# 10

# Unified Stream Assessment: A User's Manual

*Version 1.0*

**March 2004**

## CENTER FOR WATERSHED PROTECTION

## Manual 10

# Unified Stream Assessment:
# A User's Manual
*Version 1.0*

Prepared by:

Anne Kitchell and Tom Schueler
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
[www.cwp.org](http://www.cwp.org)
[www.stormwatercenter.net](http://www.stormwatercenter.net)

Prepared for:

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# Foreword

This manual distills two decades of experience evaluating the restoration potential of urban stream corridors during dozens of rapid stream assessments. We have attempted to assemble our basic assessment approach into a single package, known as the Unified Stream Assessment (USA). Over the past two years, Center staff have continuously sought to refine, test and expand this assessment technique in our watershed practice, and it has undergone at least four major revisions. We expect that it will be further adjusted over time; therefore, we refer to this manual as Version 1.0, and hope to update it based on user feedback as time and resources permit. So, please e-mail any comments or feedback to us at center@cwp.org.

We would like to acknowledge the Maryland Department of Natural Resources teams that, under Ken Yetman, developed and tested the Stream Corridor Assessment Method as part of the state's Watershed Restoration Action Strategy program. The USA builds heavily upon this method and its associated database provided by the DNR.

Thanks also to our external reviewers, who included participants at our inaugural Watershed Restoration Institute as well as local watershed organizations, such as the Gwynns

Falls Watershed Association, Jones Falls Watershed Association, South River Federation and others. Special thanks to the Chesapeake Bay Trust, Baltimore County Department of Environmental Protection and Resource Management, and the National Fish and Wildlife Foundation for providing community watershed grants that allowed us to keep on testing this method in a variety of urban watershed conditions.

The basic Center staff team that contributed to the development of the USA includes Ted Brown, Ken Brown, Karen Cappiella, Anne Kitchell, Chris Swann, Tom Schueler, Stephanie Sprinkle, Paul Sturm, Tiffany Wright, and Jennifer Zielinski. Special thanks to Tiffany Wright and Heather Holland for their assistance in editing, proofing and producing this manual, and to Jessica Brooks for developing the accompanying Access database.

This manual was produced under a cooperative agreement with US EPA Office of Water CP-82981501. Thanks are extended to our EPA project officer, Robert Goo, for his patience, insights and flexibility during the two years it took to produce this manual series.

Sincerely,
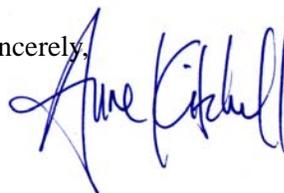
Anne Kitchell
Center for Watershed Protection

# About the Restoration Manual Series

This is the tenth in a series of 11 manuals on techniques to restore small urban watersheds. The entire series of manuals was written by the Center for Watershed Protection to organize the enormous amount of information needed to restore small urban watersheds into a format that can easily be accessed by watershed groups, municipal staff, environmental consultants and other users. The contents of the manuals are organized as follows.

## Manual 1: An Integrated Framework to Restore Small Urban Watersheds

The first manual introduces the basic concepts and techniques of urban watershed restoration, and sets forth the overall framework we use to evaluate subwatershed restoration potential. The manual emphasizes how past subwatershed alterations must be understood in order to set realistic expectations for future restoration. Toward this end, the manual presents a simple subwatershed classification system to define expected stream impacts and restoration potential. Next, the manual defines seven broad groups of restoration practices, and describes where to look in the subwatershed to implement them. The manual concludes by presenting a condensed summary of a planning approach to craft effective subwatershed restoration plans.

## Manual 2: Methods to Develop Restoration Plans for Small Urban Watersheds

The second manual contains detailed guidance on how to put together an effective plan to restore urban subwatersheds. The manual outlines a practical, step-by-step approach to develop, adopt and implement a subwatershed plan in your community. Within each step, the manual presents a variety of desktop analysis, field assessment, and stakeholder involvement methods used to make critical restoration management decisions.

The next seven manuals provide specific guidance on how to identify, design, and construct the seven major groups of watershed restoration practices. Each of these "practice" manuals describes the range of techniques used to implement each practice, and provides detailed guidance on subwatershed assessment methods to find, evaluate and rank candidate sites. In addition, each manual provides extensive references and links to other useful resources and websites to design better restoration practices.

## Manual 3: Storm Water Retrofit Practices

The third manual focuses on storm water retrofit practices that can capture and treat storm water runoff before it is delivered to the stream. The manual describes both off-site storage and on-site retrofit techniques that can be used to remove storm water pollutants, minimize channel erosion, and help restore stream hydrology. The manual then presents guidance on how to assess retrofit potential at the subwatershed level, including methods to conduct a retrofit inventory, assess candidate sites, screen for priority projects, and evaluate their expected cumulative benefit. The manual concludes by offering tips on retrofit design, permitting, construction, and maintenance considerations in a series of 17 retrofit profile sheets.

## Manual 4: Stream Repair and Restoration Practices

The fourth manual concentrates on practices used to enhance the appearance, stability, structure, or function of urban streams. The manual offers guidance on three broad approaches to urban stream restoration: stream cleanups, stream repairs, and more sophisticated comprehensive restoration designs. The manual emphasizes the powerful and relentless forces at work in urban streams, which must always be carefully evaluated in restoration and design. Next, the manual presents guidance on how to set appropriate restoration goals for your stream, and how to choose the best combination of stream restoration techniques to meet them.

The manual also outlines methods to assess stream restoration potential at the subwatershed level, including basic stream reach analysis, more detailed project investigations, and priority restoration project screenings. The manual concludes by offering practical advice to help design, permit, construct and maintain stream restoration practices in a series of more than 30 profile sheets.

## Manual 5: Riparian Management Practices

The fifth manual examines practices to restore the quality of forests and wetlands within the remaining stream corridor and/or flood plain. It begins by describing four site preparation techniques that may be needed to make a site more suitable for planting, and then profiles four planting techniques for the riparian zone, based on its intended management use. The manual presents several methods to assess riparian restoration potential at the subwatershed level, including basic stream corridor analysis, detailed site investigations, and screening factors to choose priority reforestation projects. The manual concludes by reviewing effective site preparation and planting techniques in a series of eight riparian reforestation profile sheets.

## Manual 6: Discharge Prevention Practices

The sixth manual covers practices used to prevent the entry of sewage and other pollutant discharges into the stream from pipes and spills. The manual describes a variety of techniques to find, fix and prevent these discharges that can be caused by illicit sewage connections, illicit business connections, failing sewage lines, or industrial/transport spills. The manual also briefly presents desktop and field methods to assess the severity of illicit discharge problems in your subwatershed. Lastly, the manual profiles 12 different "forensic" methods to detect and fix illicit discharges.

## Manual 7: Pervious Area Management Practices

The seventh manual reviews subwatershed practices that can improve the quality of upland pervious areas, which include techniques to reclaim land, revegetate upland areas, and restore natural area remnants. When broadly applied, these techniques can improve the capacity of these lands to absorb rainfall and sustain healthy plant growth and cover. This brief manual also outlines methods to assess the potential for these techniques at both the site and subwatershed scale.

## Manual 8: Pollution Source Control Practices

Pollution source control practices reduce or prevent pollution from residential neighborhoods or storm water hotspots. Thus, the eighth manual focuses on a wide range of stewardship and pollution prevention practices that can be employed in subwatersheds. The manual presents several methods to assess subwatershed pollution sources in order to develop and target education and/or enforcement efforts that can prevent or reduce polluting behaviors and operations. The manual outlines more than 100 different "carrot" and "stick" options that can be used for this purpose. Lastly, the manual presents

profile sheets that describe 22 specific stewardship practices for residential neighborhoods, and 15 pollution prevention techniques for control of storm water hotspots.

## Manual 9: Municipal Practices and Programs

The ninth manual focuses on municipal programs and practices that can directly support subwatershed restoration efforts. The five broad areas include improved street and storm drain maintenance practices, development/redevelopment standards, stewardship of public land, delivery of municipal stewardship services, and watershed education and enforcement. This last "practice" manual presents guidance on how municipalities can use these five programs and practices to promote subwatershed restoration goals. The manual also contains a series of profile sheets that recommends specific techniques to implement effective municipal practices and programs.

The series concludes with two user's manuals that explain how to perform field assessments to discover subwatershed restoration potential in the stream corridor and upland areas.

## Manual 10: The Unified Stream Assessment: A User's Manual

The Unified Stream Assessment (USA) is a rapid technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. The tenth manual is a user's guide that describes how to perform USA, and interpret the data collected to determine the stream corridor restoration potential for your subwatershed.

## Manual 11: The Unified Subwatershed and Site Reconnaissance: A User's Manual

The last manual examines pollution sources and restoration potential within upland areas of urban subwatersheds. The manual provides detailed guidance on how to perform each of its four components — the Neighborhood Source Assessment (NSA), Hotspot Source Investigation (HSI), Pervious Area Assessment (PAA) and the analysis of Streets and Storm Drains (SSD). Together, these rapid surveys help identify upland restoration projects and source control to consider when devising subwatershed restoration plans.

Individual manuals in the series are scheduled for delivery throughout 2004, and each will be available for free downloading for a period of six months. After this window expires, they can be ordered online or as hard copies from the Center for a nominal charge. Be sure to check our website, www.cwp.org, to find out when each manual will be available and how it can be accessed.

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# Introduction

This manual provides guidance on how to conduct the Unified Stream Assessment or USA. The USA is a continuous stream walk that systematically evaluates conditions and identifies restoration opportunities within the urban stream corridor. The manual is organized into 12 chapters.

## Chapter 1: The Basics of the Unified Stream Assessment

This chapter introduces the USA and describes its nine components: eight impact assessments and one reach assessment. Impact assessments are performed at problem sites, such as storm water outfalls, severe erosion, impacted stream buffers, trash and debris, utility impacts, stream crossings, channel modifications, and other notable features. Reach assessments are performed to get an overall picture of stream corridor conditions over defined survey reaches.

The chapter then explores how the USA identifies restoration opportunities in the stream corridor and addresses problem sites. Four phases of the USA are described: preparation, field work, quality control, and data evaluation. The chapter concludes by describing how USA data are used in subwatershed restoration planning and providing tips on organizing and interpreting USA data.

## Chapter 2: Preparing for a USA Survey

Every community has different assessment needs and capacity to conduct a USA. The second chapter reviews what is needed to prepare for a USA survey. This includes the mapping, equipment, data sheets, and staffing needed to get started, as well as the desktop analyses performed before going out in the field. The chapter also reviews how to generate useful field maps and concludes with guidance on budgeting and scoping USA surveys.

## Chapters 3-10: (Impact Assessments)

Eight impact assessment forms are used to collect basic data on the location, condition, and restorability of individual problems encountered within the stream corridor. These impact assessments generate an inventory of potential restoration opportunities, and a chapter is devoted to each assessment:

Chapter 3: Storm Water Outfalls
Chapter 4: Severe Stream Erosion
Chapter 5: Impacted Stream Buffers
Chapter 6: Utilities in the Stream Corridor
Chapter 7: Trash and Debris
Chapter 8: Stream Crossings
Chapter 9: Channel Modifications
Chapter 10: Miscellaneous Features

Each chapter describes how these features can impact the stream corridor and why they are assessed in the USA. Additionally, each chapter includes guidance on completing the field form. Particular emphasis is given on how to determine the potential for restoration at each site. Where appropriate, pictures illustrate various aspects of the impact assessment and define important terminology. Also provided are recommended criteria for conducting impact assessments and tips for making field evaluations easier. Each chapter concludes with guidance on how site impact data can be used to generate a list of candidate restoration opportunities, subwatershed metrics, and planning maps.

Where appropriate, references are provided to other manuals in this series that describe techniques for designing and constructing effective restoration practices. In addition, these manuals provide extensive references to other helpful resources.

## Chapter 11: Overall Conditions in the Survey Reach (RCH)

The last component of the USA is an overall assessment of survey reach conditions. The reach assessment form (RCH) collects general information over the entire survey reach, which is a uniform segment of the stream corridor. The RCH form characterizes overall conditions, such as average bank stability, in-stream and riparian habitat, and flood plain connectivity. The RCH form also tracks individual problem sites, screens restoration opportunities, and compares reach quality across the subwatershed.

This chapter begins with a discussion of how to delineate survey reaches and introduces the RCH form. Pictures and definitions are provided to illustrate various aspects of the RCH assessment and clarify important terminology. Recommended criteria to complete the RCH form and tips for field work are also provided. This chapter concludes with guidance on how RCH data can be used to compare reaches across the entire subwatershed, and between multiple subwatersheds.

## Chapter 12: Interpreting and Using USA Data in Subwatershed Restoration Plans

The USA generates a significant amount of stream corridor data. Impact assessments generate a large inventory of potential restoration opportunities, and RCH assessments screen those opportunities across the entire stream corridor. When USA data are analyzed together with upland USSR data, you get a full picture of the restoration potential of an urban subwatershed.

The last chapter helps you manage and interpret USA data in an effective way. It begins with recommendations on how to manage data in the field and back in the office. The chapter provides advice on how to map USA data, perform quality control, and generate the right stream corridor counts and metrics needed to develop a stream corridor restoration plan. Finally, techniques for screening subwatersheds using USA data are discussed.

## Appendices

The appendices provide blank forms and a sample database to manipulate USA data. Electronic versions of the field forms and the database are included with this manual, and can be easily customized to fit your local needs.

# Chapter 1: The Basics of the Unified Stream Assessment

Urban watershed restoration has traditionally focused on the stream corridor. Urban streams are vulnerable to a wide range of physical, habitat, and water quality impacts. Communities need to systematically assess the range of impacts and restoration opportunities found along the entire stream corridor. Although various agencies and volunteer groups routinely survey streams, they lack the tools to comprehensively evaluate the stream corridor. Stream corridor conditions are hard to assess and interpret, but must be understood to develop effective restoration plans. Further, stream corridor data helps identify and screen potential restoration opportunities.

The Center for Watershed Protection has developed a continuous stream walk method —the Unified Stream Assessment (USA)— to systematically evaluate conditions and identify restoration opportunities within the stream corridor of small watersheds (Figure 1). The USA has undergone extensive field testing, and is a composite of many different stream assessment protocols, including the Stream Corridor Assessment Survey (Yetman, 2001); the Rapid Bioassessment Protocol (Barbour *et al.,* 1999); the Outfall Reconnaissance Inventory (Brown and Caraco, 2004); the Rapid Channel Assessment (Booth, 1994); and the Stream Keepers Field Guide (Murdoch and Cheo, 1999). The USA is designed to rapidly collect basic information needed to assemble a manageable list of potential restoration projects in the stream corridor. These projects include storm water retrofits, stream restoration, riparian management, and discharge prevention (see Manuals 3,4,5, and 6, respectively).



**Figure 1: Variety of Impacts in Urban Streams**
*Urban streams and their adjacent flood plains exhibit many different local impacts. The USA systematically inventories potential restoration opportunities throughout the stream corridor.*

The USA can be applied in both rural and urban streams. Local government staff, environmental consultants, and watershed groups can perform the USA with relatively minimal training and cost. The USA protocol can and should be adapted to fit your needs and skills, and should always be customized to address regional stream conditions and unique local restoration goals. For best results, the USA should be combined with its upland counterpart, the Unified Subwatershed and Site Reconnaissance (USSR). This "windshield" survey identifies pollution prevention opportunities in the subwatershed, and is described in Manual 11.

## 1.1 Nine Components of the USA

The USA consists of nine stream corridor assessments: eight **impact assessments** and a single overall **reach assessment** (Table 1). Impact assessments collect specific information at individual problem sites along the stream corridor, such as a storm water outfall, a severely eroded stream bank, or a sewer overflow. Reach assessments collect overall information along the entire **survey reach**, where many impact sites may be located. Each survey reach represents a

relatively uniform set of conditions along the stream corridor and is used to characterize average bank stability, in-stream habitat, and riparian vegetation.

The reach assessment form (RCH) is completed for every survey reach in a subwatershed. The number of individual impact forms needed depends on the impacts and restoration opportunities discovered in the survey reach, and your assessment criteria. Impact assessment forms generate an inventory of potential restoration opportunities. The RCH form helps screen those opportunities by comparing reach conditions across the entire stream corridor. When these analyses are coupled with upland restoration projects identified during the USSR, you can get a full picture of the restoration potential of an urban subwatershed.

The basic information collected from each site impact and reach assessment is summarized in Table 2, along with associated restoration practices. Other manuals in this series should be consulted to learn more about these restoration practices.

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**Table 1: Components of the USA**

Impact assessments are site-specific and record data on condition and "restorability" at each problem site. Impact forms comprise an initial inventory of restoration opportunities. The eight impact assessment forms are as follows:

- **Outfalls** (OT)—*all storm water and other discharge pipes*
- **Severe erosion** (ER)—*bank sloughing, active widening or incision*
- **Impacted buffer** (IB)—*lack of natural vegetation, width*
- **Utilities in the Stream Corridor** (UT)—*leaking sewer, exposed pipes susceptible to damage*
- **Trash and Debris** (TR)—*trash and illegal dumping*
- **Stream Crossing** (SC)—*culverts, dams, natural features, etc.*
- **Channel Modification** (CM)—*straightening, channelization, dredging, etc.*
- **Miscellaneous** (MI)—*unusual features or conditions*

The reach assessment form (RCH) characterizes the average physical conditions over the entire survey reach. The RCH assessment tracks individual problem sites and provides information used to compare reach quality throughout the entire stream corridor.

- **Reach Assessment** (RCH)—*average bank stability, in-stream habitat, riparian vegetation, flood plain connectivity, access, flow, and substrate over the entire reach.*

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| Table 2: USA Impact and Reach Assessment Forms and Restoration Practices | | | |
|---|---|---|---|
| **Assessment Form** | **What It Assesses** | **Information Collected** *(In addition to photo & GPS)* | **Restoration Practice** *(Manual No.)* |
| Outfalls **(OT)** | All discharge pipes or channels that discharge storm water or wastewater. | Basic type, source, and condition. If flowing, then flow conditions should be recorded and potentially reported to authorities. | Storm water retrofit (#3); Stream repair/restoration (#4) Pipe discharge correction (#6) |
| Severe Bank Erosion **(ER)** | Slope failures, bank sloughing, head cuts, and incision or widening in areas noticeably worse than the average erosive condition of the survey reach. Also infrastructure or property threatened by erosion. | Location (meander or straight section), threat to property or infrastructure, accessibility; and basic bank measurements (height, angle, and bottom and top widths). | Stream repair/restoration (#4) |
| Impacted Buffer **(IB)** | Corridor lengths >100 feet long that lack at least a 25 feet wide, naturally-vegetated riparian buffer on one or both sides of stream. | Diversity and density of vegetation, flood plain conditions, adjacent land use, available area for reforestation | Riparian management (#5) |
| Utilities in Stream Corridor **(UT)** | Leaking or exposed sewer, water, or other utility lines causing water quality, habitat, or channel stability problems. Includes manhole stacks, lines along bottom, in the bank, or above the stream susceptible to damage due to lack of maintenance or exposure. | Type, condition, and discharge characteristics associated with leaks (odors, color, etc). If leaking, report immediately to authorities. Record relevant information if potential fish barrier (see SC) | Stream repair/restoration (#4); Pipe discharge correction (#6) |
| Stream Crossing **(SC)** | All man-made or natural structures that cross the stream, such as roadways, bridges, railroad crossings, or dams. Pipe crossings and other overhead utilities are assessed under UT. | Type of crossing, culvert dimensions, relative information if suspected fish barrier (6" water drop, or less than ½" water depth during normal flow conditions) | Storm water retrofit (#3); Stream repair/restoration (#4) |
| Channel Modification **(CM)** | Channelized, concrete-lined, or reinforced sections of stream >50 feet in length, regardless of construction material used. Locations of existing stream restoration or bank stabilization projects included. Enclosed sections are assessed under SC or OT. | Type of modification, length of stream impacted | Stream repair/restoration (#4) |
| Trash and Debris **(TR)** | Areas of significant trash and debris accumulation greater than average levels observed across the survey reach. Any areas where potentially hazardous or unknown chemicals have been dumped. | Mobility, dispersal, amount and type of trash; level of effort and type of equipment required for removal; location on public or private property | Riparian management (#5) Stream repair/restoration (#4) |
| Miscellaneous Impacts **(MI)** | High quality areas or unusual feature or activity impacting the stream corridor that doesn't fit into other seven impact assessments. This may include fish kills, cattle access, near stream construction, flood plain excavation, adjacent wetlands, grade controls, or other notable features. | | Depends on feature |
| Reach Level **(RCH)** | Average characteristics for each survey reach. Tracks locations of impact assessments; used for screening restoration opportunities and for comparing reaches across the subwatershed. | | N/A |

**Why Use the USA?**

- Cheap, fast
- Applies to all kinds of streams—rural and highly urban
- One of two basic tools used to initially assess restoration potential in the field
- Can and should be adapted to local needs
- Identifies problems in the stream corridor
- Collects basic feasibility factors on "restorability"
- Helps assemble initial inventory of stream corridor restoration sites, such as:

*Discharge investigations*
*Stream daylighting projects*
*Storm water retrofits*
*Local stream repair/outfall stabilization*
*Bank stabilization or grade control*
*Buffer reforestation*
*Structural repairs to sewer lines*

*Stream cleanup sites*
*Fish barrier removal projects*
*Culvert repair/replacement sites*
*Natural channel design*
*De-channelization*
*Riparian wetland restoration*
*Enforcement actions*

## 1.2 Stream Corridor Restoration Opportunities Identified by the USA

The USA provides a comprehensive picture of stream conditions and restoration opportunities available in the stream corridor of small watersheds. It has been designed to help you envision **restoration practices** that can address problem sites observed during your stream walk. For example, if you encounter a pipe leaking a foul substance into the stream, report the leak to proper authorities and consider potential restoration options such as structural repairs, pipe testing, citizen hotlines, or dry weather stream sampling.

The USA does not ask you to develop detailed concepts for restoration practices. Rather, the USA helps identify and screen potential project locations that can be subsequently investigated using detailed assessment methods described in Manual 2. The USA is an extremely valuable tool to create an initial inventory of potential restoration opportunities within the stream corridor.

Table 3 outlines some of the common stream corridor problems you may encounter, along with the corresponding restoration practices that can be used to address them. Table 3 also cross-references the appropriate restoration manual and profile sheet for each restoration technique.

## 1.3 Basic Steps to Conduct a USA

Field crews walk every surface stream and its flood plain corridor during the USA to map, locate, and collect basic data on significant impacts and average reach conditions. The four basic steps of a USA are as follows:

1. Pre-field preparation
2. Stream corridor assessment
3. Quality control
4. Data interpretation

The component tasks associated with each USA step are described in Table 4.

### Pre-field Preparation

It is important to train field crews on the USA protocol before starting any field work. Crews should use the same terminology and understand best- and worst-case stream conditions within the region (Figure 2). Walking a highly impacted stream reach and a stable, undeveloped stream reach together can help standardize data gathering. Field crews should also be exposed to examples of various restoration practices so they can better envision restoration opportunities at problem sites.

After field crews are trained, schedules and routes can be established. Three trained individuals per field crew are recommended to handle equipment, complete field forms, and

| | **Table 3: Restoration Techniques to Address Stream Corridor Problems** | |
|---|---|---|
| **ID** | **Stream Corridor Problem Assessed** | **Potential Restoration Technique (Profile sheet numbers)*** |
| **OT** | Suspected illicit discharge<br>Enclosed stream<br>Outfall location<br>Outfall damage | Discharge investigations (D-1, D-2, D-5)<br>Stream daylighting projects (R-27)<br>Storage retrofit below outfall (SR-3)<br>Local stream repair/outfall stabilization |
| **ER** | Nature and type of channel erosion<br>Severity of bank erosion<br>Threatened infrastructure<br>Nick points | Potential sites for bank stabilization (R-3 to R-15)<br>Grade control (R-18 to R-21) |
| **IB** | Encroachment in stream corridor<br>Vegetative condition of buffer | Active reforestation (F-1)<br>Greenway design (F-2)<br>Natural regeneration (F-3)<br>Riparian site preparation (SP-1 to SP-4)<br>Bufferscaping (N-20) |
| **UT** | Sanitary sewer overflows<br>Leaking sewer pipes and manholes<br>Sewers crossing streams<br>Power line rights-of-way impacting corridor | Structural repairs (D-10)<br>Pipe testing (D-6)<br>Citizen hotlines (D-5)<br>Dry weather stream sampling (D-3)<br>Active reforestation (F-1) |
| **TR** | Trash/debris in the stream<br>Dumping in stream corridor | Stream clean-up sites (C-1)<br>Stream adoption segments (C-2)<br>Removal of trash/debris (SP-1)<br>Storm drain stenciling (N-21) |
| **SC** | Fish barriers<br>Stream interruption<br>Potential runoff storage<br>Scour/erosion below crossing | Fish barrier removal (R-30)<br>Culvert repair/replacement (R-28, R-29)<br>Upstream storage retrofit (SR-1, SR-2)<br>Local stream repair (R-3 to R-21) |
| **CM** | Stream interruption<br>Channelization<br>Habitat degradation | Baseflow channel creation (R-25)<br>Natural channel design (S-32)<br>De-channelization (S-33) |
| **MI** | Wetlands and natural area remnants<br>Land disturbance and erosion<br>Livestock access/hobby farms<br>Fish kills | Riparian wetland restoration (F-8)<br>Enforcement (E-1)<br>Exclusionary fencing, alternative water source<br>Discharge prevention<br>Grade controls (R-18 to R-21) |
| **RCH** | Poor stream corridor habitat<br>Average streambank erosion<br>Disconnected flood plains<br>Flood plain encroachment<br>Restoration feasibility factors | Tracking of all potential stream corridor restoration practices, with special emphasis on stream restoration and riparian management concepts |

*\*The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series.*
- *SR- sheets can be found in Manual 3: Storm Water Retrofit Practices*
- *R-, S-, and C- sheets can be found in Manual 4: Stream Repair Practices*
- *F- and SP- sheets can be found in Manual 5: Riparian Management Practices*
- *D- sheets can be found in Manual 6: Discharge Prevention Practices*
- *N- sheets can be found in Manual 8: Pollution Source Control Practices*
- *E- sheets can be found in Manual 9: Municipal Practices and Programs*

make impact assessments, although experienced crews of two can do the job in a pinch. One person performs the impact assessments, the second keeps track of the reach assessment, and the third is responsible for taking photos, generating GPS points, and walking the stream corridor. Table 5 provides more detail on assigning responsibilities among a USA field crew.

The next step is to define survey reaches and plan assessment route for the field crews (see Chapter 2). The convention is to perform the USA while <u>walking upstream</u>, unless physical or logistical constraints make this impractical.

Creatively planning where to drop off cars and pick up crews can help reduce excessive backtracking.

In some cases, you may want to inform landowners that have property adjacent to the stream corridor before crews actually go out in the field. Sending each land owner a letter that briefly describes the purpose and general time frame of the USA is usually sufficient. Contact information should be provided in the letter for land owners that do not want crews to trespass on their property.

| Table 4: Unified Stream Assessment Steps | | |
|---|---|---|
| **Step** | **Tasks** | **Chapter** |
| 1. Pre-field preparation | Establish and train field teams<br>Get supplies in order<br>Define survey reaches<br>Generate field maps<br>Plan your assessment route and schedule | 2 |
| 2. Stream corridor assessment | Check routes and equipment<br>Perform site impact and reach assessments<br>Regroup to debrief and check field forms | 3 -11 |
| 3. Quality control | Enter data into spreadsheet or GIS<br>Quality control check<br>Identify field assessment gaps | 12 |
| 4. Data interpretation | Generate maps and metrics<br>Compare survey reaches<br>Generate inventory of restoration opportunities | 12 |



**Figure 2: Comparative Levels of Stream Bank Erosion**
*During training, show field crews a range of impacted and undeveloped stream conditions for comparison, such as streams with varying degrees of bank erosion, and discuss the types of restoration practices that can be envisioned at these impact sites.*

| Table 5: Suggested Field Crew Responsibilities | | | |
|---|---|---|---|
| Team Member | Assessment Area | Tasks | Task |
| # 1 | Stream | Reach assessment | Responsible for navigation and direction of other team members, marking locations on map, and assessing the overall survey reach based on feedback of others. May also help with data collection at individual impact sites. |
| # 2 | Stream | Impact assessments | Responsible for collecting information on outfalls, eroded banks, impacted buffers, stream crossings, etc. |
| # 3 | Flood plain/ Stream | Photos, GPS | Responsible for taking pictures of all problem sites or other features, for evaluating flood plain conditions, and occasionally tracking the source of outfalls or headcuts. Because this person is "mobile" she/he should take the lead on communicating with curious citizens. |

## Stream Corridor Assessment

Where practical, each crew should start at the downstream end of the survey reach and walk up the stream corridor, noting overall bank and channel stability, in-stream aquatic habitat, riparian vegetation, and other impacts. As individual impact sites are encountered, they are mapped and photographed, and an appropriate impact assessment form completed. If multiple problems occur at a single impact site, an individual form should be completed for each distinct problem (Figure 3). Photos should be taken at each problem site, which can be valuable to document conditions and impacts over time. For tracking purposes, the location and ID number for each problem site should be drawn on the simple reach diagram located on the RCH form. Convention is to face downstream when determining problems for the left and right stream bank, respectively.

After crews have walked the entire survey reach, they should record their general impression of reach conditions on the RCH form. While physical conditions always vary across a survey reach, the RCH form asks you to assign an average, or overall condition. When conditions vary so much that average conditions cannot be characterized, the survey reach should be split into more uniform segments. An RCH form should be completed for every survey reach (Figure 4). Overall channel and riparian scores can be computed

for each survey reach, which could be used during the data evaluation phase to identify the most restorable stream reaches in the subwatershed.

If more than one field crew is used, everyone should regroup at the predetermined meeting location at the end of the day to debrief (Figure 5). This field meeting is used to track stream



**Figure 3: Site Impact Assessment at Outfall and Bank Erosion Location**
*Site impact assessments should be performed for each problem area in the survey reach. Here, two site assessments are being performed, one for a storm water outfall, and another for the bank erosion threatening public infrastructure.*

miles covered, report general findings, and solve any logistical problems. It is also a good time to make sure all crews are measuring and recording information consistently. This can be particularly important when assessing erosion severity and site accessibility, or reporting emergency problems.

