User's Guide
Stream Restoration Database
Version 1.0

Supporting
WERF-U5R14: Stream Restoration BMP Database Module
WERF-IT13: Stream Restoration as a BMP (Crediting)

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1 PURPOSE AND OVERVIEW

The purpose of this User's Guide is to provide an overview of the Stream Restoration Database software, project process and content (tables and data elements) to support submissions of stream restoration studies to the Stream Restoration Database.

2 SOFTWARE AND PROJECT PROCESS

The project software and process is modeled after the International Stormwater Best Management Practices (BMP) Database project, including both the urban stormwater and agricultural BMP modules (Figure 1). The Stream Restoration Database is maintained as a separate database module, but will be operated and maintained as part of the overall BMP Database project led by WERF and will be accessible at www.bmpdatabase.org.

The project software utilizes the Microsoft Office 2013[1] suite of programs including Excel for data entry, Access for data storage (and download by users), and eventually SQL server for web-based applications that may be developed in the future. (Note that Figure 1 includes the SQL Database for completeness, but it is not included in Version 1.) Data entry and upload is accomplished through entry of data into an Excel 2013 Workbook, which is uploaded to the master database in Access by Database Support Staff.[2] In order to enter data and utilize the database, users will need to own licenses for these programs.

Web-based search tools may be developed in the future that would enable access to the data sets in a comma separated value (CSV) format. In that case, a user could utilize a variety of software programs to further analyze the retrieved data. For example, on-line queries of the Urban Stormwater BMP Database export data into a CSV format. The initial release of the Stream Restoration Database does not include web-based tools.

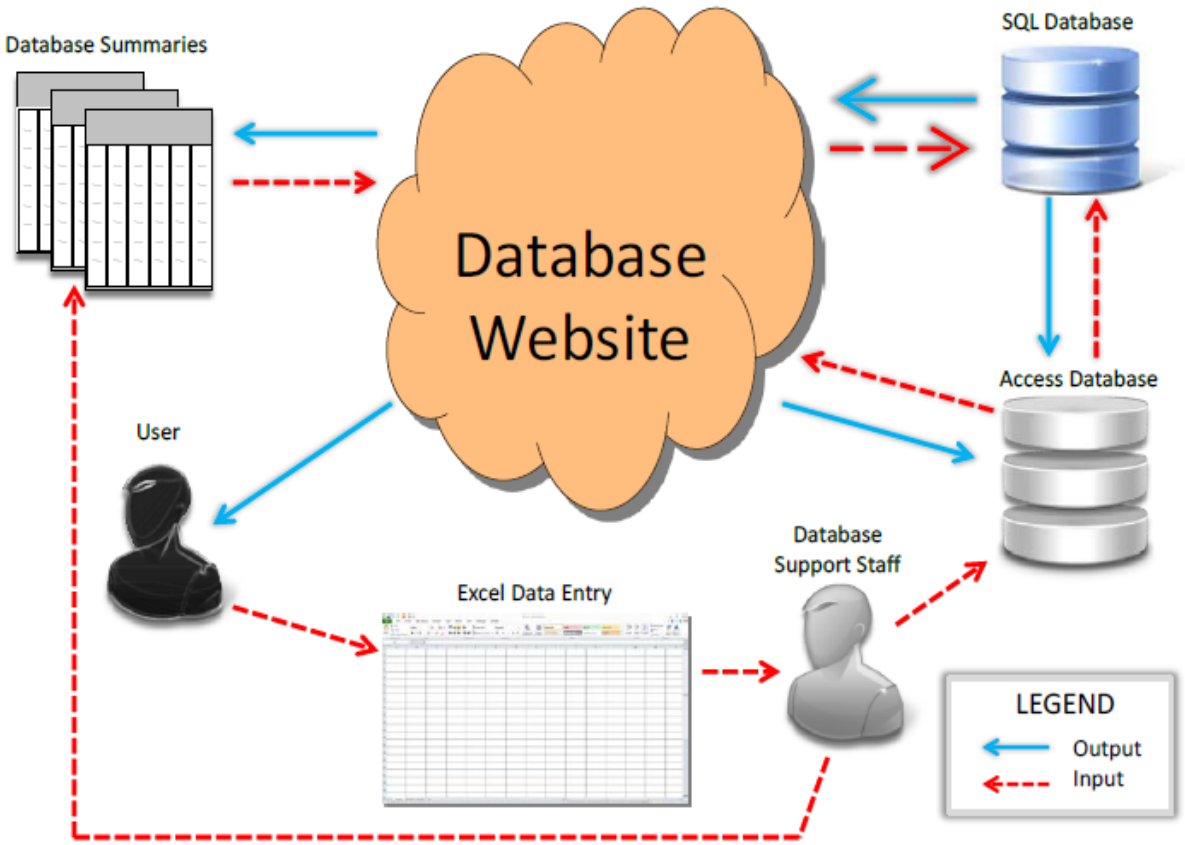
To enter data, a user will need to have a basic working knowledge of Excel and the ability to electronically submit the completed data entry package to the Database Support Staff. Database Support Staff will conduct a basic review of the study for data entry errors, reasonableness and completeness prior to accepting the study for upload. Once the study is accepted, the Database Support Staff will be responsible for uploading the data contained in the file to the master database.

Routine maintenance and backup of the Stream Restoration Database and tools is conducted as part of the overall BMP Database project associated with the www.bmpdatabase.org website.

[1] Backwards compatible with Microsoft Office 2010.

[2] The International Stormwater BMP Database project is currently operated and maintained by Wright Water Engineers and Geosyntec Consultants. Geosyntec Consultants hosts the project website as an in-kind service for the overall project.

Figure 1. Stream Restoration Database Project Process Overview



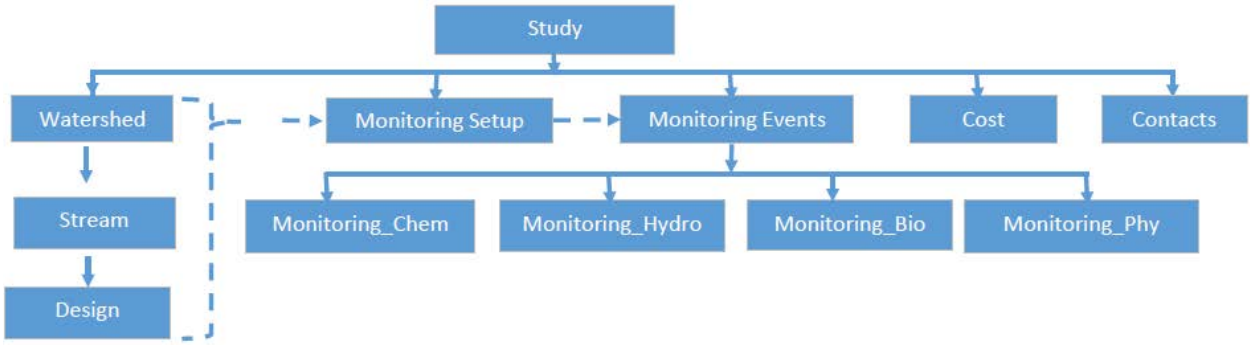
3 DATABASE STRUCTURE OVERVIEW

The overall objective of the database structure is to enable consistent reporting and compilation of critical aspects of stream restoration projects. The Stream Restoration Database follows a relational database model that organizes data into twelve tables of information. Each row in a table includes a unique numeric "key" that identifies each record and enables the information in a table to be related to information in other tables. The columns in each table are attributes (i.e., data entry fields) associated with each record. Figure 2 provides a simplified overview of the Stream Restoration Database structure.[3]

Supporting documents can also be submitted (and are encouraged) in addition to completing the data entry spreadsheets. Examples of supporting documents include photos, site diagrams, channel cross-sections, design drawings, and sampling and analysis plans. To manage the database size, these files will be stored in a separate file directory.

[3] Additional database documentation is provided for each table and data element in the database itself, including an entity-relationship (E-R) diagram that specifies relationship types (e.g., one-to-one, one-to-many) and identifies primary and foreign keys and object dependencies.

Figure 2. Generalized Stream Restoration Database Structure



4 BEGINNING DATA ENTRY

To begin data entry, the following items are important:

- The Begin Here table must be completed first, as described in Section 4.1.
- The spreadsheet tabs must be completed in order. (For example, monitoring stations must be identified before monitoring data are entered.)
- Certain fields utilize picklists, as described in Section 4.2.
- A significant amount of information is requested; however, the data elements are prioritized, as discussed in Section 4.3. It is recognized that most data providers will not be able to provide all of the requested information.

4.1 Begin Here Table

To begin data entry, the first table to be completed is the “Begin Here” Table, which is necessary to ensure proper linkage of the tables once the data set is imported into the master database. This table includes three steps:

1. Name the study.
2. Name each watershed in the study.
3. Name each stream reach that is monitored in the study.

Important Tips:

- Naming conventions should be as short as possible and include key words that include the stream name and its role in the study (e.g., test, reference, control). For the stream reach entries, if there is a pre-restoration and a post-restoration condition, then complete two entries for the stream so that conditions before and after restoration can be described independently.
- Underscores should be used instead of spaces if multiple words are used.
- Do not change the names of the Study, Watershed or Stream/Reach in the Begin Here spreadsheet after data entry has begun; otherwise, these names will need to be repopulated in subsequent data entry spreadsheets to maintain table linkages.

Table 1. Begin Here Study Setup Table

Enter Study Name (Project Name)	Test Site ID (7-digit)
Spring Creek	2016001

Enter Watershed Name(s) (Study Sites)*	Watershed ID (9-digit)
Spring_Crk_Test	201600101
Snow_Crk_Ref	201600102

Enter Stream/Reach Name(s)*	Stream ID (11-digit)
Spring_Pre	20160010101
Spring_Post	20160010102
Snow_Ref	20160010201

4.2 Data Priority Levels

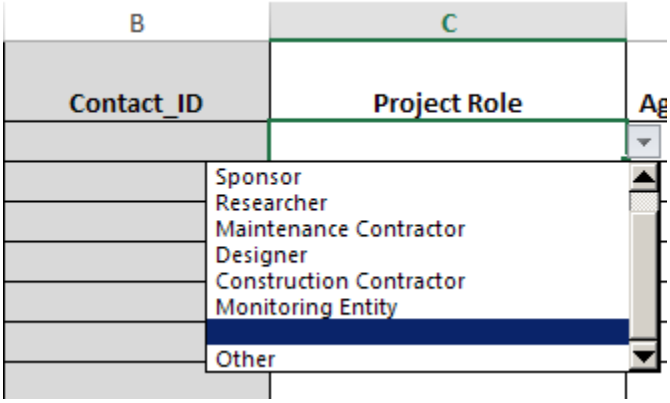
The data entry spreadsheets request a significant amount of information. Most studies will not have all of the requested data. For this reason, each data element has been assigned one of these three priority levels:

- Required (R): Data entry should be completed for all "Required" fields, at a minimum. The study may not be accepted by the Database Support Staff without these data entries.
- Important (I): "Important" data are needed to maximize the usefulness of the study and should be entered when such data are available; however, the lack of “Important” data does not preclude acceptance of the study into the database.
- Supplemental (S): "Supplemental" data are of interest to many researchers; however, missing supplemental data would not limit the general use of study findings.

4.3 Picklists

Some fields in the Excel workbook require that entries conform to pre-established “picklists”. The picklists are provided in dropdown boxes on the individual spreadsheets (Figure 3). When a picklist is provided, the data provider is not required to manually use the dropdown box, provided that the information entered is a value listed in the picklist. If the entry is not consistent with the options in the picklist, then the user will receive an error message.

Figure 3. Example Picklist in Dropdown Box



5 DATABASE TABLES

As discussed above, the Stream Restoration Database is a relational database comprised of twelve tables that relate to each other through the use of keys (i.e., record I.D.). A brief overview of each table and data element is provided within this document using formatted text as described below:

- **Blue Bolded Subheaders** provide groupings for a series of fields requesting similar types of information.
- Data Fields (i.e., Data Elements) are described using this format: "Data Field [data priority level, data type]" where the data field name is provided followed by an abbreviation indicating data priority level (e.g., R, I, S, as defined in Section 4.2), followed by the data type (e.g., number, text).
- Grey-colored font indicates an autopopulated protected cell from the "Begin Here" table or other autonumbered entry. The user does not need to populate these entries since this is automated in the spreadsheet.
- o Picklists are identified by an open-circle bullet.

5.1 Study

The purpose of the "Study" table is to provide basic descriptive information about the project purpose, the project location, and the entities conducting the research. The Study table is the "parent" of all other data provided for the study.

The Study table contains the largest number of data elements relative to other tables; however, many of the data elements in the Study table are simple "yes/no" fields that will be important to those querying data from the database and/or for use in future web-based tools. Data elements included in this table are described further below.

