

Riparian Monitoring Protocol Implementation Plan for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 8 Data Management

Version SCPN_Riparian_SOP8_20180930

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is adopted from the Northern Colorado Plateau Network’s SOP #13 Data Management, Version 1.05 (August 2016) in Weissinger, R., D. Witwicki, H. Thomas, A. Wight, K. Lund, and M. Van Grinsven. 2018. Riparian monitoring of wadeable streams protocol for park units in the Northern Colorado Plateau Network: Version 1.05. Natural Resource Report NPS/NCPN/NRR—2018/1636. National Park Service, Fort Collins, Colorado

This Standard Operating Procedure (SOP) describes data management procedures for all data derived from riparian monitoring in Southern Colorado Plateau Network (SCPN) park units. This SOP is part of a Protocol Implementation Plan based on the Northern Colorado Plateau Network (NCPN) Wadeable Streams protocol. SCPN plans to use the existing NCPN database and quality control and quality assurance procedures.

Definitions and Acronyms

<i>NPS</i>	National Park Service
<i>NCPN</i>	Northern Colorado Plateau Network
<i>SCPN</i>	Southern Colorado Plateau Network
<i>I&M</i>	Inventory & Monitoring Program of the National Park Service
<i>IRMA</i>	Integrated Resource Management Applications
<i>SOP</i>	Standard Operating Procedure
<i>GIS</i>	Geographic Information Systems
<i>GPS</i>	Global Positioning System
<i>PDF</i>	Portable Document Format
<i>TIFF</i>	Tagged Image File Format
<i>JPG</i>	Joint Photographic Experts Group File Format
<i>FGDC</i>	Federal Geographic Data Committee. The interagency committee that promotes the coordinated development, use, sharing, and dissemination of geographic data.

<i>Tabular dataset</i>	A dataset organized in a table or group of tables where each column and row has a specific interpretation; often produced by Microsoft (MS) Excel, MS Access, database, or statistical software, and managed as text, spreadsheet, or relational databases.
<i>Spatial dataset</i>	A dataset that is natively read by mapping software; often produced by mapping software, such as ESRI ArcMap and ArcInfo; also includes georeferenced imagery, geodatabases, as well as hardcopy aerial photographs, satellite imagery and maps.
<i>Primary dataset</i>	The dataset that is the most comprehensive and representative of the data associated with a project. This dataset can normally be used independently of other project datasets and is often distributed to external users. The primary dataset can be tabular or spatial.
<i>Raw data</i>	Data that have not been subjected to either quality control or documentation procedures; includes data recorded by hand on hard-copy forms, digital files from handheld devices, GPS receivers, telemetry data loggers, etc.
<i>Certified data</i>	Finalized project data, i.e., data that have undergone thorough quality assurance and screening as well as complete documentation.
<i>Working database</i>	A project-specific database for entering and processing data for the current season (or other logical period of time). This might be the only database for short-term projects where there is no need to distinguish working data for the current season from the full set of validated project data.
<i>Master database</i>	Project-specific database for storing the full project data set, used for viewing, summarizing, and analysis. Only used to store certified data.
<i>Data products</i>	Information that is derived from certified project data.
<i>Project level metadata</i>	A metadata record associated with the primary project dataset that contains cross references to all project data products and is uploaded to the IRMA Data Store.
<i>Quality assurance (QA) procedures</i>	Procedures used to maintain a defined level of quality throughout all stages of data development.
<i>Quality control (QC) procedures</i>	Procedures used to monitor or evaluate the quality of data products.

1 Overview of Riparian Data Management

There are three main types of riparian monitoring data that are collected and managed: vegetation, hydrology, and geomorphology data. Vegetation data are mostly recorded on paper data sheets and then entered into a Microsoft Access database. Since this database was developed by the NCPN, it is described in more detail in Section 2. Many of the other sections in this document are focused on vegetation data management.

Hydrology data are recorded digitally using data loggers and electronic data sheets, and then uploaded to the Aquarius system hosted by the NPS Water Resources Division.

