APPENDIX B
PROPOSED PROTOCOL FOR DETAILED DESIGN APPROACH

The objective of this Appendix is to provide a checklist for the Detailed Design Approach. The checklist may be modified to fit a specific project or site as required.

STEP 1: Project Goals and Objectives, Channel Characterization and Study Scope

This STEP is designed to provide a framework for further investigations by establishing the project goals and objectives, providing a preliminary characterization of the channel system and possible disturbances, and defining the spatial scope of the investigation.

DATA COLLECTION

1. Collection and Review of Existing Documentation
   a) Land use and topographic mapping, aerial photography
      i) historic
      ii) existing
      iii) future
   b) Infrastructure mapping
   c) Background reports, surficial geology (physiographic) mapping
   d) Hydrometeorological data
   e) Regional flow-geomorphic data
   f) Historic channel surveys
      i) engineering drawings (bridge crossings, channelization works, pipeline crossings, etc.)
      ii) geomorphic-sedimentologic surveys
      iii) geotechnical studies (soils or borehole data)
2. Desktop Analyses
   a) Longitudinal channel profile
   b) Estimated bankfull flow
   c) Anticipated channel form
3. Synoptic Field Survey
   a) Site Reconnaissance and completion of a Rapid Geomorphic Assessment (RGA)
   b) Classification of Stream Type

ANALYSIS

1. Determine Total Basin Imperviousness (TIMP)
2. Assess past changes in sediment-flow regime
3. Determine tributary area
4. Re-construct land use and channel works history
5. Preliminary Mapping of ‘like’ reaches

6. Compare historic channel form with current form
7. Assess channel stability and probable mode of alteration
8. Assess the significance of prior disturbances on channel form
9. Determine if the channel is currently in a state of adjustment
10. Identify constraints and opportunities for Stormwater Management (SWM) measures

STEP 2: Identification of Causative Factors

If a prior disturbance has had a significant impact on channel form and the channel is in a state of adjustment, then undertake the following analysis. Otherwise proceed to Step 3.

DATA SOURCES

1. Existing documentation (STEP 1)
2. Empirical Relations
   a) Channel Enlargement Curve
   b) Mesoscale Channel Form Relaxation Curve

ANALYSIS

1. Identify the probable cause and magnitude of the disturbance(s)
2. Select a methodology for assessment of the impact of the disturbance(s) based on (1.) above
3. If a natural phenomenon, assess whether the disturbance is endemic to the channel system or an external event
4. If the disturbance is anthropogenic in origin determine the timing and magnitude of the disturbance and the likely alteration in the flow-sediment regime. For example, if the impact is due to urbanization:
   (a) Determine the fraction of the tributary area for which land use alteration has occurred for 5 to 6 time periods (10 years for each period) beginning with the current year and moving backwards in time
   (b) Determine the TIMP for each period
   (c) Determine the area weighted average age of development (t_i) for each period
   (d) Estimate the relaxation time
   (e) Approximate the degree of completion of the adjustment process from the Relaxation Curve
   (f) Estimate the ultimate channel enlargement ratio under existing land use conditions and drainage practices from the Channel Enlargement Curve
   (g) Determine the amount of channel enlargement that is yet to occur
   (h) Determine the significance of other factors, e.g., knickpoints, sediment waves, hydraulic controls, channel works, localized perturbations in the flow regime, etc.

STEP 3: Reconstruct the Historic (Pre-Disturbance) Channel Form

The previous assessment of historic channel form represented a preliminary estimate of channel hydraulic geometry. This STEP involves a more rigorous definition of the historic channel form if deemed necessary. Otherwise proceed to STEP 4.