General Information

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Project Purpose Statement [R, Short Text]: Briefly state general project purpose/goals to describe the objectives of the study. This field is intended to be brief. A longer description can be provided in the Study/Abstract field.

Project Purpose(s) [R, Picklist]: Project purposes indicated below generally follow the NRRSS (National River Restoration Science Synthesis[4]) picklist. An answer is required for each field. Enter Yes, No, or NA (if unknown or not applicable).

- Aesthetics, Recreation, and/or Education
- Bank Stabilization
- Channel Incision Stabilization
- Reestablish Sediment Balance
- Channel Reconfiguration
- Dam Removal/Retrofit
- Fish Passage
- Improve Flood Conveyance
- Floodplain Reconnection
- Flow Modification
- In-stream Habitat Improvement
- In-stream Species Management
- Riparian Vegetation Re-establishment
- Stormwater Management
- Water Quality Management
- Infrastructure Protection
- Permit Requirement (e.g., 404 permit)
- Public Safety
- Other (e.g., supplemental environmental project, etc.)

Study Scale [R, Picklist]: From the picklist, select one of the following study scales:

- Network: multiple segments of stream with intervening tributaries.
- Segment: multiple reaches of stream between two tributaries.
- Reach: stream length of 10-20 annual flood top widths with relatively homogeneous stream type.
- Subreach: length of stream smaller than a reach (e.g. a single meander bend).

[4] For more information on the NRRSS project, see https://wiki.epa.gov/watershed2/index.php/National_River_Restoration_Science_Synthesis_(NRRSS)_Project or http://www.palmerlab.umd.edu/docs/Bernhardtetal2005w_SOM.pdf.

Performance Assessment Method/Study Design [R, Picklist]: From the picklist, select one of the following performance assessment methods:

- Before-After: stream condition prior to restoration is compared to stream condition after restoration, but is not compared to a control (reference site).
- Before-After with Control: stream condition prior to restoration is compared to stream condition after restoration, as well as a control (reference) reach.
- Upstream/Downstream: stream conditions monitored above and below restored area.
- Paired Watershed: stream condition is compared to comparable streams in one or more watersheds.

Study Start Year [R, Date]: Enter 4-digit year (e.g., 2015) associated with the beginning of the study.

Study Duration [R, Text]: Enter either a year range (e.g., 2009-2015) or other narrative duration description (e.g., 4 years) to describe the study duration.

Summary/Abstract [R, Long Text]: Provide a brief summary of the study and key findings.

Comments [S, Long Text]: Use this field to provide other relevant information needed to explain data entered in this table or other information necessary to understand the study.

Geographical Data

Enter geographic data that best describes the study. If multiple cities/counties are present, enter the area that best represents the study and provide additional notes in the Comments field.

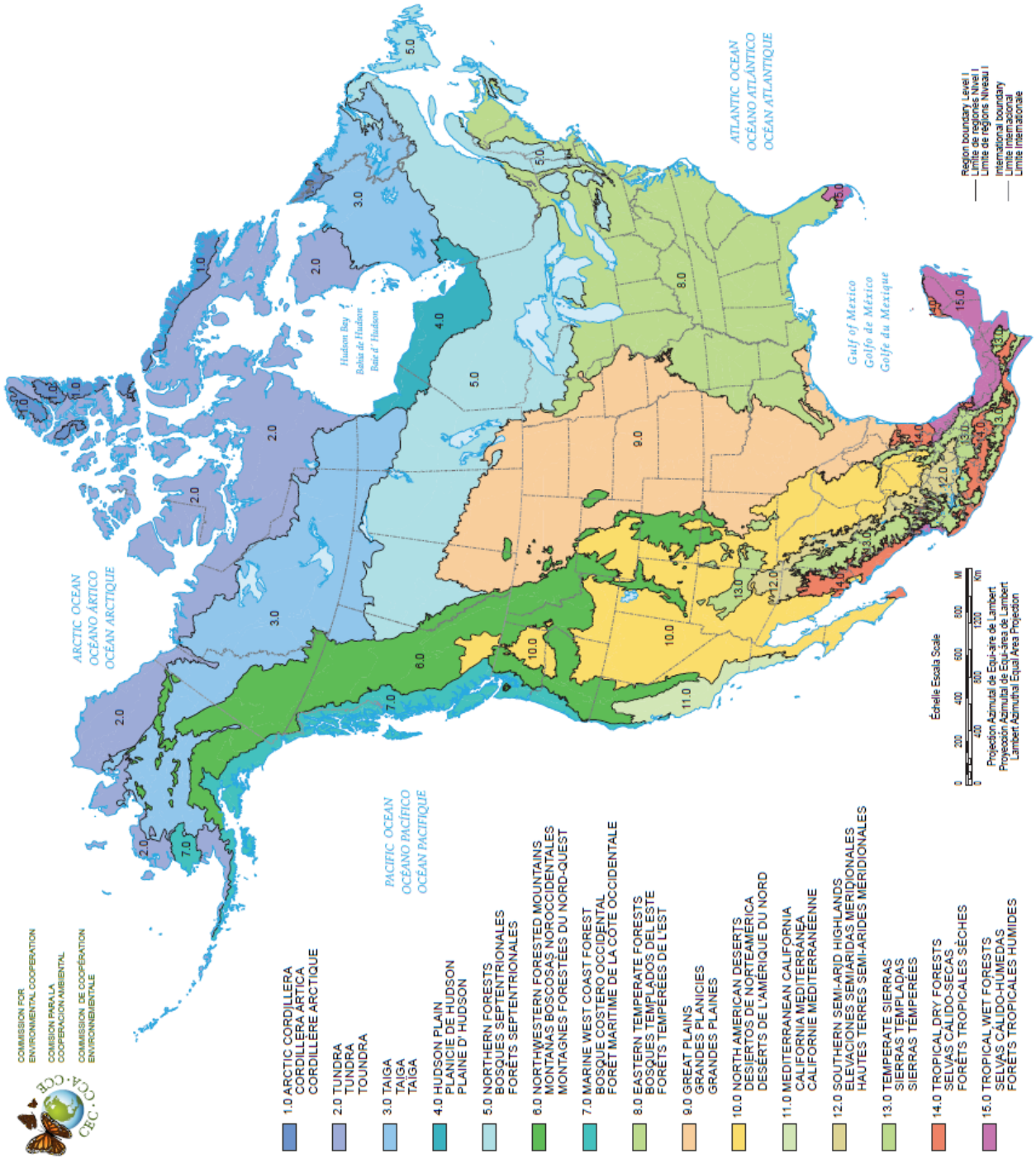
- **City (closest) [R, Short Text]:** Closest city to the study site.
- **County (or non-U.S. state/province) [R, Short Text]:** County in the U.S. where the Test Site is located. If the study is located outside of the U.S., enter the state or province in this field.
- **State (in U.S.) [R, Picklist]:** U.S. state where the study site is located. Selected from a picklist of abbreviations. If located outside of the U.S., enter XX for the state.
- **Country [R, Short Text]:** Country where the Test Site is located. Enter a two-character country code (e.g., use US for the United States).
- **Hydrologic Unit Code (10-digit) [R, Number]:** 10-digit hydrologic unit code, accessible at http://www.horizon-systems.com/NHDPlus/NHDPlusV2_home.php. Hydrologic unit code is an attribute in the WBD_SubWatershed table. The Hydrologic Unit Coding system sub-divides the U.S. into progressively smaller nested hydrologic units. The largest sub-divisions are assigned a 2-digit code from 01 through 22. 4-digit codes sub-divide the 2-digit areas. 6-digit codes sub-divide the 4-digit areas. This subdivision continues into 8-, 10-, and 12-digit coded areas. Also see http://pubs.usgs.gov/tm/tm11a3/.
- **Reach Code [R, Number]:** A unique, permanent identifier in the National Hydrography Dataset (NHD) associated with a NHD Reach. Obtain the 14-digit code from NHDPlus, accessible at http://www.horizon-systems.com/NHDPlus/NHDPlusV2_home.php. The Reach Code is an attribute in the NHDFlowline table.

- **EPA Level 1 Ecoregion [R, Number]:** Enter the U.S. Environmental Protection Agency (EPA) Level 1 Ecoregion where the study is located. The EPA Level 1 Ecoregions for North America are divided into 15 broad ecological regions, as summarized in Table 2 and Figure 4. See http://www.epa.gov/wed/pages/ecoregions/na_eco.htm for more information.
- **Decimal Latitude [R, Number]:** Enter decimal latitude at approximate midpoint of project. For large areas, the approximate centroid of the Study Area can be used. Google Earth can be used to obtain the approximate latitude and longitude by zooming into the site location and right-clicking the mouse and selecting "What's Here?" For an online conversion tool from minutes, seconds, degrees, see https://www.fcc.gov/media/radio/dms-decimal.
- **Decimal Longitude [R, Number]:** Enter decimal longitude at approximate midpoint of project. (See notes for Decimal Latitude for additional tips.)
- **Site Elevation (m) [I, Number]:** Enter approximate midpoint of site elevation to nearest 100 m.

Table 2. EPA Ecoregion IDs and Descriptions

1	Arctic Cordillera	9	Great Plains
2	Tundra	10	North American Deserts
3	Taiga	11	Mediterranean California
4	Hudson Plains	12	Southern Semi-Arid Highlands
5	Northern Forests	13	Temperate Sierras
6	Northwestern Forested Mountains	14	Tropical Dry Forests
7	Marine West Coast Forests	15	Tropical Humid Forests
8	Eastern Temperate Forests	-99	*NA-Outside of North America*

Figure 4. EPA Level 1 Ecoregions
(Source: ftp://ftp.epa.gov/wed/ecoregions/cec_na/NA_LEVEL_I.pdf)



Bibliographical Information

Literature Type [R, Picklist]: Identify the type of literature/data source providing the basis of the entered data. If Other is selected from the picklist, provide explanation in the Comments field. The picklist includes:

- Journal
- Report
- Unpublished Data
- Other

Short Reference [R, Text]: Provide a short reference in the form of "primary author last name_year" (e.g., Jones_2013). If the work is unpublished, use the researcher's last name and year that the study was completed. This short reference format may be used as the basis of future queries or summaries specific to the study.

Authors/Researchers [R, Text]: Provide a complete author/co-author list in reference format (e.g., Sharpley, A., Barnes, B.), consistent with the published research.

Year of Publication [R, Date]: 4-year date of research publication (e.g., 2013) or date research was completed.

Title [R, Text]: Report title, as published.

Report Source Citation [R, Text]: Journal name or publication type (e.g., Journal of Irrigation and Drainage, USGS Water Resources Investigation Report). If the data source is unpublished, then state "unpublished data."

Weblink [S, Hyperlink]: Link to publically available report, if applicable.

Benefits Documented by Researcher [R, Picklist]: Enter Yes, No, or NA to indicate whether the researcher documented any of these benefits. All entries should be complete, use NA to indicate unknown. If Other is selected, enter the description in the Comments field for this table.

- Water Quality
- Biological
- Physical/Habitat
- Floodplain Modification
- Infrastructure Protection
- Public Safety
- Aesthetics/Recreation
- Property Value
- Other (Describe in Comments)

Monitoring Data Types Available: Used to identify data that will be entered into monitoring data tables in workbook. Enter Yes, No, or NA to indicate whether the data set is included in the data submission. All entries should be complete, use NA to indicate unknown. If data are available for the study, but not entered in the submission, provide a note in the Describe Data Type narrative.

- **Chemistry [R, Yes/No/NA]:** Pertains to water chemistry data such as concentrations and loads, as well as soil chemistry.
- **Hydrologic/Hydraulic [R, Yes/No/NA]:** Pertains to hydrologic and/or hydraulic data such as precipitation depths and intensities, flow rates and volumes, groundwater depths, soil pore water, etc.
- **Physical [R, Yes/No/NA]:** Pertains to physical and habitat characteristics of the stream such as erosion metrics, vegetative cover, substrate, etc. This data set includes flora, but not fauna.
- **Biological [R, Yes/No/NA]:** Pertains to fauna such as fish, benthic macroinvertebrates, mammals, etc.

Describe Data Type [S, Text]: Brief narrative describing type of data available (e.g., TSS, TP, TN, flow data, benthic, fish, habitat).

Attachments Submitted [R, Picklist]: Enter Yes, No, or NA to indicate whether the researcher submitted attachments to supplement the data entry spreadsheet, which are highly encouraged. All entries should be completed, use NA to indicate unknown.