Aquarius is commercial software for managing time series data. Most processing and analysis of the hydrology data is done within Aquarius. Copies of raw digital data files and derived datasets generated in Aquarius are stored on the SCPN server. For more details on hydrologic data processing, refer to SOP #5.

Geomorphology data are recorded digitally using a total station or an RTK and then uploaded to the SCPN file server. The raw data files, post-processed data files, and metadata describing all post-processing are stored on the server. For more details on geomorphology data processing, refer to SOP #6.

2 Database Design

The primary dataset associated with the SCPN riparian monitoring project is a tabular dataset stored in a Microsoft (MS) Access database, referred to subsequently as the riparian database. The riparian database accommodates only the vegetation methods used in riparian monitoring. It has a frontend/backend file structure:

- *Riparian.accdb*: This frontend file contains all queries, forms, reports, and associated Visual Basic for Applications (VBA) application code.
- *Riparian_be.accdb*: This backend file contains the database tables.

The frontend/backend file structure allows multiple users to enter data in a network environment, and allows for easy backup and transfer of the data tables. Users typically launch the frontend file, and a utility will prompt them to establish a link to the backend file.

The riparian database was developed following the NPS Natural Resource Database Template (NRDT), which is based on a location record, one or more related event records, and observation data elements linked to each event.

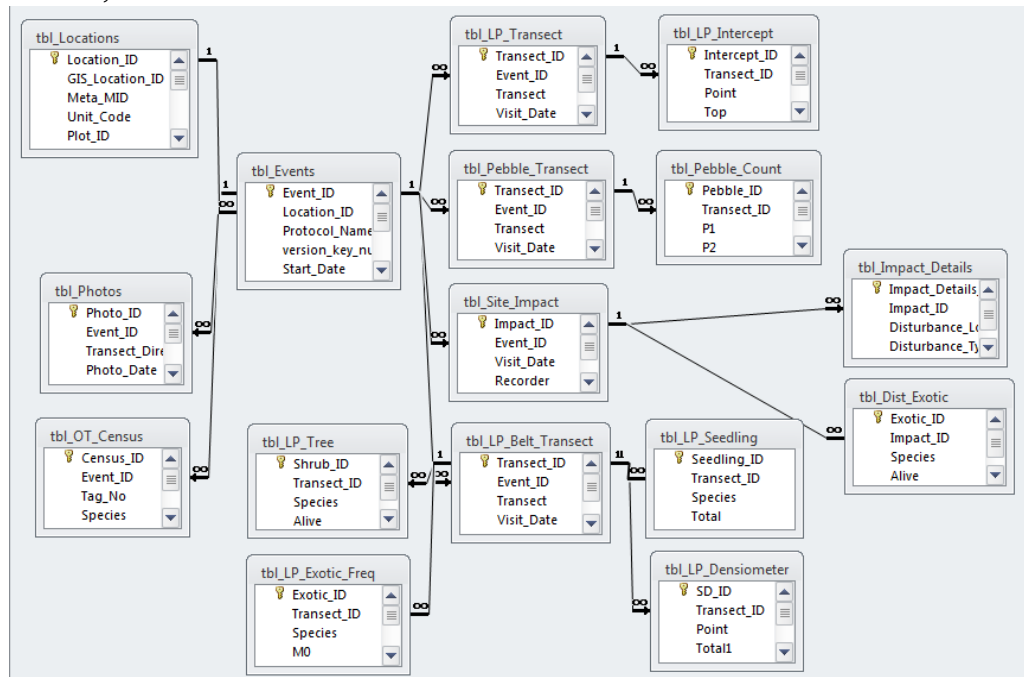


Figure 1 shows the relationships between the primary riparian database tables (all tables are not shown).