Crew leaders should also use this time to review field sheets for completeness and accuracy. Illegible handwriting should be neatened, more detail added to notes and sketches, and photos and GPS waypoints accurately cross-referenced. Field forms should always be organized in a master binder at the end of the debriefing.

## Quality Control

Once you come back from the field, field data can be entered into a spreadsheet or directly into GIS. Appendix B provides a specially modified Microsoft Access database initially developed by Yetman (2001) to organize USA data. Linking this USA spreadsheet database into GIS can make manipulation and analysis of USA data much easier.

The field crew should enter their data immediately after fieldwork is complete. Data entry should be spot checked by the project manager using quality assurance protocols. Draft stream corridor maps with site impact assessment locations and survey RCH scores should be generated as quickly as possible and distributed to all field crews for review. Quality control helps identify inaccuracies in data entry and gaps in stream corridor coverage, and should always be done prior to any data analysis.

## Data Evaluation

The ultimate goal is to create a detailed map of the stream corridor showing where non-degraded and degraded reaches are located, and where individual problem areas exist. Your subwatershed goals, available software, and GIS capabilities all play a role in what kind of maps are created. While GIS is highly recommended for data evaluation, it is not absolutely necessary.

USA data are also used to derive "metrics" of subwatershed characteristics, which are normally expressed as occurrences per stream



**Figure 4: Team Performing Reach Assessment**
*Brief crew meetings at the end of each survey reach are helpful to agree on average, representative conditions of the stretch of stream and its associated flood plain.*



**Figure 5: Regrouping After Field Work**
*Take the time to regroup after a day of fieldwork. This is a good opportunity to make sure everyone is on the same page, and adjust USA procedures where needed.*

mile. Examples include stream density (miles/ mi$^2$), outfall density, suspect outfall density, % of network with impacted buffer, road crossings/ mile, stream bank erosion severity, stream corridor habitat index, etc. These metrics can be used to compare restoration potential among many subwatersheds or reaches and to define initial restoration strategies. You will also want the capability to access details of impact sites in order to quickly identify candidate restoration sites for more detailed assessments.

## 1.4 Where the USA Fits into the Subwatershed Planning Process

The USA is one of two field assessment tools that evaluate restoration potential in the Small Watershed Restoration Framework introduced in Manual 2. The USA is typically combined with its counterpart, the Unified Subwatershed and Site Reconnaissance (USSR). Both surveys provide a comprehensive base to estimate the restoration potential of a subwatershed and provide insight into the interaction between the uplands and the stream corridor. This knowledge helps compare restoration potential across subwatersheds to assemble a manageable list of potential restoration candidate sites.

Candidate projects are assessed in the next step of the planning framework, where more detailed project investigations further refine the restoration inventory and develop initial concept designs for the high priority sites. Additionally, USA outputs and metrics can be used in the context of the Watershed Treatment Model to predict changes in pollutant loadings to the stream (Caraco, 2000).

USA data are used explicitly in several steps of the Small Watershed Restoration Framework:

- Comparative Subwatershed Analysis — *if performing assessment on multiple subwatersheds*
- Watershed Outreach/Stakeholder Identification —*generate maps and data on existing conditions for stakeholder education*

- Detailed Subwatershed Analysis —*provide basic data to identify problem sites and compare survey reaches*
- Devise a Subwatershed Restoration Strategy —*provide data to support strategy*
- Intensive Assessment of Individual Restoration Projects —*provide initial data to choose sites for this more detailed analysis*
- Detailed Stream Corridor Project Investigations —*provide basic data used for this more detailed assessment*
- Subwatershed Treatment Analysis — *provide input into Watershed Treatment Model or other model*

## 1.5 Organizing and Interpreting USA Data

While the USA generates a wealth of data to compare restoration potential in the stream corridor, this information must be organized in a way that is easily transferable to stakeholders, funders, and other local agencies. Table 6 shows some of the ways to organize and interpret USA data to support subwatershed restoration planning. USA data can explain the current stream corridor conditions, identify strategies to restore or protect the stream corridor, and help answer the many questions about subwatershed restoration potential:

- Which of the four types of restoration practices (i.e. storm water retrofits, stream repair/restoration, riparian management, or discharge prevention) should be pursued in this particular subwatershed?
- Which reaches (or subwatersheds) are the most degraded?
- Where are wetlands or other natural remnants?
- Which outfalls should be further investigated for maintenance or illicit discharges?
- Are leaking sewer lines or sewer overflows prevalent?
- Where should civic groups target stream cleanups or stream watch programs?
- How many road crossings are potential fish blockages?

| Table 6: Organization and Interpretation of USA Data |
| --- |
| USA data can be organized to assess restoration potential in the stream corridor using:<br>• Maps of condition of existing stream network<br>• Simple counts of restoration projects<br>• Maps of candidate restoration projects (storage retrofits, stream repair, reforestation, clean-up sites)<br>• Maps of stream problems (map of fish barriers, suspect outfalls and overflows, riparian buffer continuity)<br>• Designation of adopt-a-stream segments |
| USA data can be used to compare restoration potential among many subwatersheds or reaches using:<br>• Subwatershed metrics, based on number of occurrences per stream mile surveyed (stream density, outfall density, suspect outfall density, % of network with impacted buffer, road crossings/mile, etc.)<br>• Reach index maps (habitat quality, erosion severity, average condition, trashiness, etc.) |

- Is room available for potential storm water retrofits within the stream corridor?
- How many miles of the stream network have adequate forested buffers, and where should reforestation efforts be targeted?
- How many miles of stream are actively eroding and where are the most severe reaches?
- Do opportunities exist to daylight piped streams?

USA data can be used to generate stream corridor metrics, riparian corridor maps, and assemble an inventory of restoration opportunities. Impact assessment data can be used to derive stream corridor metrics such as outfall density, number of leaking sewer pipes, miles of stream with impacted riparian buffers, number of severely eroding reaches, and length of potential daylighting opportunities, to name a few. Reach assessments can generate stream corridor metrics, such as stream density, a riparian habitat index, or an erosion severity index. Each of these data analyses helps determine the right restoration practices for the stream corridor, and prioritize which subwatersheds are the most restorable.

USA data can also be used to create impact-specific maps, such as suspect outfalls, trash cleanup locations, and natural area remnants for restoration planning. Impact assessment forms can be analyzed to create lists of potential restoration projects, such as storm water retrofits, reforestation sites, stream repairs. These opportunities can then be screened down to a more manageable list, based on feasibility factors and your overall restoration goals. Chapter 12 presents more guidance on data analysis methods to incorporate USA data in restoration planning.

Whenever possible, USA data should be integrated with USSR data to understand the relationship between upland areas and the stream corridor. For example, the USA may identify an eroded stream reach for a potential stream bank stabilization project. However, this project may not be feasible unless it is matched with upstream storage retrofits or a rooftop disconnection program identified during the USSR (Figure 6).
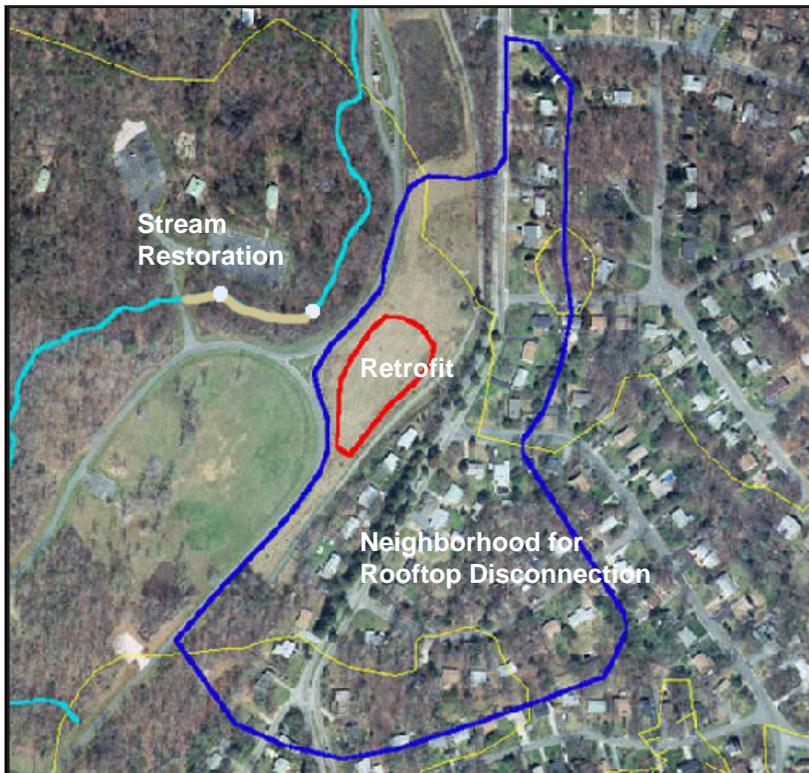
**Figure 6: Linking Riparian and Upland Restoration Opportunities**

*The streambank stabilization project pictured here (in light green) is enhanced with a potential storm water retrofit upstream (in red), as well as a neighborhood targeted for downspout disconnection. The blue line shows the portion of the neighborhood that drains directly to the restoration sites.*

# Chapter 2: Preparing for a USA Survey

This chapter describes the equipment, mapping, and budget information needed for a USA survey. Not every community has access to fancy field equipment or extensive mapping resources, nor will every field crew be staffed by experienced "watershed naturalists" with skilled eyes for envisioning stream restoration opportunities. Therefore, this chapter provides basic guidance on how to prepare for your USA.

While the USA can be performed any time during the year, vegetation, stream flow, and temperature should always be considered when scheduling surveys. For example, summer vegetation can disguise outfalls, trash, and eroded banks, and make stream access and flood plain walking more difficult. Dry weather conditions are needed to find suspect outfalls, so surveys should be scheduled several days after major storms. Additionally, hot, humid, or freezing weather conditions may not be ideal for field crews.

## 2.1 What Do I Need to Get Started?

The USA requires minimal mapping, equipment, and staff resources. This section outlines what you will need to get started.

### Field Maps

Field maps are required for the USA, but they don't need to be fancy. Indeed, the scale and level of detail on your field maps should reflect your data needs, preferences and navigational skills of your field crew. While GIS can generate very detailed maps, simple paper maps may be sufficient. The basic purpose of the field map is to orient field crews as to where they are in the subwatershed, and help them record their findings accurately.

At a minimum, USA field maps should have labeled streets, hydrologic features (blue line streams, wetlands, and ponds), and delineated survey reaches. Urban landmarks, such as land use, property boundaries, and storm drain outfalls are often useful. USA maps can also be used to ground truth pre-existing maps that show outfall locations or riparian buffers.

Street maps offer the advantage of simplicity, availability, and well-labeled road networks and urban landmarks. Street maps, however, often fall short on hydrology and land use details, and maps such as a 1": 2000' scale USGS quad sheet or finer scale aerial photograph are often needed as a supplement. USGS quad sheets are readily available, and display major transportation networks and landmarks, blue line streams, wetlands, and topography. Quad sheets are adequate in less developed subwatersheds, but are not always accurate in more urban subwatersheds.

Recent aerial photographs are the best mapping format to delineate survey reaches, navigate the subwatershed, and assess existing land cover. On the other hand, aerial photos generally lack road names, are potentially costly, and may be difficult to record field notes. GIS-ready aerial photos and USGS quad sheets can be downloaded from the internet (try http://www.gisdatadepot.com/) or obtained from local planning, parks, or public works agencies.

### Equipment

Basic field equipment needed for a USA consists of waders, measuring tapes, cameras, field forms, and GPS units. A complete list of recommended and optional equipment is provided in Table 7. GPS units are recommended to help track impact and reach

| Table 7:  Materials and Staffing Requirements of the USA | | |
|---|---|---|
| **Item** | **Minimum Needed** | **Optional but Helpful** |
| Mapping | Roads<br>Hydrology (streams, wetlands, ponds)<br>Survey reaches | Aerial photos<br>Topography<br>Landmarks (buildings, towers, etc)<br>Property boundaries<br>Flood plain boundaries<br>Storm drain network<br>Known problem areas |
| Equipment | Waders      Pencils<br>Tape measure  Notebook/clipboard<br>Camera     First aid kit<br>Field maps    Cell phone | GPS unit<br>Spray Paint<br>Clippers<br>Sanitary wipes |
| Data Forms | 8 impact assessment forms<br>  (OT, ER, IB, UT, TR, SC, CM, MI)<br>Reach assessment form (RCH)<br>Emergency response numbers | Photo Inventory Sheet<br>Authorization letter |
| Staffing | Two staff per crew with basic training<br>on USA | 3rd team member<br>Someone with stream restoration<br> experience or knowledge of local<br> plant species<br>Volunteers |

data spatially. Adequate ranging, water-resistant, downloadable GPS units can be purchased for less than $150 (try http://www.thegpsstore.com/). While the USA is designed for GPS users, pens and paper maps can be substituted. Digital cameras are preferred; however, conventional or disposable cameras can work, as long as they have flashes. Hand-held data recorders and customized software can also be used to electronically record text, photos, and coordinates in the field. While hand-held data records can eliminate field forms and tedious data entry, they may be prohibitively expensive for the one-time user. Waders, sanitary wipes, disposable gloves, cell phones, and first aid kits are recommended to protect field crews from potential perils lurking in the stream corridor.

## Staffing

For safety and logistics, the USA requires at least a two-person crew. Three-person crews are preferred to help divide up tasks, and allow one person to assess the flood plain, check out adjacent land uses, and trace outfalls to their source. All crew members should be trained in using the USA, and be able to recognize impacted sites, assess average reach conditions, and envision the typical restoration techniques employed in those conditions. Specific knowledge of native flora, common invasive plants, and stream geomorphology are helpful, but not essential. Experienced teams can usually expect to cover about 2.5 miles per day, depending on stream corridor access and density of impacts.

## Data Forms

Nine data forms are associated with the USA, including eight impact assessment forms and one reach assessment form. Depending on your goals and what you observe during your stream walk, you may choose not to use all eight of the impact forms. Each site impact form addresses a specific impact and is used to record necessary data at each problem along the stream corridor. The eight impact forms include the following:

- Outfalls (OT)—*all storm water and other discharge pipes*
- Severe Erosion (ER)—*bank sloughing, active widening or incision*

- Impacted Buffers (IB)—*lack of natural vegetation, width*
- Utility Impacts (UT)—*leaking sewer, exposed pipes in the stream corridor*
- Trash and Debris (TR)—*trash and illegal dumping in the stream corridor*
- Stream Crossings (SC)—*culverts, dams, natural features, etc.*
- Channel Modifications (CM)—*straightening, channelization, dredging, etc.*
- Miscellaneous Impacts (MI)—*unusual features or conditions in the stream corridor*

The reach assessment (RCH) form asks a series of questions to gauge overall survey reach conditions and help rank restoration priorities. The RCH form also contains a diagram of the survey reach that is used to spatially track individual impact assessment forms. The RCH form should be completed for every survey reach and should reference all recorded site IDs on the reach diagram.

Crews should always carry a list of contact phone numbers to report any emergency leaks, spills, or other problems to the appropriate local authorities directly from the field. Figure 7 shows an excellent example of a water pollution emergency contact list developed by Montgomery County, MD.

Two other helpful resources to take to the field include a photo tracking sheet and an authorization letter that describes why you are in the stream corridor. Photo tracking sheets are extremely helpful for organizing photos taken by multiple field crews so that you can easily reference locations and site descriptions for each photo (Figure 8). And since adjacent property owners, citizens, and police will inevitably approach you in the field to ask who you are and what you are doing, it is a good idea to take a one-page authorization letter explaining the purpose of the USA survey and who to contact for more information (Figure 9).



**Figure 7: Emergency Contact Numbers**
*Example of a comprehensive emergency contact list for Montgomery County, MD of various water pollution problems field crews may want to report while performing the USA.*

# Photo Inventory
## (By Camera)

**Project:** Smiley Run
**Group:** HK, EWB
**Camera:** A

> This field sheet is to be completed AS photos are taken in the field. The intent is to force us to organize pictures taken on a camera basis. Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

| Date | Stream/Reach | Location ID | Photo # | Description |
|------|-----------|----------|-------|-------------|
| 3/10/03 | 102-1 | OT-1 | 1 | TED @ outfall |
| | | TR-1 | 2 | Shopping cart in stream |
| | | ER-1 | 3 | TED measuring bank height |
| | | " | 4 | Looking upstream from eroded bank |
| | | UT-1 | 5 | Exposed manhole stack/sewer line @ ER-1 |

**Figure 8: Excerpt From Photo Tracking Form**
*An example photo tracking form used to quickly reference locations and descriptions of each picture on a roll of film or camera. A blank form is provided in Appendix A.*

**CALVERT COUNTY**
**DEPARTMENT OF PLANNING & ZONING**

150 Main Street
Prince Frederick, Maryland 20678
Phone: (410) 535-2348 • (301) 855-1243

*Director*
**Frank A. Jaklitsch**

*Board of Commissioners*
Gerald W. Clark
David F. Hale
Linda L. Kelley
Wilson H. Parran
Susan Shaw

January 29, 2004

Solomons Harbor Watershed Citizens:

Calvert County has employed the Center for Watershed Protection (CWP) to conduct environmental studies in the Solomons Harbor watershed and to develop a management plan for protecting environmental assets within the watershed. This study is a follow-up to the stream survey that was conducted last year. You should have received a letter last year about the stream survey.

Please give CWP staff your cooperation. They will be happy to answer your questions. If you have additional questions, please contact Dr. Dave Brownlee, Principal Environmental Planner by phone at 410-XXX-XXXX ext XXX or by email XXXX@XXXX

Sincerely,
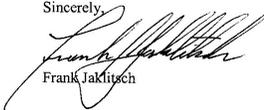
Frank Jaklitsch

3301 Courthouse Annex
Lewisburg, TN 37091
Phone: (931) 359-0547
Fax: (931) 359-0551

**Environmental Coordinator** Marshall County

June 7, 2002

This work crew stream service is surveying the Big Rock Creek as part of a project with Marshall County & Lewisburg. If there are any questions or concerns please contact the Marshall County Solid Waste Department. 410-XXX-XXXX

Thank you,

Solid Waste Department

**Figure 9: Two Example Authorization Letters**
*Several copies of an authorization letter should be carried with you in the field and left on the dash of your car. These letters should contain a brief description of the field crew activities, as well as a contact number for more information.*

## 2.2 Desktop Analysis to Support the USA

The two most critical desktop analyses to prepare for the USA are an estimate of total stream mileage and the generation of field maps. The stream mileage allows you to scope out how long the USA will take and how much it will cost. Field maps give field crews the minimum details to navigate around the subwatershed.

### Delineating Survey Reaches

The most important component of a USA field map is the preliminary delineation of **survey reaches**. The stream network within your subwatershed should be delineated into discrete survey reaches that are assumed to be of uniform character. While delineations may not always be perfect, upfront time invested in them makes the USA smoother and more efficient.

Survey reaches should be established above the confluence of streams and between road crossings that may serve as grade control. In addition, survey reaches should be defined at the transition between major changes in land use in the stream corridor (e.g. forested land to commercial area), and limited to a quarter mile or less in length (1,500 feet) (Figure 10). Access through private or public property should also be considered during delineation. Often, survey reaches in lightly developed subwatersheds are longer than those in more developed subwatersheds, which is fine if uniform stream corridor conditions are expected. You should always expect that some desktop delineations may need to be adjusted to account for field conditions (e.g., underground streams or widely variable stream corridor conditions).

The following guidance is offered to help you delineate survey reaches. Generally, each survey reach should have the following characteristics:

- Be about a quarter mile in length (~1,500 feet)
- Have at least one convenient access point to the stream (from a road or open area)
- Be located between two major road crossings or the transition between a major land use change (always include culverts with downstream section)
- Contain a relatively homogeneous land use
- Be separated at the confluence of two streams
- Include only one stream channel Be reasonably accessible (check for private property and fences)

Figure 11 shows a subwatershed map illustrating how survey reaches were delineated in Towson Run, Baltimore County, MD. This 2.9 square mile subwatershed has 13.6 miles of blue line streams, some of which appear to be enclosed. Using the delineation criteria for breaking the stream network into survey reaches, it took an hour to delineate 26 survey reaches by hand. In this example, survey reaches were identified using letters and color coded by stream order. Linking survey reach data to a GIS can help you rapidly revise your reaches to reflect conditions on the ground, quantify miles covered, and generate field maps.

You may notice that not all survey reaches in Figure 11 fully met the delineation criteria. Some reaches were longer than a quarter mile, some drained diverse land uses, and others were questionable as to whether they actually were surface streams. This is acceptable since field crews will often need to adjust survey reaches once in the field. Still, this delineation system recognizes most confluences, road crossings, land use changes, and access considerations found in the subwatershed.

**Figure 10: Criteria Used in Delineating Stream Reaches**
*Various physical factors control how survey reaches are delineated. (A) Survey reaches based on the confluence of stream tributaries. (B) A long tributary split into ¼ mile survey reaches. (C) Based on a major road crossing. You want to include the culvert in the downstream reach. (D) Based on significant changes in land use. Significant changes in stream features often occur at road crossings, and these crossings often define the breakpoints between survey reaches.*

## Naming Survey Reaches

You should establish a clear and consistent system to label survey reaches and provide a unique identifier for problem sites. Numerous conventions exist to label stream reaches, and you should check with the local natural resources agency before you establish a new one. As a general rule, survey reach labeling should be simple and flexible to prevent confusion among field crews.

The Strahler stream order system is frequently used to label survey reaches based on stream

order. First order streams are defined as headwater streams with no tributaries. When two first order streams join, a second order stream is formed. Where two second order streams join, a third order stream is formed, and so on. When a stream of lower order joins a stream of higher order, stream order does not change. Starting at the bottom of each subwatershed, each first order stream reach is numbered starting with number 101, and continues in a clockwise direction until all first order reaches are numbered (i.e., 102, 103, etc.). The process is repeated for each second order reach (i.e., 201, 202, etc.) and each third

order reach (i.e., 301, 302, etc.), until all stream reaches in the subwatershed are assigned a three-digit identifying number, as depicted in Figure 12.

As an example, the first survey reach on a first order stream in Towson Run might be defined as follows:

*Tributary Name-Reach Number-Survey Reach ID*
*(Towson Run-101-1)*

While the Strahler system works well in larger subwatersheds, it may be unnecessarily complex for smaller ones. A simpler system can be used based on the name of the major stream followed by a single identifying number or letter. For example:

*Stream Name-Section ID*
*(Towson Run-A)*

If a survey reach is modified in the field, crews can simply add a number onto the end of the survey reach ID. For example, field crews may determine that Towson Run-A should be split into three separate survey reaches. The new identifier would be Towson Run-A1, Towson Run-A2, and Towson Run-A3. This simpler naming convention produces less cluttered maps and less confusion among field crews. You may also choose to use a more detailed naming convention in your internal tracking database (i.e., including stream order).
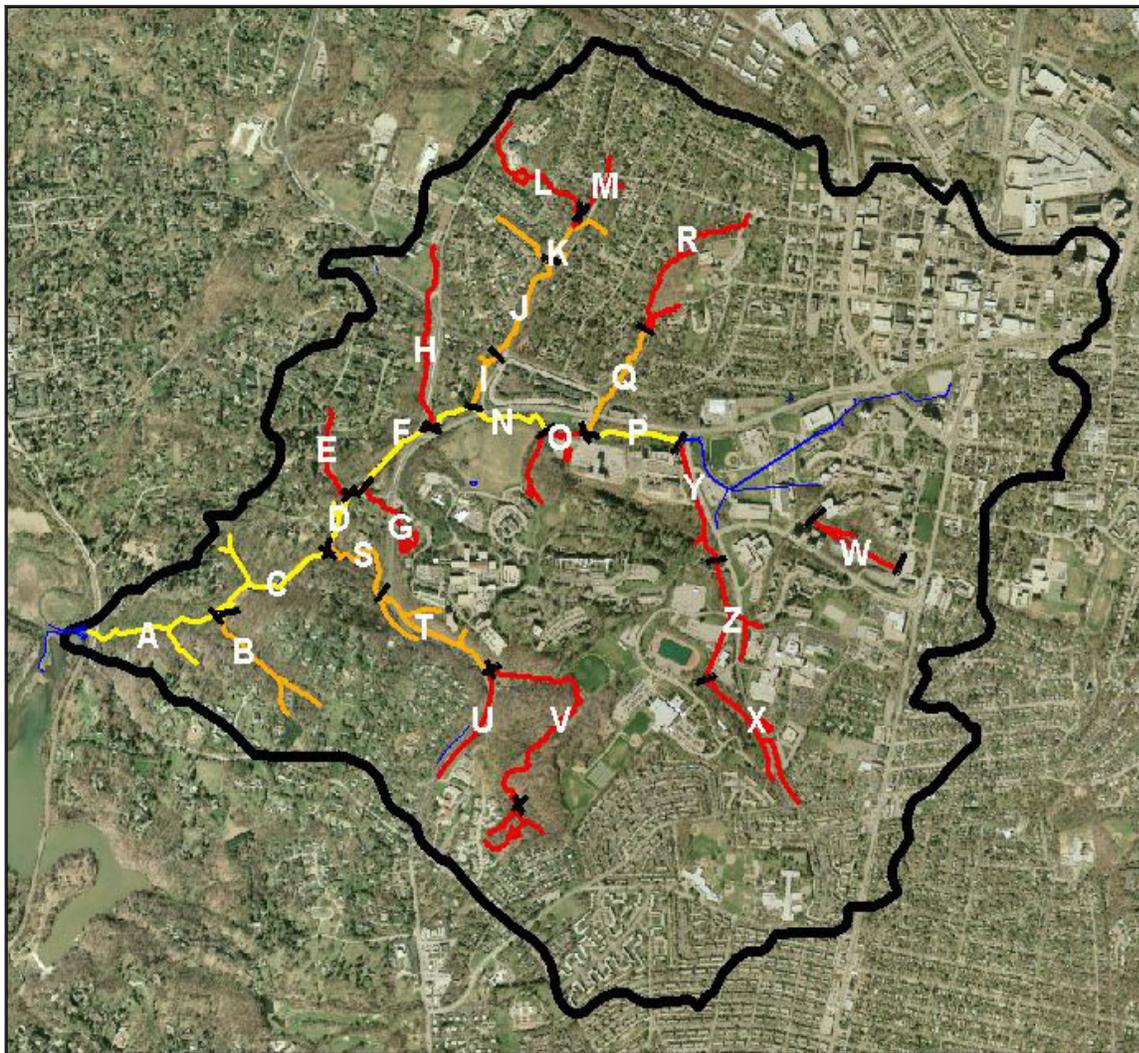


**Figure 11: Preliminary Delineation of Survey Reaches in Towson Run**
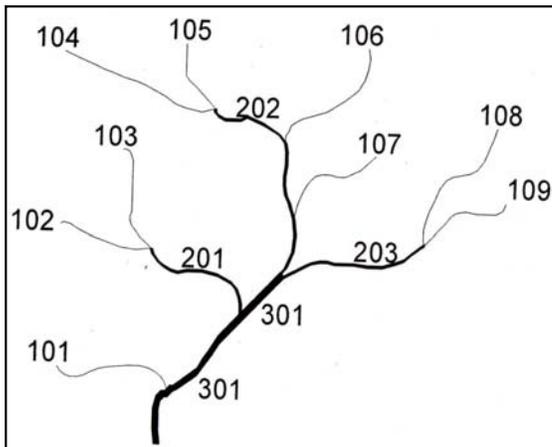
**Figure 12: Strahler's Stream Order Diagram**
*This method is one way of numbering your stream reaches.*

Similarly, the locations of individual stream corridor impacts can be labeled in various ways, but are usually assigned in consecutive order as they are observed. Since individual impact forms are tracked on the RCH form for the survey reach, simple identifiers can be used:

*Problem Initials- Site ID*
*(OT-1, OT-2, OT-3, etc.)*

### Establish Database

You should set up your USA database before going out in the field. Appendix B provides a specially modified Microsoft Access database designed for this purpose. You are encouraged to modify this database to incorporate any changes made in the stream walk protocol.

## 2.3 Generating Stream Corridor Maps

A stream corridor map that shows subwatershed boundaries, roads, structures, streams, and labeled survey reaches is generated after all survey reaches are delineated. Adjacent neighborhoods and public lands (parks, schools, etc.) can also be included on the map. The stream corridor map should be of a scale that allows field crews to draw in significant features, and make field notes.

## 2.4 Budgeting and Scoping the USA

Several factors come into play when budgeting and scoping a USA survey, including the number of stream miles to cover, available staff, equipment needed, and the density of impacts in the stream corridor. The desktop analysis step can help estimate the total stream mileage for delineated reaches that will be surveyed, so that you can estimate staff time needed. For example, in a moderately urban subwatershed with 30 stream miles, you should expect to expend five to seven staff weeks of effort to complete all four USA steps. Assuming minimal supply needs and professional rates of $25/hour, you should expect to spend approximately $15,000 on a full USA survey. Note that significant cost savings can be achieved by using volunteers. Table 8 provides a generic budget breakdown for the cost of performing the USA on a 10 square mile subwatershed.

Always keep in mind that the pre-field preparation step always requires a lot of staff time (i.e., to track down maps, assemble supplies, and generate field maps). You should allow at least a week of staff time for this important preparation. Assuming three trained staff cover about two stream miles per day, you should plan for at least 45 staff days for actual fieldwork for a 10 square mile subwatershed (15 days for a team of three). Staffing estimates should be adjusted based on field crew experience, ease of access, number of survey reaches, and density of problem sites. At least two weeks of staff time should always be allocated to process and interpret USA data (e.g., data entry, quality control, and data evaluation). Manual 2 provides more detail on how to budget and scope subwatershed investigations to evaluate subwatershed restoration potential.

| Table 8: Generic USA Budget for Hypothetical Subwatershed | |
|---|---|
| **Salaries** | |
| Task 1<br>General Prep for fieldwork<br>Generating field maps Watershed Planner I@ $25/hr 40 hrs | $1,000 |
| Task 2<br>Performing USA<br>(3 staff @ 2 miles/day) Watershed Planner I@$25/hr 120 hrs<br>  Watershed Planner II@$25/hr 120 hrs<br>  Watershed Planner III@$25/hr 120 hrs | $9,000 |
| Task 3<br>Data processing (quality control, evaluation) Watershed Planner I@$25/hr 80 hrs | $2,000 |
| **Supplies and Equipment**<br><br>  GPS unit (@ $150/unit)<br>  Waders (3 pairs @ $70/pair)<br>  Digital camera (@ $300)<br>  Street maps/orthos ($40) | $700 |
| **Copying and Reproduction** | $500 |
| **Total Costs** | **$13,200** |
| *Estimate assumes 10 square mile subwatershed with 30 miles of walkable streams* | |

# Chapter 3: Storm Water Outfalls (OT)

The USA assesses all storm water outfalls or other pipes that discharge to the stream corridor. Specifically, you will be looking for suspected illicit discharges, enclosed pipes for potential daylighting, off-line storage retrofits, and local opportunities to stabilize or repair streams and outfalls.