- **Report:** Attach published report(s), as allowed by copyright restrictions.
- **Photos:** Attach photos in jpg or png format. Photos under various flow conditions are encouraged.
- **Channel Cross-Sections:** Attach channel cross-sections in PDF format to supplement channel geometry data entered in the Stream table.
- **Channel Profiles:** Attach channel longitudinal profiles in PDF format to supplement channel geometry data entered in the Stream table.
- **Site Diagrams:** Provide as PDF, jpg or png. Diagrams, including monitoring locations, are highly encouraged so that the database user is properly oriented to the study.
- **Design Drawings:** Provide as PDF if useful for understanding key aspects of the study.
- **Calculations/Model Results/Hydrographs**
- **Sampling and Analysis Project Plan (SAPP)**

5.2 Contacts

Contact Record Identification

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Contact_ID [R, Autopopulated Number]

Contact Records (multiple contact records can be provided based on project role)

Project Role [R, Picklist]: Select the role that the contact played for the project. Multiple records can be entered, if available. The picklist includes:

- Owner
- Sponsor

- Researcher
- Maintenance Contractor
- Designer
- Construction Contractor
- Monitoring Entity
- Other

Enter contact information for each record for the following fields—minimum required entries are Agency Name and Contact Name. Only primary study contacts are necessary. The Comments field can be used to provide additional information on supporting contacts that may have incomplete contact information available. Requested contact information includes:

- **Agency Name [R, Short Text]**
- **Address 1 [S, Short Text]**
- **Address 2 [S, Short Text]:** If additional space needed.
- **City [S, Short Text]**
- **State [S, Picklist]:** 2-digit State Code
- **Zip Code [S, Number]:** 5-digit Zip Code
- **Country [S, Short Text]:** 2-digit Country Code (e.g., US, CA, NZ).
- **Contact Name [R, Short Text]**
- **Contact Phone [S, Short Text]**
- **Email [I, Short Text]**
- **Website [S, Hyperlink]**

Comment [S, Short Text]: Provide additional information needed to describe study contacts.

5.3 Watershed

The purpose of the “Watershed” table is to provide basic data about the overall watershed characteristics upstream of the restoration study that influence conditions in the stream. Each study will have a minimum of one watershed record, but some studies may have several watershed records entered.

As an example, some studies may include one record documenting pre-development watershed conditions, as well as a second record documenting post-development watershed conditions. Additionally, if a reference stream is used in the experimental design for the study, then the watershed conditions associated with the reference stream reach and the study stream reach should both be provided. For long-term studies that involve significant changes in watershed conditions over time, more than one watershed entry may also be appropriate.

Watershed Identification

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Watershed_ID [R, Autopopulated Number]

Watershed Name [R, Picklist from Begin Here]: Select the user-identified watershed name (previously identified on Begin Here spreadsheet) from the picklist. More than one watershed condition may need to be identified over the course of the study period.

General Characteristics

Year of Watershed Characterization [R, 4-digit Year]: 4-digit year during which watershed characteristics were documented. Particularly important to document if watershed conditions change significantly over study period, warranting more than one watershed condition. If watershed characterization activities are cited as conducted by another party, include citation in Comments field below.

Narrative Description [R, Short Text]: Provide a narrative description of the key aspects of the watershed.

Drainage Area (hectares) [R, Number]: Provide the drainage area to the stream segment being evaluated in hectares.

Average Annual Precipitation (mm) [I, Number]: Enter average annual precipitation for the watershed in millimeters (mm).

General Geologic Setting [I, Short Text]: Describe the general geologic setting. This may include physiographic region (e.g. Appalachian Piedmont or Great Plains) as well as major geology underlying the watershed (e.g. shale, limestone, etc.).

Dominant Upland Soil Map Unit Symbol ID [I, Short Text]: Enter the alphanumeric codes from the NRCS SSURGO Database, accessible at: http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. Provide comma-delimited list of all significant Map Units for the upland portion of the tributary watershed.

Dominant Floodplain Soil Map Symbol Unit ID [I, Short Text]: Enter the alphanumeric codes from the NRCS SSURGO Database for the floodplain. Provide comma-delimited list of all significant Map Units.

Dominant Upland Hydrologic Soil Group [I, Picklist]: Enter the dominant native hydrologic soils group(s) for the upland portion of the tributary watershed. The four primary hydrologic soil group types are described as:

- Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.
- Group B soils have a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- Group C soils have a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture to fine texture. These soils have a slow rate of water transmission.
- Group D soils have a very slow infiltration rate (high runoff potential) when thoroughly wet.

These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Select the dominant hydrologic soils group(s) from the picklist:

o A	o A/B	o B/D
o B	o A/C	o C/D
o C	o A/D	o NA (Not Known)
o D	o B/C	

Dominant Floodplain Hydrologic Soil Group [I, Picklist]: Enter the dominant native hydrologic soils group(s) for the floodplain. (See description above for hydrologic soil groups.)

Soil Narrative [I, Short Text]: Provide narrative descriptions of the Study Area soil types/texture classes. This information can also be obtained on-line from the NRCS Web Soil Survey.

NRCS Web Soil Survey

The Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the NRCS and provides access to soil maps and data available online for most of the nation's counties. It can be accessed at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Watershed Slope (avg %) [I, Number]: Enter the average watershed slope as a percentage (0-100). Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Total Watershed Imperviousness (%) [I, Number]: Enter the percentage of the watershed that is impervious. Common impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and macadam or other surfaces that similarly impede the natural infiltration of urban runoff. The percent of the total watershed that is impervious can be determined as the total impervious area divided by the total area of the watershed. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Hydraulically Connected Watershed Imperviousness (%) [S, Number]: Calculated by dividing the hydraulically connected impervious area by the total impervious area. An example of hydraulically connected impervious area includes building rooftops that drain onto paved areas. This parameter provides a general description of the connectivity of a watershed. (It is the amount of area likely to discharge in a small storm event; however, larger areas may behave as Directly Connected Impervious Area in larger events.) Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25). (Although this information is important, it may not be available in many studies.)

Controls on Hydraulic Regime [I, Long Text]: Describe features that control the hydraulic regime of the stream. Typical examples would be dams, irrigation diversions or returns, etc.

Describe Extent of Watershed Served by BMPs [I, Long Text]: Describe the extent to which the watershed is served by urban, agricultural or timber-related BMPs, based on best available knowledge of the watershed. As part of the description, identify the types of BMPs that are implemented. (Although this information is important, it may not be available in many studies.)

Land Use

General Land Use [R, Picklist]: Select the dominant general land use for the tributary watershed from this picklist:

- o Urban
- o Agriculture
- o Forest
- o Mixed
- o Other

Land Use [I, Number]: Provide percent area of dominant land uses. If the land use has changed significantly over the course of the study period, then it may be necessary to enter two separate watershed entries.[5] Enter as a percentage rather than a fraction (e.g., for 25 percent, enter 25, not 0.25).

- Residential
- Commercial
- Urban (Not-Specified)
- Industrial
- Freeway/Road
- Institutional
- Agriculture-Crops
- Agriculture-Livestock
- Agriculture-Mixed
- Forest
- Rangeland
- Open Space
- Other (Describe other land uses in Comments, as needed.)

Describe Directly Adjacent Land Use [I, Text]: Predominant land use directly adjacent to stream corridor. Include any critical infrastructure (e.g. sewers, bridges) that may impact restoration activities.

Comments [S, Long Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

[5] Contact the Project Technical Support for additional guidance on when multiple Watershed entries may be needed due to significant changes in land use.

5.4 Stream

The purpose of the “Stream” table is to document key physical characteristics of the stream and its valley. Most studies will include at least two records for stream characteristics. These are typically conditions before improvements were implemented and conditions after improvements were implemented. Alternatively, spatially-based “test” and “reference” stream conditions may be entered instead of a before-after approach. Some studies may also enter stream conditions corresponding to several temporal phases: before, interim (during establishment of improvements) and established (or “after”). For some network-scale studies, it is also possible that multiple tributaries (individual stream entries) may be described in this table.

The relational structure of the database enables monitoring data to be associated with each Stream record to facilitate comparisons of conditions with and without stream restoration practices implemented and allow for documentation of stream conditions during interim stages of restoration, as well.

Stream Identification

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Watershed_ID [R, Autopopulated Number]

Stream_ID [R, Autopopulated Number]

Stream Name [R, Picklist]: Select user-identified stream name from the picklist. Multiple stream records may be entered for the study, either spatially or temporally.

Identify Stream Condition Being Characterized

Stream Condition Type [R, Picklist]: Select the condition that best describes this stream:

- o Pre-Development (Reference)
- o Pre-Development (Agriculture)
- o Pre-Restoration (Urban)
- o Pre-Restoration (Agriculture)
- o Pre-Restoration (Impaired)
- o Pre-Restoration (Other)
- o Post-Restoration (1 yr)
- o Post-Restoration (2 yr)
- o Post-Restoration (3 yr)
- o Post-Restoration (4 yr)
- o Post-Restoration (5 yr)
- o Post-Restoration (6-10 yr)
- o Post-Restoration (11-20 yr)
- o Post-Restoration (>20 yr)

303(d) Impairment(s) [I, Text]: Biennially states are required to develop a list of impaired waters known as a 303(d) List. Enter 303(d) pollutant list for the stream, none or N/A if unknown. If a TMDL has been completed, then the pollutant(s) should be entered in the field below (TMDL Pollutants).

TMDL Pollutants [I, Text]: If a Total Maximum Daily Load (TMDL) has been completed for pollutant(s), enter pollutant list, none or N/A.

Valley Setting

Valley Slope (%) [I, Short Text]: Measured as the elevation drop along a straight-line distance between two points on the streamline. Can be estimated from a digital elevation model, topographic map, or measured in the field. This will allow for calculation of sinuosity. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Lateral constraint [I, Short Text]: Describe degree of hillslope coupling and planform confinement. Narrow valleys tend to have greater confinement and more sediment inputs from hillslopes than wider valleys (see Figure 5).

Valley type [I, Short Text]: Describe valley type. For example descriptors, see Figure 5 and Table 3.

- Gorge
- Canyon
- Glacial
- Open Floodplain
- Delta
- Other (please describe)

Table 3. Valley Geomorphic Classification from Bledsoe and Carlson (2012)

Valley Class Name	Energy / Valley Gradient	Valley Bottom Width / Coupling / Confinement	Hillslope Gradient	Energy Potential
Headwaters	> 4%	< (2 L_d + W_{BF})	Both > 30%	High
High-energy Coupled	> 4%	< (2 L_d + W_{BF}) or < (L_d + W_{BF})	Both or at least one > 30%	High
High-energy Open	> 4%	> (2 L_d + W_{BF})	Both or at least one > 30%	High
Moderate-energy Confined	0.1-4%	< 7 W_{BF}	Variable	Moderate
Moderate-energy Unconfined	0.1-4%	> 7 W_{BF}	Variable	Moderate
Canyon	Variable	> 3 W_{BF}	> 70%	Moderate to High
Gorge	Variable	< 3 W_{BF}	> 70%	Moderate to High
Glacial Trough**	< 4%	> (2 L_d + W_{BF})	~ 10% initially steepening to > 30%	Moderate to Low
Low-energy Floodplain	< 0.1%	> 7 W_{BF}	Generally < 30%	Low

L_d – length of debris runout W_{BF} – width of channel at bankfull stage
** Defined as valleys with the given characteristics, lying above the elevation of the most recent glacial activity

Channel Geometry/Condition

Channel Type [I, Short Text]: General channel characteristics. For example:

- Alluvial vs. non-alluvial: Alluvial channel beds are composed of non-cohesive material (e.g. sand, gravel, cobble, boulders) while non-alluvial channel beds are cohesive (e.g. clay or bedrock) (see Bedforms, below).
- Single thread vs. multi-thread: Single thread streams consist of a single channel while multi-thread streams contain multiple channels that may branch and intersect (i.e., braided), separated by bare bars or vegetated islands (see Planform, below).

Also include stream type from preferred classification, if desired. For example:

- Montgomery and Buffington (1997): Process-based classification system driven by relative magnitudes of sediment capacity and supply (Figure 6).
- Rosgen (1996): Form-based classification system driven by metrics such as sinuosity, slope, entrenchment, and bed material (Figure 7 and Figure 8).
- Brierley and Fryirs. (2005): River Styles framework based on valley setting, number and type of channels, and geomorphic units.

Figure 5. Examples of valley types from Rosgen (1996). Used with permission.

