Section 1:

Active River Area Methodology & SOP

1. FRAMEWORK

1.1 ACTIVE RIVER AREA MODEL

The Active River Area (ARA) model, developed by The Nature Conservancy, was chosen to refine the project scope to those areas on the ground directly linked to aquatic function. In implementing effective river conservation, it is important to include protection of “key physical and ecological processes” linked to freshwater systems. “These processes are driven in large part by the movement of water and the associated movement of sediment, energy, materials, and organisms” along with energy inputs including the organic materials that create the foundation of life within the system. The term Active River Area refers to the “active” or dynamic processes that maintain river systems and conditions, and the associated lands of both riparian and aquatic habitats that interact with and contribute to a waterway, also referred to as “river area.” The model offers a systematic process for conceptualizing and conserving the river, capturing a number of dynamic components that help to guide actions to restoration, protection and management (TNC, 2010).

There are five components of the ARA model:

- Material contribution areas - headwater areas and certain upland areas directly adjacent to the stream channel including small headwaters in the uppermost region of the watershed and upland areas along waterways;
- Meander belts - these occur where channels migrate or ‘meander’ over time, and their width is defined by the cross-channel distance that spans the outer-most edges of both existing and potential meanders;
- Floodplains - low slope areas adjacent to channels made up of sediment that has been transported by the present flow-regime;
- Terraces - former floodplains composed of deposited materials from large landscape forming events that may be inundated during rare flooding events and continue to support natural communities of floodplain forests; and
- Riparian wetlands - low-gradient areas with hydric or inundated soils that support wetland plant species.

In order to delineate the ARA, a series of steps using GIS technology are used. Out of 900,000 acres in the watershed, 46% is ARA (414,780 acres). A standard Operating Procedure(SOP) follows to detail how the model was applied to the Strategy.

STANDARD OPERATING PROCEDURE
GLRI
ACTIVE RIVER AREA OF THE NIAGARA RIVER WATERSHED

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Problem: To create an Active River Area of the Niagara River Watershed region. This framework identifies five subcomponents of the active river area:

- Material Contribution Zones
- Meander Belts
- Riparian Wetlands
- Floodplains
- Terraces

Reference: *Active River Area (ARA) Three-Stream Class (3SC) Toolbox Documentation*, by Analie Barnett, The Nature Conservancy- Eastern Division. June 2010.

GIS Software:

- **ArcGIS 10** with Spatial Analyst extension
- *Active River Area (ARA) Three-Stream Class (3SC) Toolbox arcGIS9v3_ARA_3SC_Toobox_June20100*
    - *ArcToolbox provided by The Nature Conservancy*
    - *Note: Tool labeled "ARA Data Prep 1: Streams Data" does not load properly. Model was followed to complete this step by hand*
    - *Computer workspace: F:\BNR\2010\GLRI\DATA\ARA*

Spatial Scale of Analysis:

- 1:24000 waterways (USGS National Hydrography Dataset)
- 10m Digital Elevation Model
- ***All analysis output is in raster format, at 10m resolution.***

At this analysis scale, meander belts, riparian wetlands, floodplains and lower terraces could not be separately distinguished in the Eastern regional scale model (p.2).

GIS Data Layers:

- **10m Digital Elevation Model (DEM)**
    - Slope : Derived from DEM, using ArcGIS Spatial Analyst
- **1:24000 USGS National Hydrography Dataset (NHD) – lines and polygons**
    - Stream order values are required to use the ARA Toolbox
    - Stream order was unavailable for the 1:24K NHD data, but was available for the 1:100K NHDPlus data. Stream order attributes from the 1:100K data were assigned to the 1:24K data. Detailed streams found only in the 1:24K were assigned by hand.

Methods:

1. **Assemble model inputs**
   - 1:24K stream linework with stream order
     - Lines and Polygons (lakes)
   - 10-meter DEM

2. **Categorize stream/river size classes**
   - *(corresponds to Toolbox steps: ARA Data Prep 1: Streams Data and ARA Data Prep 2: Lakes Data)*

   - Add column called GRDCODE to streams by order into three groups:
     i. **2** = Headwater streams (1st and 2nd Order)
     ii. **5** = Small to medium streams (3rd and 4th Order)
     iii. **7** = Larger streams and rivers (5th Order)

   - Separate polygons (lakes) into four groups:
     i. **2** = Lakes connected to Headwater streams (1st and 2nd Order)
     ii. **5** = Lakes connected to Small to medium streams (3rd and 4th Order)
     iii. **7** = Lakes connected to Larger streams and rivers (5th Order)
     Note: NO 7 VALUES EXIST IN NIAGARA RIVER WATERSHED
     iv. Isolated Lakes are removed and placed in a new layer named 'IsolatedLakes'

