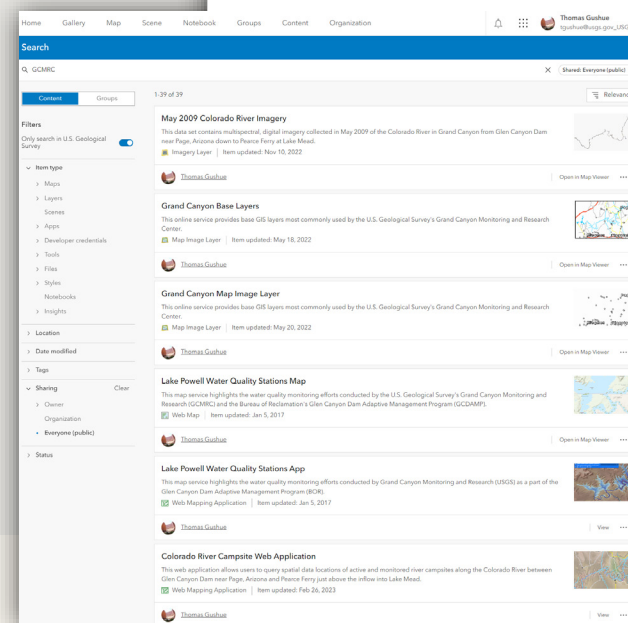 - Coordination with SBSC IT and GCMRC science projects to improve data management practices (on-going)
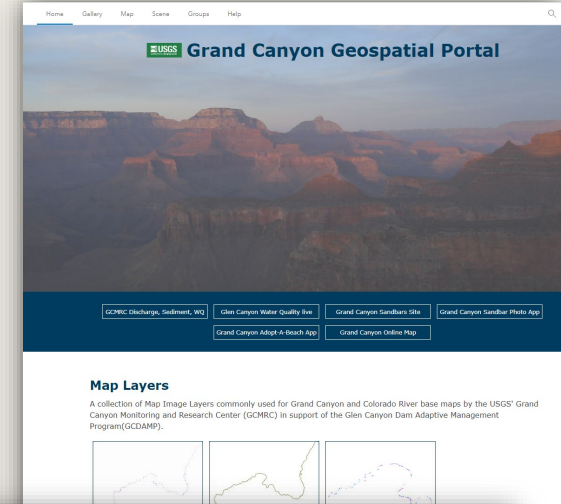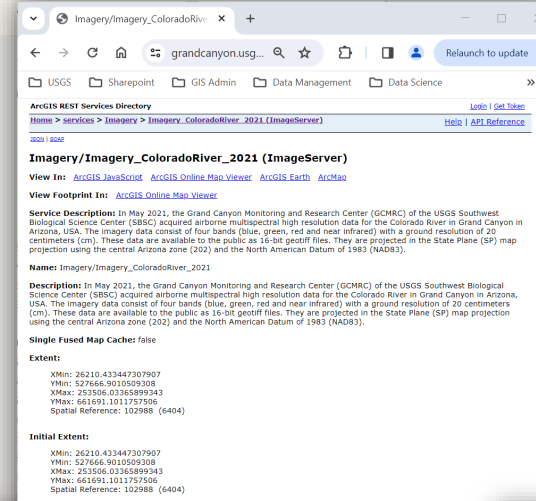
Access to Enterprise Data Resources

Case Study: Fish Monitoring Data

- ## Benefits of open-source data

  - Live link to data resources

  - Can use intuitive tools to look for trends in data
    - Tableau software shown here

  - Review recent and historical data

  - Search for anomalies / errors

  - Query and download data via the live database connection

Access to Online Data Resources

Access to Geospatial Data Online

- ### Direct Access to GIS Services:
  - https://grandcanyon.usgs.gov/server/rest/services

- ### Grand Canyon Geospatial Portal
  - https://grandcanyon.usgs.gov/portal

- ### ESRI's ArcGIS Online platform
  - Map layers, Web Maps, Web Apps

- ### Custom web-based applications
  - Sandbar Monitoring App
  - Long-term Monitoring Cameras Site

Access to Data Telemetry / Internet of Things (IoT)

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Glen Canyon Dam IoT Field Site

Glen Canyon Dam, near Page, AZ

- Sensor-to-Cloud data transmission
  - Field computer on-site communicates with sensor
  - Data are extracted at scheduled times
  - Data packets are sent via MQTT encrypted messages using a cellular connection to a data brokering client in Amazon Web Services.