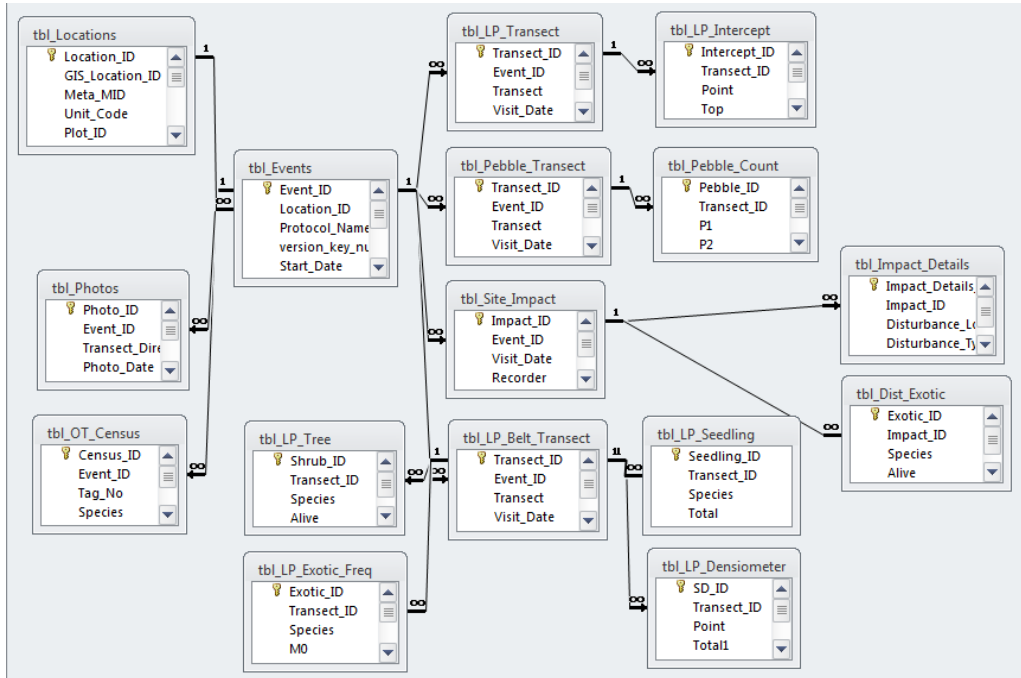


Figure 1. Data Model for Riparian Database

Each riparian monitoring site or reach has a record in *tbl_Locations*, which stores basic location information as well as other site characteristics that are recorded during reach establishment. Each reach can have many site visits, which are recorded in *tbl_Events*. During each site visit, several different types of observations are recorded. The main types of observations recorded are described briefly below:

- Understory species, surface features, and disturbance are recorded using point-intercept sampling for each of seven cross-section transects and stored in *tbl_LP_Transect* and *tbl_LP_Intercept*.
- Density of trees and tree seedlings is measured in a 5-meter belt transect for each of seven cross-section transects and recorded in tables *tbl_LP_Belt_Transect*, *tbl_LP_Tree*, and *tbl_LP_Seedling*.
- Estimates of canopy closure are recorded for each of seven cross-section transects in *tbl_LP_Densiometer*.
- Exotic species frequency is sampled in quadrats placed at regular intervals along each of seven cross-section transects and is recorded in table *tbl_LP_Exotic_Freq*.
- Transect and transect establishment photos are taken for each of seven cross-section transects and recorded in *tbl_Photos*.
- A reach census is conducted and recorded in *tbl_OT_Census*.

- Qualitative descriptions of reach disturbances are recorded in *tbl_Site_Impact* and *tbl_Impact_Details*. Exotic plant species observed during a timed plant walk are recorded in tables *tbl_Site_Impact* and *tbl_Dist_Exotic*.

Each site visit is linked to tables *tbl_master_version* and *tbl_SOP_version*, which together define the narrative and suite of SOP versions in effect at the time of the site visit. Documentation of all tables and fields in the riparian database is provided in Appendix A.

3 Populating the Riparian Database

Prior to each field season, the working database for the riparian monitoring protocol is prepared for the upcoming field season's data entry. The working database is initially an "empty" database, i.e., it contains no observation data, just populated lookup tables and certain "static" site information (e.g., location information). The working database is used for data entry, verification, and validation for a given field season. After the dataset in the working database is quality checked, it is merged into the master riparian database.