   - Convert vector hydrography (line) into a 30m raster grid: INPUTWAT_LINE
   - Convert vector hydrography (polygon) into a 30m raster grid: INPUTWAT_LAKE
   - Combine both raster datasets to create: INPUTWAT
     i. Cell values of **INPUTWAT** are: 2, 5, or 7
     ii. Extract value of **2** to create raster file: **HDWATERS**
     iii. Extract value of **5** to create raster file: **MEDIUM**
     iv. Extract value of **7** to create raster file: **RIVERS**

ARA Step 1: Option A - Create Cost Distance Surface, Does not Fill DEM

- **Required data:** HDWATERS, MEDIUM, AND RIVERS rasters and ELEVATION (to derive slope)
  i. p. 19, Do not fill DEM sinks. *A **sink** is a cell or set of spatially connected cells whose flow direction cannot be assigned one of the eight valid values in a flow direction raster. This can occur when all neighboring cells are higher than the processing cell or when two cells flow into each other, creating a two-cell loop. Sinks are considered to have undefined flow directions and are assigned a value that is the sum of their possible directions. For example, if the steepest drop and, therefore, flow direction are the same to both the right (1) and left (16), the value 17 would be assigned as the flow direction for that cell. To create an accurate representation of flow direction and, therefore, accumulated flow, it is best to use a dataset that is free of sinks. A digital elevation model (DEM) that has been processed to remove all sinks is called a depressionless DEM.*
- USER PARAMETER: none

- **Output data:**
    i. ***Output Allocation:*** allocates an area of influence for HDWATERS, MEDIUM, and RIVERS layers
    ii. ***Slope:*** *Identifies the slope (gradient, or rate of maximum change in z-value) from each cell of a raster surface. Here, measured in degrees.*
    iii. ***Flow Accumulation:*** *The result of Flow Accumulation is a raster of accumulated flow to each cell, as determined by accumulating the weight for all cells that flow into each downslope cell. Output cells with a high flow accumulation are areas of concentrated flow and can be used to identify stream channels. Output cells with a flow accumulation of zero are local topographic highs and can be used to identify ridges.*
    iv. ***Cost Distance***: *Calculates the least accumulative cost distance for each cell to the nearest source over a cost surface. Here, based on SLOPE.*

ARA Step 2: Reclass Cost Distance Surface

- Reclass the cost distance grids generated for each stream/river size class based on user defined threshold for each stream/river size class
- Purpose: creates a base riparian flood zone and the wetflat zone for each stream size class
- USER PARAMETER:
    i. Page 24 : I used the RECLASS tool to determine how much of the project area contained a slope of 0 degrees.
    ii. Category 1 : 0°-0.25° slope: **19%**
    iii. Category 2 : 0.25° - 0.5° slope: **13%**
    After discussion with BNR, **Category 2** was used
- **Output data:**
    i. Fldzone, Fldzone2, Fldzone5, Fldzone 7 : Flood zones
    ii. Wfzone, Wfzone2, Wfzone5, Wfzone7: Wetland flats: *used as a mask in Step 4 to limit the area from which wetflat cells can be grabbed.*
    iii. Fldzone and Wfzone output layers are the same

ARA Step 3: Create Moisture Index to Build Wetflats

- Inputs: Slope; Flow Accumulation; Elevation. Not based on Step 2 at all.
- Generate a moisture index using **slope** and **flow accumulation** to identify riparian areas that are likely to be wet as a result of high groundwater and overland runoff from adjacent uplands
- USER PARAMETER: none
- **Output data:**
    i. Moisture Index (Moistind) converted to Moisture Integer (Moistint)
    ii. Fmean: Focal mean of the Moisture Index

ARA Step 4: Option A – Refine Wetflats and Add to Base Riparian Zones

- Refines the moisture index created in Step 3 to create a wetflat grid where moisture is high (**low slope and high flow accumulation**). Identify wet areas that overlap with the base riparian zones and are within the wetflat grab zone generated in Step III. Combine the base riparian zones and the wetflat zones into a single grid, assigning unique codes to identify the different components of the Active River Area.
- USER PARAMETER: threshold: **1,000**

i. Determine threshold to identify cells likely to be wet based on high flow and low slope. All values less than the threshold are set to 100 and represent “wet” cells.
ii. Compare fmean layer to hydric soils and nwi layers
iii. Classified values into 10 natural break classes, compared fmean raster values to nwis and hydric soils. An fmean value of 500 and greater seemed to correlate with nwis and hydric soils well.
iv. Model crashes when used ‘out of the box’. Must use in Model Builder…
    1. Had to create WET layer outside of model, using the Raster Calculator. Once the WET portion was removed from Model and all other model parameters were set, it ran successfully.

ARA Step 5: Generate Non-Headwater Material Contribution Zones (MCZs) and Add to Base Riparian Zones and Wetflats

- Delineate the non-headwater material contribution zones, and combine with the base riparian zones and wetflat zones
    - USER PARAMETER: buffer zone for all 1:24K waterways
        - Buffer zone used was **100 feet** (30m)
    - Output Data: completed refined active river area that now includes MCZs