- Data stored in cloud-based Postgres database
  - Partnering with USGS Cloud Hosting Solutions
  - Acceptable values defined for parameters
  - Redesigned the real-time data visualization

GCMRC IoT Diagram for Water Quality sensor at Glen Canyon Dam

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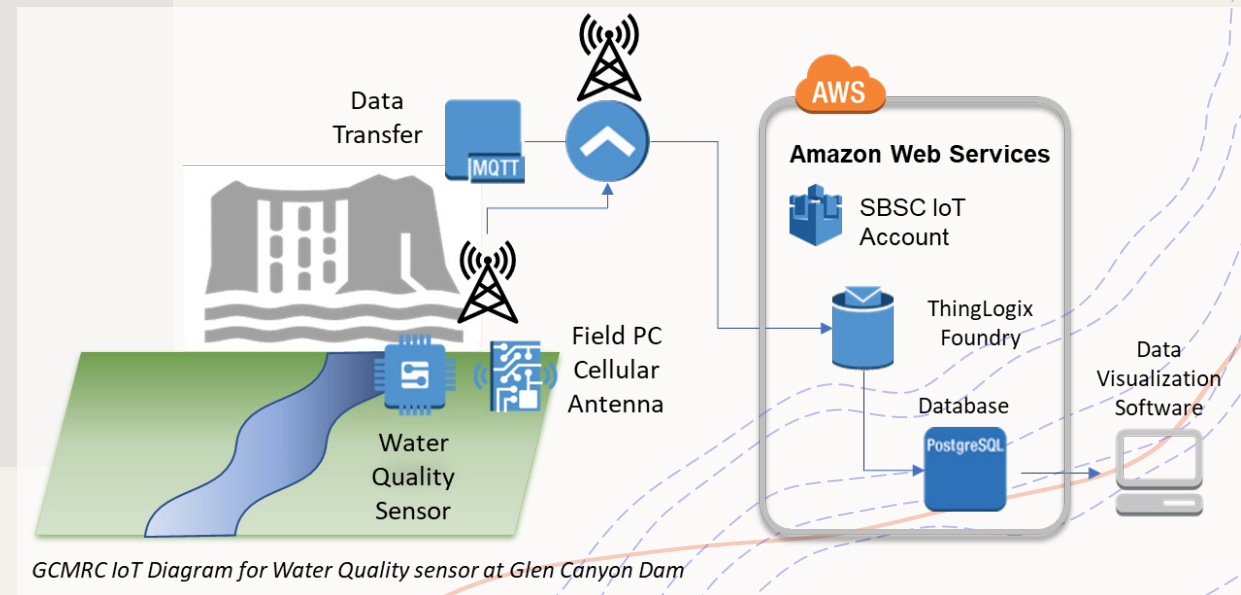# Access to Data Telemetry / Internet of Things (IoT)
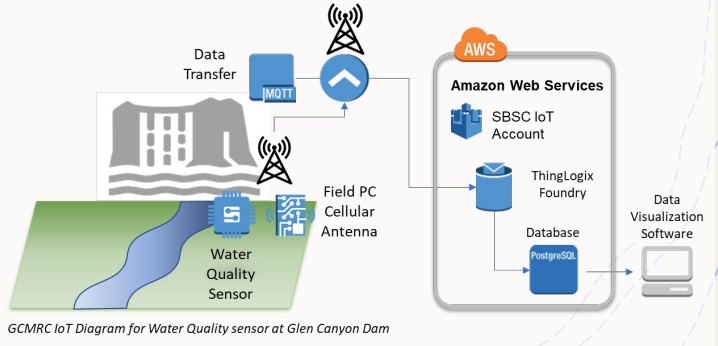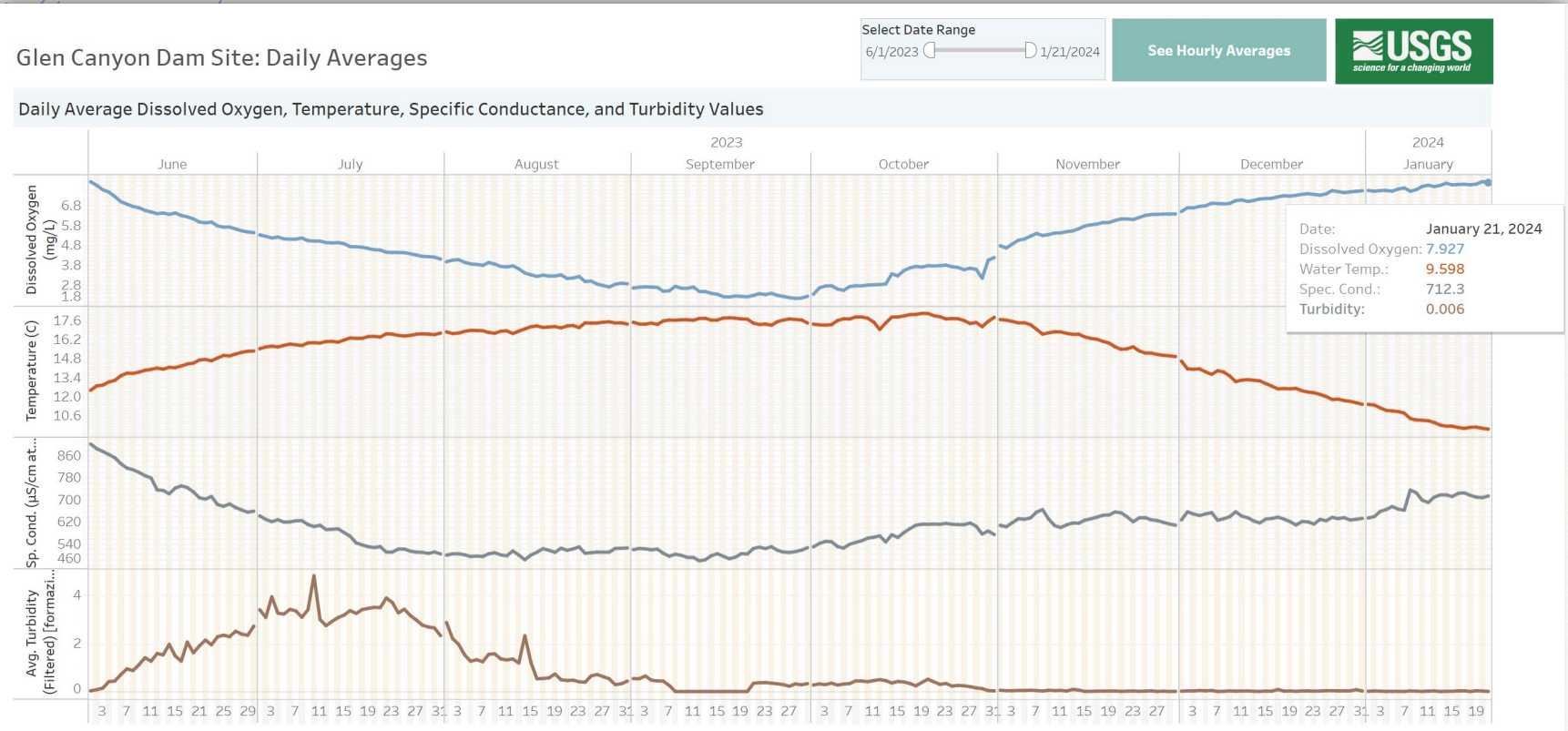

