GISmo Solutions Ltd.

Watershed and Stream Classification Project

for the Foothills Model Forest

Chisholm / Dogrib Fire Research Initiative
Data Entities / Process Descriptions

foothills MODEL FOREST
research growing into practice.

MODEL FOREST NETWORK
RÉSEAU DE FORÊTS MODÈLES

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Data Entities / Process Descriptions

The project context overview is presented in the form of VISIO diagram with corresponding data entities and process outline descriptions. Several, more detailed flow diagrams are intended as a documentation and as a guide for project execution and for communication with client on specific data issues, tasks and selected solutions.

The following diagrams were generated:

FMF_Context	**-** Project Context Diagram.
FMF_P0_OVERVIEW	**-** Project overview flow diagram
FMF_P1_HYDRO_NET	- Correction / Classification of single line stream network
FMF_P2_DEM	- Creation of hydrologically corrected DEM
FMF_P3_WATERSHEDS	- Creation of watershed polygons and related attributes
FMF_P31_REACHES	- Delineation and Classification of Stream Reaches
FMF_P32_WSD_EDIT	- Watersheds edit sub-process

1.0 Contex Diagram Data Entities Descriptions

Major entities and data stores are described in the following list. Interim data sets may only be outlined on on VISIO diagrams.

E1 Project Requirements Entity This entity represents project requirements as expressed in the Request for Proposal, and in the additional documents prepared following a project meeting on April 17, 2002.

E2 RDB BF SDE Repository Resource Data Branch, Alberta Sustainable Resource Development (ASRD) maintains a Spatial Database Engine (SDE) repository, that

contains several data layers including Hydrography, Hypsography and Access Map Base information. Data is stored in geographical projection and NAD83 datum as various spatial and ORACLE database entities.

E3 Source Data Sets Entity represents data provided by Resource Data Branch

ASRD. Seamless DEM 25m grid data , Hydrography and Base Map information was extracted from SDE repositories and formatted for GIS use. Data projection is UTM zone 11, NAD83 datum. Two separate seamless sets are provided for Chisholm, and Dogrib areas.

E4 QC Report Corrections and modifications to source data may require client's

validation or feedback. The related Quality control report will be generated in initial phase of this project.

E5 Hydrologically Corrected DEM (TOPO) This data entity represents DEM

adjusted by a TOPOGRID process using a final, adjusted and corrected single line network, contours and lakes. This ARC/INFO grid coverage for study area with a 25m resolution (NAD83, UTM zone 11 geo-referencing) is available as seamless grid and as collection of tiles based on 1:20K map sheets. The final data set is partially filled (5m tolerance) to remove imperfections and minor depressions. Fully filled terrain, flow lines and contours used in the quality control process are included

E6 Streams Data Set *Classified Hydro Network* depicts Strahler classified single line

stream network built with primary and secondary flows. Source data may be adjusted (directionality, ps-flow, connectivity, Inflow class) but a direct link to RDB repository is maintained as BF_ID attribute.

Classified Stream Reaches depict data set delineated from single line streams using topological and topographical breaks as per client request, and classified with attributes derived of DEM analysis such as downstream elevation, slope, drainage

area,etc. This data set corresponds to primary flows only, and is used for watershed delineation.

E7 Watersheds This entity corresponds to a region polygon topology coverage created from Hydrologically Corrected DEM for individual reaches. Each reach has *Individual Reach Polygon* and *Upstream Contributing Area* in this data set.

E8 FMF Fish and Watershed Researches Primary Client

E9 Optional Deliverables

Stream Routes and Reach Events

Hydrocodes for Streams, Watersheds

Software Utilities(Upstream Aggregation, Route / Event support tools, Interactive Drainage delineation from DEM)

2.0 Data Entities Descriptions

D1 Base Features DEM ARC/INFO grids (NAD83, UTM zone 11 geo-referencing in e00 format) for requested 1:50K sheets with 25 meter resolution. Data was delivered as a seamless grid.

D2 Base Features Hydrography. Source Base Features Project hydrography was delivered as seamless SLNET, seamless polygon and seamless hydropoints information directly from RDD.

D3 Base Features Access / Base Maps. Additional base map source date from Base Features Project was provided by RD. (facilities chs_facil, hydrocarto

chs_hydcarto, pipelines chs_pipes, powerlines chs_power, raillines chs_rails, roads chs_roads)

D4 QC Report. Suggested changes to Base Feature data repository.