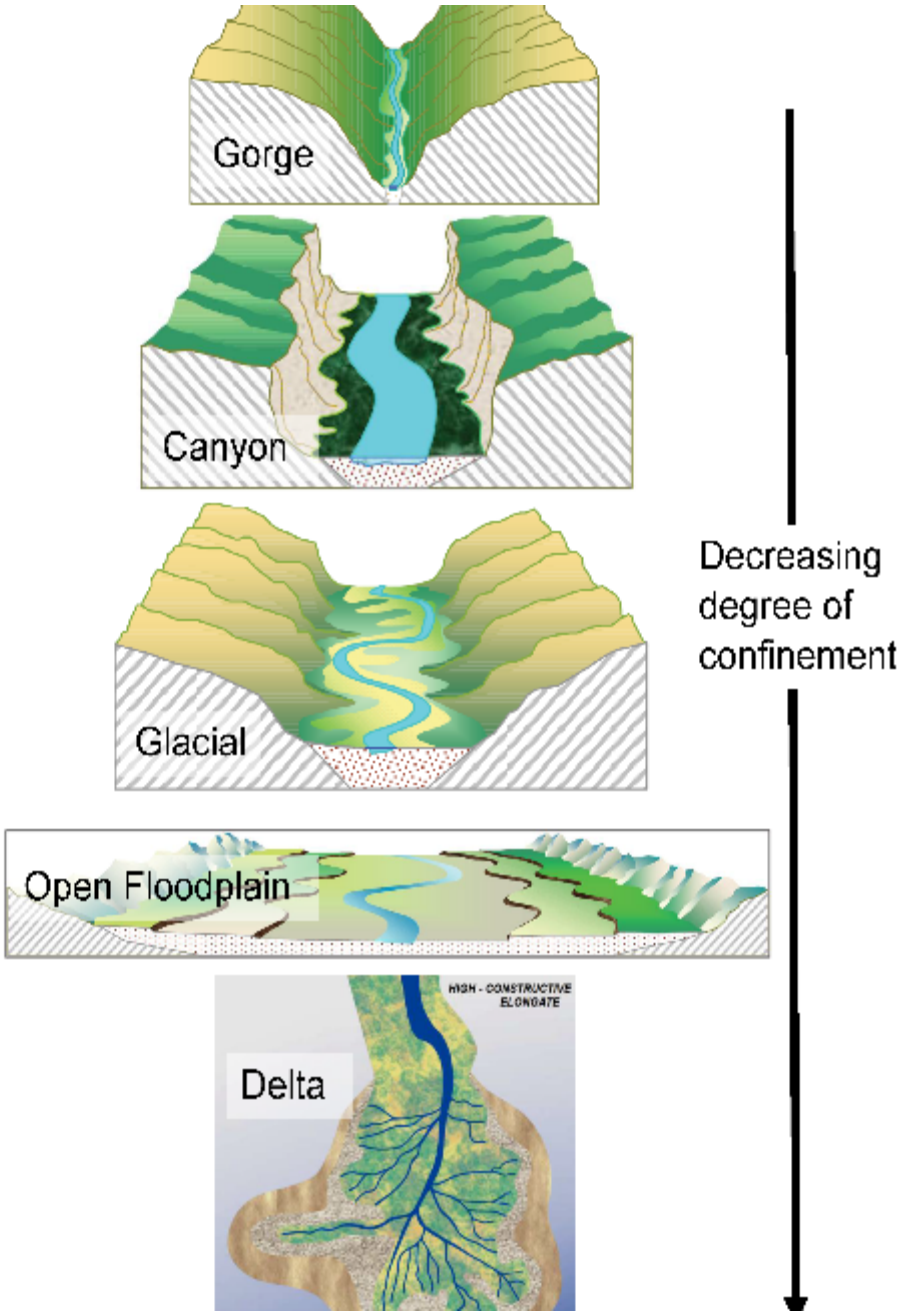


Figure 6. General Reach Geomorphic Classification
Adapted after Montgomery and Buffington (1997).

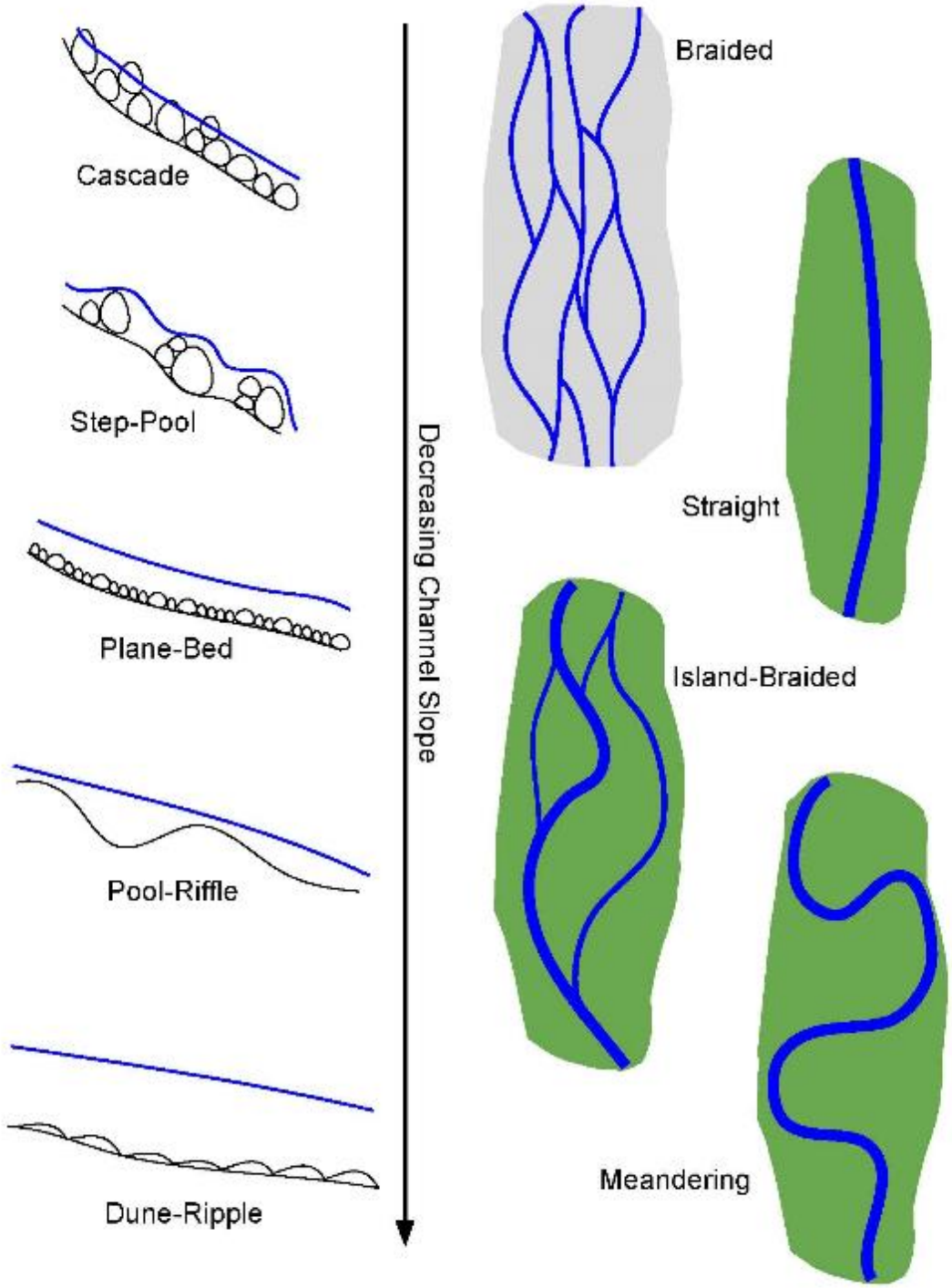


Figure 7. System Classification of Major Stream Types from Rosgen Stream Classification System (Rosgen, 1994, 1996)

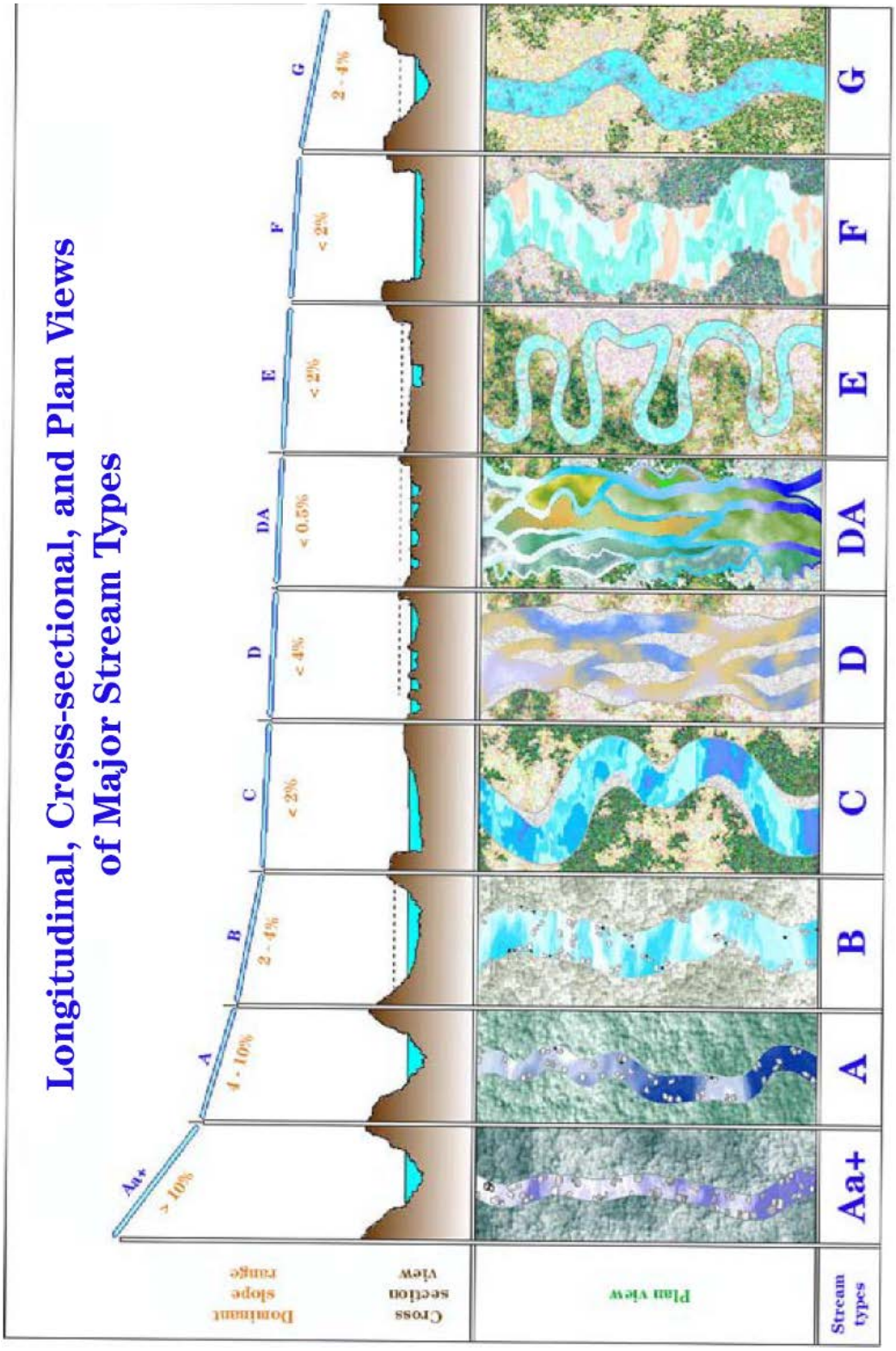
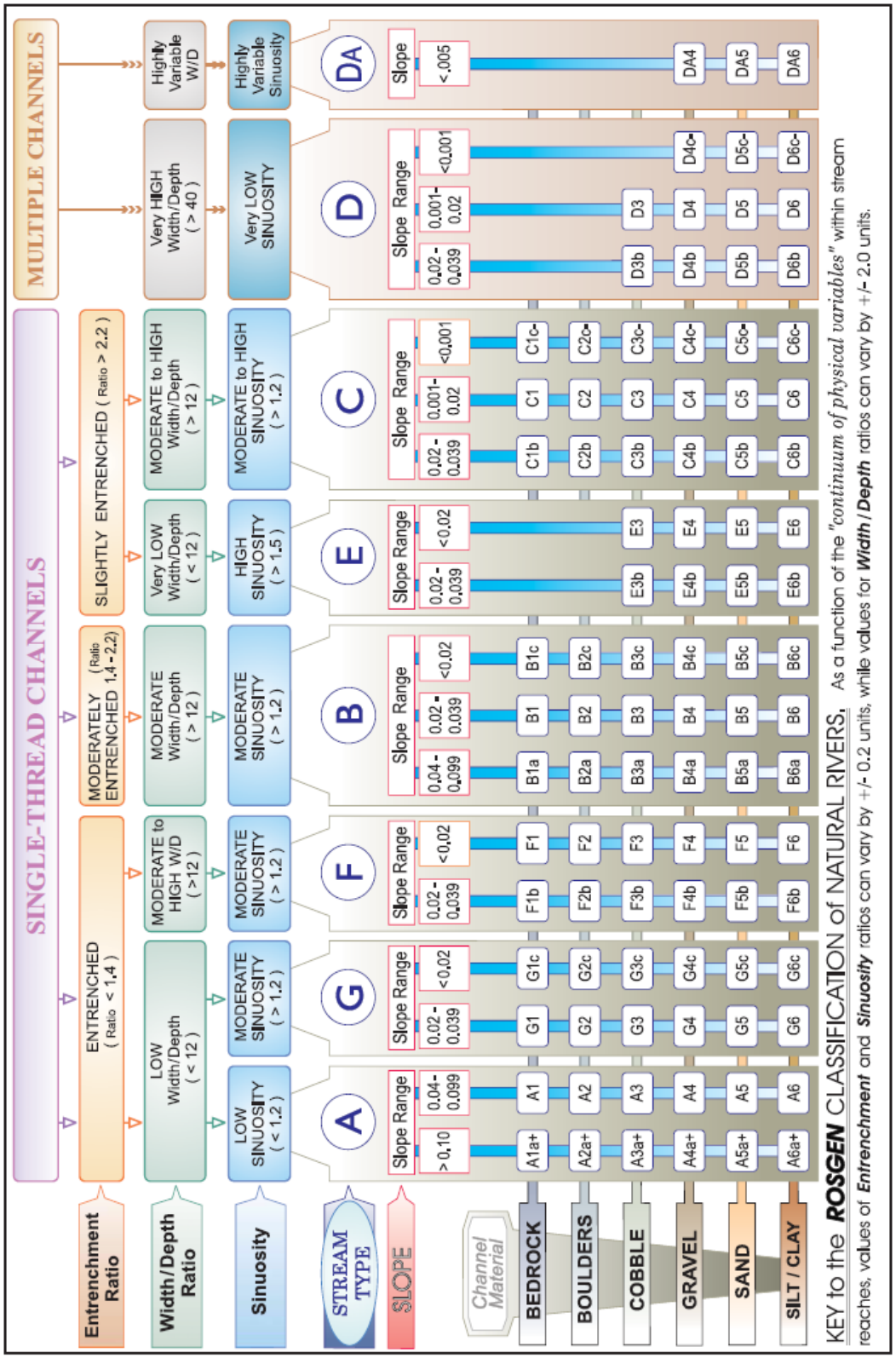
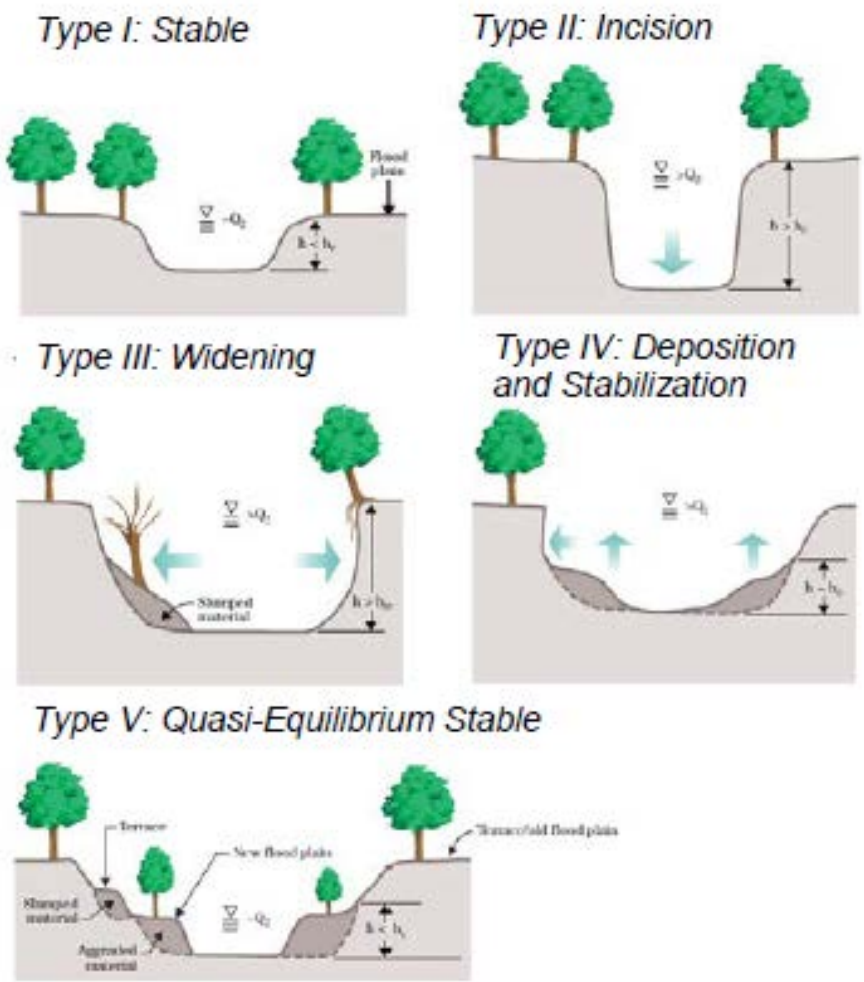