For the remainder of this document, the term "riparian database" refers to the working database. The riparian database will be populated via a combination of data import and data entry.

3.1 Data Import

Records for riparian monitoring sites can be established in the database either manually or by importing site location data collected via GPS units. It is expected that most site records will be created manually during data entry. In such cases, the site record will subsequently be updated with the corrected GPS data. Table 1 lists the fields either imported or derived from GPS data (see Appendix A for field descriptions). Elevation will not be imported directly from the GPS data, but rather will be derived from digital elevation models. Note that the fields "T1_RLocation, T1_LLocation, ..., T7_RLocation, T7_LLocation" represent the headpin locations (right and left) for the seven transects, "T1_RN, T1_RE, T1_LN, T1_LE, ..., T7_RN, T7_RE, T7_LN, T7_LE" represent the headpin UTM coordinates (right and left) for the seven transects, and "T1_REndN, T1_REndE, T1_LEndN, T1_LEndE, ..., T7_REndN, T7_REndE, T7_LEndN, T7_LEndE" represent the UTM coordinates (right and left) for the seven transect end points.

Table 1. Fields Imported/Derived from GPS Data into *tbl_Locations*

Elevation	Max_PDOP	T1_RN	T1_REndN
E_Coord	T1_RLocation	T1_RE	T1_REndE
N_Coord	T1_LLocation...	T1_LN	T1_LEndN
Coord_Units	T7_RLocation	T1_LE...	T1_LEndE...
Coord_System	T7_LLocation	T7_RN	T7_REndN
Datum		T7_RE	T7_REndE
UTM_Zone		T7_LN	T7_LEndN
Rcvr_Type		T7_LE	T7_LEndE

Site location data are expected to be relatively static over time. Thus, GPS data will normally only be imported when a reach is initially established. If the location information for a given site changes for some reason (e.g., a rebar gets lost and it's not possible to establish the new rebar at the same location), it will need to be re-imported from the GPS files. When imported, reach location data will be imported from corrected GPS files into *tbl_Locations*.

3.2 Data Entry

The majority of data in the riparian database will be populated via data entry. Data entry should occur as soon as possible after data collection is completed, before the next observation occurs, and by the person who collected the data or someone who is familiar with the project and data. The primary goal of data entry is *to record data in digital form with 100% accuracy*.

Detailed data entry instructions are provided in the Riparian Database User's Guide (NCPN-NPS 2015a). The user's guide is available as a standalone document in the same folder location as the working copy of the riparian database:

Z:\Active_Projects\IM\Monitoring\Water_Resources\integrated_riparian\data\databases

The project manager makes certain that persons performing data entry are familiar with the user's guide and understand how to enter data and follow the protocols. Data entry technicians are responsible for becoming familiar with the field data forms, database software, database structure, and any standard codes for data entry. The data manager, in conjunction with the project manager, will ensure that the user's guide is kept current as new features are implemented in the database and/or as data entry procedures change.

QA/QC measures for data entry are built into the database forms to automatically validate data where possible. Data entry forms maximize the use of auto-filled fields, range limits, pick lists, and spelling checks. Error messages alert the operator to correct mistakes. Any errors or omissions that become apparent during data entry should be resolved as soon as possible. In such cases, the data entry technician should contact the person who collected the data for clarification. The appropriate modifications should then be made to the field sheets according to the instructions provided in Section 4.

3.3 Data Import

Some information for riparian monitoring sites come from continuously monitoring equipment used only for the duration of the sampling trip (temperature, core parameters). This information is either summarized external to the database and a single value is entered or all of the data is imported into the database. When all data is imported into the database, the database will have the file source information as well.

4 Data Verification and Validation

To ensure that riparian monitoring data are of the highest possible quality, verification and validation of riparian monitoring data will be performed according to the procedures described in Chapter 6 and Chapter 7 of the Data Management Plan for the Southern Colorado Plateau Network (SCPN 2006). Data verification checks that data entered into a secondary (i.e., electronic) format match the source data, while data validation checks that the data make sense.