D5 Hydrologically Corrected DEM (CHS_TOPO, PCC_TOPO) This data entity represents DEM adjusted by a TOPOGRID process using final, adjusted and corrected single line network, contours and lakes. It is an ARC/INFO grid coverage for study area with a 25m resolution (NAD83, UTM zone 11 geo-referencing). PCC_TOPO is partially filled (5m tolerance).

D6 Hydrologically Corrected DEM (20K Tiles) This data entity represents DEM tiles That were not created for Chisholm / Dogrib project, but may be required as per Base Features Watershed project in future (TTM tiles for entire province)

D7 Single Line Hydrography (CSA_SLNET) Attributed single line stream network with all primary and secondary flows. Arcs correspond to Base Features elements (and have BF-ID link). Strorder attributes are added. A version of this coverage (CID_SLNET) intersected with polygon features is also created.

D8 Classified Stream Reaches (CHS_REACHES) Stream reaches delineated and attributes as per client requirements. Classification is also transferred to a downstream point for each reach (REACHPOINTS). Attributes include Strahler, gradient, class, accumulation area, sinuosity.

D9 Watershed Polygons (CHS_WSD) Polygons of watershed drainage areas, associated with individual arcs. Absreach attribute links polygons with a corresponding arc. Upstream aggregation regions are provided in this overage.

D10 Hydrologically Correct Filled DEM (AFC_TOPO) This data entity represents a filled version of corrected DEM: Several ArcInfo processes are used, including a FILL function. It is an ARC/INFO grid with 25m resolution (NAD83, UTM zone 11 geo-referencing)

D11 DEM Derived Flow Accumulation Grids . These coverages represent stream flow accumulation as derived from DEM. Two grid coverages (FIL_ACC_LIN, PACLIN) correspond to AFC_topo and PCC_topo surfaces

D14 Data/Process Documentation. ArcView data display project, VISIO process Diagrams, data set documentation, overview plot.

D20 Outline of Study Area Boundary (CHS_OUT) ARC/INFO shape polygon coverage created from watershed polygons coverage.

3.0 Processes

P1 Correction / Classification of hydro network

In this process the single line network is validated against BF specification and agreement with DEM data.
Validated are proper Primary/Secondary attributes, connectivity and directionality

of streams, then agreement with TOPOGRID processes and watershed creation processes. All detected issues and changes are recorded for client's approval. Strahler ordering of primary and secondary hydrography flows is applied.

P1.1 Create User Study Area Boundary. Two primary boundary data sets are created, one based on approximated Height of Land and the other on 1:20k map borders.

P1.2 Validate seamless DEM Sub-process of creation of required DEM. Grid MOSAIC process may be applied to create a seamless coverage.

1.2.1 GRID Mosaic (if multiple sets)
1.2.2 Clip DEM to extended outline boundary
1.2.3 Validate contour creation
1.2.4 Filter / correct spikes holes
1.2.5 Create contours. Validation of source DEM quality by 5m contours. If edge miss-match detected data is re-requested from data distribution or repaired locally.

P1.3 Prepare Lakes Lakes are extracted from hydrography polygon coverage (as large lakes are used in topogrid)

P1.4 SLNET Preparation & QC Validation against BF specification, addition of Strahler attributes (connectivity test), and clip to study area
Hydro QC: P/S flows, sinks/sources, directionality, gaps, zingers, adding missing centerlines & connections.
External information if required for incoming data is also analysed.

1.4.1 Validate link to BF repository BF data
1.4.2 Analyse / add inflows (NES data)
1.4.3 Clip data set for outline boundary (extend of hydrologically corrected tiles) and for study area
1.4.4 Run initial Strahler for detecting circular drainage and suitability check. (also connectivity and directionality validation)
1.4.5 Add data corrections attributes (Add edit_det, BF_edit_fl attributes Add sec_seg attribute = PS_flow)
1.4.6 Run initial route for naming and secondary segments errors
1.4.7 Minor initial hydro edits flip, P/S code

P1.5 Hydro/DEM QC process
Validation and edits related to discrepancies of SLNET and DEM. If SLNET is used in the TOPOGRID process the terrain may be significantly modified , where streams are set to flow in the wrong direction. The flows derived of DEM are also suggesting possible missed connectivity segments. Some errors were detected in the Chisholm area.

1.5.1 Adjust DEM by hydro. net (and lakes) and validate contours before/ after Topogrid
1.5.2 Fill DEM (partiall and full) . Derive arbitrary flows.
Analyze hydro/ DEM consistency issues
1.5.3 Hydro QC Edit
Complete / adjust nydro network
Connectivity edits (inc. centerlines, gaps,flip, DEM derived)
Primary / secondary flow coding
Sinks / sources circular drainage / zingers
1.5.4 Overlay with hydropolys (Identity for lake, wetland segments)

P1.6 Client Validation Some changes have to be validated by client according as per field check or local knowledge of area.