Figure 8. Key to Rosgen Stream Classification System (Rosgen, 1994, 1996)



Describe Channel Evolution Stage [I, Text]: Use key words to describe stage of channel evolution using terms similar to Figure 10, or regionally specific comparable diagrams. If this is not possible, general description of the reach is acceptable (e.g. stable, eroding, or aggrading).This information is important for anticipating benefits gained from stream restoration.

Figure 9. Channel Evolution Model after Schumm et al. (1984) (see NRCS 2007, CH3)



Bedforms [I, Short Text]: Describe general bedform characteristics in the reach. For example (and see Figure 6):

- Cascade
- Step-pool
- Plane bed
- Pool-riffle
- Dune-ripple
- Other (describe)

Planform [I, Short Text]: General planform type of the stream. For example (and see Figure 6):

- Straight
- Meandering
- Braided
- Anastomosing (or island braided)
- Other (please describe)

Return Period that Reaches Floodplain (yr) [S, Number]: This is an estimate of the frequency of the bankfull discharge.

Average Bank Height (m) [I, Number]: Bank heights can be measured in the field using a measuring tape. The measured bank height should be converted to a vertical height based on the bank angle (Figure 11). If multiple measurements were taken, report the average. Raw data can be submitted in the "Physical Data" table.

Average Bank Angle (degrees) [I, Number]: Bank angle can be measured using a contractor's protractor or similar device. If multiple measurements were taken, report the average. Raw data can be submitted in the "Physical Data" table.

Effective Channel Slope (%) [I, Number]: Channel bed slope can be measured multiple ways, including field surveys and remotely from digital elevation models. See the U.S. Forest Service's "Stream Channel Reference Sites" for details on surveying longitudinal profiles (http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF). Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25). If multiple measurements were taken, report the average. Raw data can be submitted in the "Physical Data" table.

Sinuosity [S, Number]: Estimate of the channel sinuosity of the reach. Alternatively, users may input both an Effective Channel Slope and Valley Slope and this value will be computed by Database Support Staff.

Average Channel Width (m) [I, Number]: This is the average bankfull channel width (Figure 12).

Average Channel Depth (m) [I, Number]: This is the average bankfull channel depth. Can be measured directly or calculated by dividing flow area by bankfull channel width (Figure 11).

Channel Geometry/Condition Comments [S, Short Text]: Allows narrative description of channel geometry/condition.

Figure 10. Schematic of Bank Height Measurement
Total bank height = A*sin(α)+B*sin(β)

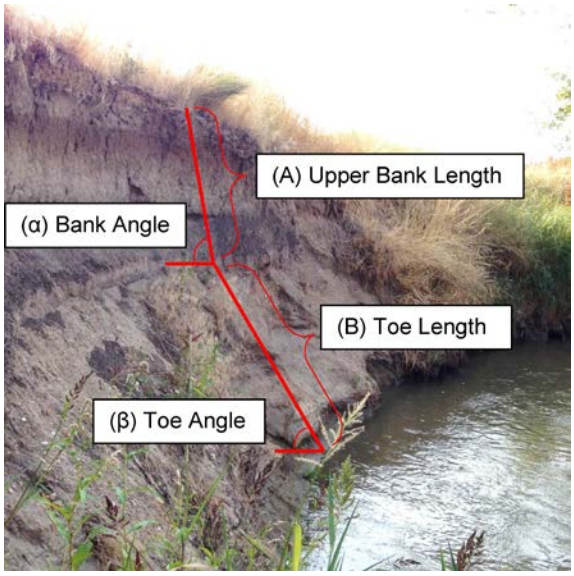
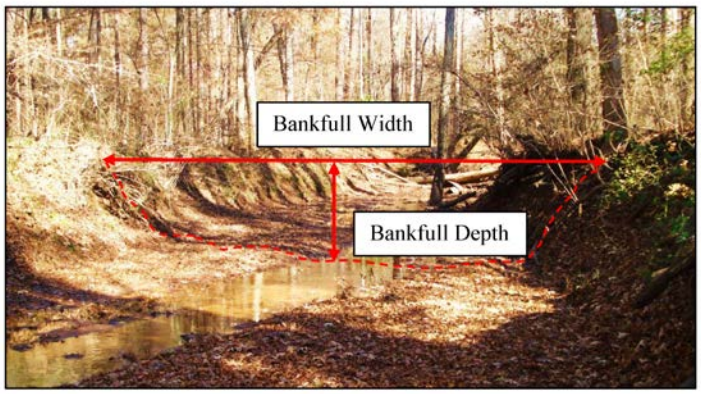


Figure 11. Schematic of Bankfull Channel Width and Depth Measurement



Flow Regime

Flow Regime Type [R, Picklist]: Select the dominant flow regime from the picklist:

- Perennial: Water flows in the stream year-round
- Intermittent: Flow in the stream may be spatially discontinuous (e.g. alternating wet and dry reaches). Flow may only occur seasonally.
- Ephemeral: Flow only occurs in response to a precipitation event in the immediate or upstream area.
- Other (please describe)

Primary Hydrologic Source [I, Short Text]: Describe the primary hydrologic source and/or primary hydrologic influences on the stream. Examples could include:

- Rain: Runoff primarily rain-driven.
- Rain+Snowmelt: A combination of rain and snowmelt runoff.
- Snowmelt: Runoff primarily from snowmelt characterized by a large annual runoff peak in early summer.
- Groundwater: Flows are relatively stable.
- Reservoir Release: Flows largely controlled by managed releases from reservoirs.
- Effluent: Discharges from wastewater treatment plants, thermoelectric facilities, or other industry is the dominant component of streamflow (or at least baseflow).
- Other combinations such as Rain+Groundwater, Rain+Groundwater+Snowmelt, etc.

Flow Regime Estimates

Dominant Discharge Type [I, Picklist]: Select the dominant discharge type from the picklist below:

- Bankfull discharge: Discharge that would just fill the channel before overbank flooding occurs. The bankfull concept may not apply to deeply incised streams.
- Effective discharge: The discharge that is responsible for the most cumulative sediment transport over time. Calculated based on flow frequency, flow magnitude, and sediment transport (see http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-viii-4.pdf).
- Half-load discharge: The half-load (or half-yield) discharge is the discharge above and below which half of the cumulative sediment load has been transported over time. It is computed following a similar procedure as the effective discharge.
- Other (please describe)

Dominant Discharge (m^3/sec) [I, Number]: The estimated value of the dominant discharge of the type selected above entered in cubic meters per second.

Flow Estimates: [I, Number]: Enter values for discharges with the following recurrence intervals in cubic meters per second (if available).

- 1.3-yr Flow (m^3/sec)
- 1.5-yr Flow (m^3/sec)
- 2-yr Flow (m^3/sec)
- 5-yr Flow (m^3/sec)
- 10-yr Flow (m^3/sec)
- 50-yr Flow (m^3/sec)
- 25-yr Flow (m^3/sec)
- 100-yr Flow (m^3/sec)

Design Storm Duration (hrs) [I, Number] (if flow estimates defined above are from Event-Based Modeled Flows): The design storm duration used if a hydrologic model was used to quantify the stream discharge used in the restoration design.

Bank Materials--Toe

Toe Materials (Describe) [R, Short Text]: Briefly describe toe layering/stratigraphy. Include general toe material type (e.g. cohesive, sand, gravel, etc.).

Soil Bulk Density (g/cm^3) [S, Number]: Enter the soil bulk density of the dominant materials of the bank toe. Soil bulk density is defined as the dry weight of soil per unit volume of soil. Bulk density considers both the solids and the pore space; whereas, particle density considers only the mineral solids.

Consolidation [R, Picklist]: Select type of consolidation that best characterizes the toe materials from the picklist:

- Moderately- or well-consolidated: Moderate or well packed material, primarily clay, silt, or fine sand.
- Poorly or unconsolidated fine: Loose fine grained material (e.g. sand).
- Poorly or unconsolidated coarse: Loose coarse grained material (e.g. gravel or coarser).
- Other (please describe)

Gradation of Toe Materials [S, Number]: Soil gradation determined from laboratory test (e.g. hydrometer or pipette method). Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

- % clay
- % silt
- % sand
- % gravel
- % other mineral
- % organic matter

Toe P Content (mg/kg) [S, Number]: Phosphorus content of the bank toe, determined from laboratory tests. If multiple samples were analyzed, report the average. Raw data can be submitted in the “Physical Data” table.

