Creating Value …

… Delivering Solutions

Stream Restoration Design and Implementation in Urban Environments

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Presentation Overview

- Natural channel design (NCD) versus traditional urban designs
- Urban challenges and opportunities
Stream Restoration Overview

- Stream restoration using natural channel design is increasing throughout the U.S.
  - Mitigation Related Projects
  - Watershed Restoration Projects
Traditional vs. Natural Channel Design
Natural Versus Channelized Streams
A stable stream moves the sediment and water generated by its watershed while maintaining dimension, pattern and profile, without aggrading or degrading
Bankfull Discharge

- Fills a stable channel up to the elevation of the active floodplain.
- Represents a breakpoint between processes of channel formation and floodplain development.
- Often leaves a visual indicator.
Identifying bankfull discharge in urban channels using visible indicators is often difficult.

- Channel disturbance
- Changes in hydrologic regime

Any visual indicators should be verified with further analysis.
The Evolution of Stream Restoration

- **Traditional Approach**
  - Spot fixes using hard armoring techniques
    - Concrete, gabion baskets, rip-rap

- **Evolving NCD Approach**
  - Holistic restoration to promote stream function and health
    - Green techniques for banks – live staking, brush mattress, coir fiber log, geo-lifts
    - In stream structures - cross vanes, j-hooks, double wing deflectors, root wads
Urban Challenges

- Confinement
- Sediment supply and transport issues
- Flood control requirements
- Storm drainage networks
- General constraints
- Landowners / Public
- Utilities
Confinement keeps more water in the channel and therefore increases stream power – the ability of the stream to do work.

Encourages channel enlargement through incision and bank erosion.
Quantifying Confinement

MORPHOLOGICAL MEASUREMENTS AND RATIOS

PATTERN (PLAN VIEW)

CHANNEL PATTERN MEASUREMENTS
- MEANDER LENGTH (Lm)
- RADIUS OF CURVATURE (Re)
- BELT WIDTH (Wbib)

CHANNEL PATTERN CALCULATIONS
- RATIO: RADIUS OF CURVATURE / RIFFLE WIDTH (Re / Wr)
- RATIO: MEANDER LENGTH / RIFFLE WIDTH (Lm / Wr)
- MEANDER WIDTH RATIO (MWR = Wbib / Wr)
- SINUOSITY (K) = CHANNEL LENGTH / VALLEY LENGTH
Design Rule of Thumb

- We have seen a number of projects experience problems because the designer tried to force a meandering channel in a confined valley.
- Must have a meander width ratio of 3.5 or greater to get a sinuosity greater than 1.2.
Example of Meandering Design vs. In-line Design

Meandering Channel

Step/Pool Channel

Step/Pool Channel
Sediment Supply and Transport Issues

From Rosgen (1996), from Lane, Proceedings, 1955. Published with the permission of American Society of Civil Engineers.

Bed Load – material that rolls, skips, slides or hops along the bottom of the stream

Suspended Load – material that is suspended; generally includes silt, clay, and fine sand

From a stream restoration standpoint, we are most concerned with bedload when considering sediment transport issues.
Sediment Transport

- **Competency**
  - The ability of the stream to move a given sediment grain size.
  - Expressed as a force such as shear stress of tractive force.

- **Capacity**
  - The ability of the stream to move a quantity of sediment through a cross section.
  - Expressed as a sediment transport rate and/or measurement of stream power.
Special circumstances may require more robust methods such as sediment transport modeling.
Because of flooding concerns, most urban restoration projects will require a Priority 2, 3, or 4 approach.
Priority 2 Example to Address Flooding
Many recent projects include both stream restoration, stormwater BMP’s, and/or low impact development (LID).

- Stormwater outfall protection.
- Bioretention cells
- Wetland cells
- Filtration through buffers
Stormwater Considerations
Landowners / Public Considerations

The general public in urban environments is used to seeing manicured and maintained streams.

The public can be your biggest advocates or your biggest detractors. Involvement upfront is the key to getting buy-in from the public.
Natural channel design and bio-engineering approaches require the establishment of vegetation. You must be realistic with the public on expectations.
Landowners / Public Considerations
Steep eroding streambanks can cause a safety issue, especially in public areas such as parks. Improving public safety has been a goal of some past projects.
In urban environments, we are seeing increased desire to incorporate recreational aspects with stream restoration projects.
Example Project – Tinley Creek

MWRD is conducting feasibility studies to investigate stabilizing streams when structures and infrastructure are at imminent risk due to active erosion.
Example Project – Tinley Creek

Feasibility Study for Tinley Creek includes 3 miles of stream stabilization, including natural channel design and the replacement of some existing retaining walls.
Example Project – Tinley Creek
Urban Stream Enhancement Concepts

TYPICAL STREAM RESTORATION CROSS SECTION

TYPICAL STREAM ENHANCEMENT CROSS SECTION
Questions?