## 3.1 About Outfalls

Storm water outfalls are ubiquitous to urban streams. They consist of open channels or closed pipes that discharge storm water runoff from the subwatershed into the stream corridor after a rain event. As impervious cover in the subwatershed increases, less rain water infiltrates into the ground and larger volumes of storm water runoff are conveyed through the storm drain system. This causes increased flooding, peak flows, and stream erosion, along with declines in stream habitat and water quality. In some cases, storm water outfalls may contain illicit discharges of sewage and other pollutants that can create water quality problems. Figure 13 illustrates some types of storm water outfalls you may encounter during the stream walk.

Outfalls are an important component of the USA for several reasons:

- *Suspected Illicit Discharges*: Many communities are regulated under NPDES Phase I and Phase II storm water permits, and must locate their storm water outfalls to assess illicit discharges. The USA is a useful tool to update existing outfall mapping information or create it from scratch. More importantly, the USA identifies dry weather flows and other "suspect" discharges that may warrant further investigation (Manual 6).

- *Outfall Damage*: The storm water outfall or adjacent stream bank may require maintenance or repair to maintain its integrity. Often, bank stability in the immediate vicinity is compromised by powerful flow velocities from the pipe, and bank stabilization practices should be pursued (Manual 4).

- *Storage Retrofits:* Some outfalls are suitable locations for storage retrofits where water quality storage is provided between the outfall and stream corridor (Manual 3). Also, outfall locations can influence the design of stream restoration projects.
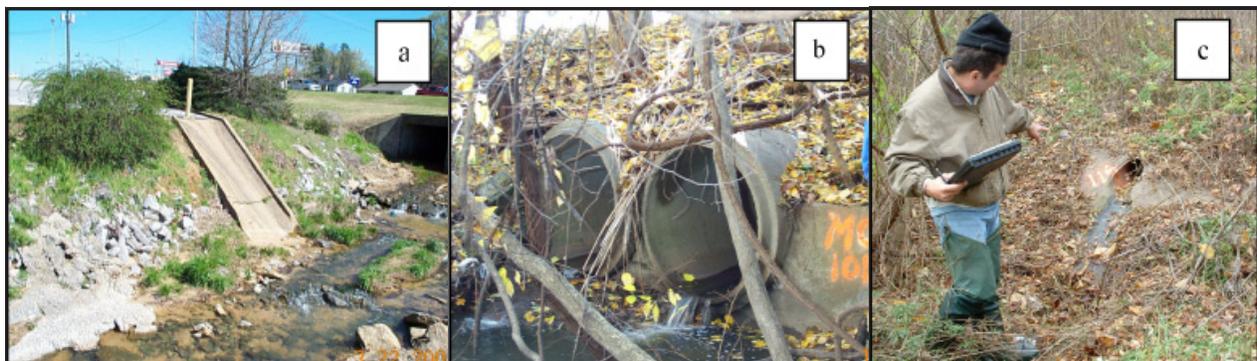


**Figure 13. Types of Outfalls to Expect**
*Storm water outfalls come in a variety of shapes and sizes. For example, not all outfalls will be closed pipes, such as the open channel draining the corner of a commercial parking lot (Panel A). Some outfalls may be single or double concrete pipes draining directly to the stream (Panel B), while others may be quite small, such as the six-inch diameter pipes discharging into the buffer in Panel C.*

---

**Questions to ask when assessing an outfall:**

What is the general condition of the outfall?

Is there flowing discharge? If so, what are the characteristics of that flow?

Is there any noticeable stream or bank erosion near the outfall?

Is this outfall a candidate for retrofitting or daylighting?

---

- *Enclosed Streams:* Many outfall locations have enclosed channels that were once surface streams. In some cases, it may be possible to **daylight** these streams by removing the pipe and restoring the channel to a more natural condition (Manual 4).

## 3.2 Introduction to the OT Form

While an outfall is just the final discharge point of a much larger underground network of pipes, its physical characteristics can tell a lot about local restoration potential. This section introduces the outfall impact form (OT) used to evaluate outfalls encountered during your stream walk. The OT form is used to collect basic information on the location, condition, flow characteristics, and potential restoration opportunities at each outfall. This section describes each part of the OT form and gives guidance on how to complete it. A full version of the OT impact form can be found in Appendix A. A completed example OT form is included at the end of this chapter in Section 3.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the OT form contains general header information common to all impact assessment forms, most of which is self-explanatory.

You may need to modify the header section depending on your reach and site labeling system, and whether you are using GPS units to fix locations. If you are using GPS units, record the coordinates for each site, the **GPS unit ID #,** and an **LMK** number. The LMK is an internal ID assigned to the latitude and longitude coordinates recorded by the GPS

unit. This ID carries over when coordinates files are downloaded from the GPS unit to your computer. The LMK serves as a backup in case field crews are sloppy in recording location information on their field sheets. While not critical, recording the LMK on the field form also serves as a reminder to save the coordinates to the GPS unit so they can be downloaded.

The next part of the OT form asks for the location, type, size, and condition of the outfall and its immediate environs.

You need to determine if the outfall is an **enclosed pipe** or **open channel** and then record its material, shape, and dimensions. For enclosed pipes, record whether it is a single or a multiple pipe, its **pipe diameter**, and whether it discharges above the water level or is submerged. Pipe diameter at the outfall can be used to get a rough estimate of the upland area draining to the outfall (Table 9). Pipe diameters can vary, but most have a diameter that is a multiple of six inches (6, 12, 24, 36, and 48 inches). Trapezoidal channels have distinct angles, while parabolic channels are smoothly curved.

You should also note whether the outfall exhibits signs of **physical deterioration** such as corroding metal, cracking concrete, or peeling paint. Use your nose to detect any odors emanating from the pipe, which may suggest a potential illicit discharge worthy of follow-up investigation. For example, if you detect a sulfur, or "rotten egg" smell, this may indicate the presence of sewage or high organic loads. Rancid or sour smells are sometimes associated with food wastes or industrial discharges.

| Table 9: Relationship Between Outfall Pipe Diameter and Contributing Drainage Area | | | | |
|---|---|---|---|---|
| **Pipe Diameter (inches)** | **Area (sq. feet)** | **Discharge (cfs)** | **Avg Velocity (fps)** | **Drainage Area (approx acres)** |
| 6 | 0.3 | 1 | 4 | 0.1 to 1 |
| 12 | 0.8 | 3 | 6 | 1 to 2 |
| 24 | 3.4 | 25 | 10 | 2 to 5 |
| 36 | 7.1 | 90 | 12 | 5 to 25 |
| 48 | 12.6 | 150 | 14 | 25 to 100 |
| 60 | 19 | 350 | 18 | 100 to 200 |
| *For concrete pipes flowing full, with 1% slope.* | | | | |

**Vegetative density** refers to the presence of vascular plants directly below an outfall, whereas pipe **benthic growth** asks you to check for algal or bacterial growth within the pipe itself. Orange colored growths, called flocs, are generally derived from the natural presence of manganese and iron in the water and may not always indicate pollution. Green or brown growths, on the other hand, are often associated with high nutrient levels. If a **pool** has formed directly below an outfall, you should check to see if any suds, oil sheens, algae, or signs of water pollution are present. **Floatables** are defined as trash and debris carried in storm flows that float on the surface of the pool.

If you find a **flowing outfall**, check the color, turbidity, and physical content of the flow. These simple characteristics can help classify the likely sources of contaminants. If other concerns such as excessive trash, bank erosion, or heavy sediment deposition are associated with the outfall, note these on the OT form as well. Table 10 illustrates common characteristics to look for during an outfall assessment.

The last part of the OT form asks you to recommend any potential restoration projects you feel may be appropriate for the outfall.

**Restoration projects** might include further discharge investigations, stream daylighting, storm water retrofits, or local outfall or stream repairs. If dry weather flow is observed at the outfall, or unusual odors, stains, or growths are associated with it, it should be considered a suspect outfall for further discharge investigation (Figure 14). You should also assign a **discharge severity** score on a scale of one to five, where five is the most severe, based on the type of discharge observed. Descriptions to rate the severity score are included on the OT forms, which are used later to screen the most severe discharges in the subwatershed.

**Daylighting** is a stream repair practice that opens up a stream back up by uncovering and removing sections of storm drain pipe. Daylighting re-establishes historic streams that are currently enclosed, or are artificially channelized (see Manual 4). To evaluate daylighting potential, you should estimate the length above the existing pipe that is open and available (i.e., no structures or utilities), and the depth of over burden above the top of the pipe. Figure 15 shows potential locations for daylighting opportunities.

**Stream repair** techniques may be needed to protect infrastructure or stabilize an eroding stream bank near the outfall (Figure 16). As always, emergency maintenance concerns should immediately be reported to the local utility.

**Storm water retrofit** opportunities should be assessed at each outfall. Field crews are not expected to come up with detailed concept designs, just good locations that may warrant further investigation. First, trace the outfall pipe backward to assess the potential

**Table 10: Outfall Characteristics to Note During Site Assessment**



Elliptical, single barrel, concrete pipe. You may want to measure both horizontal and vertical diameter



Small diameter (<2") plastic pipe. Often a sump pump (legal), or used to discharge laundry water (illicit).



Measuring the diameter of a partially submerged single barrel, concrete outfall



Excessive vegetation may indicate enriched flows associated with sewage



Bacterial growth at the outfall indicates nutrient enrichment and a likely sewage source.



This bright orange bacterial growth often indicates high manganese and iron concentrations



Green benthic growth on an outfall and high turbidity in pool



Suds in pool may indicate raw sewage



Unlike synthetic oils that swirl upon touch, sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed



Check for staining or obvious deposits indicating suspect discharges



Floatables collecting in the discharge pool at an outfall location



Look for oils or other pollutants collecting at the outfall pool

feasibility of a storage retrofit within the flood plain. Key points to note are the elevation of the bottom of the pipe (known as the invert) in relationship to the stream channel. If the elevation difference is greater than three feet, look to see if unutilized land is available in the stream corridor to provide storage. Try to determine how much downgradient land area is available to insert an offline retrofit between the drain pipe and the stream. Figure 17 shows how a storm water retrofit can be inserted into the stream corridor. You should also check to see if the outfall is connected to a nearby storm water practice (e.g., pond , wetland, or other structure). Existing storm water practices should be noted for further investigation during a retrofit inventory (Figure 18).



**Figure 14: Detailed Discharge Investigations**
*Discharge investigations will involve more extensive assessments at outfall locations. Local Illicit Discharge Detection and Elimination (IDDE) protocols often involve the physical marking of outfalls with spray paint and water quality sampling of suspected illicit discharges (Brown and Caraco, 2004).*



**Figure 15: Evaluating Stream Daylighting Potential**
*Panel A shows a before and after example of a stream daylighting project. Notice the flat slope and grass vegetative cover of the site, which increased the feasibility of excavating the pipe and exposing the stream to its natural condition. In Panel B, the field crew is shown pondering the potential for opening this stream back up, particularly given the slope of this location. Panel C illustrates another location where daylighting could be combined with a reforestation effort.*

**Figure 16: Local Stream or Outfall Repair**
*This is an example of catastrophic failure of an outfall caused by significant erosion that could have been prevented if caught early. Conditions like this should be reported to the appropriate local authorities.*
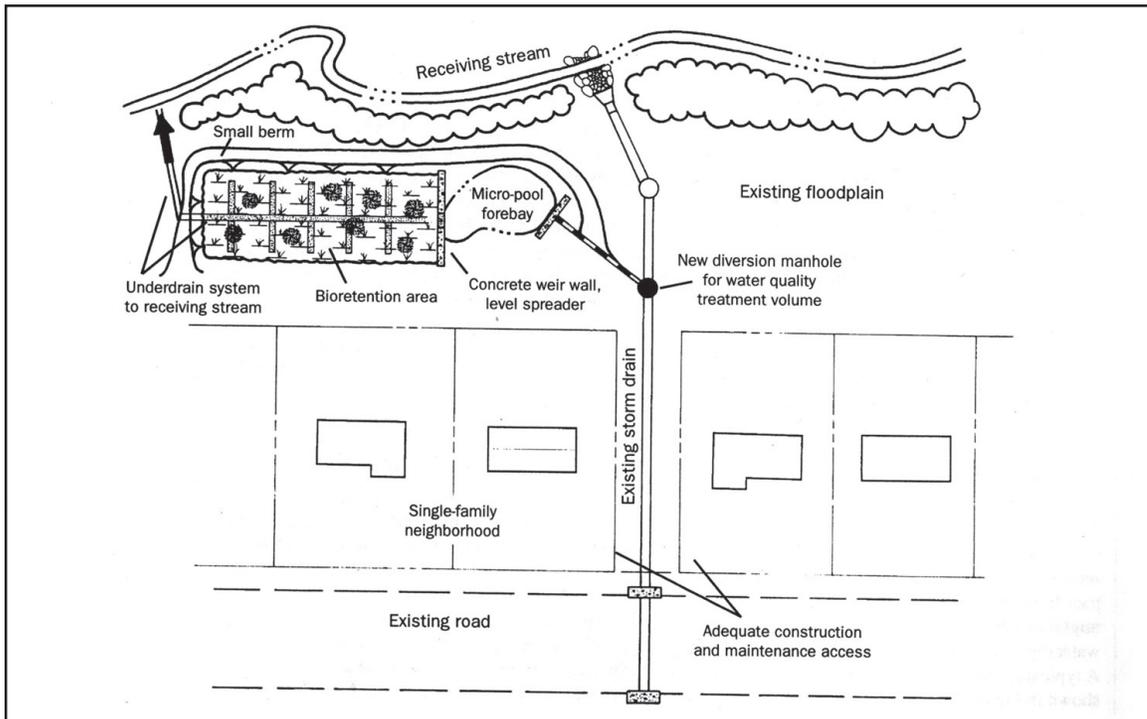


**Figure 17: Schematic of Off-line Retrofit in the Riparian Corridor**
*This schematic details how a water quality retrofit can be inserted into the stream corridor.*

## 3.3 What Outfalls Should I Assess?

You should decide in advance the minimum outfall diameter you will sample. Depending on your goals, you may sample all outfalls, or only record those that have suspect discharges. It is a good idea to assess **all** stormwater outfalls in highly urban subwatersheds, regardless of impact, diameter, or restoration potential (Table 11). In less developed watersheds, you may only want to sample outfalls with a diameter of six inches or greater.

## 3.4 Field Assessment Tips

Some quick tips for assessing outfalls are offered below:

- Thick vegetation can make outfalls hard to see or gain access to, so OT surveys work best during late fall, winter, or early spring.
- You may need to make more than one pass through the survey reach to discover all the outfalls.
- Illicit discharges are most easily discovered during extended periods of dry weather, when flows are more obvious.
- If you want to sample water quality at outfalls, take along test strips or field probes to sample water quality parameters, such as ammonia and conductivity.



**Figure 18: Investigate Existing Storm Water Treatment Practices**
*When assessing an outfall, you may want to take a quick trip up-pipe to determine if the discharge is controlled by a storm water facility. In this case, the outfall is the discharge point for a dry pond. Dry ponds do little for water quality and are therefore good retrofit candidates.*

| Table 11: Recommended Outfalls to Assess | |
|---|---|
| **Types of outfalls you should count include:** | **Types of outfalls to ignore:** |
| Large and small diameter closed pipes<br>Open channels<br>Outfalls that appear to be piped headwater streams<br>Field connections to culverts<br>Submerged or partially submerged outfalls<br>Outfalls that are sedimented in or blocked with debris<br>Pipes that appear to be outfalls from storm water treatment practices<br>Flexible HDPE that appear to serve as slope drains<br>Pipes that are clearly connected to roof drains<br>Small diameter ductile pipes that appear abandoned | Drop inlets from roads in culverts<br>Cross-drainage culverts in transportation right-of-way (i.e., can see through other end)<br>Weep holes |

- Not all outfalls discharge directly to the stream, so keep an eye out for outfalls that discharge farther away to slopes or flood plains. Often, you can find outfalls by tracing channels away from the stream corridor.
- Bridges and culverts should not be considered in the OT assessment unless you can clearly and safely see an internal outfall within a culvert.
- Natural oil sheens crack into irregular shapes when poked; synthetic oils will not break up.
- Don't taste anything.
- All outfalls with dry weather flows should be considered suspect and identified for further discharge investigations.
- Don't sweat the storm water retrofit potential, but you may want to review Manual 3 to get a feel for what different retrofit practices look like before doing an OT assessment.

## 3.5 Using OT Data in Subwatershed Restoration

Outfall data can be used for restoration planning in a number of ways. OT data can identify problem locations and suspect outfalls, generate a list of potential restoration practices, develop stream corridor metrics, and generate planning maps (Table 12). OT data can help you decide whether illicit discharges are a significant threat to your subwatershed. In addition, OT data can show whether retrofits or stream repairs should be a part of the overall restoration plan.

| Table 12:  How OT Data Can Be Used | |
|---|---|
| **Problem Assessed** | Suspected illicit discharge<br>Enclosed stream<br>Outfall location<br>Outfall damage |
| **Potential Restoration Practice**<br>*(Manual profile sheets)* | Discharge investigations (D-1, D-2, D-5)<br>Stream daylighting projects (R-27)<br>Storage retrofit below outfall (SR-3)<br>Local stream repair/outfall stabilization |
| **Stream Corridor Metric** | Outfall density<br>Suspected illicit outfall density<br>Number of outfalls discharging uncontrolled storm water<br>Treatable outfalls<br>Length of potential daylighting |
| **Output for Planning** | Outfall map<br>Map of potential storage retrofit sites<br>Map of potential daylighting opportunities<br>Map of threatened infrastructure |
| *The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series. The codes are as follows:*<br>• *SR- sheets can be found in Manual 3: Storm Water Retrofit Practices*<br>• *R- sheets can be found in Manual 4: Stream Repair Practices*<br>• *D- sheets can be found in Manual 6: Discharge Prevention Practices* | |

## 3.6 Example OT Form

The OT form is used to collect basic information on the location, condition, flow characteristics, and potential restoration opportunities at each outfall. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Stormwater Outfalls **OT**

---

**WATERSHED/SUBSHED:** SMILEY RUN    **DATE:** 3/10/03    **ASSESSED BY:** ACK, ENB

**A.**

**SURVEY REACH ID:** 102-1    **TIME:** 9:15 (AM)/PM    **PHOTO ID:** *(Camera-Pic #)* A    /# D1

**SITE ID** *(Condition-#):* OT- 1    **LAT** ___°___'___" **LONG** ___°___'___" **LMK**___    **GPS:** *(Unit ID)*

---

**BANK:** ☐LT ☑RT ☐ Head

**FLOW:** ☑None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:

**TYPE:**
☑ Closed pipe
☐ Open channel

**MATERIAL:** ☑Concrete ☐Metal ☐ PVC/Plastic ☐Brick ☐ Other:
☐Concrete ☐ Earthen ☐ Other:

**SHAPE:** ☑Single ☑Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:
☐ Trapezoid ☐ Parabolic ☐ Other:

**DIMENSIONS:** Diameter: 48 (in)
Depth: ___(in)  Width (Top):___(in)  " (Bottom):___(in)

**SUBMERGED:** ☑No ☐ Partially ☐ Fully

*NOT APPLICABLE*

**B.**

**CONDITION:** ☑None ☐ Chip/Cracked ☐ Peeling Paint ☐ Corrosion ☐ Other:

**ODOR:** ☑No ☐Gas ☐ Sewage ☐Rancid/Sour ☐ Sulfide ☐ Other:

**DEPOSITS/STAINS:** ☑None ☐Oily ☐ Flow Line ☐ Paint ☐Other:

**VEGGIE DENSITY:** ☑None ☐ Normal ☐ Inhibited ☐ Excessive ☐ Other:

**PIPE BENTHIC GROWTH:** ☑None ☐ Brown ☐ Orange ☐ Green ☐ Other:

**POOL QUALITY:** ☑No pool ☐ Good ☐Odors ☐Colors ☐Oils ☐ Suds ☐ Algae ☐ Floatables ☐ Other:

---

**FOR FLOWING ONLY**

**COLOR:** ☐Clear ☐ Brown ☑Grey ☐ Yellow ☐ Green ☑Orange ☐ Red ☐ Other:
**TURBIDITY:** ☐None ☑ Slight Cloudiness ☐ Cloudy ☑Opaque
**FLOATABLES:** ☐None ☑ Sewage (toilet paper, etc.) ☑Petroleum (oil sheen) ☐ Other:

**OTHER CONCERNS:** ☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation ☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other: NONE

---

**POTENTIAL RESTORATION CANDIDATE** ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☑ no    ☐ Storm water retrofit ☐ Other:

*If yes for daylighting:*
Length of vegetative cover from outfall: ___ft   Type of existing vegetation:___   Slope: ___°

*If yes for stormwater:*
Is stormwater currently controlled?   Land Use description:___
☑ Yes ☐ No ☐ Not investigated   Area available:

**C.**

| **OUTFALL SEVERITY:** *(circle #)* | Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream. | Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized. | Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems. |
|---|---|---|---|
| | 5        4 | 3        2 | (1) |

**SKETCH/NOTES:**

DRAINS STORMWATER POND FOR GROCERY STORE PARKING LOT

**REPORTED TO AUTHORITIES:** ☐ YES ☑ NO

## How the Example OT Form Was Completed

### Part A

In the first part of the form, field crews performed an OT assessment on an outfall in the Smiley Run subwatershed in survey reach 102-1. They took a photo at this location (happened to be the first one of the day), which also happened to be the first outfall they came across.

### Part B

The outfall, located on the right bank facing downstream, was a concrete, circular, single-barrel pipe. The pipe had a diameter of 48 inches, and no notable degraded conditions, odors, or growths were associated with it. No dry weather flow was observed when the crew examined the outfall.

### Part C

In the last part of the form, the field crew made no restoration recommendation since no major problems identified were at the outfall. The field crew followed the pipe up and found a storm water pond that appeared to be functioning properly.

# Chapter 4: Severe Erosion (ER)

The USA assesses the most severe eroding banks along the survey reach, particularly at places where valuable infrastructure is threatened. Specifically, you will look for potential stream repair or restoration opportunities such as bank stabilization or grade control.

## 4.1 About Erosion

Stream erosion reflects the natural process of channel migration and adjustment, whereby streams continuously meander, widen and narrow in an attempt to reach a stable equilibrium. The balance between sediment load and discharge can be disrupted by urbanization. Severe erosion can occur when a stream's current velocity exceeds stability thresholds for bank materials at channel boundaries. Reduced bank stability caused by increased bankfull flooding can lead to rapid and excessive bank erosion as the stream adjusts to the changing hydrologic conditions.

The process of channel widening or downcutting can worsen as streams become progressively disconnected from their flood plain. Nick points occur where significant changes in streambed elevation are caused by channel incision, and are indicators of dynamic channel processes at work. Eroding banks can cause loss of property, destroy in-stream habitat, and contribute significant sediment loads downstream. Trimble (1997) estimated that more than half of the sediment loads from highly urban watersheds were derived from eroded stream banks. Figure 19 shows various examples of stream erosion you may encounter while conducting an ER assessment.

Extensive bank erosion and channel headcuts should be expected in urban subwatersheds. The ER form only collects information on localized nick points and banks where erosion greatly exceeds average reach conditions. Broader bank stability conditions are assessed as part of the overall RCH assessment (Chapter 11).
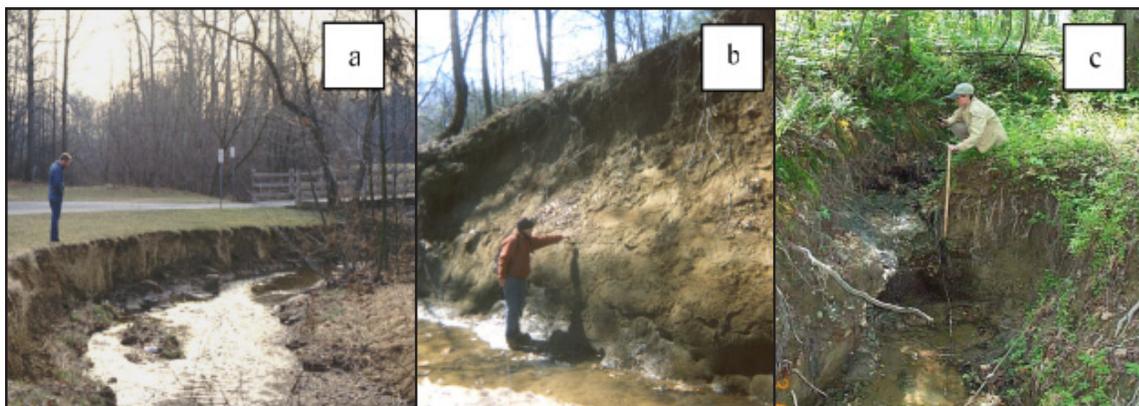


**Figure 19: Types of Stream Erosion**
*Active bank erosion you can expect along meander bends in urban settings (Panel A), extreme erosion events that contribute significant sediment loads to receiving waters (Panel B), and in-stream nick points indicating channel erosion occurring in an upstream direction (Panel C) are examples of severe erosion you will want to record on ER forms.*

**Questions to ask when assessing eroded banks:**

Is this area more severe than the rest of the survey reach?

Is infrastructure or property threatened?

What appears to be the cause of the erosion?

Are the banks actively contributing sediment to the stream?

Is this site a candidate for bank stabilization or grade control?

Severely eroded banks are evaluated during the USA for several reasons:

- *Nature and type of channel erosion*: Knowing the nature and type of erosion within urban streams can help determine how eroding areas are influencing upstream and downstream reaches. The dominant channel erosion process in an urban stream often dictates which types of stream repair and restoration practices should be applied, if any (Manual 4). Locating nick points or headcuts can indicate where upstream erosion problems may occur in the future given current hydrologic conditions. A quantitative estimate of bank erosion can be used to model subwatershed sediment loadings.

- *Severity of bank erosion*: While most urban streams exhibit some evidence of past or current bank erosion, the ER helps identify the most severe locations for potential bank stabilization or restoration (although they may not always be practical or feasible given overall subwatershed restoration goals).

- *Threatened infrastructure:* Excessive erosion may expose or undermine existing infrastructure such as outfalls, sewer lines, telephone polls, bridge abutments, roads, parking lots, or other structures built too close to the stream. In some cases, it may be critical to repair or stabilize eroding areas to prevent future damage to valuable infrastructure.

## 4.2 Introduction to the ER Form

This section introduces the severe erosion impact form (ER) that assesses individual locations of eroded stream banks encountered during your stream walk. You are asked to record basic data on the location of erosion sites, estimate current channel dynamics and dimensions, and identify potential bank stabilization opportunities at each problem site. This section describes each part of the ER form, and provides guidance on how to complete it. Appendix A contains a blank copy of the ER impact form. A completed example ER form is included at the end of this chapter in Section 4.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the ER form contains general header information common to all impact forms, and is self-explanatory.

You may want to modify the header section to reflect your reach and site labeling system, and whether you are using GPS units to fix locations. If you are using GPS units, record the beginning and end coordinates for each site, the **GPS unit ID #** and an **LMK** number. If the eroded bank is less than 100 feet long, GPS cannot calculate an accurate length, and you should measure it by pacing or with a tape measure.

The next part of the ER form asks you to describe the general channel processes that affect the eroding bank or stream channel. You should note the location and dimensions of the eroding area, as well as the ownership of the adjacent stream corridor.

You are asked to determine the overall **channel process** affecting the erosion site (e.g., is it aggrading or degrading), and to characterize how the channel process exerts itself on the stream (e.g., scour, slope failure, etc.). Of significant interest are headcuts and **nick points**, which are locations where active channel erosion is migrating in an upstream direction. Nick points are excellent indicators of the active channel erosion dynamics and directly affect the design of stream restoration projects. **Headcuts** observed on the side of a stream may also indicate the presence of an outfall discharging to the flood plain or side slope. You should trace these headcuts to their source. **Scour** is the process of removing bed or bank material through the erosive action of flowing water. **Bank failure** occurs when the toe of the stream bank is eroded beyond the point of bank support. **Slope failure** is often used describe the failure at steep bank slopes.

While not everyone has a full understanding of urban stream geomorphology, Table 13 gives some tips on how to determine the dominant channel processes in the stream. Table 14 also illustrates what many of these channel processes look like in the stream. If you feel uncomfortable about describing the channel process, simply check the **currently unknown** box.