DATA SOURCES

1. Existing documentation (STEP 1)
2. Personal accounts
3. Empirical Relations (STEP 2)
4. Paleo-fluvial techniques
5. Field survey data (STEP 5)

ANALYSIS

1. Re-construct the pre-disturbance channel form from historic surveys and/or paleo-fluvial techniques
2. If the historic surveys were taken subsequent to the de-stabilization of the channel use hindecasting techniques, such as the Relaxation Curve, to estimate the pre-disturbance channel form
3. Confirm the hindecaste estimation of the pre-disturbance form using a regional data base (if available), geomorphic indicators (see STEP 5), personal accounts, oblique and aerial photographs, historic mapping, and/or paleo-fluvial techniques
4. Estimate the bankfull hydraulic geometry parameters

STEP 4: Assess the Impact of Future Disturbances Using Empirical Relations

Assuming that the development project were to proceed without the implementation of SWM control measures determine the probable impact on channel morphology.

DATA SOURCES

1. Existing documentation (STEP 1)
2. Empirical Relations (STEP 2)

ANALYSIS

1. If it has been determined from the pervious STEPS that the channel is evolving toward a new equilibrium position in response to a past disturbance, then this alteration in form must be accounted for in this STEP
2. Assess the impact of future land use change
   a) determine the t_i under future land use conditions
   b) determine the total directly connected impervious area under future land use conditions
   c) assess the impact of proposed SWM measures for erosion control
3. Determine the ultimate Enlargement Ratio

4. Assess the impact of other contributing Factors (assumed to be secondary to the change in flow regime associated with urban development)
5. Determine the increase in Enlargement Ratio between existing and future land use conditions
6. Identify constraints and opportunities if different from STEP 2

STEP 5: Existing Channel Dynamics

The preceding analysis have relied primarily on existing data sources, with the possible exception of the paleo-fluvial investigations. The remaining STEPS are based on the collection of field data characterizing the current channel form.

DATA SOURCES

1. Field Survey
    a) Geodetic survey of channel longitudinal profile (along the channel thalweg). A fixed longitudinal spacing for measurement of the bed profile can be adopted if the selected interval is approximately 1/5 the length of the shorter of the pool or riffle features. If a fixed interval sampling protocol is selected, measurements should also be recorded at all major break of slope points.
    b) Geodetic survey of the channel cross-section:
        i) select a representative number sites for detailed sections
        ii) select a number of sites for less detailed study
    c) For each of the detailed sections:
        i) map bank stratigraphy
        ii) characterize the bank materials
        iii) map root zone depth
        iv) determine root density
        v) characterize the riparian vegetation
        vi) complete a pebble count survey
        vii) map bankfull stage indicators
        viii) prepare photographic documentation
        ix) sketch bank profile noting location of bankfull indicators, soil strata, terraces, root zone depth, etc.
        x) sketch channel plan form geometry up and downstream of the survey section
2. Regional Data Base (if available)

ANALYSIS

1. Determine channel hydraulic geometry relations
2. Determine sediment mass curves
3. Develop shear stress vs. depth curves
4. Develop stream power relations
5. Estimate critical shear stress values for selected boundary stations

6. Plot the longitudinal profile
7. Plot the cross-sections
8. Determine hydraulic parameters such as Manning's 'n' value, water surface slope, flow rate versus depth, etc.

STEP 6: Observed Channel Response

If a significant prior disturbance has occurred, then the actual response of the channel to the disturbance must be estimated and its impact on the proposed development project assessed. Otherwise proceed to STEP 7.

DATA SOURCES

1. Field Survey (STEP 5)
2. Historic channel form (STEP 3)
3. Pre-disturbance channel form (STEP 3)
4. Empirical relations (STEP 1)

ANALYSIS

1. Determine actual Channel Enlargement Ratio using the current channel form as measured in STEP 5 and the estimated pre-disturbance form as determined in STEP 3
2. Plot the actual Channel Enlargement Ratio on the Channel Enlargement Curve to validate the estimate of ultimate channel form completed in STEP 3
3. Determine actual channel evolutionary state using the Relaxation Curve
4. Identify the mode of channel enlargement and the probable, ultimate channel plan and cross-sectional form