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Glen Canyon Dam IoT Field Site

- https://tableau.usgs.gov/views/colorado-river-water-quality-gcd/GlenCanyonDamSiteDailyAverages

Glen Canyon Dam, near Page, AZ

Glen Canyon Dam Site: Daily Averages

Select Date Range 6/1/2023 — 1/21/2024   See Hourly Averages   USGS science for a changing world

Daily Average Dissolved Oxygen, Temperature, Specific Conductance, and Turbidity Values

Date:	January 21, 2024
Dissolved Oxygen:	7.927
Water Temp.:	9.598
Spec. Cond.:	712.3
Turbidity:	0.006

The water quality data shown here are filtered raw values and are subject to revision through quality control / quality assurance procedures. These data are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data. Please visit GCMRC's Discharge, Sediment and Water Quality web site to plot or download the processed measurements from this station: https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09379901

GCMRC IoT Diagram for Water Quality sensor at Glen Canyon Dam

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Preliminary Information-Subject to Revision. Not for Citation or Distribution.

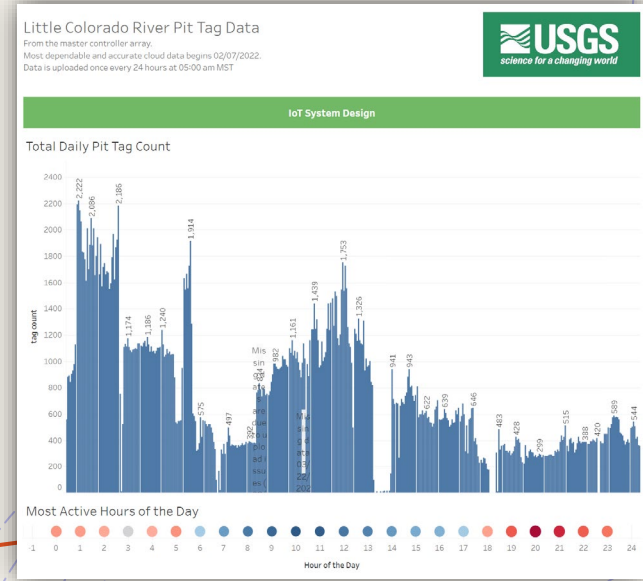# Access to Data Telemetry / Internet of Things (IoT)

Little Colorado River IoT Site

- ### Sensor-to-Cloud data transmission

  - Fish pit-tag antenna located in Little Colorado River now connected via cellular data service

  - Radio signal between River IoT site and Rim site with cellular

  - Access to provisional pit-tag readings for scientists and stakeholders in near real-time

  - Data download capabilities are now possible

Little Colorado River

Fish Antenna Array

Little Colorado River

Field PC Radio

MQTT

AWS

Amazon Web Services

SBSC IoT Account

ThingLogix Foundry

Database

PostgreSQL

Data Visualization Software

Little Colorado River Pit Tag Data
From the master controller array.
Most dependable and accurate cloud data begins 02/07/2022.
Data is uploaded once every 24 hours at 05:00 am MST

IoT System Design

Total Daily Pit Tag Count

Most Active Hours of the Day

Additional Project Support

- Integrating Content: Lake Powell Water Quality
  - Published WQ Database; Online Web App

- Programming Code Services
  - USGS GitLab maintenance and support
  - Python scripts & GUIs for automatic data downloads, field computer status, remote reboot for field systems
  - Developing code-base for accessing data

- Field Engineering Support
  - Designing, installing and maintaining solar power systems to support sensor deployments.
  - New water quality buoy to be deployed at Lees Ferry
  - Low Earth Orbit (LEO) Satellite antennas
    - First deployment of its kind within the U.S. Geological Survey
    - Improved reliability of data and reduced costs

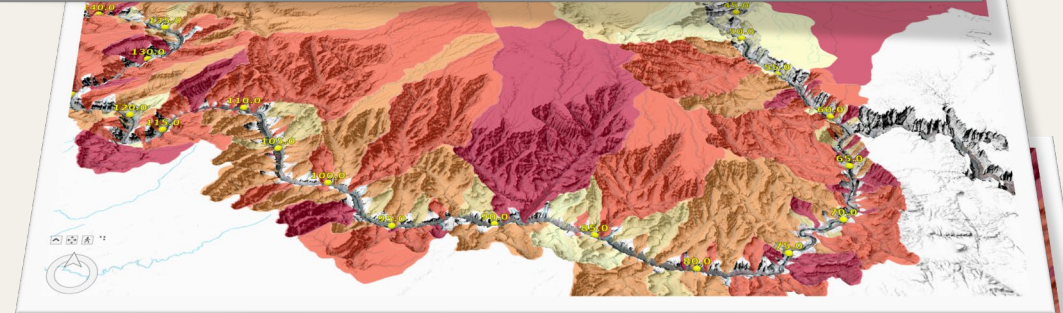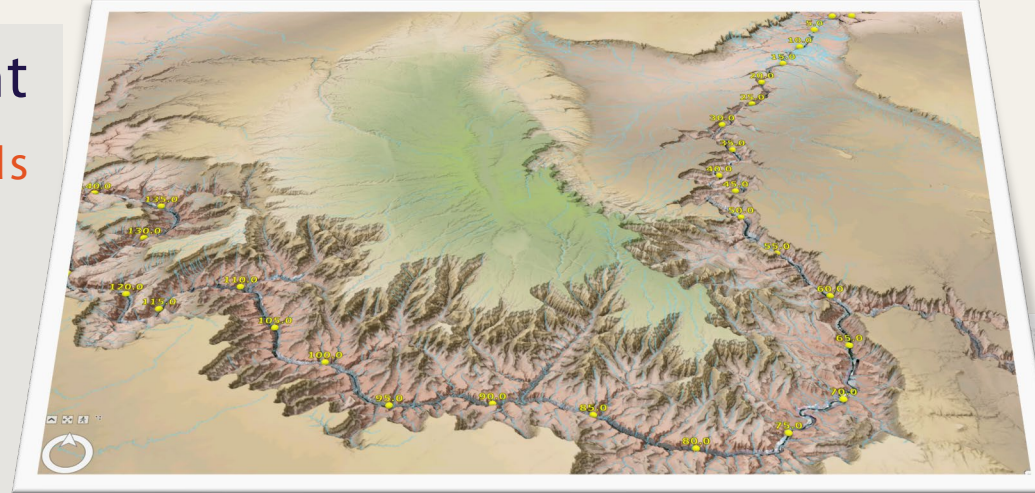# Added Benefits of Project – Collaborations and Affiliations