Toe N Content (mg/kg) [S, Number]: Nitrogen content of the bank toe, determined from laboratory tests. If multiple samples were analyzed, report the average. Raw data can be submitted in the “Physical Data” table.

Describe Methods for Toe Content Analysis [S, Short Text]: Laboratory methods used for measuring P & N bank content. If a standard method was not used (e.g. EPA 3051a), briefly describe the extraction employed.

Bank Materials--Dominant Materials above the Bank Toe

Bank Materials [R, Short Text]: Briefly describe bank layering/stratigraphy for the bank above the toe. Include general bank material type (e.g. cohesive, sand, gravel, etc.).

Soil Bulk Density (g/cm^3) [S, Number]: Enter the soil bulk density of the dominant materials above the bank toe. Soil bulk density is defined as the dry weight of soil per unit volume of soil.

Bulk density considers both the solids and the pore space; whereas, particle density considers only the mineral solids.

Consolidation [R, Picklist]: Describe the consolidation of the dominant materials above the bank toe from the picklist:

- o Moderately- or well-consolidated: Moderate or well packed material, primarily clay, silt, or fine sand.
- o Poorly or unconsolidated fine: Loose fine grained material (e.g. sand).
- o Poorly or unconsolidated coarse: Loose coarse grained material (e.g. gravel or coarser).
- o Other (please describe)

Gradation of Bank Materials: Soil gradation determined from laboratory test (e.g. hydrometer or pipette method). Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

- % clay
- % silt
- % sand
- % gravel
- % other mineral
- % organic matter

Bank P Content (mg/kg) [S, Number]: Phosphorus content of the bank, determined from laboratory tests. If multiple samples were analyzed, report the average. Raw data can be submitted in the “Physical Data” table.

Bank N Content (mg/kg) [S, Number]: Nitrogen content of the bank, determined from laboratory tests. If multiple samples were analyzed, report the average. Raw data can be submitted in the “Physical Data” table.

Describe Methods for Bank Content Analysis [S, Short Text]: Laboratory methods used for measuring P & N bank content. If a standard method was not used (e.g. EPA 3051a), briefly describe the extraction employed.

Bed Materials

Gradation of Surficial Bed Materials [S, Number]: D refers to the diameter of the grain size of the “Xth” percentile of the cumulative grain size distribution (e.g., D10 is the grain size diameter for the 10th percentile). Enter the gradation for each grain size distribution below, or leave blank if unknown:

- D10 (mm)
- D16 (mm)
- D50 (mm)
- D84 (mm)
- D90 (mm)

Fines included or truncated in D estimates? [S, Yes/No/NA]: Were fine grains (<2 mm) included in the grain size distribution or not? Report "NA" if no fines were present.

% Bed surface area that is exposed hardpan or bedrock [S, Number]: Hardpan or bedrock are relatively erosion-resistant and may be present in the channel bed. This material may be overlain by alluvium (e.g. sand or gravel). Report only the percentage that is visible. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

% Bed surface area covered in fines < 2 mm [S, Number]: Fines includes sand, silt, and clay. In a fully sand-bed streams this value should be reported as 100% (assuming no gravel patches are present). Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Ratio of D50 of Surface Pavement to D50 of Subpavement in Coarse Grained Beds [S, Number]: The goal of this metric is to characterize bed armoring. Details on sampling methodology can be found here: http://www.stream.fs.fed.us/publications/PDFs/rmrs_gtr74.pdf.

Vegetation

Bank Vegetation Condition [I, Short Text]: A short description of dominant bank vegetation (e.g. grass, shrubs, trees, or bare) and condition (e.g. healthy, grazed, etc.). Also note the percentage of coverage and species if known.

Floodplain Vegetation Condition [I, Short Text]: A short description of dominant floodplain vegetation (e.g. grass, shrubs, trees, or bare) and condition (e.g. healthy, grazed, etc.). Also note the percentage of coverage and species if known.

General Vegetation Type [R, Picklist]: For riparian zone in general (including both banks and floodplain).

- Forest
- Herbaceous (native)
- Herbaceous (urban manicured)
- Herbaceous (cultivated)
- Other (please describe)

% Canopy Closure [S, Number]: The percentage of the stream channel that is shaded/covered by riparian vegetation canopy. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

% Native Vegetation Intact [S, Number]: Coverage of native vegetation for the banks and floodplain. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

% Invasive Species [S, Number]: Coverage of invasive vegetation species for the banks and floodplain. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Rooting Depth, as % of Bank Height [S, Number]: The average depth of bank or floodplain vegetation roots scaled to bank height. Roots may be visible on actively eroding banks but may

not be on stable banks. Enter as a percentage instead of a decimal fraction (e.g., for 25 percent, enter 25, not 0.25).

Describe Vegetation Types [R, Short Text]: Addition description of vegetation to supplement picklist (General Vegetation Type).

Describe Methods for Vegetation Assessment [S, Short Text]: List methods used to characterize vegetation. These may include visual inspection or specific methods for quantification of vegetation coverage (e.g. basal area measurement).

Comments

Comments [S, Short Text]: Any additional comments related to general stream characteristics.

5.5 Design

The purpose of the "Design" table is to document key attributes of the stream restoration design associated with a "Stream" record. The intent of the table is provide enough detail on the design to enable comparison and identification of features influencing performance but not request so much detail that the data entry process is time-prohibitive. (Note: the Study table enables submittal and upload of photos, channel cross-sections, site diagrams and design details, which can be referenced to support the descriptions in the Design table.)

Important: Each Design record corresponds to one Stream record (i.e., one-to-one relationship in the database design).

Stream Identification

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Watershed_ID [R, Autopopulated Number]

Stream_ID [R, Autopopulated Number]

Design _ID [R, Autonumber]: Autopopulated

Stream Name [R, Picklist]: Select user-identified stream name from the picklist. Multiple stream records may be entered for the study, either spatially or temporally.

Stream Restoration Practice Type(s) [R, Yes/No/NA]: Identify which restoration practices are present for this study. An answer is required [R] for each field. Enter Yes, No, or NA (if unknown or not applicable). Note that multiple practice types may be implemented on individual projects.

- **Redirective Practice:** Reduces the erosive power of the stream by redirecting the flow (e.g. spurs/groynes, bendway weirs, and guidebanks).
- **Resistive Practice:** Increases the erosive resistance of the bank (e.g. bioengineering, rip-rap, and revetments).

- **Grade Control:** Prevents channel incision by providing a hardpoint on the channel bed, often reducing channel slope (e.g. drop structure, cross-vane, constructed riffle)
- **Flow Control:** Upland practices (e.g. stormwater controls) or improved dam management to restore a more natural flow regime.
- **Riparian Condition/Buffer Reestablishment:** Re-establish or protect existing riparian vegetation. This may be as intensive as direct planting or as simple as livestock exclusion to prevent grazing.
- **Floodplain Connectivity/Reconfiguration:** Hydrologic reconnection of a floodplain to increase frequency of overbank events. May be achieved through lowering stream banks, removing or breaching levees, or raising the channel bed.
- **Habitat Enhancement/Instream Features:** Construction of in-stream features to improve physical habitat or meet some other objective (e.g. grade control or bank stabilization). Examples include constructed riffles, log jams, cross-vanes, or j-hooks.
- **Channel Reconfiguration/Planform Changes:** Construction of a new channel or reconnection to a historically abandoned channel, typically for increasing sinuosity and reducing channel slope.
- **Barrier Removal/Fish Passage:** Includes removal of dams or other structures that block passage of fish, other aquatic organisms, and abiotic fluxes of sediment and/or nutrients.
- **Passive Approaches:** Included practices that avoid direct human modification of the stream itself. Examples include fencing to prevent grazing, beaver reintroduction, or restoring upland processes (e.g. reforestation to reduce runoff and sediment supply).

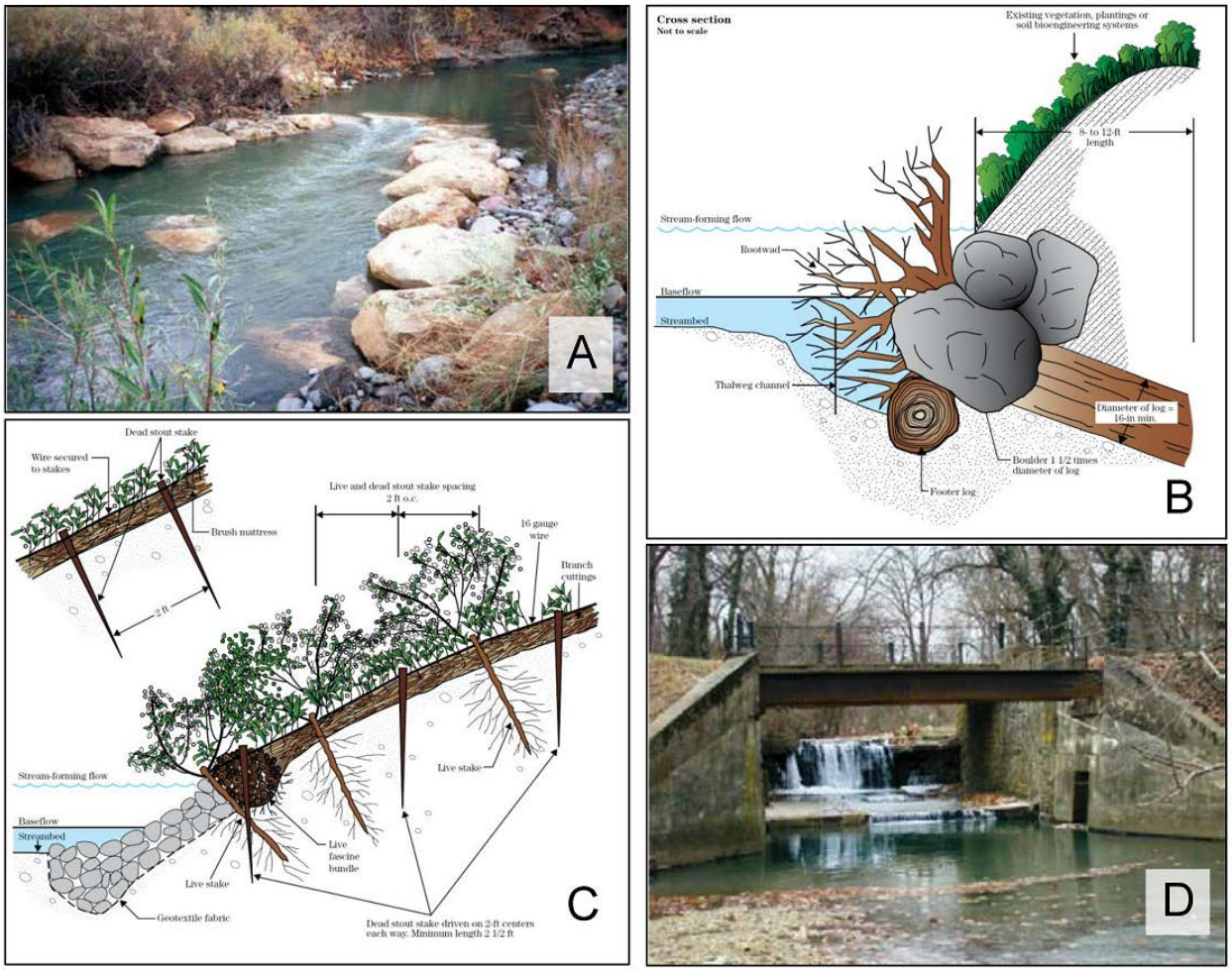


Figure 12. Examples of Various Restoration Practices
(A) Cross-vane for grade control. (B) Toe wood for bank stabilization and habitat enhancement. (C) Bioengineering for bank stabilization. (D) Structure to be removed to enhance fish passage. All images from NRCS (2007).

Additional Information

Year Improvements Completed [I, Number]: Enter the 4-digit year during which construction of the improvements was completed. (Note: vegetation may still be in the process of establishment beyond this date.)

Channel Length Restored (m) [I, Number]: Total length of channel on which restoration was completed. If channel length was altered as a part of restoration (e.g. channel reconfiguration) report the post-restoration length. Report value in meters.

Riparian Width Restored (m) [I, Number]: Width of restored riparian buffer measured perpendicular to the channel. Report value in meters.

Reference/Guidance for Design [S, Short Text]: A description of the reference or guidance document used to inform design (if applicable). Examples include the NRCS Stream Restoration

Design Handbook and the USACE Channel Restoration Design for Meandering Rivers (see http://go.usa.gov/BvNA), although there are many more options.

Model(s) Used to Support Design or Predict Performance [S, Short Text]: If a model was used to support the project design, enter the model name and how it was used. Otherwise, enter unknown or N/A.