Data Verification

Data verification immediately follows data entry and involves checking the accuracy and completeness of the computerized records against the hard copy field records and identifying and correcting any errors. The following verification methods will be used to verify riparian data:

1. **Visual review at data entry.** The person doing data entry verifies each and every record after input and immediately corrects any errors.
2. **Visual review after data entry.** All records are compared to the original data source. Each data field on the corresponding electronic data entry form is compared with the original values from the hard copy, preferably by a second person who did not perform the data entry. Any errors that are discovered are corrected in the database as soon after data entry as possible.
3. **Summary queries and tallies.** Queries are run that detect broad errors such as duplicate or omitted records. Examples of such queries for riparian vegetation data are given below:
 - a. Listing and count of the monitoring reaches established by park by year.
 - b. Listing and count of the monitoring reaches visited by park by year.
 - c. For each year/park/reach combination, a count of the number of photo points recorded.
4. **Visual review of spatial data.** Using GIS, riparian monitoring location data are visually inspected for accuracy. This review will take place at the end of the field season.

Detailed verification procedures are provided in Riparian Database Quality Assurance (QA)/Quality Control (QC) Procedures (NCPN-NPS 2015b).

4.1 Data Validation

While many errors are prevented by including validation routines that function during data entry, additional review of the data by the project manager is needed to detect generic and specific errors that fall outside the scope of automated validation.

Invalid data commonly consist of slightly misspelled names, the wrong date, or out-of-range errors in parameters with well-defined limits (e.g., elevation). Other errors consist of unreasonable metrics or associations. For example, suppose a species was dominant on a reach during the current year's visit, but there was no observation recorded during the

previous year's visit. Such data seem questionable and might indicate a species identification error. These types of logic errors (or potential errors) can be challenging to resolve, and in some cases it may not be possible to resolve them during the current year. Such questionable data will be flagged for future resolution.

Validation queries are of two types: one type presents tabular data in ways that allow records to be reviewed for content and context; the other type performs specific calculations or routines to detect logic or range errors. Corrections to errors detected during validation require notations in the *original paper field records* about how and why the data were changed. Modifications to the field records, whether made during data collection or subsequently, should be clear and concise while preserving the original data entries or notes. The original data entries should be crossed out with a single line and initialed - they should **not** be erased. Validation efforts should also include a check for the completeness of a dataset since field sheets or other sources of data could easily be overlooked.

Detailed validation procedures are provided in Riparian Database Quality Assurance (QA)/Quality Control (QC) Procedures (NCPN-NPS 2015b).

4.2 Data Quality Review and Communication

The project manager and any personnel involved in data collection or entry will meet several times during the field season to discuss data quality problems and issues. Procedures may need revision if verification and validation processes reveal an unacceptable level of data quality. Quality checks may also reveal the need to modify field or computer forms if data transcription or entry errors are frequent.

Once validation has been completed, the validation level of each record in the database will be indicated in a validation column.

Validation levels include:

- Valid: This record is valid and usable
- Issue: This record contains an unresolvable issue but may be usable for some purposes
- Replaced: This record reflects the original data as recorded on the datasheet but a new corrected record has been created and should be used for reporting and analysis
- Correct: This record contains the corrected information that should be used for reporting and analysis
- Error: This record contains an unresolvable issue that renders it unusable for reporting or analysis

In addition, each record will indicate the version of the SOP used in collecting the record.

5 Version Control

Version control is the process of managing copies of changing files over the course of a project. Change includes any alteration to the structure or content of the files, which should not be made without the ability to fully recover a dataset as it existed before changes were made. SCPN uses several techniques to help ensure proper version control: data archiving (refer to Section 6 for data archiving details), directory structure conventions, backup procedures (refer to the Appendix B of the Data Management Plan for the Southern Colorado Plateau Network (SCPN 2006), and database versioning.