Each eroded bank section should be recorded as either left, right, or both banks, and whether it occurs on a bend in the stream, or along a relatively straight section. Headcuts branching off the stream should also be recorded as either left or right bank, while nick points are, by definition, located within the stream channel itself. Bank erosion is typically found along meander bends and may be enhanced if the bend occurs against a steep slope.

| Table 13: Features Used to Determine Current Channel Process | | |
|---|---|---|
| **Process** | **Definition** | **Geomorphic Evidence** |
| Aggradation | The geologic process by which a streambed is raised in elevation by the deposition of additional material transported from upstream (opposite of degradation)* | Mid-channel bars<br>Embedded riffles<br>Siltation in pools<br>Accretion on point bars<br>Deposition in the overbank zone |
| Degradation | The removal of streambed materials caused by the erosional force of water flow that results in a lowering of the bed elevation throughout the reach (opposite of downcutting)* | Deepened or "entrenched" stream bed<br>Cut face on bar forms<br>Headcutting and nickpoint migration<br>Suspended armor layer in bank<br>Terrace cut through older bar material<br>Exposed sanitary or storm sewers |
| Downcutting (or incision) | Deepening of stream channel cross section resulting from process of degradation* | Tall banks (may see stratification)<br>Disconnection from flood plain<br>May occur if widening prohibited |
| Headcutting | The erosion of the channel bed, progressing in an upstream direction* | Nickpoints<br>Small drops in elevation (mini waterfalls)<br>Abnormally steeped channel segments |
| Widening | Increased width of stream channel cross section resulting from degradation process | Falling/leaning trees<br>Scour on both banks through riffle<br>Exposed tree roots; Fracture lines along top of bank<br>Exposed infrastructure |
| Stable | Channel in balance between aggrading and degrading forces | Water reaches toe of each bank<br>Moss on rocks or extending down into bottom of bank<br>Banks are stable; connected to flood plain<br>Erosion is slight and limited to meander bends |
| *\* Definitions from the Washington State Aquatic Habitat Guidelines Program (2002)* | | |

The ER form also asks for some basic channel and bank dimensions. Figure 20 provides guidance on how to measure the cross-sectional area of a stream channel. **Bank height** is typically the distance from top of water to top of bank. At streamside headcuts, be sure to estimate the length of active erosion, as well as its potential distance if the headcut has not migrated all the way to its source. For nick points, record the height and distance to the next upstream grade control structure such as a road crossing or channelized section. Alternatively, you can simply note the location of the next grade control structure and calculate the length back in the office.

The last part of the ER form allows you to recommend any potential restoration practices that may be appropriate for the eroded bank (Box 6). Envisioning stream restoration potential can seem difficult at first, but can be acquired with a little study and a lot of practice. Some practices to consider include bank stabilization, grade control, or other stream restoration techniques. **Rigid bank stabilization** includes such things as boulder

**Table 14: Erosion Characteristics to Note During Site Assessment**

| | | |
|---|---|---|
|  Stable reach, with low banks, stream still has access to flood plain at high flows. |  Aggrading reach with obvious formation of mid channel bars. |  Signs of degradation include visible stratification lines in stream bank |
|  Downcutting reach with tall banks on either side |  Presence of manhole stack in stream is evidence of stream widening process |  Moss covered banks are indicators that banks have since stabilized |
|  Extreme erosion can occur when streams cut into steep slopes. Check level of soil consolidation in these areas to see if actively eroding |  Below this eroded bench is a stabilized stream bank. This should not be considered as active bank erosion. |  Headcut rapidly migrating upwards towards an outfall. Note collapse of adjacent vegetation |

revetments, root wads, rip rap, or other relatively hard structures. **Soft bank stabilization** practices include coir fiber logs, live fascines, brush mattresses, or other bioengineering techniques that use vegetation to protect the banks (Figure 21). **Grade control** techniques refer to step pools, rock vanes, or log drops that prevent the migration of headcuts (Figure 22). These and other stream repair practices are described in more detail in Manual 4.

The **erosion severity score** rates the extent of erosion on a five-point scale, where five is the most severe. You should also check to see if access is available to get heavy equipment to the site. Erosion severity and access scores should be marked on the ER form to identify the most severe and accessible eroded banks in the subwatershed.



*This sketch shows how to measure basic stream dimensions, such as bank height and angle, bottom width, and channel wetted width.*
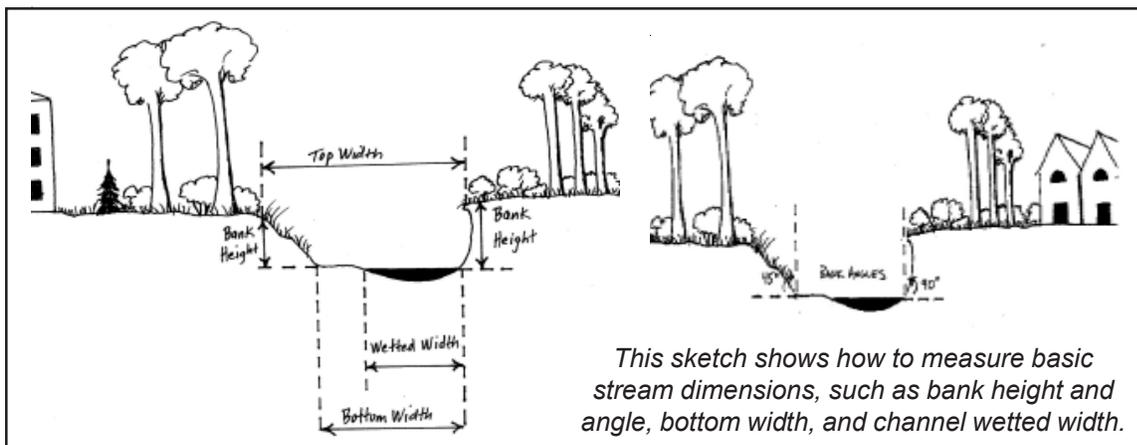
**Figure 20: Stream Features Diagram**



**Figure 21: Example Hard and Soft Bank Stabilization Practices**
*Panel A illustrates the use of rip rap to restore an eroded section of stream; Panel B shows the mixed use of coir fiber logs and riprap to stabilize outfall and repair adjacent stream bank.*

## 4.3 Which Eroded Banks Should I Record?

Some bank erosion should be expected in most urban streams, and it is unrealistic to have field crews GPS and assess every foot of eroded bank if restoration is not practical. Therefore, slope failures, bank sloughing, incision, or channel enlargement should only be recorded for banks that are noticeably worse than the "average" eroded bank along the survey reach (Figure 23). Sites with average bank erosion should only be counted if adjacent infrastructure is threatened or significant property loss is evident. Streamside headcuts and channel nick points with elevation changes of at least two feet should always be recorded, since they signal that active channel erosion is migrating upstream.

## 4.4 Field Assessment Tips

This list provides some quick tips for assessing stream erosion:

- Track all headcuts to their source, even if they are lateral to the stream.
- Only include channel nick points if the vertical change in stream elevation is more than a foot.
- Look for root hairs on stream banks to determine active erosion.
- Look for signs of major sediment deposition to determine channel degradation.
- Stratified layers in the bank may be a clue that the stream is downcutting.
- Banks composed of unconsolidated materials such as gravel, sand, or silt are often more unstable than those of compacted clay.
- If bedrock is present, then stream widening may be the dominant channel process. In this case, bank height may not be greater than average reach conditions, but the increase in cross sectional area may be greater.
- Make sure to look behind overhanging vegetation to determine extent of bank erosion and vegetative cover.



**Figure 22: Example Grade Control Practice**
*Steps pools can be used as grade control.*



**Figure 23: Expected Levels of Urban Bank Erosion**
*In highly urban settings, three- to four-foot eroded banks are probably the norm. This condition should be noted on the RCH form; however, impact assessments should be limited to the severely eroded sites.*

- Be sure not to confuse historic channel migration features with newly formed, actively eroding benches.
- Don't worry if you can't envision stream restoration. Take a look at Manual 4, and tour some local stream restoration projects prior to performing the ER.

| Table 15:  How ER Data Can Be Used | |
|---|---|
| Problem Assessed | Nature and type of channel erosion<br>Severity of bank erosion<br>Threatened infrastructure |
| Potential Restoration Practice<br>*(Manual profile sheets)* | Potential sites for bank stabilization (R-3, R-15)<br>Grade control (R-18 to R-21) |
| Stream Corridor Metric | # of severe bank erosion sites<br>Estimated bank erosion sediment load |
| Output for Planning | Map of erosion sites |
| *The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series. R- sheets can be found in Manual 4: Stream Repair Practices* | |

# 4.5 Using ER Data in Subwatershed Restoration

Severe erosion data can be used to identify eroded banks, generate a list of potential stream repair practices, develop stream erosion metrics, and generate planning maps (Table 15). This information can show the degree to which channel erosion poses a significant threat in the stream corridor and how important stream stabilization and repair projects will be in the overall restoration plan.

## 4.6 Example ER Form

The severe erosion impact form (ER) assesses individual locations of eroded stream banks encountered during your stream walk. You are asked to record basic data on the location of erosion sites, estimate current channel dynamics and dimensions, and identify potential bank stabilization opportunities at each problem site. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Severe Bank Erosion **ER**

**A.**

| WATERSHED/SUBSHED: SMILEY RUN | DATE: 3/10/03 | ASSESSED BY: ACK, SUB |
|---|---|---|

| SURVEY REACH: 102-1 | TIME: 9:45 AM/PM | PHOTO ID (CAMERA-PIC #): A #03-04 |
|---|---|---|

SITE ID: *(Condition-#)*
ER- **1**

START LAT ___°___'___" LONG ___°___'___" LMK ____
END LAT ___°___'___" LONG ___°___'___" LMK ____
GPS: *(Unit ID)*

**B.**

**PROCESS:** ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☑ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☑ Slope failure
☐ Sed. deposition ☐ Channelized

**BANK OF CONCERN:** ☐ LT ☑ RT ☐ Both *(looking downstream)*
**LOCATION:** ☐ Meander bend ☐ Straight section ☑ Steep slope/valley wall ☐ Other: TALL EMBANKMENT
**DIMENSIONS:**
Length *(if no GPS)* LT ___ ft and/or RT 100 ft | Bottom width 10 ft
Bank Ht LT ___ ft and/or RT 8.5 ft | Top width 15 ft
Bank Angle LT ___° and/or RT 90° | Wetted Width 7.5 ft

**LAND OWNERSHIP:** ☑ Private ☐ Public ☐ Unknown | **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

**C.**

**POTENTIAL RESTORATION CANDIDATE:** ☐ Grade control ☑ Bank stabilization
☐ No ☐ Other:

**THREAT TO PROPERTY/INFRASTRUCTURE:** ☐ No ☑ Yes (Describe): SEWER LINE

**EXISTING RIPARIAN WIDTH:** ☐ ≤25 ft ☑ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

| **EROSION SEVERITY** *(circle#)*  Channelized= ☐ 1 | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. (5) | Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure -4  3 | Grade and width stable; Isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. 2  1 |
|---|---|---|---|
| **ACCESS:** | Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. (5) | Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. 4  3 | Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required. 2  1 |

**NOTES/CROSS SECTION SKETCH:**

BIG MESS!!
JUST UPSTREAM OF GROCERY STORE, BANK ACTIVELY ERODING, HEAVY SEDIMENT DEPOSITION IN STREAM, SEWER LINE EXPOSED.

tree

8FT

ERODING FACE

SEWER LINE

**REPORTED TO AUTHORITIES** ☐ YES ☑ NO

## How the Example ER Form Was Completed

### Part A

The field crews in this example assessed an eroded bank in the Smiley Run subwatershed in survey reach 102-1. They took two photos at this location that also happened to be the first excessively eroded site they encountered in the reach.

### Part B

In this part of the ER form, the eroded bank extended about 100 feet along the right bank and appeared to be threatening an embankment. Measured bank height was almost nine feet.

### Part C

Here the field crew identified an eroded bank as a potential candidate for bank stabilization due to an exposed sewer line. Because of the immediate threat to infrastructure, the crew rated the bank erosion as a "5" for severity. Site access was considered good, although the best access was across private property.

# Chapter 5: Impacted Buffers (IB)



The USA assesses portions of the stream corridor that lack an adequate stream buffer. You will specifically be looking for sites where active reforestation, greenway design, natural regeneration, and buffer management practices can be targeted.

## 5.1 About Impacted Buffers

Streamside buffers are important to stabilize banks, create habitat, and remove pollutants. The vegetative species found in the stream buffer vary by ecoregion, but a mature forest represents the optimal condition in most temperate climates. Urbanization often results in encroachment, tree clearing and mowing of the buffer. These changes can interrupt the continuity of the stream buffer corridor and undermine its many benefits. Urban stream buffers may also be fragmented by road and utility crossings, and are often short circuited by storm water pipes. In commercial settings, buffers are often cleared and replaced with parking lots and rip-rap directly adjacent to the stream. Homeowners may also replace natural buffer cover with turf grass that lacks the root depth needed to maintain bank stability.

Remaining buffer fragments can become overrun with invasive plant species such as kudzu, ivy, and honeysuckle. As access to buffer fragments becomes more limited, active management and reforestation of remaining buffer areas becomes difficult. Figure 24 shows various types of stream buffers conditions you may observe during an IB assessment.

Impacted buffers are included in the USA for several reasons:

- *Encroachment in the riparian corridor*: The IB form can systematically show which areas of the stream network lack adequate buffers, and verify the quality of existing buffers. Communities may have an aerial mapping layer that shows buffer areas, but seldom know which specific areas are most suitable for reforestation or improved management. The IB form is a useful tool to identify candidate regeneration or active reforestation sites that should be targeted for more detailed riparian restoration surveys.
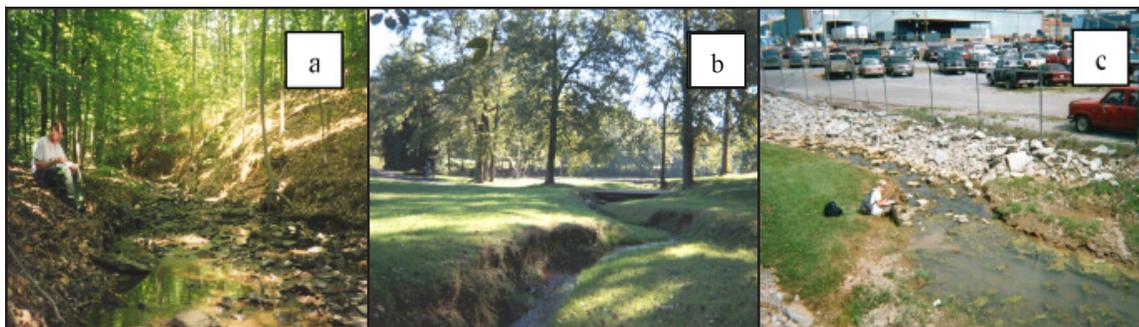


**Figure 24: Types of Stream Buffers to Expect**
*Wide, naturally vegetated buffers provide many benefits to streams. Panel A shows optimal buffer conditions rare in urban systems. Panel B shows an impacted buffer often seen in parks and residential settings. Panel C shows an example of the paved buffer frequently observed in more highly urban settings.*

---

**Questions to ask when assessing the stream buffer:**

Why is this buffer considered inadequate?

What is the adjacent land use and how does it impact the buffer?

What is the density and diversity of vegetative cover (grass, shrub, woody)?

Are invasive plant species present?

What kinds of reforestation opportunities exist?

---

- *Vegetative condition of buffer*: The regulatory status of stream buffers varies tremendously throughout the country. While many local ordinances require a certain width (25 to 100 feet or more), specific guidelines for vegetative diversity or density, use of native species, and overall maintenance planning are not always addressed. Understanding the diversity and density of existing buffer vegetation can help identify locations to control invasive plant species and to craft better buffer management practices.

- *Watershed Treatment Model:* Quantitative values for riparian continuity can be inserted into various water quality models, such as the Watershed Treatment Model (WTM). The WTM estimates pollutant load reductions for reforested buffers.

## 5.2 Introduction to the IB Form

This section introduces you to the impacted buffer form (IB), which evaluates riparian buffers encountered during your stream walk. You are asked to record basic information on the location and quality of buffers, along with adjacent wetland restoration and reforestation opportunities at each site. This section describes each part of the IB form, and presents guidance on how to complete it. Appendix A provides the full version of the IB form. A completed example IB form is included at the end of this chapter in Section 5.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the IB form contains general header information.

You should modify the header to reflect your reach and site labeling system, and whether you are using GPS units to fix locations. If you use GPS units, record the beginning and end coordinates for each buffer segment, the **GPS unit ID #,** and an **LMK** number. If you are not using a GPS unit, then measure the buffer length using calibrated paces or a tape measure.

The next part of the IB form asks which side of the stream lacks a buffer and the reason(s) you consider it inadequate.

You should decide in advance what criteria you will use to define the adequacy of buffers. **Buffer adequacy** can be defined based on your local buffer protection criteria. For example, if your local ordinance requires a minimum buffer width of 25 feet, then this may be a benchmark to judge whether a buffer is too narrow. Adjacent land ownership is also a useful criterion since parks and public lands are often the best places for buffer restoration. Buffer expansion on public land can sometimes be accomplished by changing mowing practices used by local maintenance crews. The IB form also asks you to estimate the extent of **invasive plant** coverage, as well as the amount of **stream shading** provided by the overhead tree canopy. You should also note if wetlands are present in unbuffered segments that may be suitable for potential enhancement or restoration projects. Table 16 illustrates what many buffer features can look like in the field.

The last part of the IB form asks you to recommend any potential management practices you feel may be appropriate for the impacted buffer.

Buffer management practices to consider include natural regeneration, active reforestation, greenway design, and control of invasive species. **Active reforestation** involves planting native tree species to eventually produce a streamside forest. **Natural regeneration** is a more hands-off approach that allows nature to take the area back on its own. This is done in areas where mowing is stopped and existing plants and seed banks are allowed to propagate after invasives are removed (Figure 25). In some cases, unbuffered segments may be associated with **greenways**, trail systems, or other open space areas. Integrating appropriate management practices in these buffer segments may be a restoration opportunity (Figure 26). Watershed groups can be a great source of support for active reforestation planting and invasive species control projects (Figure 27). Riparian management practices are described in more detail in Manual 5.

| **Table 16: Buffer Characteristics to Note During Site Assessment** | | |
|---|---|---|
|  Aerial photography showing wide, forested buffer between residential area (top left) and stream. |  Lack of buffer on one side of stream; impacted buffer should be at least 100 ft long to record. |  Example of inadequate buffer on both sides of stream; potential site for active reforestation. |
|  Turf grass mowed to stream edge in public open space should be targeted for bufferscaping projects. |  Buffer management at golf courses should integrate course requirements with bank stability and in-stream goals. |  If forest cover is not practical, buffers should, at a minimum, contain shrubs or tall grass. |
|  Sometimes impacted buffers may have been recently planted. This should be noted on your field form. |  The extensive presence of invasive plant species can threaten an otherwise healthy buffer system. |  Note the width of the restorable area. Structural encroachment may limit the available restorable width. |

**Figure 25: Active Reforestation and Natural Revegetation Locations**
*Active reforestation can be done even in utility corridors (Panel A). These activities can serve as highly visible educational opportunities, particularly if appropriate signage is used (Panel B). Some areas can regenerate vegetation themselves, if access is limited and invasive plants are controlled (Panel C).*



**Figure 26: Riparian Management in Open Space**
*Panel A shows an area identified as a community greenway where buffer enhancement should be part of the master planning process. Panel B shows poor backyard landscaping practices where vegetation is mowed frequently, and chemical sprays are used to remove vegetation from the stream edge.*



**Figure 27: Using Local Volunteers for Buffer Restoration**
*Watershed groups can generate volunteer support for removing invasive species (Panel A) or active planting (Panel B).*

To evaluate reforestation potential, first estimate the available area or length suitable for reforestation, and then assign a **reforestation potential** score based on adjacent land use, access, and site constraints. The reforestation score is based on a five-point scale, where five is the most suitable. You should look for any potential conflicts that might hinder successful reforestation (e.g., lack of adjacent water, or presence of beaver, utilities, or invasive plants). Feasibility factors are used later to rank the most promising riparian management sites in the subwatershed.

## 5.3 Which Impacted Buffers Should I Record?

The IB form is designed to help you find the total length of buffered/unbuffered stream miles in a subwatershed, even if full reforestation is impractical. You may want to set criteria based on minimum widths cited in local buffer ordinances, or based on protection goals (e.g., 100 feet). At a minimum, field crews should evaluate buffers that extend outward at least 25 feet from the stream, as measured from the top of each bank.

To avoid repetitive starts and stops, field crews should only record impacted buffer areas greater than 100 feet in length. In some cases, a wide vegetated buffer may be considered inadequate if its health is compromised by invasive species or diseased vegetation.

Not all impacted buffer sites can be successfully reforested due to physical site or land use constraints. In commercial settings, for example, roads, buildings, or other encroachments may often constrain buffer width. While it is important to record these areas, they may not be considered prime candidates for reforestation, although options for riparian management should be explored.

## 5.4 Field Assessment Tips

Keeping track of inadequate buffer sites can become a field nightmare if crews are sloppy in recording data. Some tips to guide your buffer assessments are provided below:

- If you have access to good aerial photos, analyze survey reaches based on the presence or absence of buffer vegetation.
- If vegetative conditions in the buffer change significantly, fill out a new IB form. This generally occurs when you switch from one to both banks, or vice versa, or if there is a shift in land cover or other features.
- Remember to only record inadequate buffer segments longer than 100 feet, otherwise you'll find yourself completing too many forms. Fragmented buffer conditions are best reported on the RCH form.
- Take some clippers with you, since many urban buffers contain dense thickets with invasive vines and shrubs such as multiflora rose (ouch!).
- Watch out for poison ivy! You should also consult a local plant guide to learn the common invasive and poisonous plants you may encounter on your streamwalk.
- Look closely at your map beforehand and try to determine if multiple buffer sites exist within your survey reach.
- Start a new IB form if you cross over to a new survey reach. Alternatively, consider redefining the boundaries of the survey reaches to accommodate the full extent of the inadequate buffer.
- Reforestation on public lands or large parcels such as schools or golf courses will generally take a higher priority than small, privately-owned parcels.

| Table 17: How IB Data Can Be Used | |
|---|---|
| Problem Assessed | Encroachment in the stream corridor<br>Vegetative condition of existing buffer |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Active reforestation (F-1)<br>Greenway design (F-2)<br>Natural regeneration (F-3)<br>Related site preparation (SP-1 to SP-4)<br>Bufferscaping (N-20) |
| Stream Corridor Metric | Riparian forest continuity (buffer miles/stream miles)<br>Miles of invasives |
| Output for Planning | Map of reforestation sites<br>Map of invasive removal locations |
| *\*The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series.*<br>• *F- and SP-sheets can be found in Manual 5: Riparian Management Practices*<br>• *N- sheets can be found in Manual 8: Pollution Source Control Practices* | |

## 5.5 Using IB Data in Subwatershed Restoration

Impacted buffer data serves many restoration planning purposes. For example, IB data can help define buffer lengths, generate a list of potential riparian management practices, develop stream buffer metrics, and generate planning maps (Table 17). These products can help you decide if inadequate buffers are a significant problem in your subwatershed, and how integral riparian management will be to the overall restoration plan.

## 5.6 Example IB Form

The IB form evaluates riparian buffers encountered during your stream walk. You are asked to record basic information on the location and quality of buffers, along with adjacent wetland restoration and reforestation opportunities at each site. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Impacted Buffer **IB**

| WATERSHED/SUBSHED: SMILEY RUN | | DATE: 3/10/03 | ASSESSED BY: Azk, Eu | **A.** |
|---|---|---|---|---|
| SURVEY REACH: 702 -) | TIME: ___:___ AM/PM | PHOTO ID: *(Camera-Pic #)* A | # 07 | |

SITE ID: *(Condition #)*
IB- )

| | START | LAT ___ ° ___ ' ___ " LONG ___ ° ___ ' ___ " LMK ___ | GPS: *(Unit ID)* |
|---|---|---|---|
| | END | LAT ___ ° ___ ' ___ " LONG ___ ° ___ ' ___ " LMK ___ | |

**IMPACTED BANK:** ☑LT ☐RT ☐Both

**REASON INADEQUATE:** ☑Lack of vegetation ☑Too narrow ☐Widespread invasive plants ☐Recently planted ☐Other: BEAVER PRESENT

| LAND USE: *(Facing downstream)* | Private | Institutional | Golf Course | Park | Other Public : |
|---|---|---|---|---|---|
| LT Bank | ☑ | ☐ | ☐ | ☐ | ☐: |
| RT Bank | ☐ | ☐ | ☐ | ☐ | ☐: |

| DOMINANT LAND COVER: | Paved | Bare ground | Turf/lawn | Tall grass | Shrub/scrub | Trees | Other. |
|---|---|---|---|---|---|---|---|
| LT Bank | ☐ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐: SOME SCATTERED PINE TREES |
| RT Bank | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐: |

**INVASIVE PLANTS:** ☑None ☐Rare ☐Partial coverage ☐Extensive coverage ☐unknown

**STREAM SHADE PROVIDED?** ☑None ☐Partial ☐Full   **WETLANDS PRESENT?** ☑No ☐Yes ☐Unknown **B.**

**POTENTIAL RESTORATION CANDIDATE** ☑Active reforestation ☐Greenway design ☐Natural regeneration ☐Bufferscaping
☐no   ☐Other:

**RESTORABLE AREA**
LT BANK RT
Length (ft): ≈600ft ___
Width (ft): >100ft ___

| REFORESTATION POTENTIAL: *(Circle #)* | Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting | Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate | Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting |
|---|---|---|---|
| | 5 | ④ PRIVATE3 | 2 1 |

**POTENTIAL CONFLICTS WITH REFORESTATION** ☐Widespread invasive plants ☐Potential contamination ☐Lack of sun
☐Poor/unsafe access to site ☐Existing impervious cover ☐Severe animal impacts (deer, beaver) ☐Other: **C.**

**NOTES:**

THIS IS A PERFECT PLACE TO REPLANT BUFFER - NOW ITS JUST A MOWED AREA. IF ACTIVE USE OF OPEN AREA, THEN MAYBE ENCOURAGE IMMEDIATE BUFFER PLANTING NEXT TO STREAM... LOOKS LIKE THERE IS A BEAVER IN THE AREA

SEE REACH SKETCH

## How the Example IB Form Was Completed

### Part A

Field crews assessed an unbuffered segment in the Smiley Run subwatershed in survey reach 102-1. They took a photo (#7) at this location, which also happened to be the first impacted buffer segment they came across.

### Part B

The buffer in this example was located on the left bank (facing downstream), and was considered inadequate because it was too narrow and primarily vegetated with turf grass. The buffer area was located in a homeowner's back yard, and all of the trees that once shaded the stream were cleared.

### Part C

The impacted buffer was identified as a candidate for active reforestation, and had more than 6,000 square feet available for planting. Beaver signs were noted in the vicinity, which could pose a threat to tree planting efforts (i.e., may have to either remove the beaver or use sturdy tree shelters). The biggest drawback to this site was that it was located on private property, which will require landowner permission.

# Chapter 6: Utilities in the Stream Corridor (UT)

The USA assesses all locations where utilities cross the stream corridor and can cause water quality, stream habitat, or channel stability problems. Utilities may include leaking or exposed sewer pipes, sewer overflows at manhole stacks, and overhead power line crossings. You will specifically be looking for locations where stream repairs or discharge investigations may be needed.

## 6.1 About Utilities

Utility pipes and rights-of-way are frequently located within urban stream corridors, often parallel to or underneath the stream itself. When sewer lines leak or overflow, they can be a direct discharge source of raw sewage into the stream. Leaking water pipes can increase dry weather stream flows. Pipe infrastructure may physically impact the stream, particularly at crossings that cause bank destabilization or stream scouring, or create fish barriers. Exposed pipes in the channel are also susceptible to damage from floating debris, especially during large storm events. Vegetative maintenance under power line crossings can also impact stream buffers, through removal of native cover, spread of invasive plant species, and regular herbicide spraying. On the other hand, sewer, water, and power utilities have a strong interest in protecting their infrastructure, and can become good partners in subwatershed restoration. Figure 28 illustrates various impacts that utilities can cause along the stream corridor.

Utility impacts are included in the USA for several reasons:

- *Sanitary sewer overflows*: Sanitary sewer lines can overflow and leak untreated sewage to the stream due to blockages or lack of capacity. Sewage overflows may be a chronic problem in some subwatersheds that local authorities need to address. The UT form can help identify locations where overflows have recently occurred and refer these for immediate correction or add them to a "watch list" for the future. Additionally, the UT form quickly inspects the outside condition of manholes to identify whether structural repairs and discharge prevention investigation are needed.

- *Leaking sewer pipes and manholes:* Field crews can report location coordinates directly to the utility for a faster response when active leaks are detected or suspected.



**Figure 28: Types of Utility Impacts to Expect**
*Common utility-related impacts include sewer overflows (Panel A), damaged and leaking pipe crossings (Panel B), or power line rights-of-way interrupting the stream buffer (Panel C).*

---

**Questions to ask when assessing utility impacts:**

How is the utility impacting the stream corridor?

Are there any maintenance issues that should be reported?

Is there evidence of any sewer leaks or recent overflows?

What kind of utility repair would I suggest here?

---

- *Sewers crossing streams:* Stream sewer crossings can be a serious problem. The UT can evaluate the potential risk of sewage leaks in the stream corridor, and also locate where existing utility infrastructure is threatened by erosion or floodwater. These crossings are also good candidate sites for subsequent pipe testing and dry weather sampling investigations to confirm whether they are a sewage source (Manual 6).

## 6.2  Introduction to the UT Form

This section introduces the utility impacts (UT) form that evaluates the impact of utilities on the stream corridor. At each manhole or crossing, you are asked to collect basic information on its location, structural features, evidence of discharge, and potential repair opportunities. This section describes each part of the UT form and provides guidance on how to complete them. Appendix A offers a full version of the UT form. A completed example UT form is included at the end of this chapter in Section 6.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

As with other USA forms, the first part of the UT form contains general header information. As always, the header should be modified to reflect your reach and site labeling system, and whether you are using a GPS unit. If you are using GPS, record the coordinates for each site, the **GPS unit ID #,** and an **LMK** number.

The next part of the UT form asks you to describe the type, location, and structural condition of the utility feature.

Manhole stacks should always be checked for signs of external **deterioration** or recent **overflows**. Sewer lines that cross stream channels should be evaluated for their potential to act as **fish barriers** or whether they might be subject to damage from channel erosion or flooding. If a pipe crosses the stream and creates at least a six-inch vertical water drop, you should classify it as a potential fish barrier. In many cases, sewer pipes are located on the stream bottom and are encased in a layer of protective concrete. Note any damaged exposed sewers or coverings in the **Condition** box. If there is any evidence of sewer **discharge**, you should note colors, odors, or types of deposit observed. Table 18 illustrates what many of these utility features look like in the field.

In the last part of the UT form, you are asked to recommend any potential restoration practices you feel may be appropriate for the utility.