Design Approach [I, Picklist]: General design approach:

- Reference/Geomorphic: Design is based on channel form of a reference reach.
- Threshold: Design for channels with erosion resistant boundaries where sediment movement is episodic.
- Alluvial/Sediment continuity: Design for channels with erodible boundaries where sediment transport is observed at nearly all flows. Accounting for sediment supply to the design reach is more important in these systems.
- Other (describe)

Fluxes Managed [R, Short Text]: Flux management could involve direct approaches (e.g. adding gravel downstream of a dam) or indirect approaches that attempt to restore natural processes (e.g. riparian buffer establishment and/or beaver reintroduction to restore more natural wood flux to streams). Examples of fluxes that might be managed include:

- Water
- Sediment
- Wood
- Other organic matter
- Nutrients
- Heat

Describe Goals/Performance Standards of Restoration Design [I, Long Text]: Enables additional discussion regarding targeted outcomes. Include both general goals (e.g. improve fish habitat) and specific performance standards for assessing goal achievement (e.g. # pools created, % increase in fish abundance).

Describe Measures Implemented to Achieve Benefits: Allows for detailed descriptions of specific measures installed or implemented for each of restoration practice types, as applicable. *Enter none or unknown if information not available.*

Bank Stabilization Measures [R, Long Text]: Describe specific practices implemented, including extent (e.g. only out outer bends, both banks, etc.). Examples of specific practices include:

- Barbs
- Vanes
- Bendway weirs
- Spur dikes
- Bioengineering (e.g. vegetation)
- Toe wood

- Log jams
- Rock walls
- Riprap

Bed Stabilization Measures [R, Long Text]: Describe specific practices implemented, including extent (e.g. number of structures constructed, spacing, etc.). Examples of specific practices include:

- Grade control
- Vanes
- Weirs
- Drops

Riparian Condition/Buffer Reestablishment [R, Long Text]: Describe specific practices implemented, including extent (e.g. width or area of planting, one or both sides of the stream) and specific species planted, if applicable.

Floodplain Connectivity/Reconfiguration [R, Long Text]: Describe specific practices implemented, including extent (e.g. length of stream, area of floodplain reconnected).

Habitat Enhancement/Instream Features [R, Long Text]: Describe specific practices implemented, including extent (e.g. number and spacing of structures).

Channel Reconfiguration/Planform Changes [R, Long Text]: Describe specific practices implemented, including extent (e.g. length of channel reconfigured, use of an abandoned channel or new channel constructed).

Barrier Removal/Fish Passage [R, Long Text]: Describe specific practices implemented, including extent (e.g. number of type of structures removed, number of stream miles newly connected as a result of removal).

Infrastructure Protection Measures [R, Long Text]: Describe specific practices implemented, including extent (e.g. type and length of infrastructure protected).

Other Approaches [R, Long Text]: Describe specific practices implemented, including extent (e.g. length of stream protected from grazing, number of beavers introduced, upland area reforested or subject to new stormwater management).

Other Characteristics

Design Return Period(s) (yr) [S, Short Text]: Describe return periods of flows used in design of stream restoration structures, if applicable.

Operation, Maintenance and Replacement Description/Frequencies [S, Long Text]: Describe proposed plan for monitoring, maintenance, and replacement of restoration structures. Include at what frequency these events are expected to occur (e.g. yearly maintenance or replacement after 25 years).

Expected Stabilization/Establishment Period (months) [S, Number]: The length of time for the project to begin functioning as designed. This may be dependent on vegetation establishment and growth and/or sediment delivery to the restored reach.

Expected Response Time (range of yrs) [S, Short Text]: The expected length of time before project objectives will be met. Examples of objectives include improved water quality or increase in fish abundance.

Expected Design Life (range of years) [S, Short Text]: Longevity of practices will vary depending on the design and other factors. Include basis of calculation or estimate.

Comments [S, Long Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

5.6 Monitoring

The "Monitoring" series of tables includes information on the monitoring setup (related to experimental design), monitoring events and monitoring data for chemical data (water quality), biological data and physical (habitat) characteristics. **The primary focus of the initial release of the Stream Database is on water quality**; therefore, the biological and physical monitoring data tables are provided as general placeholders to be further refined in future upgrades of the database, as funding allows.

5.6.1 Monitoring Setup

The purpose of the "Monitoring Setup" table is to provide basic data on the monitoring approach and to relate each monitoring location to previously assigned study attributes such as the Study ID, Watershed ID and Stream ID[6] and enable association of monitoring data with the study. The Monitoring Setup table is the "roadmap" that relates the monitoring data to the study site. Proper population of the Monitoring Setup table is essential for proper use of the data set by third parties.

Monitoring Station Identification

Site_ID [Number]: Autopopulated

Watershed_ID [Number]: Autopopulated

Stream_ID [Number]: Autopopulated

MS_ID [Number]: Autopopulated

Pair_ID [Number, R]: User must provide an integer to enable pairing of monitoring locations. For example, the first pair of monitoring stations to be compared against each other would both

[6] Stream and Design records are defined as having a "one-to-one" relationship; therefore, the Design ID is not carried in the Monitoring setup table.

be assigned a “1”, the second pair would be assigned “2”, etc. If no pairing is appropriate, then enter the next integer in the sequence.

Stream Name [R, Picklist]: Select user-identified stream name from the picklist. Multiple stream records may be entered for the study, either spatially or temporally.

Monitoring Station Name [R, Short Text]: Multiple monitoring station records (rows) can be added in this table. User-defined monitoring station name (or monitoring unit name), e.g., Up-1, Down-1, Reach-1, Reach-2. If same location is monitored over a phased implementation period for major improvements, create a new monitoring station ID for new major phases so that data are not comingled.

Monitoring Station Information

Monitoring Station Type [R, Picklist]: The monitoring station type defines the relationship of the monitoring station to the stream condition or reach. This field is critical to proper future use of the data set. The picklist includes:

- Pre-restoration
- Post-restoration
- Upstream
- Downstream
- Inflow
- Outflow
- Intermediate (other location within practice/restoration area)
- Reference/Control
- Other (describe in Comments)

Media Monitored [R, Short Text]: Provide a comma-separated list of the various media monitored at this location that have been included in the submission. Examples include surface water, pore water, soil, vegetation, fish, macroinvertebrates.

Decimal Latitude [I, Number]: Enter the latitude of the monitoring station in decimal degrees.

Decimal Longitude [I, Number]: Enter the longitude of the monitoring station in decimal degrees.

Additional Spatial Information [I, Short Text]: Provides the data provider an opportunity to include supplemental spatial information. For example, enter the monitoring station distance from project (approximate) and relative relationship (e.g. 10 meters upstream of improvements).

Major Influences during Monitoring Period [I, Short Text]: If monitoring period was affected by major events in the watershed, describe those events in this field. Examples could include major storms, drought, forest fires, etc.

Describe Protocol(s) Followed [I, Short Text]: Describe the monitoring protocol followed for the measurements collected at this monitoring station (e.g., USGS Techniques of Water-Resources Investigations, Rapid Bioassessment Protocol (Barbour et al. 1999), others.) Note: specific laboratory methods are requested for each chemical result in the table Monitoring_Chem.

Describe Equipment/Instrumentation [I, Short Text]: Describe the type(s) of instrumentation installed at the monitoring location, if any. Examples could include rain gauge, staff gauge, automated sampler (including brand), bedload sampler, or a combination of multiple types of equipment.

Describe Calculation Methods [I, Short Text]: Most applicable for "physical" monitoring data such as method used to calculate soil loss from streambank erosion.

Comments [S, Short Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

Data Types Collected at Monitoring Station [R, Yes/No/NA/NP]: Document the types of data collected at this monitoring station. Multiple types of monitoring data are often collected at a single location. Enter Yes, No, NA (if unknown or unavailable) or NP (if available, but not provided) for each of these fields:

- Chemical
- Hydrologic/Hydraulic
- Biologic
- Physical

5.6.2 Monitoring Events

The purpose of the “Monitoring Events” table is to provide a common Event ID that can be used to relate multiple types of monitoring data (e.g., water quality, biological and/or physical) to a common monitoring period. The database structure can accommodate multiple types of monitoring “events” that can be represented individually or cumulatively. Representative examples include:

- Individual instream monitoring events (e.g., event records for 20 sampling dates over a five-year period).
- Cumulative sampling results (e.g., pollutant loading for the cumulative pre-restoration period, pollutant loading for the cumulative post-restoration period).
- A combination of both individual and cumulative results.

The Monitoring Events table is fundamental to understanding how the data are being reported for a particular study. The Monitoring Events table can also enable future users to query monitoring event types of interest.

Event Identification

Site_ID [Number]: Autopopulated

Event_ID [Number]: Autopopulated

Monitoring Data Parameters

Monitoring Event Period [R, Picklist]: Describe the monitoring event period that is associated with reported data for the study from the picklist:

- Event
- Annual
- Multi-Month
- Multi-Year
- Season
- Other

General Monitoring Date(s) [R, Short Text]: General date description or period monitored in text format. (e.g., spring 1998, 1998-2000, January 1998, January 1, 1998).

Start Date [I, Date]: Enter the start date for the monitoring event. Applies to a series of individual, specific sample dates entered in Date format. (e.g., 01/24/2015).

End Date [S, Date]: Enter the end date for the monitoring event. Applies to a series of individual, specific sample dates entered in Date format. (e.g., 01/24/2015).

Start Time [S, Time]: The start time for an individual sampling event in time format (e.g., 14:00, 01:23). This information will only be entered for a time series of individual monitoring events.

End Time [S, Time]: The end time for an individual sampling event in time format (e.g., 14:00, 01:23). This information will only be entered for a time series of individual monitoring events.

Monitoring Trigger [I, Short Text]: Examples include routine, post 5-year event, post vegetation establishment, etc.

Antecedent Dry Weather Period (days) [I, Number]: Number of days since last measureable precipitation event. Convert hours to a decimal (e.g., 12 hours would be 0.5 days).

Approximate Cumulative Seasonal Rain (cm) Prior to Monitoring Event [S, Number]: Enter the cumulative seasonal rain prior to the monitoring event.

Flow Condition [R, Picklist]: Select the flow condition that best describes the sampling event. (This field is particularly important when a time series of multiple individual events is entered.)

- Baseflow
- Storm Runoff
- Spring Runoff (for snowmelt-dominated streams)
- Unspecified

Flow Condition Return Frequency [I, Text]: Enter the return frequency of flow condition that best describes the sampling event. (This field is particularly important when a time series of multiple individual events is entered.) Examples include 1-year, 2-Year, 50-Year, etc.

Monitoring Data Types Collected [R, Yes/No/NA]: Enter Yes, No or NA to indicate which monitoring data types were collected.

- Chemical Data: Water quality data.
- Hydrologic Data: Hydrologic data include precipitation, flow, groundwater, etc. Ideally flow data will be provided with water quality samples.

- Biological Data: Biological data (e.g., fish, macroinvertebrates).
- Physical Data: Channel and riparian corridor-related measurements.

Other [S, Short Text]: If other data types are available, describe them in this field.

5.6.3 Chemical Data (Water Quality)

The purpose of the "Chemical Data" table is to record chemical water quality data associated with the study. Data sets can include both concentrations and loads. Multiple picklists are provided to support this table, drawing upon picklists previously created for the urban and agricultural BMP databases.

Water Chemistry Record Identifiers

Rec_No [R, Autopopulated Number]

Site ID [R, Autopopulated Number]

MS_ID [R, Autopopulated Number]

Event_ID [R, Autopopulated Number]

Monitoring Station Name [R, Picklist]: From the picklist, select the monitoring station for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Setup.

General Monitoring Date(s) [R, Picklist]: From the picklist, select the monitoring event for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Events.

Water Chemistry Data

Sample Media [R, Picklist]: From the picklist, identify the sample media monitored for chemical parameters.

- o Surface Water
- o Groundwater
- o Precipitation
- o Soil
- o Precipitation
- o Pore Water
- o Other

Sample Type [R, Picklist]: Identified the sample type from the picklist. If the result entered is for a summary statistic (e.g., annual average), enter the original sample type (e.g., flow-weighted composite).

- o Flow-weighted composite
- o Grab
- o N/A (if not specified)

- Other

Reported Statistic Type [R, Picklist]: From the picklist, select the statistic type associated with the data being entered. If the result being entered is not a summary statistic, use “Event Result.” If Other is selected, describe the Other entry in the Comments field.

- Total
- Mean
- Median
- Minimum
- Maximum
- Event Result
- Geometric Mean
- Standard Deviation
- Standard Error
- Coefficient of Variation
- 25th Percentile
- 75th Percentile
- Other

Characteristic Monitored [R, Short Text/Picklist]: Enter the chemical parameter monitored (e.g., iron, phosphorus, etc.) including the sample fraction and form reported (e.g., phosphorus as P, nitrate-N, total recoverable iron, dissolved selenium). A picklist based on EPA’s Water Quality Exchange (WQX) is provided on the last worksheet of the spreadsheet; however, the user is not restricted to this picklist.