- PI serves as liaison to SBSC IT group
  - Coordination with SBSC IT Lead on all topics relevant to information technology, data management, data access and cloud strategies

- USGS Ecosystems Mission Area, IT Advisory Council
  - Representation & active involvement in IT initiatives, trends, and advances that shape science in USGS <u>and</u> across the DOI

- USGS Center for Data Integration Community of Practice
  - Project successfully been funded to support data-centric work that has complimented our mission for GCDAMP

- USGS Cloud Hosting Solutions (CHS)
  - GCMRC (and SBSC) use of Amazon Web Services (AWS)
  - Expanded Use of CHS: data backups to AWS, hosting online web applications for science projects.
  - Glen Canyon Dam Water Quality Data <u>LIVE</u>

Figure 1: Conceptual framework illustrating the tiered approach to IMT governance in USGS
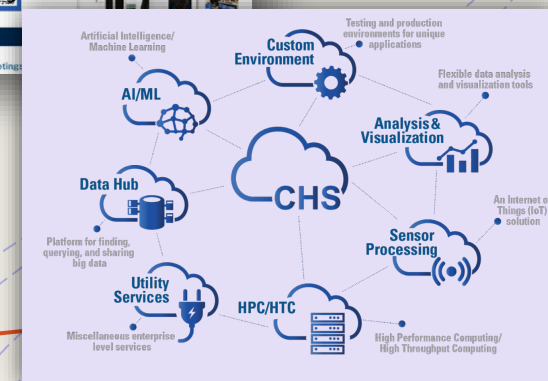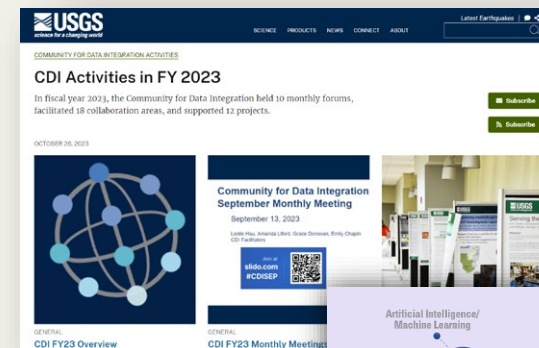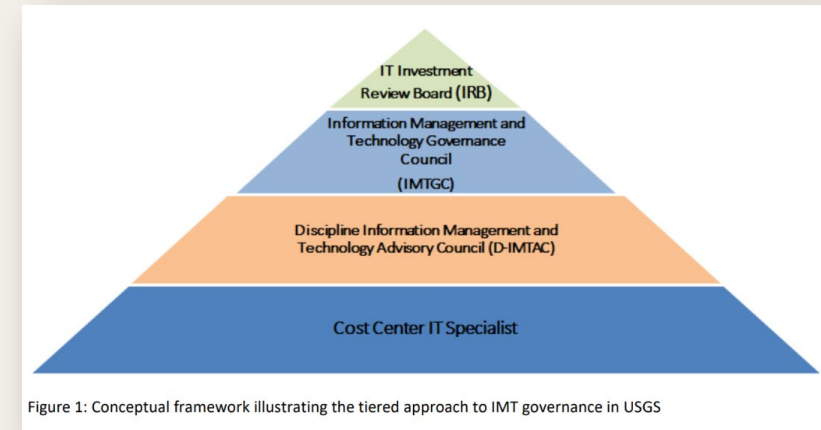
Added Benefits of Project – Integration and Innovation

- ## Debris Flow / Flash Flood Risk Assessment

  - Project staff developed / funded by USGS Hazards Mission Area

  - Leveraging existing GCMRC data sets, many funded by GCDAMP, to develop preliminary risk assessment related to debris flows and flash floods in Grand Canyon.