You may want to consider practices such as **structural repairs**, **pipe testing**, **citizen hotlines**, or dry weather **water quality sampling** to fix the utility problem. More detail on discharge prevention practices can be found in Manual 6. If the pipe is a potential barrier to fish migration, record the height of the water drop (Figure 29).

The UT form asks you to assign a **utility impact severity** score based on the extent and potential for discharge on a scale of one to five, where five is the most severe condition. If a sewage discharge is detected, the site automatically scores a five and should be immediately referred to local authorities. Guidance on how to estimate discharge severity and access scores are provided on the UT form, and are used later to identify the most severe utility impacts in the subwatershed.

## 6.3 What Utility Data Should I Record?

All leaking or exposed sewer infrastructure in the stream corridor that causes (or threatens to cause) water quality, aquatic habitat, or channel stability problems should be recorded. This can include manhole stacks, sewer or water lines, or rights-of-way. Exposed pipes along the stream bottom, in the stream bank, along the stream corridor, or crossing the stream should always be assessed. Particular attention should be paid to utilities that are vulnerable to damage due to lack of maintenance or floating debris. Overhead utility crossings such as major power lines should be recorded as well.

| **Table 18: Utility Characteristics to Note During Site Assessment** | | |
|---|---|---|
| Utilities crossing above the stream can be susceptible to floating debris during storm events. You should note the length and condition of exposed pipes. | The structural condition of manhole stacks in-stream due to bank erosion should be examined. This site may rank highly for restoration to prevent future degradation. | Manholes are typically spaced 200-400 feet apart. You should examine the condition of each |
| Look for any colored discharges or structural problems with manholes sitting in flood plain wetlands. | The presecence of toilet paper and solid waste are evidence of overflows. | Powdered agents spread over sewer overflows in the flood plain are a sign of clean-up efforts. |
| Popped manhole covers and toilet paper in branches are good evidence of past discharge. | Check condition of concrete or brick manhole stacks. Open or missing manhole cover may indicate recent overflow. | Pipes crossing the stream can be at risk from floating debris or contribute to debris jams, as shown here. |

## 6.4 Field Assessment Tips

Some quick tips for assessing utility impacts are provided below:

- Manhole stacks typically occur every 200 to 400 feet along the stream corridor.
- To be safe, perform an external inspection of utility pipes only. Do not open manhole covers or climb into open sewer pipes.
- If you smell something, take extra time to look for visual evidence of a leak or spills.
- Visual cues of recent sewer overflows may include open manholes, toilet paper and other sanitary deposits, obvious staining or dried residues, lime, or "stay out" signage.
- Report any spills or leaks to appropriate authority on your emergency contact list.

- Record any phone numbers or identification information written on utility poles or manhole covers to help response crews find the "address" of the problem.

## 6.5 Using UT Data in Subwatershed Restoration

Utility impact data can be useful for restoration planning in several ways. UT data can identify major sewage discharges, generate a map of discharge detection properties, and screen subwatersheds for priority investigations to identify illicit discharges (Table 19). The UT assessment can help determine whether sewage leaks or overflows are a major problem in your subwatershed and whether they should be addressed in your overall restoration plan.



**Figure 29: Structural Repair and Fish Barrier Removal at Utilities**
*Structural repair or relocation of sewer lines may be necessary to stop leaking pipes as shown here (Panel A), or to restore fish passage at potential fish barriers like the one shown here (Panel B).*

| Table 19: How UT Data Can Be Used | |
|---|---|
| Problem Assessed | Sanitary sewer overflows<br>Leaking sewer pipes and manholes<br>Sewers crossing streams<br>Powerline rights-of-way impacting buffers or stream banks |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Structural repairs (D-10)<br>Pipe testing (D-6)<br>Citizen hotlines (D-5)<br>Dry weather stream sampling (D-3)<br>Reforestation (F-1) |
| Stream Corridor Metric | # of sanitary sewer overflows<br># of leaking sewer pipes and manholes<br>Sewers crossings/stream mile |
| Output for Planning | Map of problem areas<br>Additional discharge investigations |
| *\*The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series:*<br>• *D- sheets can be found in Manual 6: Discharge Prevention Practices*<br>• *F- sheets can be found in Manual 5: Riparian Management Practices* | |

## 6.6 Example UT Form

The UT form evaluates the impact of utilities on the stream corridor. At each manhole or crossing, you are asked to collect basic information on its location, structural features, evidence of discharge, and potential repair opportunities. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

**UT**

| WATERSHED/SUBSHED: SMILEY RUN | DATE: 3 / 10 / 03 | ASSESSED BY: AZK, EWB | | **A.** |
|---|---|---|---|---|
| SURVEY REACH ID: 102-1 | TIME: 9:45 AM/PM | PHOTO ID: (Camera-Pic #)  A   # 05 | | |
| SITE ID: (Condition-#) UT-___ | LAT ___° ___' ___" LONG ___° ___' ___" | LMK: ___   GPS: (Unit ID) | | |

| TYPE: | MATERIAL: | LOCATION: | POTENTIAL FISH BARRIER: | PIP DIMENSIONS: |
|---|---|---|---|---|
| ☐ Leaking sewer | ☑ Concrete STACK | ☐ Floodplain | ☐ Yes ☑ No | Diameter: 28 in |
| ☑ Exposed pipe | ☐ Corrugated metal | ☑ Stream bank | | Length exposed: 50 ft |
| ☑ Exposed manhole | ☑ Smooth metal PIPE | ☐ Above stream | **CONDITION:** ☐ Joint failure ☐ Pipe corrosion/cracking | |
| ☐ Other: | ☐ PVC | ☐ Stream bottom | ☐ Protective covering broken ☐ Manhole cover absent | |
| | ☐ Other: | ☐ Other: | ☐ Other: EVERYTHING LOOKS OKAY | |

| EVIDENCE OF DISCHARGE: | COLOR | ☑ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other: |
|---|---|---|
| | ODOR | ☑ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other: |
| | DEPOSITS | ☑ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other: |

**B.**

POTENTIAL RESTORATION CANDIDATE ☑ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no                             ☐ Fish barrier removal ☐ Other:

*If yes to fish barrier,* Water Drop: _____ ---- (in)

| UTILITY IMPACT SEVERITY: *(Circle #)* | Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure. | A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event. | small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel. | **C.** |
|---|---|---|---|---|
| Leaking= ☐ 5 | 5 | 4        3 | 2        1 | |

NOTES: NOT LEAKING, SO DIDN'T CALL UTILITY, BUT PROBABLY NEEDS TO BE
LOOKED AT SOON. BANK IS COLLAPSING ALL AROUND
(SEE ER-1)

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☑ No

## How the Example UT Form Was Completed

### Part A

In this example, field crews performed a UT assessment at a sewer manhole stack in the Smiley Run subwatershed in survey reach 102-1. The crew took one photo at this location, which also happened to be the first utility impact assessed.

### Part B

Bank erosion exposed a manhole stack and about 50 feet of exposed pipe in this example. While the pipe appeared to be in good structural condition, and no visible evidence of sewage overflow or leaks was found, the field crew still recorded it because of its potential vulnerability to future erosion.

### Part C

The site was identified as a strong candidate for structural repairs, in combination with a local bank stabilization project. Because no discharge was detected, the utility was not immediately contacted. Given the nature of the problem, however, the utility may eventually be contacted as a follow-up or be invited to participate in the subwatershed restoration plan.

# Chapter 7: Trash and Debris (TR)



The USA evaluates the stream corridor to find locations where trash and debris (TR) are dumped or have accumulated. TR data help target stream reaches for routine stream cleanups, adoption, or major removal of dumped materials (bulk or hazardous).

## 7.1 About Trash and Debris

Nothing is more unsightly than the accumulation of bags, cans, bottles, and other trash and debris along the stream corridor. Despite decades of anti-litter campaigns, trash still finds its way into streams and flood plains either from direct dumping or through transport through the storm drain system. Since the stream corridor is the low point of the urban landscape, considerable quantities of trash and debris build up over time. Yard wastes such as grass clippings, leaves, and trees are often dumped from the backyard to the stream. In more urban subwatersheds, fill material, construction debris, and rubble are frequently dumped in remaining flood plains, since they are perceived as vacant land. The presence of trash and debris can degrade resident perceptions about stream quality, reduce community amenities, contribute pollutants (e.g., nutrients, oil, bacteria), and create blockages at outfalls or other locations in the stream. Examples of trash conditions you may observe during the USA survey are shown in Figure 30.

Trash and debris are documented in the USA for several reasons:

- *Trash/debris in the stream*: Stream cleanups are a terrific way of getting the community involved in subwatershed restoration. The TR form can help identify sites for trash pick-up events or adopt-a-stream segments (Manual 4). The TR form allows you to quantify the relative "trashiness" between subwatersheds and help devise upland education campaigns (e.g., storm drain stenciling, public trash cans, and signage).

- *Dumping in the stream corridor:* The TR form can also be used to identify locations in the stream corridor where chronic dumping is a problem. Preventative measures such as limited access, signage, and more aggressive enforcement can then be used to address dumping problems. Additionally, the TR form



**Figure 30: Types of Trash Impacts to Expect**
*Floating trash can accumulate at debris jams (Panel A) or along the banks, or be deposited in the flood plain during storm events. Of course, no urban stream is complete without its signature trash item: the shopping cart (Panel B). Outfalls often convey trash into the stream corridor (Panel C).*

---

**Questions to ask when assessing trash and debris:**

Is this area trashier than the rest of the survey reach?

What kind of trash is it, and is it hazardous?

Is there an illegal dump, or other obvious source?

What level of effort will it take to clean this up?

---

indicates whether access is available for heavy equipment needed to remove bulk items (e.g. cars, mattresses, refrigerators).

*Locating hazardous materials:* The TR form is used to report medical waste, chemical drums, or unknown hazardous materials that the field crew should NOT remove. These sites should be immediately referred to the appropriate hazardous waste response agency for cleanup and response.

## 7.2 Introduction to the TR Form

This section introduces you to the trash and debris assessment form (TR) to report problems in the stream corridor. You are asked to collect basic information on the location, type, and amount of trash at each site, and estimate the level of effort needed to clean it up. Each part of the TR form is described in this section, followed by guidance on how to complete each part. Appendix A includes a full version of the TR form. A completed example TR form is included at the end of this chapter in Section 7.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the TR form contains general header information. The header information should be modified to reflect your reach and labeling system, and whether you are using GPS. If you are using GPS units, record the coordinates for each site, and provide the **GPS unit ID #** and an **LMK** number.

The next section of the TR form asks you to describe the type, location, and likely source of the trash or debris. **Industrial** trash refers to large drums, construction debris and rubble, while **commercial** trash may include fast food items, plastic bags, grocery carts, car parts, or

other items generated from commercial areas. **Residential** trash may include yard waste, toys, and household items that originate from backyard dumping. You should assess the dominant type of trash (e.g., is it mostly plastic bags or lumber from a nearby construction site?), and try to find the likely source. If you find **hazardous materials**, record it as "other," describe it as best as you can, and report it to the appropriate authorities listed on your emergency contact list.

While you may not always be able to tell where the trash came from, you can usually guess how it was delivered—either by stream flooding, dumping, or from the nearest storm water outfall. Delivery information can help determine the best cleanup or prevention option to explore. Lastly, try to estimate the quantity of trash at the site by envisioning the number of pickup **truck loads** it would take to remove it (Figure 31).

In the last part of the TR form, you are asked to recommend potential **cleanup** or **prevention practices** that are appropriate for the site. Practices to consider include routine stream

**Figure 31: Estimating Truck Loads of Trash**
*Quantify the volume of trash in the area by estimating the number of pickup truck loads it would take to haul it away.*

cleanups, stream adoption, municipal removal, upstream source control, and enforcement. **Stream cleanups** organized by watershed groups can be great outreach tools to involve citizens in restoration (Figure 32). If a storm water outfall is thought to be a chronic source of trash, upstream **catch basin clean-outs**, storm drain stenciling, or retrofitting to reduce floatables may be an option. If dumping appears to be associated with easy vehicle access, restricting or eliminating access may also solve the problem (Figure 33).

If trash needs to be removed from the site, estimate the type of equipment and personnel most suitable for the job. Also, look around for the best location to store the collected trash (ideally, a nearby dumpster). The TR form asks you to assign a **cleanup potential score** based on the trash volume and site access (on a scale of one to five, where five is the best). The TR form provides descriptive scoring criteria to help make this determination.



**Figure 32: Stream Cleanup Events**
*Identify target locations for organized stream cleanup events.*



**Figure 33: Deploying a Trash Boom**
*Prevention and enforcement practices for addressing trash in highly urban watersheds may include inserting a trash boom downstream of a storm water outfall to catch floatables (Panel A), or removing vehicle access and posting "no dumping" signs.*

## 7.3 What Trash/Debris Impacts Should I Record?

You don't need to record every bottle, beer can, or plastic bag you find along the stream corridor. As a general rule, only note areas where trash and debris have accumulated well above the average level observed for the survey reach, or where potentially hazardous or unknown chemical containers are found.

## 7.4 Field Assessment Tips

Some quick field tips for assessing trash and debris impacts are offered below:

- If trash is a known or potential hazard, contact appropriate authorities immediately.
- Trash tends to accumulate around debris jams and may be mobile during storm flows.
- Try to note the presence of poison ivy or other hazards (e.g., traffic or deep, fast-flowing water) that may limit volunteer cleanups to older teens and adults.
- Look around for a nearby dumpster, and think about accessibility and available parking for cleanup volunteers.
- Do your part and take a plastic bag along to pick up some trash during the USA survey.

## 7.5 Using TR Data in Subwatershed Restoration

Trash and debris data can guide restoration planning in a number of ways. For example, it can be used to map stream cleanup sites, prioritize stream segments for adoption, and develop trash metrics to compare different subwatersheds (Table 20). TR data can help you decide if trash and dumping are a major problem in your subwatershed and help select the mix of prevention and enforcement practices to address the problem.

| Table 20: How TR Data Can Be Used ||
|---|---|
| Problem Assessed | Trash or debris in stream or flood plain<br>Dumping in the stream corridor |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Stream clean-up sites (C-1)<br>Stream adoption segments (C-2)<br>Removal of trash/debris (SP-1)<br>Storm drain stenciling (N-21) |
| Stream Corridor Metric | General index of trashiness |
| Output for Planning | Map of clean-up sites<br>Mapping of stream adoption segments |
| *The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series.*<br>• *C- sheets can be found in Manual 4: Stream Repair Practices*<br>• *SP- sheets can be found in Manual 5: Riparian Management Practices*<br>• *N- sheets can be found in Manual 8: Pollution Source Control Practices* ||

## 7.6 Example TR Form

The TR form is used to report problems in the stream corridor. You are asked to collect basic information on the location, type, and amount of trash at each site, and estimate the level of effort needed to clean it up. A detailed explanation of how the field crew filled out each section of this example form is included below.



Trash and Debris | TR

| WATERSHED/SUBSHED: *SMILEY RUN* | DATE: *3 / 10 / 03* | ASSESSED BY: *ACK, EMS* | A. |
| SURVEY REACH ID: *102-1* | TIME: *9:30* AM/PM | PHOTO ID: (*Camera-Pic #*) *A    /# 02* | |
| SITE ID: (*Condition-#*) TR-*1*    LAT ___°___'___" LONG ___°___'___" LMK ___ | GPS: (*Unit ID*) | |

| TYPE: | MATERIAL: | | | SOURCE: | LOCATION: | LAND OWNERSHIP: | B. |
|---|---|---|---|---|---|---|---|
| ☐ Industrial | ☑ Plastic | ☐ Paper | ☐ Metal | ☐ Unknown | ☑ Stream | ☐ Public  ☐ Unknown | |
| ☑ Commercial | ☐ Tires | ☐ Construction | ☐ Medical | ☐ Flooding | ☐ Riparian Area | ☑ Private *BEHIND STORE* | |
| ☐ Residential | ☐ Appliances | ☐ Yard Waste | | ☑ Illegal dump | ☐ Lt bank | AMOUNT (*# Pickup truck loads*): *1 – 1.5* | |
| | ☐ Automotive | ☐ Other: *BEER CANS/ GROCERY CARTS* | | ☐ Local outfall | ☑ Rt bank | | |

POTENTIAL RESTORATION CANDIDATE   ☑ Stream cleanup  ☐ Stream adoption segment  ☐ Removal/prevention of dumping
☐ no                                                ☐ Other:

| *If yes for trash or debris removal* | EQUIPMENT NEEDED: ☐ Heavy equipment ☑ Trash bags ☐ Unknown | DUMPSTER WITHIN 100 FT: ☑ Yes ☐ No ☐ Unknown | C. |
|---|---|---|---|
| | WHO CAN DO IT:  ☑ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other | | |

| CLEAN-UP POTENTIAL: (*Circle #*) | A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access | A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe. | A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials | |
|---|---|---|---|---|
| | ⑤ | 4 | 3 | 2 | 1 |

NOTES: *JUST GENERAL TRASH FROM STORE – CARTS, BAGS, ETC 2-3 VOLUNTEERS COULD KNOCK IT OUT IN 3 HRS; BUT MAY BE A RECURRING EFFORT... UNLESS WE CAN RESTRICT ACCESS. DUMPSTER BEHIND STORE*

REPORTED TO AUTHORITIES ☐ YES ☑ NO

## How the Example TR Form Was Completed

### Part A
In this example, field crews assessed a trash dump site in the Smiley Run stream corridor at survey reach 102-1. They took a photo at this location, which also happened to be the first dump site they encountered.

### Part B
The trash site had approximately one to two pickup truck loads of trash, which were thought to come from the adjacent grocery store (on the right bank). The crew could not tell if the trash was due to littering, or if it came from an overloaded dumpster located behind the store.

### Part C
The trash site in this example was deemed appropriate for routine cleanup by volunteers. The crew estimated that a few volunteers could clean the area up in two or three hours, so a large organized stream cleanup day was probably not needed.

# Chapter 8: Stream Crossings (SC)



This part of the USA examines each structured crossing that occurs within the stream corridor, which can include bridges, culverts, railways, and dams. Note that sewer and water line crossings are evaluated on the UT form. You will be looking for potential fish barriers, culverts in need of repair or replacement, opportunities for upstream storage retrofits, or associated stream repair projects at each crossing.

## 8.1 About Stream Crossings

As subwatersheds urbanize and transportation networks expand, the number of stream crossings increases. Stream crossings interrupt the stream corridor, alter local stream hydrology, impact bank stability, and prevent fish migration. Stream crossings are generally designed based on the width of the road and the stream, the slope of the flood plain, and runoff volumes generated by extreme storms. In many cases, crossings enclose the stream for an extended distance. Known as culverts, these involve a long pipe or box-like structure installed to safely convey storm water through or under a structure (e.g. roadway or driveway). When culverts are poorly designed,

they can degrade habitat, create fish barriers, and contribute to local flooding and erosion problems (i.e., if they are clogged, misaligned, or under capacity). Both man-made and beaver dams are considered to be stream crossings. Figure 34 illustrates various types of stream crossings you may encounter in the field.

Stream crossings are important to assess during the USA survey for several reasons:

- *Stream Impacts:* While maps can provide a general sense of how many crossings occur in your subwatershed, they do not show all crossings, nor do they indicate whether the crossings are a barrier to fish migration or a local grade control feature.

- *Flooding Models*: Detailed information on crossings, such as capacity and flow alignment, is essential for analyzing flooding risk using hydraulic simulation models.

- *Potential repair retrofits.* Undersized culverts may be prime candidates for repair or replacement, which can improve natural stream flow (Manual 4), or may be ideal sites for an upstream storage retrofit (Manual 3).



**Figure 34: Types of Stream Crossings You May Encounter**
*Roadways (Panel A), dams (Panel B), and pedestrian bridges (Panel C) are structured crossings that you may observe during the USA. You should assess all crossings that have a direct impact on the stream. Structures like the one shown in Panel C that do not have a significant impact should not be assessed.*

---

**Questions to ask when assessing stream crossings:**
What impact is the crossing having on the stream?
Is this a potential fish barrier?
Is there any maintenance or flooding concerns related to this crossing?
Is this crossing a candidate for removal or retrofitting?

---

## 8.2 Introduction to the SC Form

This section introduces you to the stream crossing (SC) assessment form. The SC form asks you to record basic information on the location, dimensions, condition, and restoration potential of each stream crossing. This section describes each part of the SC form, and provides guidance on how to complete it in the field. A full version of the SC form can be found in Appendix A. A completed example SC form is included at the end of this chapter in Section 8.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the SC form contains general header information that locates the subwatershed, survey reach, crossing identifier, and GPS coordinates for the crossing.

The next part of the SC form asks you to describe the type and general features of each stream crossing. Structured crossings can be quite diverse in urban subwatersheds. Table 21 shows examples of some of the different crossings you may find in the field. If the crossing is not related to a road or a culvert, you can skip to the next section. If it is a culvert, record some basic information describing its shape and condition. In particular, note whether the culvert is **bottomless** (has a natural stream bottom) and what, if any, impact it may be exerting on the stream. For example, does the culvert cause a **scour hole**, promote upstream sediment deposition (occurs when floodwaters back up behind the crossing), or threaten adjacent embankments (often caused by misdirected flow)?

If you want to perform flooding analysis, measure the general barrel dimensions, as well as roadway elevation, alignment, and slope. **Roadway elevation** is measured from the stream bed to the road surface. **Alignment** refers to the direction of the culvert in relation to stream flow (does the upstream culvert line up with the direction of stream flow, or does it angle away?). Try to gauge the relative **slope of** the culvert by looking upstream through the culvert. Keep in mind that a 2% slope represents a rise of two feet over a run of 100 feet.

In the last part of the SC form, you are asked to recommend any restoration projects that are suitable for the crossing, and determine whether it is a potential fish barrier.

Potential practices to consider at crossings include fish barrier removal, culvert repair/replacement (Figure 35), and local stream repair. These **stream repair** techniques are discussed in more detail in Manual 4. Additionally, you should check out the potential to have an upstream **storage retrofit** at the stream crossing (Figure 36).

It is a good idea to consult with a local fishery biologist to determine the criteria to define fish blockages before sending crews out in the field. In the mid-Atlantic region, **fish barriers** are defined as crossings that create at least a six-inch water drop and/or have an average depth of flow less than one-half inch deep during normal conditions. If you consider the crossing a potential fish barrier, describe the extent of the blockage (spatially); classify it as total, temporary, or partial; and note your rationale for your decision. Note that some fish barriers can also be created by steep culverts slopes or extended culvert lengths (100 feet or

**Table 21: Stream Crossing Characteristics to Note During Site Assessment**



Elliptical, concrete, single-barrel roadway culvert, with an associated outfall.



Round, metal culvert. Estimate culvert length by walking above ground.



This arched, corrugated metal culvert is bottomless (or is it? Be sure to check!).



Single box culvert not well-aligned with flow path.



Replacing existing culverts with ones like this provides a natural channel bottom.



Double-barrel, concrete road culvert with significant sediment deposition.



Double box culvert with in-stream sediment deposits forming on the left side and a distinct vegetated bar forming on the right.



Culverts or dams that result in at least a six-inch water drop should be considered potential fish barriers.



Culverts with a significant slope or over a certain length (100 feet or more) may prevent fish passage.



Dams should also be recorded as stream crossing features. Measure dam heights, if you can.



Culvert being blocked by large vegetation established on in-stream bar formations.



While tempting, we do not encourage field crews to walk through long, dark culverts.

more). You should assign a **blockage severity** score for the crossings (one to five, where five is the most severe blockage). The SC form contains criteria to help you rate the severity of the potential blockage.

The SC form also asks you to determine whether the culvert serves as **grade control**, meaning that the bottom of the culvert controls the invert or bottom elevation of the stream. A grade control often acts to prevent upstream channel incision, and stops the upward migration of nick points. If you see a vertical drop in water elevation at the downstream end of the culvert (a little waterfall), this often signals that the culvert could be acting as grade control for stream erosion (Figure 37). It is helpful to understand grade control in stream restoration and fish passage design to predict what might happen to stream channel dynamics if a culvert is repaired or replaced.



**Figure 35: Minor Culvert Repair**
*Example of where culvert repair may be needed in combination with buffer planting and storm water control.*
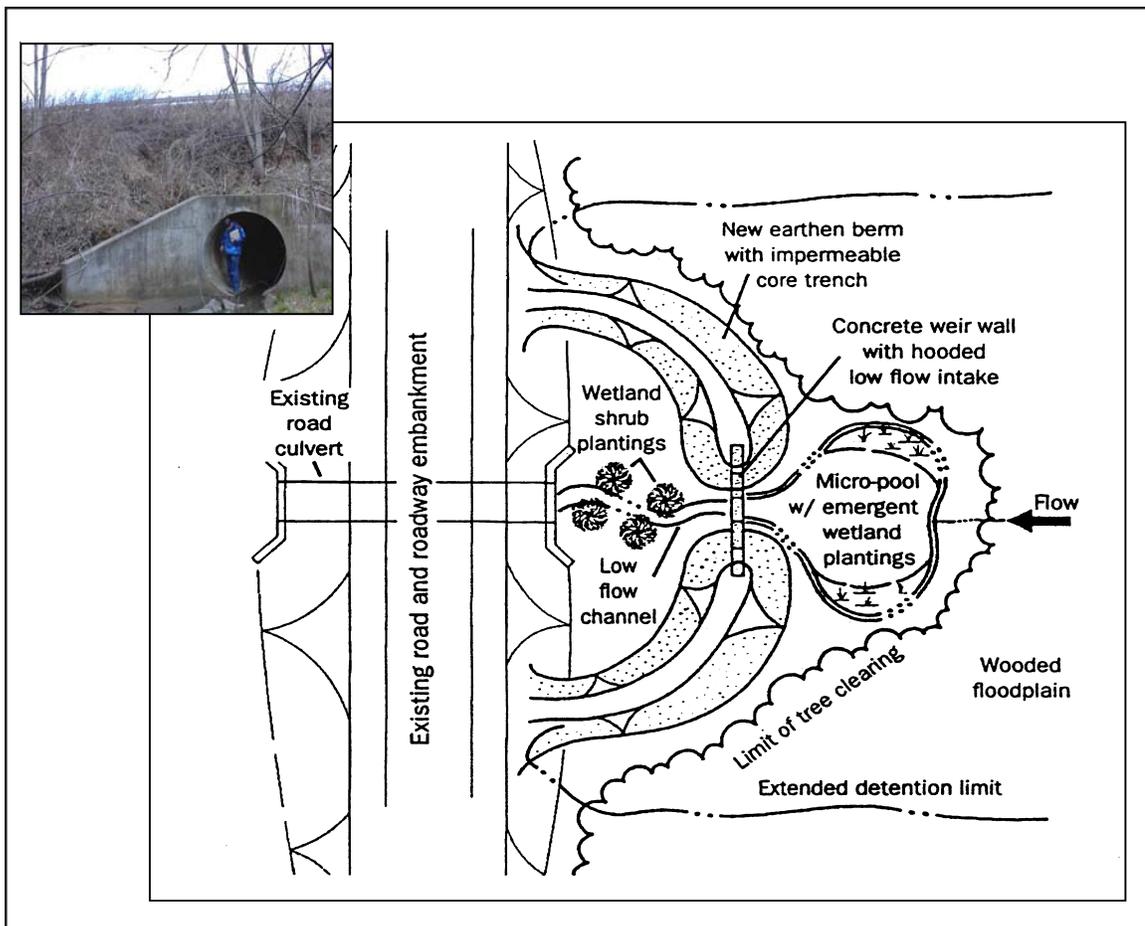


**Figure 36: Schematic of Upstream Storage Retrofit**
*This retrofit was proposed for a highway culvert, which is pictured at top left.*

## 8.3 What Stream Crossings Should I Record?

You should try to assess all man-made or natural structures that cross the stream, such as road culverts, railroad crossings, dams, or natural falls that create a change in grade or elevation in the stream. Exceptions include sewers or other utility crossings, which are evaluated using the UT field form (see Chapter 6), and channelized stream sections longer than 100 feet, which are separately assessed by the Channel Modification (CM) field form (see Chapter 9). Overhead crossings that appear to have minimal impact on the stream corridor can be skipped.

## 8.4 Field Assessment Tips

Some tips for assessing stream crossings in the field are offered below:

- Be careful investigating culverts. Do not enter them unless you can clearly see through to the other side AND enough light is available for walking.
- Be on the look out for outfalls inside culverts.
- Many culverts and other crossings lack enough capacity to pass floodwaters; you can often observe this if you see a lot of sediment deposition, debris jams, or slack or standing water upstream of the culvert.
- Since road crossings may often be your end/start points for survey reaches, make sure to track them on the downstream reach level assessment form (RCH).
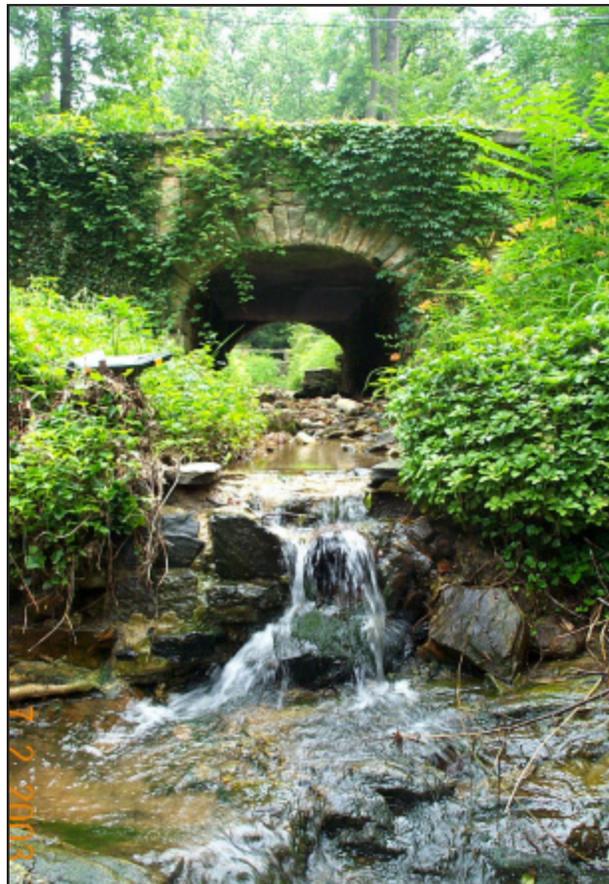


**Figure 37: Grade Control and Potential Fish Barrier**
*This vertical drop indicates that the structural crossing may serve as a grade control feature along this reach.*

| Table 22: How SC Data Can Be Used | |
|---|---|
| Problem Assessed | Fish barriers<br>Stream interruption<br>Potential upstream storage retrofit<br>Scour/erosion below crossing<br>Lack of capacity to pass floodwaters |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Fish barrier removal projects (R-30)<br>Culvert repair/replacement sites (R-28/29)<br>Upstream storage retrofit sites (SR-1/2)<br>Local stream repair (R-3 to R-21) |
| Stream Corridor Metric | Stream interruption (crossings/mile)<br># of potential retrofit crossings |
| Output for Planning | Map of potential fish barriers<br>Map of upstream storage retrofits<br>Map of grade control structures<br>Culvert dimensions for flooding analysis |
| *The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series.*<br>• *SR- sheets can be found in Manual 3: Storm Water Retrofit Practices*<br>• *R- sheets can be found in Manual 4: Stream Repair Practices* | |

## 8.5 Using SC Data in Subwatershed Restoration

Stream crossing (SC) data can support restoration planning by identifying problem crossings, generating a candidate list of culvert retrofit practices, developing metrics of stream interruption, and generating fish barrier maps (Table 22). SC data can help you decide how stream crossings impact your subwatershed and how they can be managed to better promote the passage of fish and floodwaters.