5.1 Directory Structure Conventions

SCPN has adopted directory structure conventions for I&M project folders, which are detailed in the Data Management Plan for the Southern Colorado Plateau Network (SCPN 2006). Based on these conventions, each project has an active folder for storing all current or working project files and an archive folder for storing archived project files. In general, the active project folder stores only the most recent project files (e.g., data and reports from current year, current protocol version). All active project folders are stored on the SCPN Common Files (Z:). The active riparian project folder is in the following location:

Z:\Active_Projects\IM\Monitoring\Water_Resources\integrated_riparian

The structure of the active project folder is as follows (all folders are not shown):

- **Data:**
 - **Database** (Riparian database):
 - **Backups:** Contains one or more backup copies of database files made during data entry (not retained permanently).
 - **Current:** Contains the working database (current year data) and user's guide.
 - **Master:** Contains a copy of the master database (complete data record) to be used for analysis and reporting (the master database is stored in the riparian archive folder).
 - **Field_Forms:** Contains scanned field forms for current year.
 - **GPS_Downloads:** Contains corrected data downloaded from GPS units.
 - **Spatial:** Contains GIS files related to site selection.
- **Field_Crews:** Contains files used by field crews, such as plant lists and trip reports.
- **SCPN_Working_Files:** Contains miscellaneous files used internally, such as database requirements documentation.
- **Project_Life_Cycle:** Contains files related to project data life cycle tracking for current year, e.g., data certification form, data quality documentation (refer to Section 7 for more details on the project data life cycle).

5.2 Database Versioning

Database versioning refers to the process of tracking modifications to the database structure or application code, which can occur independently of modifications to the data. SCPN uses a version numbering scheme to track database modifications, in which modifications are grouped into software releases. Major releases are those involving

significant changes to the database and are designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). For releases with only minor database changes (e.g., bug fixes), version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02, etc).

6 Data Archiving

Archiving is a critical step in ensuring the long-term preservation of data. Riparian data will be archived on an annual basis, after the current year data have been quality checked and analysis and reporting have been completed. Archiving of certain data may occur more frequently, e.g., if a protocol version change occurs. Archiving will be done for both digital and hard copy data.

6.1 Digital Data Archiving

All digital riparian data will be archived on the SCPN read-only shared drive in the riparian archive folder (Z:\Archive\Monitoring_Archive\Integrated_Riparian). Table 2 lists the riparian monitoring digital data files that require archiving, along with their respective archive folder locations. The digital files listed in Table 2 will also be burned onto an archival-standard CD or DVD and sent to the Western Archeological and Conservation Center (WACC) according to the procedures outlined in the NCPN Archiving Guidance Document (NCPN-NPS 2010). WACC is the official archival repository for all SCPN data. This facility provides temperature and humidity-controlled storage conditions and a professional archives staff, and it meets all NPS museum standards.

Table 2. Riparian Digital Data Archiving Summary

Data Product(s)/ File(s)	Archive Location¹	Comments
Database	Data\<year ² >\Database\	Contains archived riparian database files for a given year
Geomorphology	Data\<year>\Geomorphology\	Contains archived geomorphology data files for a given year
Hydrology	Data\<year>\Hydrology\	Contains archived hydrology data files for a given year
Field forms	Data\<year>\Field_Forms\	Contains archived digital field forms (PDF) for a given year
GPS data	Data\<year>\GIS_Data\GPS_Data\	Contains archived GPS data files for a given year
Field crew files	Field_Crews\<year>\	Contains archived field crew files for a given year
Project data life cycle files	Project_Life_Cycle\<year>\	Contains archived files related to project data life cycle tracking for a given year
Protocol	Protocol\<version ³ >\	Contains archived protocol files for a

¹ Archive location is relative to Z:\Archive\Monitoring_Archive\Integrated_Riparian unless stated otherwise.

² <year> indicates year in yyyy format.