  - Funding has led to collaboration with NOAA NWS, Coconino County Emergency Services, National Park Service, Tribal Representation and Recreation use groups

  - Outcome: NWS / County Alerts sent to satellite texting devices across the region. Has implications far beyond just weather alerts.

Future Direction and Ideas…
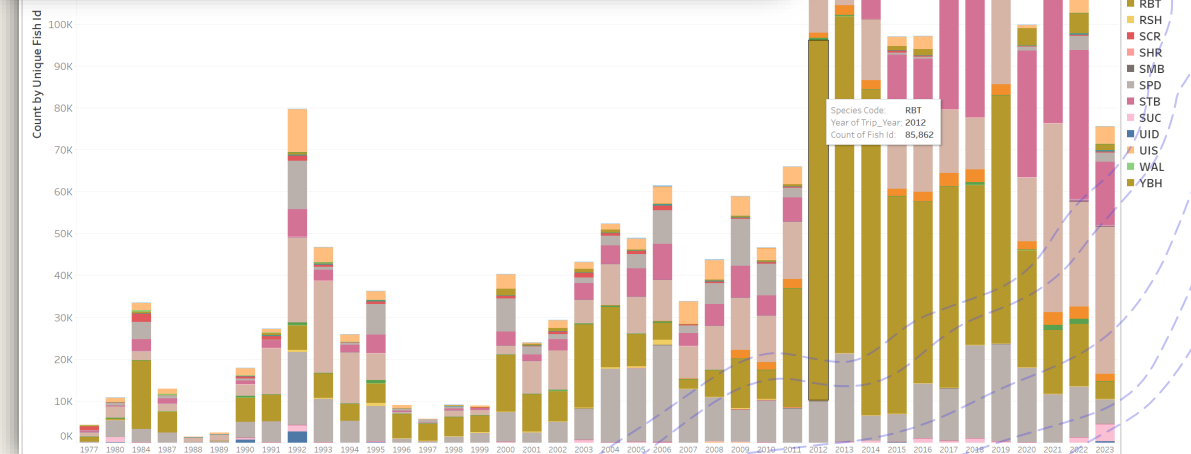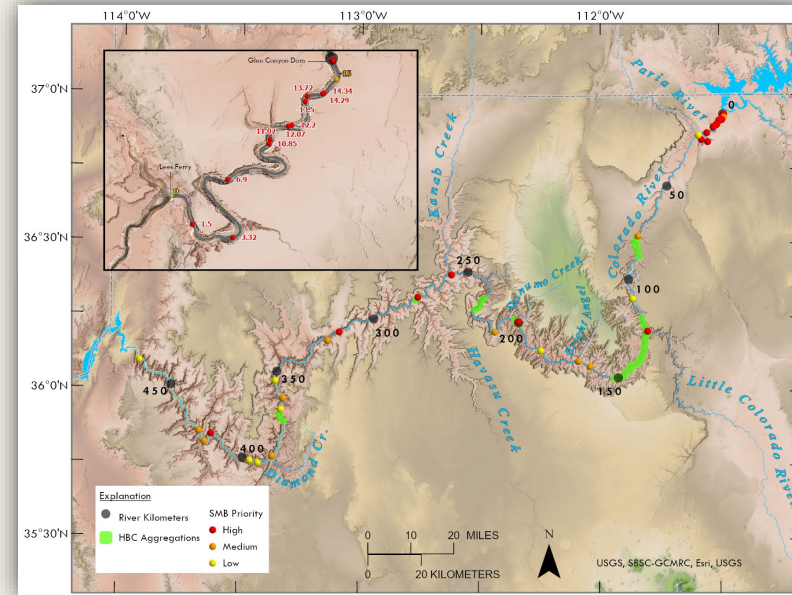

- ## Geospatial
  - Moving more data to enterprise databases, and available through online services
  - Integrating data sources into online content
  - Advanced data visualizations that bring together maps, data, and tools

- ## Data and Databases
  - Moving Databases to online access
  - Apply more data analytics to these resources

- ## IoT Real-time Data Access
  - Actively tracking advances in data communication
  - Rapid growth in emerging technologies

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Thank you!

Questions?