## 8.6 Example SC Form

The SC form asks you to record basic information on the location, dimensions, condition, and restoration potential of each stream crossing. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Stream Crossing **SC**

| WATERSHED/SUBSHED: Smiley Run | DATE: 3 / 10 / 03 | ASSESSED BY: AVK, GWB |
|---|---|---|
| SURVEY REACH ID: 102-1 | TIME: 10:15 AM/PM | PHOTO ID: (Camera-Pic #) A #09 |
| SITE ID: (Condition-#) SC- 2 | LAT ___° ___' ___" LONG ___° ___' ___" LMK _____ | GPS (Unit ID) |

**A.**

**TYPE\*:** ☑ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

**FOR ROAD/ RAILROAD CROSSINGS ONLY**

| SHAPE: | # BARRELS: | MATERIAL: | ALIGNMENT: | DIMENSIONS: (if variable, sketch) |
|---|---|---|---|---|
| ☐ Arch ☐ Bottomless<br>☑ Box ☐ Elliptical<br>☐ Circular<br>☐ Other: | ☑ Single<br>☐ Double<br>☐ Triple<br>☐ Other: | ☑ Concrete<br>☐ Metal<br>☐ Other: | ☑ Flow-aligned<br>☐ Not flow-aligned<br>☐ Do not know | Barrel diameter: 12 (ft)<br>Height: 12 (ft) |

| CONDITION: (Evidence of...) | CULVERT SLOPE: | Culvert length: 48 (ft) |
|---|---|---|
| ☐ Cracking/chipping/corrosion ☐ Downstream scour hole<br>☐ Sediment deposition ☐ Failing embankment<br>☐ Other (describe): No PROBLEMS | ☐ Flat<br>☐ Slight (2°–5°)<br>☐ Obvious (>5°) | Width: 12 (ft)<br>Roadway elevation: 24 (ft) |

**B.**

**POTENTIAL RESTORATION CANDIDATE** ☑ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit

☐ no ☐ Local stream repair ☐ Other:

**IS SC ACTING AS GRADE CONTROL** ☐ No ☐ Yes ☑ Unknown

**If yes for fish barrier**

**EXTENT OF PHYSICAL BLOCKAGE:**
☑ Total ☐ Partial
☐ Temporary ☐ Unknown

**CAUSE:**
☐ Drop too high Water Drop: _____ (in)
☑ Flow too shallow Water Depth: < 2 (in)
☐ Other:

**BLOCKAGE SEVERITY:** (circle #)

| A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present. | A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish. | A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls. |
|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**C.**

**NOTES/SKETCH:**

No MAINTENANCE PROBLEMS, NO BLOCKAGE – JUST REALLY SHALLOW, FAST FLOW

ROAD

RIP RAP

REPORTED TO AUTHORITIES ☑ YES ☐ NO

## How the Example SC Form Was Completed

### Part A

Field crews in this example assessed a stream crossing in the Smiley Run subwatershed at survey reach 102-1. They took a single photo of the crossing, which happened to be the second crossing they encountered during the stream walk.

### Part B

In this part of the form, the field crew classified the road crossing as a single box culvert that was flow-aligned and showed no signs of sediment deposition or bank erosion. The crew did not observe a downstream scour pool at this location.

### Part C

The field crew considered the crossing to be a potential fish barrier because flow depths were extremely shallow (less than two inches). The crew rated the blockage severity as moderate, given that the culvert was located on a small stream. No maintenance problems were observed.

# Chapter 9: Channel Modification (CM)

This part of the USA examines the extent to which stream channels are modified within the urban stream corridor. Examples of channel modifications include channelization, bank armoring, channel lining, and flood plain encroachment. During the channel modification (CM) assessment, you will be specifically looking for channel segments that may need structural repair or present opportunities for a more natural stream channel design.

## 9.1 About Channel Modification

Many urban stream segments have been historically modified to safely convey floodwaters, maintain a stable channel, restrict channel migration, or realign channels around property or infrastructure. The basic engineering approach is to "design" a new channel or flood plain with less roughness (e.g., boulders, vegetation, large woody debris, meander bends), greater slope, and expanded cross-sectional area to pass floodwaters more quickly and efficiently. As a consequence, some urban streams are converted into straight channels that are often lined with concrete to reduce roughness. In other streams with little

room for channel migration, banks are often fixed in place by armoring them with rip-rap and rock. In other situations, the capacity of the flood plain to accommodate floodwaters has been structurally altered by filling, dikes, or other measures.

In the most extreme instances, streams are entirely enclosed in underground pipes or extended culverts (note: this category of channel modification is already assessed in the USA by the SC form). Both stream and riparian habitat can be degraded or eliminated by channel modifications, and in some cases, fish passage may also be prevented. Newer, more environmentally-sensitive channel design may be a viable option to restore some natural features within modified channels. Figure 38 illustrates some of the typical channel modifications you may encounter during the USA.

Channel modifications are included in the USA survey for several reasons:

● *Stream Interruption:* An understanding of channel modification gives you a sense of the degree of stream interruption in your subwatershed. This factor is extremely



**Figure 38: Types of Channel Modifications You May Encounter**
*Various types of modified streams include a concrete channel and flood plain (Panel A), a concrete-lined channel (Panel B), and a straightened, armored stream segment (Panel C).*

---

**Questions to ask when assessing channel modifications:**

How severely is this modification affecting stream corridor habitat?

What is the length and purpose of the modification?

Can softer bank stabilization methods be used?

Can more natural channel design be employed?

---

important to determine where stream restoration projects make sense across the entire stream corridor.

- *Channelization:* In some instances, channelized segments of the stream network are candidates for restoration using techniques such as de-channelization, natural channel design, and baseflow channel creation. Also, if the CM form suggests armoring or other stabilization techniques are failing, it may be a good opportunity to replace them with bioengineering techniques (Manual 4).

- *Habitat Degradation*: The CM form quickly identifies the portion of the urban stream network where stream or riparian habitat has been degraded or eliminated by channel modification.

- *Tracking Stream Bank Armoring*: While some communities have been stabilizing banks for decades, institutional knowledge of these project locations may have been lost. The CM form can help generate a map of these repair/ restoration locations.

## 9.2 Introduction to the CM Form

This section introduces you to the channel modification (CM) assessment form. The form asks you to record basic data on the length and nature of the channel modification, and determine whether it might be a candidate for possible restoration. This section describes the four parts of the CM form, and provides guidance on how to complete each one. Appendix A provides a blank version of the CM form. A completed example CM form is included at the end of this chapter in Section 9.6,

along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the CM form contains general header information that locates where the modified channel section is in the survey reach.

As always, the header should be modified to reflect your reach and site labeling system. If you are using a GPS unit, record the beginning and ending coordinates for each channel segment, and remember to note the **GPS unit ID #** and an **LMK** number. If the modified section is shorter than 50 feet long, GPS units cannot calculate an accurate length. Instead, measure these sections by pacing or with a tape measure. Depending on how extensively channels have been modified in the subwatershed, you may want to skip these short sections altogether.

The next part of the CM form asks you to describe the type of channel modification and the dominant material that comprises it.

Four basic options are available. **Channelization** refers to a channel that has been excavated and straightened to eliminate natural meanders and bends. **Bank armoring** consists of an extended length of bank protected by hard stabilization measures, such as rip-rap, gabions, rock, or retaining walls. Armoring can occur on one or both banks and should only be recorded if it extends more than 50 feet. **Concrete channels** should be checked on the CM form if the natural stream or banks have been replaced with concrete lining that extends more than 50 feet. Lastly, **flood plain encroachment** should be checked if you see obvious signs of earth fill, levees, or dikes in

the flood plain or stream corridor. Note that more than one type of channel modification can occur in each segment. If only one bank is affected by the modification, indicate this in the notes section on the CM form. Table 23 illustrates a number of common channel modifications you may encounter in the field.

Next, assess the condition of the channel, and note any perennial flow, sediment deposition, vegetative growth, or apparent connection with the flood plain. Each of these conditions provides useful clues about sediment and flow dynamics through the modified channel. You should also measure the basic dimensions of

the channel modification, take a photo, and draw a rough sketch.

The next part of the CM form asks you to assess the nature of the stream corridor adjacent to the channel modification and the current baseflow channel segment. Both factors are crucial to determine if natural channel design may be suitable for the channel segment.

You should estimate the "**available**" width of the adjacent stream corridor on both sides of the channel. Available means open ground, with no obvious structures or utilities present.

| Table 23: Channel Modifications to Note During Site Assessment | | |
|---|---|---|
| At crossings, only record on CM form if modification extends at least 100 feet up or downstream. | Measure the width of the channel bottom. If there is perennial flow, measure the water depth. | Channelized and concrete-lined segment that maintains good connectivity with the flood plain. |
| Sediment deposits and algal growth on bottom of a concrete-lined channel. | Rock revetments should be recorded as bank armoring. | Imbricated rip-rap used for bank stabilization; Record if 50 feet or longer. |
| Gabion baskets used to stabilize a stream bank. | Highly urban subwatersheds frequently have most of their surface streams piped. | Exposed portion of an enclosed stream in a commercial area. |

Also, note if any earthen fill, dikes, or levees occur in the adjacent stream corridor, which could constrain flood plain capacity. Lastly, you should examine the **baseflow channel**, noting the average depth of flow, and the fraction of the channel bottom over which it flows. Check to see if there is a defined low-flow channel, and record its average depth of flow.

The last part of the CM form asks you to recommend whether the modified channel might be a candidate for structural repair, more natural channel design, or fish barrier removal. Consult profile sheets R-5 to R-15, R-25, R-30, S-32, and S-33 in Manual 4 to familiarize yourself with these stream restoration techniques. If you don't feel comfortable making a restoration recommendation, simply check the "Can't tell**"** box. The CM form provides some guidance on how to score the overall **severity** of channel modification on a scale of one to five (five being the most severe). Figure 39 illustrates modified channel segments that should be considered restoration candidates.

## 9.3 Which Modified Channels Should I Record?

Most urban streams are extensively modified over much of their length, so only record "hard" channel modifications longer than 50 feet. Do not record channel modifications that are immediately associated with structured stream crossings unless they extend 100 feet above or below the crossing. "Soft" bank stabilization practices should not be counted.

## 9.4 Field Assessment Tips

Some quick tips for evaluating channel modifications in the field are provided below:

- To reduce the number of forms you will need to complete, only record channel modifications that are at least 50 feet long.
- Also, you only need to record channel modifications associated with stream crossings if they extend at least 100 feet upstream or downstream of the crossing.
- Keep in mind that channel modifications can occur on the bed, banks, and flood plain of the stream corridor.
- If a channel modification extends on both sides of a road crossing that is used as a survey reach boundary, make sure to extend the survey reach to include the entire modified channel.
- Enclosed sections or extended culverts are picked up on the SC form and should not be recorded on the CM form.



**Figure 39: Restoration of Channelized Stream Segments**
*Candidate site for structural repair (Panel A) and natural channel restoration (Panel B).*

| Table 24: How CM Data Can Be Used | |
|---|---|
| Problem Assessed | Stream interruption<br>Channelization<br>Habitat degradation |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Baseflow channel creation (R-25)<br>Natural channel design (S-32)<br>De-channelization (S-33) |
| Stream Corridor Metric | Channelized length<br>Channelized length per stream mile |
| Output for Planning | Map of potential fish barriers<br>Map of channelized sections<br>Map of potential de-channelization projects<br>Map of grade control structures |
| *\*The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series. R- and S- sheets can be found in Manual 4: Stream Repair Practices* | |

## 9.5 Using CM Data in Subwatershed Restoration

Channel modification (CM) data can be used in several ways for restoration planning. CM data can be used to measure stream interruption, generate a list of stream restoration practices, develop stream channelization and habitat metrics, and generate planning maps (Table 24). CM data can help you decide whether channel modifications are a significant problem in the subwatershed and how important channel restoration should be in the overall restoration plan.

## 9.6 Example CM Form

The CM form asks you to record basic data on the length and nature of the channel modification, and determine whether it might be a candidate for possible restoration. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Channel Modification **CM**

**A.**

| WATERSHED/SUBSHED: SMILEY RUN | | DATE: 3 /10 /03 | ASSESSED BY: ACK +HE |
|---|---|---|---|
| SURVEY REACH ID: 102-1 | TIME: 10 :25 AM/PM | PHOTO ID: (Camera-Pic #) A /# 08 | |
| SITE ID: (Condition-#) CM-__1 | START LAT ___°___'___" LONG ___°___'___" LMK ____ | GPS: (Unit ID) | |
| | END LAT ___°___'___" LONG ___°___'___" LMK ____ | | |

**B.**

TYPE: ☒ Channelization  ☒ Bank armoring  ☐ concrete channel  ☐ Floodplain encroachment  ☐ Other:

| MATERIAL: | | DIMENSIONS: | |
|---|---|---|---|
| ☐ Concrete  ☐ Gabion ☒ Rip Rap  ☐ Earthen ☐ Metal ☐ Other: | Does channel have perennial flow? ☒ Yes ☐ No | Height ____6.5____ (ft) | |
| | Is there evidence of sediment deposition? ☐ Yes ☒ No | Bottom Width ____8.0____ (ft) | |
| | Is vegetation growing in channel? ☐ Yes ☒ No | Top Width: ____15.0____ (ft) | |
| | Is channel connected to floodplain? ☐ Yes ☒ No | Length: ____150____ (ft) | |

**C.**

BASE FLOW CHANNEL
Depth of flow ____10____ (in)

Defined low flow channel? ☒ Yes ☐ No

% of channel bottom ____70____ %

ADJACENT STREAM CORRIDOR
Available width  LT ___50___ (ft)  RT ___100___ (ft)

Utilities Present?          Fill in floodplain?
☒ Yes ☐ No                ☐ Yes ☒ No

**D.**

POTENTIAL RESTORATION CANDIDATE  ☐ Structural repair  ☐ Base flow channel creation  ☐ Natural channel design  ☐ Can't tell
☒ no  ☐ De-channelization  ☐ Fish barrier removal  ☐ Bioengineering

| CHANNEL-IZATION SEVERITY: (Circle #) | A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel. | A moderate length ( > 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel. | An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area. |
|---|---|---|---|
| | 5 | 4            3 | ②            1 |

NOTES: Bottom of CHANNEL IS NATURAL — JUST BANKS HAVE BEEN STRAIGHTENED AND ARMORED DOWNSTREAM OF ROAD CROSSING — SEEMS A BIT EXCESSIVE — NOT MUCH REST. POTENTIAL

## How the Example CM Form Was Completed

### Part A
In this example, the field crew assessed an armored stream section in the Smiley Run subwatershed in survey reach 102-1, and took a single photo at this location.

### Part B
The field crew evaluated a channel segment armored with 150 feet of rip-rap on both banks as part of a past bank stabilization project. The channel had perennial flow, but showed no signs of deposition or vegetative growth in the channel, which also did not appear to be connected to the flood plain.

### Part C
In this part of the form, the field crew observed a defined low flow channel. Flow was approximately 10 inches deep and took up most of the width of the channel. Exploring the adjacent flood plain area, the field crew observed no fill or excavation activities, though utilities did interrupt the stream corridor on the left bank.

### Part D
The field crew assigned this segment a low severity rating due to its natural channel bottom and relatively short distance of modification. They were unable to envision a particular type of restoration at the site.

# Chapter 10: Miscellaneous Features (MI)

The miscellaneous features (MI) form is used to track any unusual impact or notable feature encountered during the stream walk that cannot be assessed using any of the other impact forms. Specifically, the MI form is used to record high quality habitats or rare biota in the stream corridor, grade controls that could influence stream restoration, disturbances in the stream corridor, or in-stream water quality problems that may warrant further investigation.

## 10.1 About Miscellaneous Features

When walking a stream, you inevitably encounter features that may be important for restoration planning but do not conveniently fit into the other seven impact forms. You can either choose to note these features on the overall RCH form, or you can track them on the MI form to ensure that they are included in restoration planning. For example, you may want to track the locations of high quality habitats such as emergent wetlands, or disturbances to the stream corridor due to construction, excavation, and livestock access. You may also want to record in-stream water quality problems not visibly associated with storm water outfalls, or any other features you feel are important. Miscellaneous features should be considered in the context of stream corridor restoration potential and how they might relate to discharge prevention, riparian management, stream restoration, and storm water retrofit strategies. Table 25 illustrates some miscellaneous features worth tracking during the USA.

Miscellaneous features are included in the USA for several reasons:

- The protection or restoration of **high quality habitats** or rare species found in the stream corridor can be an important element of a subwatershed restoration plan. Presence of vernal pools, wetlands, rookeries, rare or threatened mussel or plant communities, or specimen trees should be noted.
- **Construction activities** within the stream corridor that lack proper erosion and sediment controls, violate tree clearing regulations, or fail to meet flood plain standards should be referred for immediate enforcement.
- Natural **grade controls** such as rock outcrops, bedrock, or waterfalls help fix the elevation of the streambed, and can control stream channel processes.
- Algal blooms, fish kills, turbid water, oil sheens, and other **water quality** problems should be noted, particularly if they are not associated with a leaking pipe or outfall. If water quality problems are severe, you may want to follow up with monitoring investigations at all upstream outfalls.
- If you encounter any **stream gauges** or **sampling stations**, you should record their location on the MI form and remind yourself to track down the data when you get back to the office. Current or historic monitoring stations should always be considered when picking locations for future sentinel monitoring stations.
- **Cattle access** or other livestock crossings can cause water quality problems and damage both stream habitat and riparian buffers. If livestock are causing severe problems, bank stabilization, exclusionary fencing, or alternative water sources may be worth exploring.

**Table 25: Examples of Miscellaneous Stream Corridor Features**



Excavation, dumping, or construction activities in the stream corridor may require enforcement.



Unstructured crossings such as culvertless roads, ATV trails, or gravel livestock crossings.



Failed erosion and control practices causing sediment loading into stream.



Cattle in the stream can contribute to water quality, stream habitat, and riparian degradation.



Stream gauges or other features denoting repeat sampling or monitoring locations.



Water quality problems like excessive algae, fish kills, or sediment plumes.



Unusual deposits not associated with an immediate source.



Special natural areas, such as wetlands, heron rookeries, and vernal pools.



Specimen trees or rare plant or animal species found within stream corridor.



Log jams that may create flooding or erosion problems.



Grade control features such as exposed bedrock, rock outcroppings, or water falls.



Stream sinks or sources, particularly in karst areas where caves and sinkholes are common.

## 10.2 Introduction to the MI Form

The miscellaneous feature form (MI) is used to track stream and flood plain features that don't fit into one of the other seven impact forms or the overall RCH assessment. Simply note basic data on the location of your feature on the MI form, and a brief description of any potential restoration recommendations. Appendix A provides a blank version of the form. A completed example MI form is included at the end of this chapter in Section 10.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

## 10.3 What Features Should I Record?

This is the catch-all form for recording unusual features that you want to track, but aren't sure where to record them. Include any features you want on the MI form, but make sure that the feature relates to your overall restoration goals.

## 10.4 Field Assessment Tips

The following tips should help you use the MI form:

- If you end up reporting a lot of the same kinds of features on your MI form (such as livestock crossings), consider developing a new impact form to specifically evaluate that feature.
- Waterfalls or other hard features that provide a fixed location for change in vertical elevation (at least two feet) should be recorded (excluding pipes, stream crossings, or modified channels).

- Nickpoints, where softer substrates are actively eroding, should be recorded on the ER form.
- If you see water quality impairments, look around for outfalls, pipes, or other potential sources.
- Construction activity associated with a known stream restoration project need not be recorded.
- Note the presence of log and debris jams, particularly if they could clog or block downstream road crossings.
- Document as much information as possible about suspicious activities, and take photos, which are extremely helpful to support local enforcement measures.
- Write down whatever information you can ascertain from stream gauges or monitoring station markers.
- Don't forget about these miscellaneous features during data analysis and review.

## 10.5 Using MI Data In Subwatershed Restoration

Miscellaneous stream data can be used in a number of ways. Depending on the feature, you can identify locations for natural area protection, or generate a list of potential enforcement actions or upstream discharge investigations. MI data can also be used to develop stream corridor metrics and generate planning maps (Table 26). This information can supplement data collected during the impact and overall RCH assessment and can provide additional perspective on restoration opportunities within the stream corridor.

| Table 26: How MI Data Can Be Used | |
|---|---|
| Problem Assessed | Wetlands and natural area remnants<br>Land disturbance and erosion<br>Livestock access/hobby farms<br>Fish kills, water quality problems |
| Potential Restoration Practice<br>*(Manual Profile sheets)* | Riparian wetland restoration (F-8)<br>Enforcement (E-1)<br>Exclusionary fencing, alternative water source<br>Discharge prevention (D1-D12)<br>Grade controls (R-18 to R-21) |
| Stream Corridor Metric | # of natural area remnants<br># livestock access points per stream mile<br># of log jams, grade controls, etc |
| Output for Planning | Map of potential natural area remnants<br>Map of grade controls, log jams, etc<br>Water quality problem map<br>Monitoring station location map |
| *\*The code in parentheses refers to the appropriate restoration profile sheet in the Restoration Manual Series.*<br>• *R- sheets can be found in Manual 4: Stream Repair Practices*<br>• *F- sheets can be found in Manual 5: Riparian Management Practices*<br>• *E- sheets can be found in Manual 9: Municipal Practices and Programs* | |

## 10.6 Example MI Form

The MI form is used to track stream and flood plain features that don't fit into one of the other seven impact forms or the overall RCH assessment. A detailed explanation of how the field crew filled out each section of this example form is included.

**A.**



### How the Example MI Form Was Completed

#### Part A

The field crew came across a cattle access point in this example. Cows in the stream can contribute to water quality impacts, as well as damage to in-stream habitat and riparian conditions. Field crews took a picture of the culprit and suggested the location as a potential riparian and stream restoration candidate.

# Chapter 11: Overall Conditions in the Survey Reach (RCH)



The reach assessment form (RCH) collects overall information about each channel and corridor conditions in the survey reach. The RCH form evaluates overall conditions such as average bank stability, in-stream and riparian habitat, and flood plain connectivity across the survey reach. In addition, the RCH form is used to track and locate any of the eight individual impacts encountered along the survey reach. RCH data can be used to compare stream quality in reaches within a subwatershed, and is an important ingredient in stream and riparian restoration design.

## 11.1  About the Survey Reach

While it is important to track individual problem sites, you also want to gain an understanding of the overall physical conditions along the entire stream corridor. The physical condition and restoration potential of survey reaches varies along the stream corridor, as shown in Figure 40. The RCH assessment helps identify the highest quality, most impacted, or most restorable stream reaches in your subwatershed. It can also be used to screen reaches for potential restoration.

Much of the RCH assessment draws heavily from the EPA's Rapid Bioassessment Protocol for Habitat (Barbour *et al.*, 1999).

The RCH assessment is designed to track individual problem sites along the stream corridor, and to rapidly measure habitat conditions over discrete segments of the stream corridor, termed **survey reaches**. Field crews should sketch each survey reach, record average channel dimensions, and assess the general stream channel, water column, and flood plain characteristics. Numeric scores are assigned to each survey reach based on the quality of habitat, bank stability, and flood plain conditions. Total scores are then used to compare survey reaches across the subwatershed.

Since field crews must assign an "average" value, try to ensure that each survey reach is fairly uniform in character. Survey reaches are initially delineated before going out into the field, but field crews can and should modify delineations to reflect on-the-ground conditions. Desktop procedures for delineating and naming survey reaches are detailed in Chapter 2.



**Figure 40: Range of Survey Reach Conditions**
*Narrow, forested stream corridors, with few discharge or erosion problems may offer sufficient in-stream habitat and little restoration potential (Panel A). Impacted reaches on institutional or public lands may be great opportunities for restoration and education (Panel B). Restoration in highly impacted reaches with significant infrastructure can be very expensive (Panel C).*

## 11.2 Introduction to the RCH Form

This section introduces the reach assessment form (RCH) used to evaluate the average condition of each survey reach in your subwatershed. The RCH form has three parts:

A. General header
B. Average physical condition
C. Quantitative evaluation of eight stream corridor habitat parameters

This section describes each part of the RCH form, and presents guidance on how to complete it. Appendix A includes a full version of the RCH form. A completed example RCH form is included at the end of this chapter in Section 11.6, along with detailed explanations to help clarify how the field crew filled out each section of the form.

The first part of the RCH form contains general header information. The header should be modified to reflect your reach labeling system. If the reach starts or ends at a road crossing or other notable landmark, include a general **description** of it (e.g., at the HWY 21 bridge, the Piggly Wiggly, or behind Linglestown elementary school). You are also asked to document past and current **weather conditions**, since recent storm events can influence stream flow conditions, sediment scouring and deposition, and water clarity. In addition, record the most prevalent land use(s) adjacent to your survey reach. If you take a photo of the reach, record the photo number in the notes section of your RCH form.

The next part of the RCH form has two columns. The first column asks you to record the physical features of the channel and water column, and evaluate access to the stream corridor for potential restoration projects. The second column asks you to draw a sketch of the survey reach, which includes major structures affecting the stream or flood plain, as well as the locations of each problem or impact site evaluated in the survey reach. This sketch also serves as a quick visual reference to help you track the location of impact forms.

The physical condition of the stream reach is defined by nine parameters. **Baseflow percentage** refers to the fraction of the stream bottom width covered by the baseflow channel, sometimes known as the wetted width. The **dominant substrate** reflects the predominant inorganic particle size found on the streambed observed throughout the channel (sand, gravel, cobble, etc). Field crews should also note the general **clarity** of the water column before they enter the stream. **Stained** generally refers to a reddish or brownish color often associated with tannic acids (think of iced tea). **Turbid** refers to cloudy water containing suspended silt or organic particles. Algae, suspended solids, dyes, or chemical discharges may also cause poor water clarity.

Excessive nutrient loading can often cause excessive growth of **aquatic plants** and algae, and field crews should note the presence of attached and floating plants in the streambed. As an example, the presence of stringy or clumps of floating algae can be a sign of an unhealthy stream. Look for evidence of **wildlife** in the stream corridor, such as beaver and deer that could harm potential riparian restoration projects. The percentage of **stream shading** by overhead tree canopy is an important factor, since it influences large woody debris and stream temperature. Crews are also asked to determine overall **channel processes** (e.g., aggradation, degradation) and record average channel dimensions (bank heights, channel widths) observed within the survey reach. Consult Chapter 4 for a review of channel processes and guidance on how to measure stream channel dimensions. Many of these stream features are illustrated in Table 27.

The third part of the RCH form asks you to evaluate eight parameters that rate the quality of stream and riparian habitat.

**Habitat parameters** are classified as optimal, suboptimal, marginal, or poor condition, and are assigned a score ranging from zero to 20 (with 20 being the most pristine stream corridor condition observed in your region). The RCH form combines habitat and streambank parameters from Barbour *et al.* (1999) with additional questions on flood plain

## Table 27: Characterizing the Survey Reach

| | | |
|---|---|---|
|  Base flow width taking up less than 50% of the channel width |  Baseflow width taking up 100% of the channel width |  Sand as the dominant surface substrate |
|  Gravel (0.1-2.5") as the dominant substrate |  Cobble (2.5-10") as the dominant channel substrate |  Opaque water clarity |
|  Rooted aquatic vegetation |  Attached algae |  Floating aquatic plants |
|  Evidence of beaver activity |  Visual evidence of fish in stream |  An unshaded (<25%) stream reach |
|  A mostly shaded (>75%) stream reach |  Field crew assessing channel dynamics in reach |  Field crew measuring top width of stream channel |

features, to characterize overall stream corridor conditions. The first four habitat parameters focus on stream channel conditions, and the next four relate to riparian areas outside the channel. Together, the maximum score for all eight habitat parameters is 160 points (which represents the highest quality stream conditions for your region). Few urban streams will score this well. The composite habitat score for a survey reach should always be evaluated <u>relative</u> to the other survey reaches in your subwatershed.

General criteria for scoring habitat parameters are included on the RCH form. Barbour *et al.* (1999) also provides more illustrations on how to evaluate habitat parameters in the field.

To determine **in-stream habitat quality**, think like a bug or a fish. Habitat structure includes riffles, boulders, large woody debris, undercut banks, and deep, stable pools, and provides locations to hide, eat, or breed. The more abundant and diverse habitat structures are, the better the habitat quality will be for aquatic insects and fish. Stream habitat criteria should be adopted to reflect the gradient of streams in the subwatershed. The criteria provided on the RCH form are geared towards high gradient streams that tend to have a wider diversity of substrate and available cover. Barbour *et al.* (1999) recommends reducing the habitat cover percentage thresholds in **lower gradient** streams to 50%, 30%, and 10% to define optimal, suboptimal, and marginal habitat conditions, respectively.