STEP 7: The Need For Mitigation and the Development of Channel Remediation Strategies

Based on STEPS 4 and 6 assess the:

(a) need for mitigation of the channel due to past disturbances and the probable impact from the proposed development project
(b) develop channel restoration alternatives (if required)

DATA SOURCES

1. Dimension of the ultimate channel form (STEP 6)
2. Goals and objectives (STEP 1)

ANALYSIS

1. Determine if the ultimate channel form and its function meet the project goals and objectives
2. Based on (1.) above assess the need for and feasibility of remediation

3. Identify constraints and possible remediation strategies
4. Develop SWM design targets

STEP 8: Watershed Management Strategies

Develop a SWM program that addresses the predicted impact on channel form and function relative to project goals and objectives using the design criteria developed in STEP 7.

DATA SOURCES
1. All previous STEPS
2. Hydrologic-hydraulic and sediment transport models

ANALYSIS
1. Identify SWM alternatives (each alternative is comprised of a suite of management practices)
2. Develop a decision support algorithm for use in the evaluation of the SWM alternatives
3. Evaluate the SWM alternatives and select a preferred approach
4. Undertake the preliminary design and costing of the preferred approach
   (a) locate the required SWM facilities
   (b) develop the appropriate implementation programs
   (c) design the end-of-pipe facilities by establishing the:
      - contribution of lot level and conveyance controls
      - the active storage volume in the end-of-pipe facility
      - the rating curve for the pond outlet structure (Appendix D)

STEP 9: Selection of the Preferred Channel Restoration Strategy

Once the SWM program has been established, the final assessment of the channel restoration options may be completed resulting in the selection of a preferred restoration program. If channel restoration is not required, proceed to STEP 10.

DATA SOURCES
1. Dimension of the ultimate channel form (STEP 6)
2. Goals and objectives (STEP 1)
3. Existing data sources (previous STEPS)
4. Constraints and opportunities mapping (STEP 7)

ANALYSIS
1. Translate generic design alternatives into site specific remediation options
2. Develop cost estimates
3. Select a preferred channel restoration alternative

STEP 10: Preferred Restoration Plan

DATA SOURCES

1. Funding mechanisms
2. Cost estimate (STEP 9)
3. Land use plans (STEP 1)
4. Stewardship partners
5. Monitoring requirements
6. Land use activities (STEP 1)
7. Stormwater management policies (STEP 8)
8. Construction opportunities and constraints

ANALYSIS

1. Identify funding partners, requirements and funding formulas
2. Identify phasing options and schedule
3. Identify stewardship options
4. Identify monitoring strategies (baseline, during and after construction)
5. Develop an Implementation Plan

STEP 11: Detailed Design

Prepare detailed design drawings and specifications for the SWM facilities and stream restoration works as required.

DATA SOURCES

1. Design relations and criteria from previous STEPS
2. Location of aggregate mines, quarries and disposal sites
3. Transportation route mapping
4. Constraint mapping from previous STEPS
5. Cost estimates from previous STEPS
6. Hydraulic, hydrologic and sediment transport models
7. Monitoring requirements from previous STEPS

ANALYSIS

1. Erosion threshold analysis
2. Plan and cross-section details
3. Bed armor specifications
4. Evaluate scour and deposition scenarios for possible service corridor conflicts
5. Outline a detailed monitoring program for key geomorphic and habitat variables
6. Complete geotechnical analyses of banks as required
7. Relocate services as required
8. Identify construction periods for instream work, access routes, material supply sites, haulage routes, fill disposal areas, etc.

9. Prepare detailed design drawings, landscape plans, specifications and tender documents as required
10. Undertake construction supervision (if required), and
11. Revise cost estimates
12. Implement baseline and during construction monitoring
13. Undertake any other tasks deemed necessary

Note: The above list of tasks and data sources is not exhaustive. Proponents are expected to undertake the design in accordance with their own specifications and requirements as identified by the proponent for any particular project.