Stantec

Personal Introduction

- Randy Brook is a Civil Engineering Technician with over 30 years of experience. Randy's career has focused on land development and environmental engineering projects. Over the last 9 years Randy has applied lessons learned over his land development career to stream restoration projects with a focus on improving stream design using Civil 3D.
- Hamish Trenam is a Water Resources Engineer in Training with 7 years of experience. Hamish's project experience has allowed him to work on stream projects from inception through construction and into post-construction monitoring. This has allowed Hamish to gain a unique perspective on how the design process can streamline construction and increase stream quality.

Slide 3 – Project Objectives

- It may seem odd to start with urban land at a stream restoration conference but many of the same principles can be applied to both types of project
- Both Hamish and Randy started their careers in urban land development where designs are highly optimized to maximize profits (number of units) and minimize construction costs.
- This principle can also be applied to stream design where the goal is to maximize stream habitat and minimize construction costs.

Slide 4 – Challenges in Stream Design

- Stream optimization is a slow process which can lead to inefficient designs
- Optimization is a slow process and budgets are tight – this leads to optimization often being overlooked
- The goal of this presentation is to show a process that can make stream restoration optimization an easier process

Slide 5 – Streamline Your Design

- Other than one macro (the one that transfers data between excel and Civil3D) none of this information is proprietary so we encourage others to use this information to make your own process

Slide 6 – Design Process – Channel Alignment

- Use a reference reach and morph tables to determine channel design parameters for both channel plan form and channel-cross sections.
- The channel layout includes variables such as: thalweg alignment (sinuosity), pool-pool spacing, riffle and pool length etc. as determined by the reference reach survey
- Use alignment design parameters to more easily determine riffle and pool length, and radius of curvature.

- From the alignment (X and Y coordinates) and an existing profile (Z coordinate) there is the potential to make a 3D surface – still need to apply the channel cross-sections (for the proposed Z coordinates).
- Remember that the alignment is along the stream CL but SR CAD and Excel will move the thalwag.

Slide 8 – Design Process – Cross Sections

- At each point of curvature or point of tangency (top and bottom of a riffle), apply a riffle cross-section. At the apex of each curve, apply a pool cross-section. This means that each line (riffle) will have a riffle cross-section and each curve (pool) will have a curve cross section.
- Use Excel to interpolate between the point of curvature/tangency and the apex of the curve, apply "transition" sections that will form runs and glides.
- To allow Civil 3D to make an efficient surface, make sure that each cross-section (riffle and pool) has an equal number of points – this will allow the user to run multiple featurelines along the channel and will create a "grid" of points.

Slide 11 – Design Process – Profile

- Using bankfull to determine riffle and pool depths. Bankfull should remain relatively constant along the reach.
- Start the optimization process (we'll come back to this later)

Slides 13 & 14 – Design Process – Surface

- Using the proposed alignment, cross-sections and profile; it's now possible to create a 3D surface.
- Use excel to organize the points into a series of lines that could be imported into Civil3D as either 3D polylines or featurelines. For example a series of points along the thalweg, inner berm, bankfull and floodplain.
- From Excel it's possible to turn use a .csv converted to a text file to bring the points into excel. Bring similar points in together (thalweg, inner berm, etc.) to they can easily be connected with a featureline. It's possible to do this with a VB macro (speeds up the process) but this isn't necessary.

Slide 16 – Design optimization

- Slope variation – Using the alignment, cut a profile view along the channel to ensure that no portions of the channel are overly deep or shallow. Channels don't always have a constant slope and varying the slope by a very small amount can allow the design channel to better conform to the landscape. For example, instead of having a constant 1.0% slope, a channel may better conform to a landscape by using a channel at 0.9% and 1.1% in different sub-reaches.
- Cut fill balance – Raising or lowering a channel by small amounts can make a big difference. For example, if a 1 km channel with a floodplain width 10 m is lowered by

0.10 m, it will create an addition cut volume of 1,000 m³. Cut/fill can also be balanced on a much smaller scale (say every 250 m of channel length) which would reduce construction costs. Done through Civil 3D automatically once set up.

- Material re-use - On a similar note, it also becomes easier to determine what onsite materials can be reused and where it can be reused. For example, any impacted vegetation can be reused as toe-wood or as a stream structure.

Slide 17 – Design Advantages

- Both programs are used to go through multiple iterations of the channel design that permit the visualization of the upstream and downstream tie-ins. Find conflicts with services etc. Show as a finished produce. Can be used for marketing or public consultation (next step).
- More accurate quantity estimates – Since both the existing and design conditions are built using a 3D surface, it's possible to easily calculate what volumes of materials are required.   Working with a contractor, it is also possible to determine the optimal position for material stockpiles.
- Easy to update hydraulic models (HEC-RAS)
- Minimizes construction inefficiencies – Localized cut/fill balance optimization and accurate quantity estimates can reduce the volume of materials that are moved. Working with a contract can determine stock pile locations, haul routes, construction staging. Why move things multiple times when then can be moved once or twice?
- Minimizes construction deviation from the design – Using the Civil 3D surface, a contractor can quickly and accurately layout and construct a channel. This also removes any "guess work". Especially if machines have gps.

Slide 18 – Next Steps

- We encourage people to take this process, improve on it and share. Across North America, stream restoration is still emerging and there is lots of room for innovation. At the end of the day, each project reflects on stream restoration practices and it is important that we share innovations to improve the industry.