**Vegetative protection** should not be confused with vegetated buffer width. This habitat factor explicitly deals with the diversity and abundance of vegetation found on the face and top of stream banks. The roots and shoots of vegetation hold bank sediments together and can protect the bank from erosion. <u>Each bank should be evaluated separately.</u> Survey reaches with dense and diverse bank vegetation receive the highest score. **Vegetative buffer width**, on the other hand, measures the average width of the naturally-vegetated buffer on each side of the stream, and accounts for any impacts. You may choose to modify the buffer criteria to suit your local needs; generally, lawns and row

crops are not counted as natural cover. Reaches with a continuous, naturally-vegetated buffer at least 50 feet wide receive the highest score.

Average channel stability is determined by simultaneously assessing vegetative protection, bank erosion and flood plain connection. Field crews are asked to assess the general level of **bank erosion** occurring throughout the reach. Bank erosion is a natural process; however, hydrologic changes associated with urbanization often cause excessive erosion. Natural stream banks have gentle slopes, whereas many urban streams have steep, exposed banks and may exhibit signs of collapse and active scouring. Reaches exhibiting minimal erosion receive the highest score. Illustrations of actively eroding streams can be found in Chapter 4.

**Flood plain connection** examines the degree to which the steam and flood plain are hydrologically connected. Flood waters often spill into the flood plain in undeveloped streams. When this occurs, the energy of the flood water is effectively dissipated as it spreads over a wider area. Many urban streams become separated from their flood plain by downcutting or channel alteration. You can evaluate flood plain connection by checking to see if the stream has incised to the point that moderate flood events can no longer escape the channel. A connected system usually has short stream banks, which allow flood waters to move from the channel out into the flood plain. Look for signs of fresh sediment, water marks, and debris jams in the flood plain to confirm if the flood plain is connected. Streams where moderate flood flows can reach the flood plain receive the highest scores.

The next habitat parameters focus on flood plain vegetation, habitat, and encroachment. **Flood plain vegetation** helps to slow flood waters and promote sediment deposition, and is classified based on the dominant vegetative cover found on both sides of the stream corridor. Forest cover receives the highest score because bottomland forests slow flood waters to the greatest degree, and are valuable habitats for plant and wildlife species. Flood plains consisting of turf or crops have less

ability to slow flood waters and receive lower scores. A high scoring **flood plain habitat** consists of a diversity of wetland and non-wetland habitat types. Also look for standing/ponded water in the flood plain, which provides valuable habitat for amphibians and other animals. **Flood plain encroachment** asks you to determine the extent of encroachment in the flood plain by filling, land development, and/or man made structures. Try to assess encroachment from the perspective of how it alters the flood plain ability to pass extreme flood events. Higher scores are assigned to flood plains with a low percentage of encroachment over their length. Table 28 shows examples of how field crews can assess various types of survey reaches using the habitat parameters. Overall scores are totaled at the bottom of the form.

| Table 28: Diversity of Reach Conditions in Urban Subwatersheds | |
| --- | --- |
|  | **Stream Condition**<br>This survey reach has optimal in-stream habitat (large woody debris, undercut banks, deep pools); 100% vegetative protection on stream banks; no evidence of bank erosion; and is completely connected to its flood plain.<br><br>**Riparian/Flood plain Condition**<br>Both stream banks have wide, natural buffers; flood plain vegetation is bottomland forest and wetland meadow; no encroachment<br><br>Total Score 150-160 points |
|  | **Stream Condition**<br>Marginal in-stream habitat (very little stable structure); no vegetative protection on stream banks (due to removal of bank vegetation with chemical spray); no evidence of bank erosion (very little flow in these headwaters) and reach remains connected to its flood plain.<br><br>**Riparian/Flood plain Condition**<br>No natural buffer on either bank and has been highly impacted by landscaping practices. Dominant flood plain vegetation is turf grass; no evidence of standing water or wetland habitat. Because of small stream size, buildings and berms have probably not encroached significantly on flood plain function<br><br>Total Score 60-70 points |
|  | **Stream Condition**<br>Poor in-stream habitat (no structure); no vegetative protection on one side of stream (due to rip-rap); no evidence of bank erosion; and reach has been disconnected from its flood plain (road on one side, parking lot on other).<br><br>**Riparian/Flood plain Condition**<br>No natural buffer on either bank. Dominant flood plain vegetation is turf grass (where vegetated); no evidence of standing water or wetland habitat. Encroachment has significantly impacted flood plain function.<br><br>Total Score 30-40 points |

## 11.3 What Survey Reaches Should I Assess?

An RCH assessment form should be completed for every survey reach in the subwatershed. The initial desktop delineation of survey reaches should be modified by field crews to reflect conditions on the ground. For example, field crews may extend the length of a survey reach to accommodate an entire modified channel or impacted stream buffer, eliminate a survey reach that has been piped, or combine two similar reaches together.

## 11.4 Field Assessment Tips

Some field tips to keep in mind when performing an RCH assessment include the following:

- Use the tips for assessing erosion and inadequate buffers provided in Chapters 4 and 5, respectively.
- Determine left and right bank by facing downstream.
- One person on the field crew should be responsible for assessing flood plain parameters, while the other assesses the stream channel. Field crews should communicate frequently in order to quickly complete the RCH form.

- Don't waste your energy trying to agree on the exact numeric score for the eight stream corridor parameters, but focus instead on being consistent with respect to the general category into which the survey reach condition falls (e.g., optimal, suboptimal, marginal, poor).
- Don't waste time adding up the numbers in the field, you should do the math later, preferably during the debriefing meeting at the end of the day.
- Walk the entire survey reach before completing the assessment parts of the RCH form, although you should sketch the reach as you go.
- If you notice significant changes in reach conditions or an obvious break point, feel free to split your survey reach in two, but make sure to note these modifications on your field map.

| Table 29: How RCH Data Can Be Used in Restoration Planning | |
|---|---|
| Problem Assessed | Poor stream corridor habitat<br>Average stream bank erosion<br>Flood plain connectivity<br>Flood plain encroachment<br>Feasibility factors |
| Potential Restoration Practice | Tracking of all potential corridor restoration practices, with special emphasis on stream restoration and riparian management concepts |
| Stream Corridor Metric | Stream density (miles/sq. mi)<br># of problems/survey reach<br>Stream corridor habitat index<br>Stream bank erosion severity index<br>Access and other feasibility factors |
| Output for Planning | Average reach erosion map<br>Sediment loading estimates from bank erosion<br>Reach quality/prioritization map<br>Subwatershed screening |

## 11.5 Using RCH Data in Subwatershed Restoration

Reach assessment data can support restoration planning in several ways. Total habitat scores can be used to identify stream reaches of optimal or poor condition. Component indices of in-stream habitat condition can also be generated (Table 29). In addition, tracking access by survey reach allows you to examine the feasibility of restoration. RCH data is particularly useful to analyze possible options for stream restoration and riparian management across the survey reach, and scoping more detailed restoration investigations in the stream corridor.

## 11.6 Example RCH Form

The RCH form is used to evaluate the average condition of each survey reach in your subwatershed. A detailed explanation of how the field crew filled out each section of this example form is included on the next page.

Reach Assessment **RCH**

**A.**

| SURVEY REACH ID: *102-1* | WTRSHD/SUBSHD: *Smiley Run* | DATE: *3 / 10 / 03* | ASSESSED BY: *HCK, EWB* |
|---|---|---|---|

| START | TIME: *9:00* AM/PM | LMK: ____ | END | TIME: *10:30* AM/PM | LMK: ____ | GPS ID: |
|---|---|---|---|---|---|---|
| LAT __° __' __" LONG __° __' __" | | | LAT __° __' __" LONG __° __' __" | | | |
| DESCRIPTION: | | | DESCRIPTION: | | | |

| RAIN IN LAST 24 HOURS | ☐ Heavy rain | ☐ Steady rain | PRESENT CONDITIONS | ☐ Heavy rain | ☐ Steady rain | ☐ Intermittent |
|---|---|---|---|---|---|---|
| ☑ None | ☐ Intermittent | ☐ Trace | ☐ Clear | ☐ Trace | ☐ Overcast | ☑ Partly cloudy |

| SURROUNDING LAND USE: | ☐ Industrial | ☑ Commercial | ☑ Urban/Residential | ☐ Suburban/Res | ☐ Forested | ☐ Institutional |
|---|---|---|---|---|---|---|
| | ☐ Golf course | ☐ Park | ☐ Crop | ☐ Pasture | ☐ Other: | |

**B.**

**AVERAGE CONDITIONS** *(check applicable)*

**BASE FLOW AS %**
CHANNEL WIDTH
☐ 0-25%  ☐ 50%-75%
☐ 25-50 %  ☑ 75-100%

**DOMINANT SUBSTRATE**
☐ Silt/clay (fine or slick)  ☐ Cobble (2.5 –10")
☐ Sand (gritty)  ☐ Boulder (>10")
☑ Gravel (0.1-2.5")  ☐ Bed rock

**WATER CLARITY** ☑ Clear ☐ Turbid *(suspended matter)*
☐ Stained *(clear, naturally colored)* ☐ Opaque *(milky)*
☐ Other *(chemicals, dyes)*

**AQUATIC PLANTS IN STREAM**
Attached: ☐ none ☑ some ☐ lots
Floating: ☑ none ☐ some ☐ lots

**WILDLIFE IN OR AROUND STREAM**
*(Evidence of)*
☑ Fish ☑ Beaver ☐ Deer
☐ Snails ☐ Other:

**STREAM SHADING** *(water surface)*
☐ Mostly shaded (≥75% coverage)
☑ Halfway (≥50%)
☐ Partially shaded (≥25% )
☐ Unshaded (< 25%)

**CHANNEL DYNAMICS**
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☑ Unknown ☐ Sed. deposition ☐ Channelized

**CHANNEL DIMENSIONS** *(FACING DOWNSTREAM)*
Height: LT bank *3* (ft)
RT bank *3.5* (ft)
Width: Bottom *7.5* (ft)
Top *10* (ft)

**REACH ACCESSIBILITY**

| **Good:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. | **Fair:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. | **Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required. |
|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

NOTES: *(biggest problem you see in survey reach)*

**REACH SKETCH AND SITE LEVEL ASSESSMENT TRACKING**

*Simple planar sketch of survey reach. Track locations and IDs for all site level assessments within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow*



REPORTED TO AUTHORITIES ☐ YES ☐ NO

**C.**

## OVERALL STREAM CONDITION

| | Optimal | Suboptimal | Marginal | Poor |
|---|---|---|---|---|
| **IN-STREAM HABITAT** *(May modify criteria based on appropriate habitat regime)* | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| | 20  19  18  17  16 | 15  14  13  12  (11) | 10  9  8  7  6 | 5  4  3  2  1  0 |
| **VEGETATIVE PROTECTION** *(score each bank, determine sides by facing downstream)* | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| | Left Bank  10  9 | 8  7  6 | 5  (4)  3 | 2  1  0 |
| | Right Bank  10  9 | 8  7  (6) | 5  4  3 | 2  1  0 |
| **BANK EROSION** (facing downstream) | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. | Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. |
| | Left Bank  10  9 | 8  7  6 | 5  (4)  3 | 2  1  0 |
| | Right Bank  10  9 | 8  7  6 | (5)  4  3 | 2  1  0 |
| **FLOODPLAIN CONNECTION** | High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched. | High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. |
| | 20  19  18  17  16 | 15  14  (13)  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |

## OVERALL BUFFER AND FLOODPLAIN CONDITION

| | Optimal | Suboptimal | Marginal | Poor |
|---|---|---|---|---|
| **VEGETATED BUFFER WIDTH** | Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone. | Width of buffer zone 25-50 feet; human activities have impacted zone only minimally. | Width of buffer zone 10-25 feet; human activities have impacted zone a great deal. | Width of buffer zone <10 feet: little or no riparian vegetation due to human activities. |
| | Left Bank  10  9 | 8  7  (6) | 5  4  3 | 2  1  0 |
| | Right Bank  10  9 | 8  7  6 | 5  4  (3) | 2  1  0 |
| **FLOODPLAIN VEGETATION** | Predominant floodplain vegetation type is mature forest | Predominant floodplain vegetation type is young forest | Predominant floodplain vegetation type is shrub or old field | Predominant floodplain vegetation type is turf or crop land |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | (5)  4  3  2  1  0 |
| **FLOODPLAIN HABITAT** | Even mix of wetland and non-wetland habitats, evidence of standing/ponded water | Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water | Either all wetland or all non-wetland habitat, evidence of standing/ponded water | Either all wetland or all non-wetland habitat, no evidence of standing/ponded water |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  (8)  7  6 | 5  4  3  2  1  0 |
| **FLOODPLAIN ENCROACHMENT** | No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures | Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function | Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function | Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | (5)  4  3  2  1  0 |

**Sub Total** In-stream: __43__ /80    +    Buffer/Floodplain: __27__ /80    =    **Total** Survey Reach __70__ /160

## How the Example RCH Form Was Completed

### Part A

In this example, field crews performed an RCH assessment for reach 102-1 in the Smiley Run subwatershed. The survey reach started just downstream of the stormwater pond and ended at the 5th Avenue road crossing. It was partly cloudy during the assessment and no rain showers had occurred over the past 24 hours. Land use along this survey reach was predominantly commercial (right side) and high density residential (left side).

### Part B

The field crew indicated on this part of the form that base flow was clear and took up most of the eight-foot wide channel bottom. The most prevalent surface substrate was gravel, and attached algae were observed in the reach, but were not considered excessive. Field crews noted signs of deer and beaver along the reach, and indicated that trees along the banks shaded about half its length. The dominant channel process affecting the survey reach was unknown, and banks were less than four feet high. From the sketch, you can see that eight impact forms were completed in the survey reach (a stormwater outfall, bank erosion, impacted buffer, trash dump, two stream crossings with a modified channel, and an exposed utility). The field crew indicated that the top priority for restoration in this survey reach was stabilization of the eroding bank (ER-1) at the point where the utility line and manhole stack were exposed.

### Part C

Field crews determined that overall conditions for survey reach 102-1 were marginal, with flood plain conditions bringing the total score down (total score of 70).

# Chapter 12: Interpreting and Using USA Data in Subwatershed Restoration Plans

The USA generates a wealth of information to help define an initial stream corridor restoration strategy for your subwatershed. This chapter presents a series of methods to compile, organize and interpret your USA data. Six different methods can be used to translate USA data into effective upland restoration projects:

1. Basic Data Management and Quality Control
2. Simple Stream Corridor Project Counts
3. Mapping USA Data
4. Devising USA Metrics
5. Subwatershed and Reach Screening
6. Additional Stream Corridor Investigations

The choice of which method(s) to use depends on your local resources, restoration goals, and the actual problems and opportunities discovered in the stream corridor. In general, the most common stream corridor problems and opportunities will shape your initial subwatershed restoration strategy. This initial strategy outlines which candidate sites or reaches should be targeted for more detailed investigations for future restoration project design.

## 12.1 Basic Data Management and Quality Control

The USA produces an enormous amount of raw data to characterize stream corridor conditions. It is not uncommon to compile dozens and even hundreds of individual forms for a single subwatershed. The real trick is to devise a system to organize, process, and translate this data into simpler outputs and formats that can guide subwatershed restoration efforts. The system starts with effective quality control procedures in the field.

To start, organize field forms in a three-ring binder instead of the traditional clipboard, at least for the eight impact forms. A small **field binder** lets you quickly flip back and forth between the various forms you will be using during your stream walk. RCH sheets and photo tracking forms can be kept in one section and the impact assessment forms in another. Authorization letters and emergency contact lists can be tucked into the binder's front pocket.

Carry enough blank forms for the day's work; this will depend on the density and types of problem areas you expect to encounter. For example, if you anticipate having a lot of storm water outfalls and sewer lines in your subwatershed, take a lot of OT and UT forms with you. Blank USA field forms are provided in Appendix A. Feel free to double-side forms to minimize the number of copies you will need to make. Also, copying field sheets onto hole-punched paper saves time. If you use handheld computer devices (such as personal data assistants or PDAs) to record and store field data, you can save a lot of time and tedious data entry when you get back in the office.

At the end of each day, field crews should regroup at a predetermined location to compare notes. The crew leader should confirm that all survey reaches have been surveyed, discuss initial findings, and deal with any logistical problems. It is also a good time to check whether field crews are measuring and evaluating impact data in the same way, and are consistent in what they are (or are not) recording. Crew leaders should also use this time to review field forms for accuracy and thoroughness. Illegible handwriting should be neatened and details added to notes and sketches. Also, make sure that RCH sketches include all site impacts, and that reach IDs, GPS waypoints, and photo numbers are properly cross-referenced.

The crew leader should also organize the forms together into a single **master binder** for future analysis. This binder should be divided into nine sections, one for RCH forms, and eight for the impact forms. If you are using photo tracking forms, then you will need an additional section in the master binder. Blank field sheets should be added to the field binders at this time.

Once you return from the field, data should be entered into a spreadsheet or directly into GIS. Spreadsheets are probably the easiest method to sort USA data. Appendix B provides a specially-modified Microsoft Access database, which can be used to input and organize your USA data. Access allows you to enter data into forms that look like the field sheet and can link databases by survey reaches (Figure 41).

Spreadsheet data can also easily be imported into GIS for mapping purposes. The GIS system will create its own database table that allows you to create subwatershed maps showing reach quality, problem areas, and candidate restoration sites.

Once data entry is completed, you should be sure to check the quality of USA data by randomly spot-checking 10% of entered data. For example, if you had 100 field forms, check 10 of the spreadsheet entries. Once data can be transferred into GIS, **quality control maps** should be created that display labeled problem sites and survey reaches color coded by total habitat score. Each member of the field crew should review the accuracy of quality control maps.
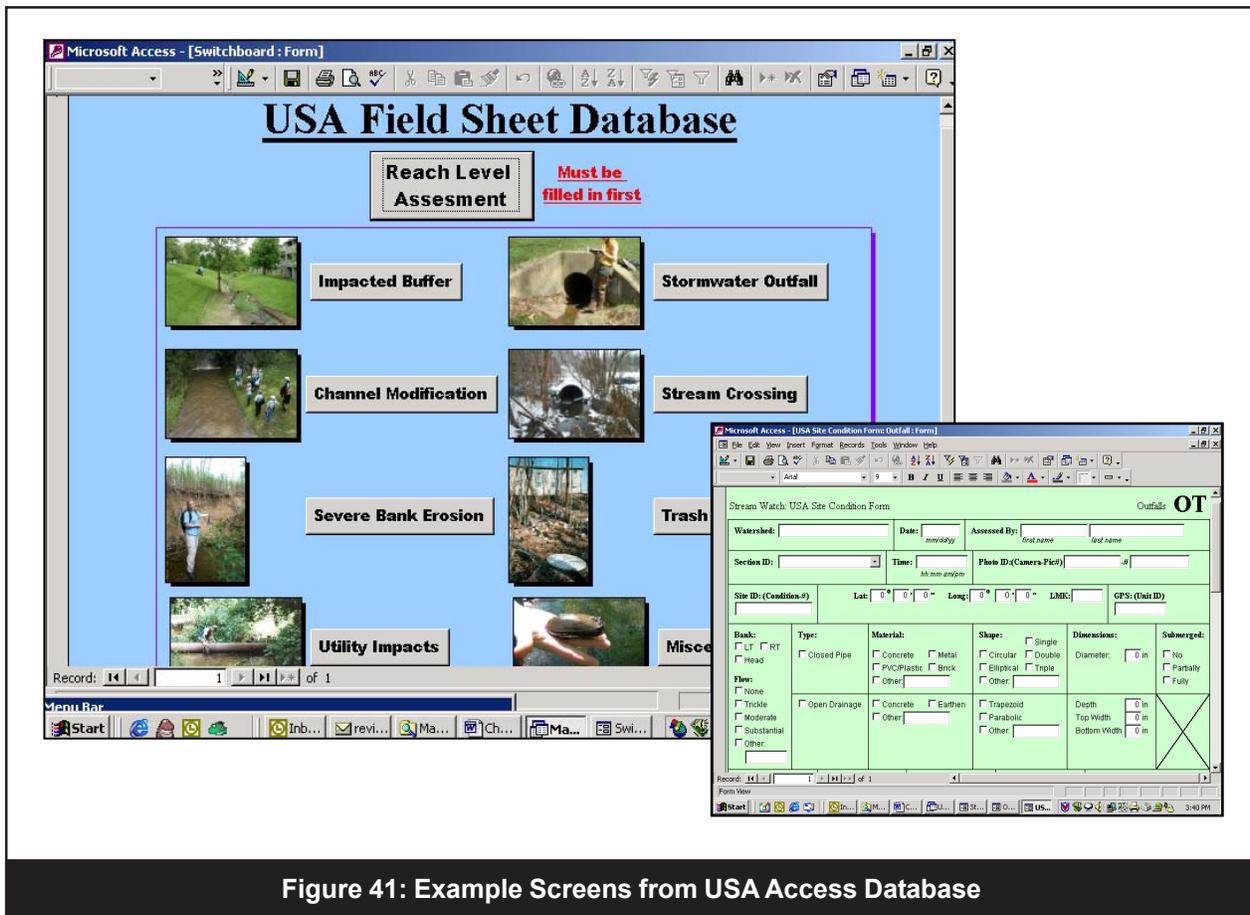


**Figure 41: Example Screens from USA Access Database**

## 12.2 Simple Stream Corridor Project Counts

An initial screening analysis counts the major outputs of the USA that appear to have the greatest stream corridor restoration potential. Often, the sheer number, length or area of stream corridor problems will give you a strong sense of what practices to consider in the restoration plan. For example, you may want to compile the number and distribution of the following:

- Suspect outfalls or sewage discharges
- Storage retrofit candidate sites
- Stream daylighting opportunities
- Severe bank erosion sites
- Inadequate buffers
- Suspected fish barriers
- Channelized segments
- Livestock access points
- Threatened infrastructure
- RCH habitat score
- Reach erosion severity score

At this stage, you simply count the number of sites, or express them as a fraction of total stream corridor or survey reach length. For example, counts may include the length of inadequate buffers as a fraction of total stream length, the number of suspected outfalls, potential storage retrofit sites, or severe bank erosion sites.

Based on your counts, you may discover that a particular stream corridor restoration strategy may not apply to the subwatershed. For example, if no suspect outfalls or sewer overflows are found in the survey, you won't want to make discharge investigations a big part of the initial restoration strategy. On the other hand, if the USA counts reveal that dozens of impacted buffer sites exist along the stream corridor, you may want to immediately pursue more detailed reforestation investigations. The key point is to avoid getting lost in the raw data, but look instead to find patterns that can shape the development of the initial restoration strategy.

## 12.3 Mapping USA Data

Maps are always an excellent way to portray stream corridor data. If your GIS system is linked to the USA database, many different kinds of stream corridor maps can be created to show the spatial distribution of stream problems, potential restoration projects, and overall reach conditions. What you choose to map depends on your initial findings, restoration goals, available software, and GIS capability. Many different kinds of USA data can be effectively portrayed on maps:

- Suspect storm water outfalls
- Potential storage retrofit sites
- Potential daylighting locations
- Threatened infrastructure
- Potential riparian reforestation sites
- Buffers needing invasive species control
- Dumping and trash clean-up sites
- Stream adoption segments
- Channelized segments and associated de-channelization projects
- Potential fish barriers
- Grade control structures
- Natural area remnants along the steam corridor
- Current and future monitoring stations
- Reach habitat quality scores
- Reach bank erosion scores
- Severe erosion sites for stream repair or bank stabilization

Subwatershed maps that depict reach quality and the locations of all potential stream corridor restoration projects are especially useful in restoration planning (Figure 42). Maps that overlay the locations of restoration projects on aerial photos are quite effective for showing stakeholders exactly where restoration sites are located in the subwatershed (Figure 43). These maps can also help identify adjacent stakeholders that should be consulted about proposed restoration projects.

Where possible, USA data should be integrated with USSR data to better understand the relationship between upland areas and the stream corridor. For example, you may want to examine the relationship between upland retrofits and downstream stream repair

projects, as shown in Figure 44. When USSR and USA data are combined on a single map, you often discover connections between subwatershed pollution sources and stream corridor impacts (e.g., suspect outfalls, dumping sites, bank erosion, etc.). Combined maps can also powerfully illustrate the link between upland residential behaviors and stream quality conditions.

The key point to remember is that maps are only a tool of restoration and not a final end point. Try to map with a purpose in mind. A large number of cluttered subwatershed maps
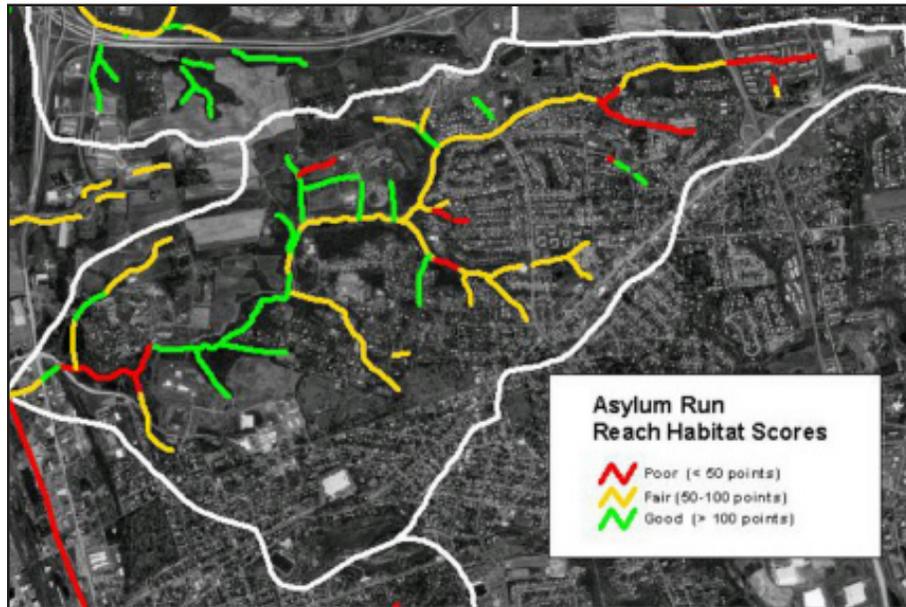


**Figure 42: Reach Habitat Quality Map**
*USA stream corridor map showing locations of poor, fair, and good quality reaches based on total habitat scores from the RCH assessment.*
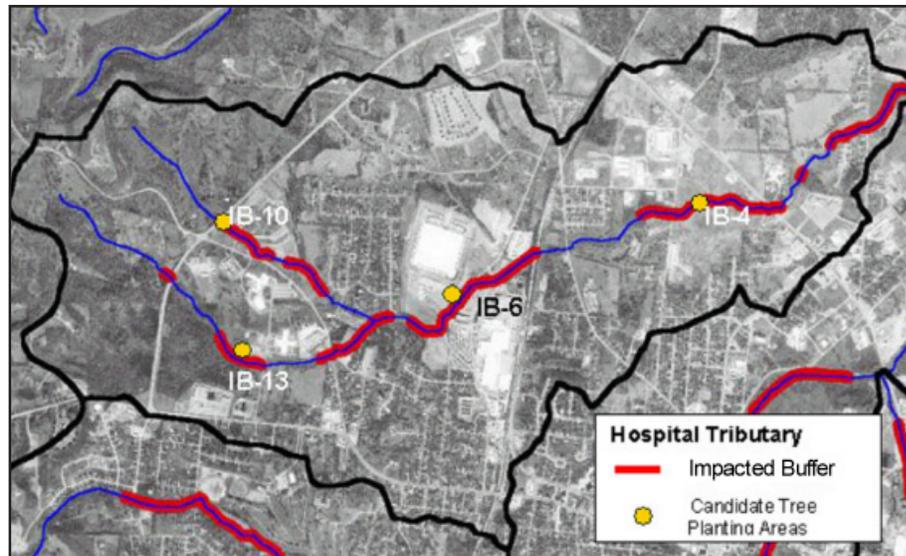


**Figure 43: Location of Impacted Buffers and Potential Restoration Sites**
*USA stream corridor map showing locations of impacted stream buffers and four prime locations for active riparian reforestation projects.*

may only confuse stakeholders, whereas a smaller number of well-designed maps may stimulate ideas for the initial restoration strategy.

## 12.4 Deriving Stream Corridor Metrics

"Stream corridor metrics" is a term used to describe the process of aggregating data from individual USA forms to get a clearer picture of what is happening at the survey reach or stream corridor level. Metrics are expressed as the frequency of a problem or restoration opportunity over a defined stream length or stream corridor area. One example of a stream corridor metric is the number of suspect storm water outfalls per stream mile (i.e., the storm water outfalls with dry weather flows and signs of possible sewage contamination recorded on the OT field form). Stream corridors with a high density of suspect outfalls are obviously a high priority for additional pipe discharge investigations to find and fix illicit discharges. Consequently, communities with NPDES Phase I or II storm water permits may want to use this metric to decide where to look for illicit discharges. The ability to trace illicit discharges is further enhanced when the metric is coupled with other upland metrics, such as the density of confirmed storm water hotspots and pollutant-generating land uses.

Other stream corridor metrics examine the quality of riparian buffers. Two different metrics can be derived, depending on your needs. The first looks at riparian forest continuity, measured as the length of inadequate buffers as a fraction of total stream length. This metric can help distinguish survey reaches based on the continuity of stream buffer cover. Alternately, you may want to derive a metric that looks at the percent of the stream corridor that can feasibly be reforested. This metric is computed by comparing the total length (or area) of reforestation sites ranked highly on the IB form to the total length (or area) of the entire stream corridor.

The RCH assessment form can be used to derive several metrics that give a good picture

of the overall quality of the stream corridor, and the feasibility of restoration. For example, the back of the RCH form contains an overall index of stream habitat quality, which can be subdivided into stream and flood plain components. Other metrics can be computed from the RCH form that relates to the overall feasibility of restoration, such as reach accessibility, land ownership and wildlife utilization. Additional ideas on other stream corridor metrics that can help guide restoration plans are provided in Table 30.