Result Type [R, Picklist]: Enter whether the water quality result is a load, concentration, field measurement (e.g., temperature), or some Other type of measurement.

- L: Load
- C: Concentration/Field Measurement
- R: Rate
- O: Other

Result [R, Number]: Enter the result as a numeric value. Results may be concentrations and/or mass (loads), or other. If data are missing or invalidated, enter -999999 and explain further in Comments.

Units [R, Short Text]: Enter the units associated with the result (e.g., kg/yr, mg/L).

Qualifier [R, Picklist]: Enter data qualifier provided with the sample results. Picklist includes:

- U for nondetect.
- J for estimated value between the method detection limit and practical quantitation limit.
- H for exceeded sample hold time.
- B for parameter detected in sample blank.
- R or sample rejected/invalidated.
- > for result present greater than upper quantitation limit.

*Note: If other qualifiers are used that are not provided in the picklist, the data provider can add additional qualifiers to the “Picklists” tab of the spreadsheet.

Method [I, Short Text]: Enter the laboratory or field analysis method used to obtain the result. For example, EPA 365.1 for phosphorus, SM 2540 for total suspended solids.

Detection Limit [I, Number]: In same measurement units as result, enter the method detection limit associated with the analysis. If a sample result is non-detect, then the detection limit must be provided.

Sample Size [I, Number]: Enter the number of samples utilized in the result provided for the event. For annual statistics, this entry would be the number of sampling event results. For individual flow weighted composites, this number would be the number of sample aliquots composited by the automated sampler or manually composited.

Comments [S, Short Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

5.6.4 Hydrologic Data

The purpose of the “Hydrologic Data” table is to record hydrologic data associated with the study. Hydrologic data sets could include precipitation, groundwater, surface water and soil pore water. Hydrologic data sets can be provided for monitoring events or for entire monitoring periods. Hydrologic data provide important context for water quality and other data collected as part of a monitoring program for performance. Hydrologic data are also essential for load and load reduction calculations.

Hydrologic Data Record Identifiers

Rec_No [R, Autopopulated Number]

Site ID [R, Autopopulated Number]

MS_ID [R, Autopopulated Number]

Event_ID [R, Autopopulated Number]

Monitoring Station Name [R, Picklist]: From the picklist, select the monitoring station for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Setup.

General Monitoring Date(s) [R, Picklist]: From the picklist, select the monitoring event for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Events.

Hydrologic Data

Media [R, Picklist]: Identify the sample medium for the hydrologic result from this picklist:

- Surface Flow
- Groundwater

- o Pore Water
- o Precipitation
- o Other

Characteristic Monitored [R, Short Text]: Enter the hydrologic or hydraulic characteristic monitored (or calculated) for the monitoring event. Representative examples of characteristics monitored include:

- Depth: Depth of flow for surface water or total depth of precipitation for a specific event.
- Volume: Flow volume (flux) during the monitoring period.
- Flow Rate: Flow rate of either surface water or groundwater.
- Peak Flow Rate: Peak flow rate during monitoring event.
- Velocity: Velocity of either surface water or groundwater.
- Duration of Peak Flow: Duration of peak flow (reported in time units).
- Duration above Bankfull Flow: Duration above Bankfull Flow (reported in time units).
- Percent Saturation: Saturation of riparian soil.
- Shear Stress: Shear stress in channel from surface flow. [$\tau = \gamma RS$ where τ is the shear stress (Pa), γ is the specific weight of water (N/m^3), R is the hydraulic radius (m), and S is the channel slope (m/m).]
- Stream Power: Stream power in channel from surface flow. [$\Omega = \gamma QS$ where Ω is the total stream power (W/m), γ is the specific weight of water (N/m^3), Q is the discharge (m^3/s), and S is the channel slope (m/m). Specific stream power (W/m^2) is the total stream power divided by channel width.]
- Other (please describe)

Reported Statistic Type [R, Picklist]: From the picklist, select the statistic type associated with the data being entered. If the result being entered is not a summary statistic, use “Event Result.” If Other is selected, describe the Other entry in the Comments field.

- o Total
- o Mean
- o Median
- o Minimum
- o Maximum
- o Event Result
- o Geometric Mean
- o Standard Deviation
- o Standard Error
- o Coefficient of Variation
- o 25th Percentile
- o 75th Percentile
- o Peak 1-hour
- o Other

*Note: If other statistics are used that are not provided in the picklist, the data provider can add additional qualifiers to the “Picklists” tab of the spreadsheet.

Result [R, Number]: Enter the result as a numeric value. If data are missing, enter -999999 and explain further in Comments.

Units [R, Short Text]: Enter the units associated with the result (mm, cm, m, m^3/sec).

Sample Size [I, Number]: Enter the number of measurements utilized in the result provided for the event.

Stream Gauge Data Available [S, Yes/No/NA]: Identify whether stream gauge data are available to support study. If so, identify gauge in Comments.

Comments [S, Short Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

5.6.5 Biological Data

The purpose of the “Biological Data” table is to provide a basic framework for recording biological monitoring data collected as part of the study. Biological monitoring commonly includes benthic macroinvertebrates and/or fish, but could also potentially include insects and wildlife inhabiting a stream corridor following restoration. Biological data are much more challenging to compare among studies conducted in diverse geographical settings. As a result, the approach used for this data table is generalized for purposes of the initial release of the database. This table should be considered an initial “placeholder” that could be refined in the future.

Note: The initial release of the Stream Restoration Database is focused on water quality; therefore, only limited biological data are included in the first release of the Stream Restoration Database.

Biological Data Record Identifiers

Rec_No [R, Autopopulated Number]

Site ID [R, Autopopulated Number]

MS_ID [R, Autopopulated Number]

Event_ID [R, Autopopulated Number]

Monitoring Station Name [R, Picklist]: From the picklist, select the monitoring station for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Setup.

General Monitoring Date(s) [R, Picklist]: From the picklist, select the monitoring event for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Events.

Biological Monitoring Data

Biological Data Type [R, Picklist]: Select general biological data type from picklist:

- Algae/Aquatic Plants
- Macroinvertebrates
- Fish
- Other

Use the "Characteristic Reported" field to further defined the specific reporting metric.

**Note: fecal indicator bacteria data should be entered in the Water Quality table.*

Reported Statistic Type [R, Picklist]: From the picklist, select the statistic type associated with the data being entered. If the result being entered is not a summary statistic, use "Event Result." If Other is selected, describe the Other entry in the Comments field.

- Total
- Mean
- Median
- Minimum
- Maximum
- Event Result
- Geometric Mean
- Standard Deviation
- Standard Error
- Coefficient of Variation
- 25th Percentile
- 75th Percentile
- Other

*Note: If other qualifiers are used that are not provided in the picklist, the data provider can add additional qualifiers to the "Picklists" tab of the spreadsheet.

Characteristic Reported [R, Short Text]: User defined and dependent on Biological Data Type, for example:

- Algae and aquatic plants: Include general type (e.g. filamentous, benthic) and/or specific species.
- Macroinvertebrates: Include functional guild (e.g. shredders, grazers) and/or species/genus.
- Fish: Include species.
- % benthic algal coverage
- Abundance of macroinvertebrates or fish species
- Biomass of macroinvertebrates or fish species
- Index of Biotic Integrity (IBI)

Result [R, Number]: Enter the result as a numeric value. If data are missing, enter -999999 and explain further in Comments.

Units [R, Short Text]: Enter the units associated with the result (e.g., No. of fish, g/m^2, % taxa).

Method [S, Short Text]: Basis of measurement and/or calculation used for biological data (e.g., Hess, kick-net, electroshocking).

Sample Size [I, Number]: Enter the number of samples utilized in the result provided for the event.

Comments [S, Short Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

5.6.6 Physical Data (Habitat)

The purpose of the "Physical Data" table is to provide a basic framework for recording physical monitoring information such as the results of habitat assessments that may be used to document the performance of the stream restoration project. This information may include parameters such as erosion-related metrics, vegetative cover, tree canopy, substrate embeddedness, and other metrics.

Note: The initial release of the Stream Restoration Database is focused on water quality; therefore, it is unlikely that physical data are included in the first release of the Stream Restoration Database.

Physical Data Record Identifiers

Rec_No [R, Autopopulated Number]

Site ID [R, Autopopulated Number]

MS_ID [R, Autopopulated Number]

Event_ID [R, Autopopulated Number]

Monitoring Station Name [R, Picklist]: From the picklist, select the monitoring station for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Setup.

General Monitoring Date(s) [R, Picklist]: From the picklist, select the monitoring event for which data will be entered. The picklist is populated from user-provided entries from Monitoring_Events.

Physical Monitoring Data

Reported Statistic Type [R, Picklist]: From the picklist, select the statistic type associated with the data being entered. If the result being entered is not a summary statistic, use "Event Result." If Other is selected, describe the Other entry in the Comments field.

- Total

- Mean
- Median
- Minimum
- Maximum
- Event Result
- Geometric Mean
- Standard Deviation
- Coefficient of Variation
- 25th Percentile
- 75th Percentile
- Other

Characteristic Monitored [S, Short Text]: Enter the physical or habitat characteristic being reported. Common examples include (but are not limited to):

- Erosion rate
- Volume of bank eroded
- Shear stress
- % riffle, run, pool
- Vegetative coverage
- Canopy coverage
- Stream bank phosphorus or nitrogen content (e.g., sample results at multiple locations)

Result [S, Number]: Enter the result as a numeric value. If data are missing, enter -999999 and explain further in Comments.

Units [S, Short Text]: Enter the units of measurement associated with the sample result (e.g., % coverage, stems/m^2).

Method [S, Short Text]: Basis of measurement and/or calculation.

Comments [S, Short Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the physical monitoring conducted for the study.

5.7 Cost

One cost table is included in the database structure. This table accepts data related to both the stream restoration project and monitoring costs. The cost table is set up in a manner that allows a user to enter multiple records per study related to various costs. The type of cost being recorded is selected from a picklist, with an accompanying field for a narrative description to be provided by the data provider.

The cost of stream restoration practices is a significant area of interest nationally, particularly as related to comparison of various improvements that could be implemented in a watershed to achieve water quality and aquatic life goals. Unfortunately, robust cost descriptions are rarely provided in the peer-reviewed literature. For this reason, a simplified approach has been

selected to record cost data associated with stream restoration projects. Additional detail can be provided in a Comments field, at the discretion of the data provider.

A key anticipated use of the Stream Restoration Database is to support crediting and trading programs. Some type of monitoring is typically required to obtain pollutant trading credits. This monitoring may be required following completion of project, as well as for a specified duration over the life of a project credit. For this reason (among others), monitoring cost data are expected to be of significant interest to parties considering applying for a credit related to stream restoration. As was the case for stream restoration project costs, monitoring cost data are also requested in a simple narrative manner focused on the description of the monitoring program components and an overall annual cost estimate for the monitoring program. Additional detail can be provided in a Comments field, at the discretion of the data provider.

Cost Record Identification

Rec_No [Number]: [R, Autopopulated Number]

Site_ID [R, Autopopulated Number]: Unique numeric identifier used to link data in various tables. The Site_ID field is autopopulated from the Begin Here table.

Stream_ID [R, Autopopulated Number]

Stream Name [R, Picklist]: Select user-identified stream name from the picklist. Multiple stream records may be entered for the study, either spatially or temporally.

Cost Data Entered (Note: multiple records per stream are expected)

Year of Cost Estimate [S, Date/Time]: Enter 4-digit year associated with estimated cost (year for cost basis).

Cost Data Type [S, Picklist]: Enter the cost data type being entered for each cost record. If available, enter each cost component.

- Total Capital Costs
- Materials and Construction
- Engineering
- Permitting
- Maintenance
- Rehabilitation
- Contingency
- Whole Life Cycle Cost
- Monitoring
- Other

Cost Period [S, Picklist]: Enter the unit basis of the cost from the picklist:

- Total (total cost of the project for all years)
- Annual (total cost per year—applicable to Maintenance & Monitoring)
- Event (cost per event-- applicable to Maintenance, Monitoring & Rehabilitation)
- Other (specify in Comments)

Cost [S, Currency]: Enter the cost in U.S. dollars.

Description of Items Included in Cost [S, Short Text]: Provide a narrative description of the general components included in the cost estimate.

Describe Funding Sources [S, Picklist]: Using the picklist, describe the funding approach used for the study. If Other is selected, provide additional information in the Comments field.

- Public
- Private
- Public-Private
- Unspecified
- Other

Comments [S, Long Text]: Use this field to provide other relevant information needed to explain other data entered in this table or other information necessary to understand the study.

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