³ <version> indicates protocol version key number, e.g., Version_Key_1

Data Product(s)/ File(s)	Archive Location¹	Comments
		given version
Protocol review	Protocol_Review\<year>\	Contains archived protocol review documents for a given year
Reports	Reports\<year>\	Contains archived report files for a given year
Sampling design files	Sampling_Design\<year>\	Contains archived files related to sampling design for a given year
Photos	Z:\SCPN_Photos_Archive\ SCPN Photos\ Riparian	- Archive location is an absolute path - Renamed photo files archived as part of NCPN photo database processing - refer to <u>NCPN Photo Management Guidance Document</u> (NCPN-NPS 2008b) for details
Original photos	Z:\SCPN_Photos_Archive\ Raw_Photo_Data_Archive\ Monitoring\Riparian\<year>	- Archive location is an absolute path - Contains original, unedited (e.g., not rotated) photo files

6.2 Hard Copy Data Archiving

All hard copy riparian data sheets are scanned and the hard copies archived locally. We have found it necessary to have direct access to these hard copies during the process of standardizing the data and transferring databases to SQL Server. When the data has been standardized and transferred to SQL Server, these datasheets will be archived at WACC according to the procedures outlined in the NCPN Archiving Guidance Document (NCPN-NPS 2010). Table 3 lists the riparian monitoring hard copy data files that require archiving, along with a summary of archiving procedures. Digital copies of applicable items in Table 3 are also provided to parks for their working files.

Table 3. Riparian Hard Copy Data Archiving Summary

Data Product(s)/File(s)	Comments
Field forms	- Original field forms stored in SCPN archives at WACC. - Digital copies retained in SCPN office.
Reports	- Archival copies stored in SCPN archives at WACC. - Hard copies retained in SCPN office.
Protocol	- Archival copies stored in SCPN archives at WACC. - Hard copies retained in SCPN office.
Protocol review	- Archival copies stored in SCPN archives at WACC. - Digital copies retained in SCPN office.
Photos	- Slides or selected prints stored in SCPN archives at WACC. - Digital copies retained in SCPN office.
Data/metadata Printouts	- Archival copies of project-level metadata stored in SCPN archives at WACC. - Hard copies retained in SCPN office. - Above applies to any other data/metadata printouts deemed critical to long-term riparian monitoring.
Project data life cycle files	Archival copies stored in SCPN archives at WACC.

Data Product(s)/File(s)	Comments
	Digital copies retained in SCPN office.

7 Metadata

Metadata, which is defined as structured information about the content, quality, condition, and other characteristics of data, is a critical step toward ensuring that datasets are usable for their intended purposes well into the future. Metadata can take many different forms, including formal FGDC-compliant metadata, Data Store References, and protocol version information.

To comply with NPS metadata requirements, metadata for riparian datasets will be completed for each record within the dataset and will include the validation level, protocol used while collecting the data, and certification level (to be determine with further guidance from the central office). In addition an IRMA Data Store metadata record will be created for the riparian project. The Data Store metadata record, also referred to as the project level metadata, will be updated annually and will include metadata for all of the component parts of the riparian project including the databases, GIS data, photos, logger files, and reports.

Error! Reference source not found. summarizes the metadata tasks required for riparian monitoring datasets and data products, and **Error! Reference source not found.** describes the tasks and provides references where more detailed procedures are described.

8 Photo Management

Photos taken as part of riparian monitoring are managed following SCPN photo management procedures, which are described in detail in the Data Management Plan for the Southern Colorado Plateau Network (SCPN 2006). This section will focus on digital photo management, since riparian monitoring photos are taken with digital cameras.

Photos are uploaded to Z:\Active_Projects\IM\Monitoring\Water_Resources\field_resources\images\ folder. Internal to this folder, the photos are placed in the correct <Park> folder and a <VisitDate> subfolder. The photo metadata is entered into ThumbsPlus. This drive is backed up regularly, with a backup rotation scheme that includes off-site storage of backups. Refer to the Z:\SCPN_Operation\Program_Management\Program_Documents\Risk_Mnagement\2017\SCPN_FY17_Contingency_Plan_Updated.docx for detailed backup procedures. During the entry of metadata into ThumbsPlus, any photo issues are addressed (e.g. duplicate files).

Copies of the photos are burned onto archival-standard DVDs and sent to WACC, the official archival repository for SCPN data. This is in accordance with NPS Director's Order 11D: Records and Electronic Information Management (NPS 2012), which

requires that all NPS natural resource records be retained permanently and receive archival care as soon as practical.

9 References

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