**Watts Branch Restoration Sites**

Stream Restoration Candidates
Storm Water Retrofits
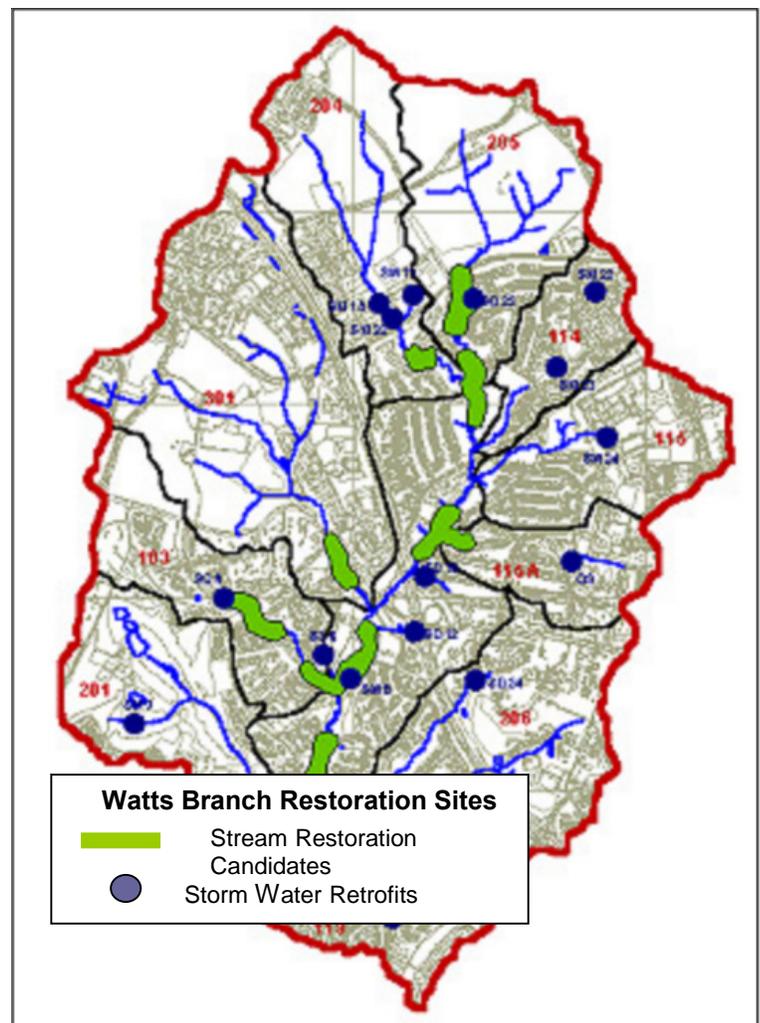
**Figure 44: Combining Stream Corridor and Upland Restoration Projects**
*This example shows stream restoration sites and potential storage retrofits identified during the USA and USSR surveys. Priority stream restoration projects should often be combined with an upland retrofit to control the volume of upstream storm flows.*

| Table 30: Metrics Generated Using USA Data | |
|---|---|
| **Assessment** | **Stream Corridor Metric** |
| **OT** | Outfall density<br>Density of suspect outfalls (#/stream mile)<br>Number of outfalls discharging uncontrolled storm water<br>Treatable outfalls<br>Length of potential daylighting |
| **ER** | # of severe bank erosion sites<br>Estimated bank erosion sediment load |
| **IB** | Riparian forest continuity (buffer miles/stream miles)<br>% of stream corridor that can be reforested<br>% of buffer length needing invasive species control |
| **UT** | # of sanitary sewer overflows<br># of leaking sewer pipes and manholes<br>Sewers crossings/stream mile |
| **TR** | General index of trashiness |
| **SC** | Stream interruption (crossings/mile)<br># of potential retrofit crossings |
| **CM** | Channel density (miles/sq. mile)<br>Channelized length<br>Channelized length per stream mile |
| **MI** | # of natural area remnants and wetlands<br># of livestock access points per stream mile<br># of log jams |
| **RCH** | Stream density (miles/sq. mile)<br># of problems/survey reach<br>Stream corridor habitat index<br>Streambank erosion severity index<br>Access and other feasibility factors |

## 12.5 Subwatershed and Reach Screening

Stream corridor metrics are particularly valuable to screen or rank restoration potential among groups of subwatersheds and streams. The basic approach is simple: select the metrics you feel are most important to your watershed planning goals, and then see how individual subwatersheds or reaches rank in the process. A simple example of this screening process is provided in Table 31. In this hypothetical example, the goal was to find the best stream reach to restore aquatic diversity. The design team derived four reach metrics that they felt would contribute most to success: riparian forest continuity, the absence of fish barriers, overall reach habitat score, and the presence of upstream retrofits. Based on this screening process, stream reach 102 was considered to have the greatest overall stream restoration potential for three of the four metrics, and was therefore selected for subsequent stream reach investigations.

The same basic approach can be used to compare subwatersheds as part of a larger watershed restoration strategy. In this case, this screening process determines which subwatersheds will be priorities for initial implementation. An example of subwatershed severity is provided in Table 32. The goal for the watershed was to stabilize streambanks and reduce channel erosion in the stream corridor. The design team chose four reach metrics to screen three subwatersheds. The four metrics

that defined the severity of the erosion problem and project feasibility were the number of severe erosion sites, threatened infrastructure, the bank erosion, and reach accessibility. Based on these screening criteria, the design team selected subwatershed X as the focus of the next phase of detailed field investigation.

The last example of how USA metrics can be used for screening involves the selection of priority reaches for riparian reforestation (Table 33). In this instance, the goal was to select the stream reach that would result in the most reforestation with the highest degree of survival. The local watershed group selected four USA reach metrics they felt would contribute to most to this goal: the percent of stream corridor that could be reforested (i.e., sites rated good or better on the IB form), the percentage of stream corridor in public

ownership, the overall riparian habitat score and the amount of deer/beaver activity (the last three derived from the RCH form). Based on the screening process, the group concluded that reforestation in reach 203 would have the greatest impact and survival, and targeted it for a riparian reforestation inventory.

| Table 31: An Example of Using USA Data to Compare Reaches | | | | |
|---|---|---|---|---|
| | Riparian Forest Continuity | Suspected Fish Barriers | Overall RCH Habitat Score | Upstream Retrofit? |
| Reach 101 | 20% | 8 | 68 | No |
| Reach 102 | 60% | 0 | 127 | Yes |
| Reach 103 | 65% | 2 | 104 | No |

| Table 32: An Example of Using USA Data to Compare Across Subwatersheds | | | | |
|---|---|---|---|---|
| | # of Severe Bank Erosion Sites | Threatened Infrastructure Sites | RCH Bank Erosion Severity Score | Reach Accessibility |
| Subwatershed X | 12 | 3 | 23 | Good |
| Subwatershed Y | 7 | 4 | 40 | Difficult |
| Subwatershed Z | 3 | 0 | 61 | Fair |

| Table 33: An Example of Using USA Data to Select Priorities | | | | |
|---|---|---|---|---|
| | % of Stream Corridor that can be Reforested | Publicly-Owned Stream Corridor | Overall RCH Riparian Score | Deer/Beaver Activity |
| Reach 201 | 10 | 0% | 31 | Moderate |
| Reach 202 | 22 | 25% | 42 | Low |
| Reach 203 | 35 | 25% | 53 | Low |

## 12.6  Additional Stream Corridor Project Investigations

By now, USA data analyses will help focus on the initial priorities for your stream corridor restoration strategy. The next step is to undertake more detailed follow-up investigations to assess the feasibility of candidate project sites and begin restoration design. Follow-up investigations create an inventory of stream corridor restoration projects for subsequent review by subwatershed stakeholders.

Table 34 describes the range of additional stream corridor investigations that may be triggered by your USA data analysis. The basic investigation techniques are summarized in Manual 2, with expanded descriptions for each technique found in Manuals 3, 4, 5, and 7. You should carefully choose the ones that are right for your subwatershed. Good hunting!

| Table 34:  How to Use USA Metrics to Develop an Initial Restoration Strategy | | |
|---|---|---|
| **Restoration Practice** | **Follow-up Project Investigations** | **Corresponding Manual** |
| Storage Retrofit | Retrofit Reconnaissance Inventory | Manual 3 |
| Stream Restoration | Stream Reach Investigation | Manual 4 |
| Riparian Restoration | Natural Area Remnant Investigations<br>Riparian Reforestation Inventory | Manual 7<br>Manual 5 |
| Discharge Prevention | Discharge Prevention Investigations | Manual 6 |
| Other | Enforcement Actions | Manual 9 |

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# Appendix A:  USA Field Forms

# OT

| **WATERSHED/SUBSHED:** | | **DATE:** ____/_____/____ | **ASSESSED BY:** |
|---|---|---|---|

**SURVEY REACH ID:**     **TIME:** ____:____ AM/PM     **PHOTO ID:** (*Camera-Pic #*)     /#

**SITE ID** (*Condition-#*): **OT-_____**    **LAT** ___°_____'_____" **LONG** ___°_____'_____"   **LMK____**   **GPS:** (*Unit ID*)

---

**BANK:**
☐ LT ☐ RT ☐ Head

**FLOW:**
☐ None ☐ Trickle
☐ Moderate
☐ Substantial
☐ Other:

**TYPE:**
☐ Closed pipe

☐ Open channel

**MATERIAL:**
☐ Concrete ☐ Metal
☐ PVC/Plastic ☐ Brick
☐ Other:

☐ Concrete ☐ Earthen
☐ Other:

**SHAPE:** ☐ Single
☐ Circular ☐ Double
☐ Elliptical ☐ Triple
☐ Other:

☐ Trapezoid
☐ Parabolic
☐ Other:

**DIMENSIONS:**
Diameter:_____(in)

Depth: _____(in)
Width (Top):_____(in)
" (Bottom):_____(in)

**SUBMERGED:**
☐ No
☐ Partially
☐ Fully

*NOT APPLICABLE*

---

**CONDITION:**
☐ None
☐ Chip/Cracked
☐ Peeling Paint
☐ Corrosion
☐ Other:

**ODOR:** ☐ No
☐ Gas
☐ Sewage
☐ Rancid/Sour
☐ Sulfide
☐ Other:

**DEPOSITS/STAINS:**
☐ None
☐ Oily
☐ Flow Line
☐ Paint
☐ Other:

**VEGGIE DENSITY:**
☐ None
☐ Normal
☐ Inhibited
☐ Excessive
☐ Other:

**PIPE BENTHIC GROWTH:** ☐ None
☐ Brown ☐ Orange ☐ Green
☐ Other:

**POOL QUALITY:** ☐ No pool
☐ Good ☐ Odors ☐ Colors ☐ Oils
☐ Suds ☐ Algae ☐ Floatables
☐ Other:

---

| ***FOR FLOWING ONLY*** | **COLOR:** | ☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other: |
|---|---|---|
| | **TURBIDITY:** | ☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque |
| | **FLOATABLES:** | ☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other: |

**OTHER CONCERNS:**
☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation
☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:

---

**POTENTIAL RESTORATION CANDIDATE** ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☐ no     ☐ Storm water retrofit     ☐ Other:

*If yes for daylighting:*
Length of vegetative cover from outfall: _____ft   Type of existing vegetation:_____ Slope: _____°

*If yes for stormwater:*
Is stormwater currently controlled?     Land Use description:_____
☐ Yes ☐ No ☐ Not investigated     Area available:

| **OUTFALL SEVERITY:** (*circle #*) | Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream. | Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized. | Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems. | |
|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |

**SKETCH/NOTES:**

 

**REPORTED TO AUTHORITIES:** ☐ YES ☐ NO

**ER**

| WATERSHED/SUBSHED: | | DATE: ___/_____/___ | ASSESSED BY: |

SURVEY REACH:      TIME:____:____AM/PM    PHOTO ID (CAMERA-PIC #):    **/#**

SITE ID: (*Condition-#*)    *START* LAT ____°___'___" LONG ___°___'___"   LMK _____    GPS: (*Unit ID*)

ER-_____    *END* LAT ____°___'___" LONG ___°___'___"   LMK _____

---

**PROCESS:** ☐ Currently unknown

☐ Downcutting    ☐ Bed scour
☐ Widening    ☐ Bank failure
☐ Headcutting    ☐ Bank scour
☐ Aggrading    ☐ Slope failure
☐ Sed. deposition    ☐ Channelized

**BANK OF CONCERN:** ☐ LT ☐ RT ☐ Both (*looking downstream*)
**LOCATION:** ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:
**DIMENSIONS:**

Length (*if no GPS*) LT_____ft and/or RT_____ft    Bottom width _____ft
Bank Ht    LT_____ft and/or RT_____ft    Top width _____ft
Bank Angle    LT_____° and/or RT_____°    Wetted Width _____ft

**LAND OWNERSHIP:** ☐ Private ☐ Public ☐ Unknown    **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

---

**POTENTIAL RESTORATION CANDIDATE:**   ☐ Grade control    ☐ Bank stabilization
☐ No    ☐ Other:

**THREAT TO PROPERTY/INFRASTRUCTURE:** ☐ No    ☐ Yes (Describe):

**EXISTING RIPARIAN WIDTH:**    ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

| EROSION SEVERITY (*circle#*) <br><br> Channelized= ☐ 1 | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. | Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure | Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. |
|---|---|---|---|
| | 5      4 | 3      2 | 1 |
| ACCESS: | **Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. | **Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. | **Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required. |
| | 5      4 | 3      2 | 1 |

**NOTES/CROSS SECTION SKETCH:**

REPORTED TO AUTHORITIES ☐ YES ☐ NO

**IB**

| | |
|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ **ASSESSED BY:** |
| **SURVEY REACH:** | **TIME:** ___:____ AM/PM **PHOTO ID:** (*Camera-Pic #*) /# |

**SITE ID:** (*Condition #*)

**IB -** _____

*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____

*END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____

**GPS:** (*Unit ID*)

---

**IMPACTED BANK:**
☐ LT ☐ RT ☐ Both

**REASON INADEQUATE:** ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants
☐ Recently planted ☐ Other:

**LAND USE:**
(*Facing downstream*)

| | Private | Institutional | Golf Course | Park | Other Public |
|---|---|---|---|---|---|
| LT Bank | ☐ | ☐ | ☐ | ☐ | ☐ : |
| RT Bank | ☐ | ☐ | ☐ | ☐ | ☐ : |

**DOMINANT LAND COVER:**

| | Paved | Bare ground | Turf/lawn | Tall grass | Shrub/scrub | Trees | Other |
|---|---|---|---|---|---|---|---|
| LT Bank | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ : |
| RT Bank | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ : |

**INVASIVE PLANTS:** ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

**STREAM SHADE PROVIDED?** ☐ None ☐ Partial ☐ Full **WETLANDS PRESENT?** ☐ No ☐ Yes ☐ Unknown

---

**POTENTIAL RESTORATION CANDIDATE** ☐ Active reforestation ☐ Greenway design ☐ Natural regeneration ☐ Invasives removal
☐ no ☐ Other:

**RESTORABLE AREA**

LT BANK RT

Length (ft): _____ _____

Width (ft): _____ _____

**REFORESTATION POTENTIAL:** (*Circle #*)

| Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting | Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate | Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting |
|---|---|---|
| 5 4 | 3 | 2 1 |

**POTENTIAL CONFLICTS WITH REFORESTATION** ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun
☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver) ☐ Other:

**NOTES:**

| **WATERSHED/SUBSHED:** | | **DATE:** ___/___/___ | **ASSESSED BY:** |
|---|---|---|---|
| **SURVEY REACH ID:** | **TIME:**___:___AM/PM | **PHOTO ID:** (*Camera-Pic #*) | /# |

**SITE ID:** (*Condition #*) **SC-____**  **LAT** ___°___'___"  **LONG** ___°___'___"  **LMK____**  **GPS** (*Unit ID*)

**TYPE:** ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

*FOR ROAD/ RAILROAD CROSSINGS ONLY*

**SHAPE:**
☐ Arch ☐ Bottomless
☐ Box ☐ Elliptical
☐ Circular
☐ Other:

**# BARRELS:**
☐ Single
☐ Double
☐ Triple
☐ Other:

**MATERIAL:**
☐ Concrete
☐ Metal
☐ Other:

**ALIGNMENT:**
☐ Flow-aligned
☐ Not flow-aligned
☐ Do not know

**DIMENSIONS:** (*if variable, sketch*)
Barrel diameter: _____(ft)
Height: _____(ft)
Culvert length: _____(ft)
Width: _____(ft)
Roadway elevation:_____(ft)

**CONDITION:** (*Evidence of…*)
☐ Cracking/chipping/corrosion ☐ Downstream scour hole
☐ Sediment deposition ☐ Failing embankment
☐ Other (*describe*):

**CULVERT SLOPE:**
☐ Flat
☐ Slight (2° – 5°)
☐ Obvious (>5°)

**POTENTIAL RESTORATION CANDIDATE** ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit
☐ no ☐ Local stream repair ☐ Other:

**IS SC ACTING AS GRADE CONTROL** ☐ No ☐ Yes ☐ Unknown

*If yes for fish barrier*

**EXTENT OF PHYSICAL BLOCKAGE:**
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

**CAUSE:**
☐ Drop too high    Water Drop: _____ (in)
☐ Flow too shallow  Water Depth:_____ (in)
☐ Other:

**BLOCKAGE SEVERITY:** (*circle #*)

| A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present. | A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish. | A temporary barrier such as a beaver dam or ablockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls. |
|---|---|---|
| 5              4 | 3 | 2              1 |

**NOTES/SKETCH:**

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

| WATERSHED/SUBSHED: | | DATE: ___/_____/___ | ASSESSED BY: |
|---|---|---|---|

| SURVEY REACH ID: | TIME:___:____AM/PM | PHOTO ID: (*Camera -Pic #*) # |
|---|---|---|

**SITE ID:** (*Condition -#*)
**CM-_____**

| | START **LAT** ____°___'___" **LONG** ____°___'___" **LMK** _____ | **GPS:** (*Unit ID*) |
|---|---|---|
| | END **LAT** ____°___'___" **LONG** ___°___'___" **LMK** _____ | |

**TYPE:** ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

**MATERIAL:**
☐ Concrete ☐ Gabion
☐ Rip Rap ☐ Earthen
☐ Metal
☐ Other:

| | |
|---|---|
| Does channel have perennial flow? | ☐ Yes ☐ No |
| Is there evidence of sediment deposition? | ☐ Yes ☐ No |
| Is vegetation growing in channel? | ☐ Yes ☐ No |
| Is channel connected to floodplain? | ☐ Yes ☐ No |

**DIMENSIONS:**
Height _____(ft)
Bottom Width _____(ft)
Top Width: _____(ft)
Length: _____(ft)

**BASE FLOW CHANNEL**
Depth of flow _____(in)

Defined low flow channel? ☐ Yes ☐ No

% of channel bottom _____%

**ADJACENT STREAM CORRIDOR**
Available width LT_____(ft) RT_____(ft)

Utilities Present?      Fill in floodplain?
☐ Yes ☐ No      ☐ Yes ☐ No

**POTENTIAL RESTORATION CANDIDATE** ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell
☐ no      ☐ De-channelization ☐ Fish barrier removal      ☐ Bioengineering

| CHANNEL-IZATION SEVERITY: (*Circle #*) | A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel. | A moderate length ( > 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel. | An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area. |
|---|---|---|---|
| | 5      4 | 3 | 2      1 |

**NOTES:**

**TR**

| WATERSHED/SUBSHED: | DATE: ___/_____/___ | ASSESSED BY: |
|---|---|---|

| SURVEY REACH ID: | TIME:____:____AM/PM | PHOTO ID: (*Camera-Pic #*)　　/# |
|---|---|---|

**SITE ID:** (*Condition #*) **TR-_____**　　LAT ___°_____'_____" LONG ___°_____'_____" LMK _____　　**GPS:** (*Unit ID*)

---

**TYPE:**
- ☐ Industrial
- ☐ Commercial
- ☐ Residential

**MATERIAL:**
- ☐ Plastic
- ☐ Tires
- ☐ Appliances
- ☐ Automotive
- ☐ Paper
- ☐ Construction
- ☐ Yard Waste
- ☐ Other:
- ☐ Metal
- ☐ Medical

**SOURCE:**
- ☐ Unknown
- ☐ Flooding
- ☐ Illegal dump
- ☐ Local outfall

**LOCATION:**
- ☐ Stream
- ☐ Riparian Area
- ☐ Lt bank
- ☐ Rt bank

**LAND OWNERSHIP:**
- ☐ Public　☐ Unknown
- ☐ Private

**AMOUNT** (*# Pickup truck loads*):

---

**POTENTIAL RESTORATION CANDIDATE**　☐ Stream cleanup　☐ Stream adoption segment　☐ Removal/prevention of dumping

☐ no　　　　☐ Other:

| *If yes for trash or debris removal* | **EQUIPMENT NEEDED:** ☐ Heavy equipment ☐ Trash bags ☐ Unknown | **DUMPSTER WITHIN 100 FT:** ☐ Yes ☐ No ☐ Unknown |
|---|---|---|
| | **WHO CAN DO IT:** ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other | |

| **CLEAN-UP POTENTIAL:** (*Circle #*) | A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access | A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe. | A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials |
|---|---|---|---|
| | 5 | 4　　　　　3 | 2　　　　1 |

---

**NOTES:**

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

**WATERSHED/SUBSHED:**    **DATE:** ____/_____/___    **ASSESSED BY:**

**SURVEY REACH ID:**    **TIME:** ____:____AM/PM    **PHOTO ID:** (*Camera-Pic #*)    **/#**

**SITE ID:** (*Condition #*)   **UT-_____**   **LAT**____°_____'_____" **LONG** ___°_____'_____" **LMK:** _____   **GPS:** (*Unit ID*)

---

**TYPE:**
- ☐ Leaking sewer
- ☐ Exposed pipe
- ☐ Exposed manhole
- ☐ Other:

**MATERIAL:**
- ☐ Concrete
- ☐ Corrugated metal
- ☐ Smooth metal
- ☐ PVC
- ☐ Other:

**LOCATION:**
- ☐ Floodplain
- ☐ Stream bank
- ☐ Above stream
- ☐ Stream bottom
- ☐ Other:

**POTENTIAL FISH BARRIER:**
- ☐ Yes ☐ No

**PIPE DIMENSIONS:**
Diameter: _____ in
Length exposed: _____ ft

**CONDITION:**   ☐ Joint failure    ☐ Pipe corrosion/cracking
☐ Protective covering broken    ☐ Manhole cover absent
☐ Other:

---

**EVIDENCE OF DISCHARGE:**

| | | |
|---|---|---|
| **COLOR** | ☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other: | |
| **ODOR** | ☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other: | |
| **DEPOSITS** | ☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other: | |

---

**POTENTIAL RESTORATION CANDIDATE** ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no      ☐ Fish barrier removal ☐ Other:

*If yes to fish barrier,* Water Drop: _____ (in)

**UTILITY IMPACT SEVERITY:** (*Circle #*)

Leaking= ☐ 5

| Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure. | A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event. | Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel. |
|---|---|---|
| 5 | 4     3 | 2     1 |

**NOTES:**


                          **REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

**WATERSHED/SUBSHED:**        **DATE:** ____/_____/___      **ASSESSED BY:**

**SURVEY REACH ID:**        **TIME:**____:____AM/PM     **PHOTO ID:** (*Camera-Pic #*)     **/#**

**SITE ID:** (*Condition #*)   **MI-_____**    **LAT**___°_____'_____" **LONG** ___°_____'_____"   **LMK:** _____    **GPS:** (*Unit ID*)

**POTENTIAL RESTORATION CANDIDATE**   ☐ Storm water retrofit   ☐ Stream restoration   ☐ Riparian Management
☐ no                   ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

                                     **REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

---

**WATERSHED/SUBSHED:**        **DATE:** ____/_____/___      **ASSESSED BY:**

**SURVEY REACH ID:**        **TIME:**____:____AM/PM     **PHOTO ID:** (*Camera-Pic #*)     **/#**

**SITE ID:** (*Condition #*)   **MI-_____**    **LAT**___°_____'_____" **LONG** ___°_____'_____"   **LMK:** _____    **GPS:** (*Unit ID*)

**POTENTIAL RESTORATION CANDIDATE**   ☐ Storm water retrofit   ☐ Stream restoration   ☐ Riparian Management
☐ no                   ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

                                     **REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

---

**WATERSHED/SUBSHED:**        **DATE:** ____/_____/___      **ASSESSED BY:**

**SURVEY REACH ID:**        **TIME:**____:____AM/PM     **PHOTO ID:** (*Camera-Pic #*)     **/#**

**SITE ID:** (*Condition #*)   **MI-_____**    **LAT**___°_____'_____" **LONG** ___°_____'_____"   **LMK:** _____    **GPS:** (*Unit ID*)

**POTENTIAL RESTORATION CANDIDATE**   ☐ Storm water retrofit   ☐ Stream restoration   ☐ Riparian Management
☐ no                   ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

                                     **REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

# RCH

| **SURVEY REACH ID:** _____ | **WTRSHD/SUBSHD:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
|---|---|---|---|

| *START* **TIME:**___:___AM/PM **LMK:** _____ | *END* **TIME:**___:___AM/PM **LMK:** _____ | **GPS ID:** |
|---|---|---|
| **LAT**___°_____'_____" **LONG** ___°_____'_____" | **LAT**___°_____'_____" **LONG** ___°_____'_____" | |
| **DESCRIPTION:** | **DESCRIPTION:** | |

| **RAIN IN LAST 24 HOURS** ☐ Heavy rain ☐ Steady rain | **PRESENT CONDITIONS** ☐ Heavy rain ☐ Steady rain ☐ Intermittent |
|---|---|
| ☐ None ☐ Intermittent ☐ Trace | ☐ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy |

**SURROUNDING LAND USE:** ☐ Industrial ☐ Commercial ☐ Urban/Residential ☐ Suburban/Res ☐ Forested ☐ Institutional
☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:

## AVERAGE CONDITIONS *(check applicable)*

**BASE FLOW AS % CHANNEL WIDTH**
☐ 0-25%   ☐ 50% -75%
☐ 25-50 %   ☐ 75-100%

**DOMINANT SUBSTRATE**
☐ Silt/clay (fine or slick)   ☐ Cobble (2.5 –10")
☐ Sand (gritty)   ☐ Boulder (>10")
☐ Gravel (0.1-2.5")   ☐ Bed rock

**WATER CLARITY**   ☐ Clear   ☐ Turbid *(suspended matter)*
☐ Stained *(clear, naturally colored)*   ☐ Opaque *(milky)*
☐ Other *(chemicals, dyes)*

**AQUATIC PLANTS IN STREAM**
Attached: ☐ none ☐ some ☐ lots
Floating: ☐ none ☐ some ☐ lots

**WILDLIFE IN OR AROUND STREAM**
*(Evidence of)*
☐ Fish   ☐ Beaver   ☐ Deer
☐ Snails   ☐ Other:

**STREAM SHADING** (water surface)
☐ Mostly shaded (≥75% coverage)
☐ Halfway (≥50%)
☐ Partially shaded (≥25% )
☐ Unshaded (< 25%)

**CHANNEL DYNAMICS**
☐ Downcutting   ☐ Bed scour
☐ Widening   ☐ Bank failure
☐ Headcutting   ☐ Bank scour
☐ Aggrading   ☐ Slope failure
☐ Sed. deposition   ☐ Channelized
☐ Unknown

**CHANNEL DIMENSIONS** *(FACING DOWNSTREAM)*
Height: LT bank _____(ft)
RT bank _____(ft)
Width: Bottom _____(ft)
Top _____(ft)

## REACH SKETCH AND SITE IMPACT TRACKING

*Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow*

### REACH ACCESSIBILITY

| **Good:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. | **Fair**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. | **Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required. |
|---|---|---|
| 5    4 | 3    2 | 1 |

**NOTES:** *(biggest problem you see in survey reach)*

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

| OVERALL STREAM CONDITION | | | | |
|---|---|---|---|---|
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **IN-STREAM HABITAT** *(May modify criteria based on appropriate habitat regime)* | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |
| **VEGETATIVE PROTECTION** *(score each bank, determine sides by facing downstream)* | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| | Left Bank   10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| | Right Bank 10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| **BANK EROSION** (facing downstream) | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. | Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. |
| | Left Bank   10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| | Right Bank 10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| **FLOODPLAIN CONNECTION** | High flows (greater than bankfull) able to enter floodplain.  Stream not deeply entrenched. | High flows (greater than bankfull) able to enter floodplain.  Stream not deeply  entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |

| OVERALL BUFFER AND FLOODPLAIN CONDITION | | | | |
|---|---|---|---|---|
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **VEGETATED BUFFER WIDTH** | Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone. | Width of buffer zone 25-50 feet; human activities have impacted zone only minimally. | Width of buffer zone 10-25 feet; human activities have impacted zone a great deal. | Width of buffer zone <10 feet: little or no riparian vegetation due to human activities. |
| | Left Bank   10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| | Right Bank 10       9 | 8       7       6 | 5       4       3 | 2       1       0 |
| **FLOODPLAIN VEGETATION** | Predominant floodplain vegetation type is mature forest | Predominant floodplain vegetation type is young forest | Predominant floodplain vegetation type is shrub or old field | Predominant floodplain vegetation type is turf or crop land |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |
| **FLOODPLAIN HABITAT** | Even mix of wetland and non-wetland habitats, evidence of standing/ponded water | Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water | Either all wetland or all non-wetland habitat, evidence of standing/ponded water | Either all wetland or all non-wetland habitat, no evidence of standing/ponded water |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |
| **FLOODPLAIN ENCROACH-MENT** | No evidence of floodplain encroachment in the form of fill material,  land development, or manmade structures | Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function | Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function | Significant floodplain encroachment (i.e. fill material, land development, or man-made structures).  Significant effect on floodplain function |
| | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1  0 |

**Sub Total** In-stream: _____ /80   +   Buffer/Floodplain: _____ /80   =   **Total** Survey Reach _____ /160

# Photo Inventory
(By Camera)

**Project:** _____

**Group:** _____

**Camera** : _____

This field sheet is to be completed AS photos are taken in the field.  The intent is to force us to organize pictures taken on a camera basis.  Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

| Date | Stream/ Reach | Location ID | Photo # | Description |
|------|---------------|-------------|---------|-------------|
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|      |               |             |         |             |

| Date | Stream/Reach | Location ID | Photo # | Description |
|------|--------------|-------------|---------|-------------|
|      |              |             |         |             |
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**Comments:**

(BACK)

# Appendix B:  USA Data Entry Database

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*The USA Data Entry Database is an Access software application designed for use as part of the Unified Stream Assessment. An electronic version of the database is included with your copy of this manual.*