P2 Create Hydrologically Correct Digital Elevation Model

P2.1 Validation of input contours (for source terrain edge-match and other errors)

P2.2 Add set lakes elevations and correct DEM

P2.3 TOPOGRID An ARC/INFO process that enforces proper definition of the terrain using the stream network directionality , large lakes and contours as input.

P2.4 Derive accumulation flow (Taccum). (stream adjustment – connect)

P2.5 Validation of output contours (stream adjustment – flip)and flows.

P2.6 FILL A combination of ARC/INFO processes including fill function, that removes sink areas in the terrain to enforce complete drainage.

P2.7 Derive accumulation flows of AF_TOPO DEM. Some flows may be used to complete connectivity of network or to revise primary / secondary coding and connections.

P2.8 Derive watersheds and validate drainage basins with arcs connectivity.

P2.9 Validate flow lines and hydrography consistency.

P2.10 Optionally clip hydrologically corrected terrain for seamless study area.

P2.11 Create hillshade

P3 Create Watershed Information

This process contains: Delineation and Classification of stream reaches, Delineation of watershed polygons, Accumulated drainage analysis, and Defining upstream contributing area for each reach.

P3.1 Create Reaches

Delineation and Classification of Stream Reaches

3.1.1 Create topological routes with segments on primary flows
3.1.2 Analyze gradients and aggregate reaches (see appendix A- rules for reach aggregation)
3.1.3 Initial reach classification

P3.2 Create Watersheds

3.2.1 Create individual 'atomic' Watershed Polygons
3.2.2 Split attached slivers, eliminate "no-arc" polygons.
3.2.3 Watershed Polygon Edits. Process for removing sliver polygons, smoothing, and node snap.
3.2.4 Aggregation of polygons into Reach Regions.
3.2.5 Area Accumulation on Stream Reach Network.

P3.3 Data \ Process Documentation

These activities are related to data display in ArcView, VISIO data / process descriptions, documentation of delivery data set and creation of an overview plot.

4.0 Functional descriptions of watersheds related entities

W1 Hydrography Information

Natural and man made water and water related features correspond to streams, rivers, water bodies (lakes, glaciers, reservoirs), barriers (dams, falls)

- Allows to store point, line and polygon attributes and classifications.
- Allows for query, display and mapping of hydrography.
- Allows to visualize approximated watershed area.

W2 SLNET

Topologically connected water flow segments corresponding to streams (segments) and water bodies representation lines (centerlines)

- Allows to navigate network (up- / down-stream)
- Allows for linking arc attributes to corresponding drainage areas
- Allows to aggregate drainage area (flow etc) in hydrography network.
- Allows certain analysis and modeling processes (route creation, Strahler classification)
- Maintains a link and integrity between certain water bodies and stream network (centerlines). Some polygon water bodies ie. recurring lakes may not have a directly corresponding arc segment.

W3 ROUTES

Grouped and inter-connected water flow segments corresponding to complete sections of streams with a specific Strahler Order (embedding centerlines)

- Allows for data locating and classification using unique measurement system. (and database structures independent of spatial data partitioning)
- Allows for partitioning (segmenting) of streams into masured eg. 100m segments.
- Allows for linking more "global" attributes (ie total stream section length, highest magnitude, Strahler order).
- Allows for aggregated and more complex analysis (ie. where does a stream start, what stream connects to what major flow, at what distance etc)

W4 DEM

Digital representation of terrain allows GIS processes to display and analyze information. Usually as regular grid lattice, but alternative format as TIN, points, breaklines etc.

- Allows to identify basins , sub basins, non draining areas.

- Supports calculation of flow direction and accumulation.
- Allows to define derived flow lines (drainage network). It is not necessarily corresponding to the observed hydrography (but may represent flow connectivity corrections)
- Allows to create drainage areas for specific points.
- Allows to create drainage areas for specific arcs (and certain polygons)
- Allows for digital manipulation and analysis including enhancements and changes to terrain representation (filling, topogrid enhancements, smoothing noise removal)

W5 Hydrologically corrected DEM (TOPO surface)

Digital representation of terrain related to and reflecting hydrology features.
Could be a result of adjustments by GIS processes (such as TOPO flow enforcement, lake "flattening" etc) .

- Generation of derived flow lines closely resembling hydrography data used in the adjustment process.
- Allows for analysis and corrections of initial source DEM, SLNET and hydropoly data.

W6 Fully Draining DEM ("Filled" TOPO surface)

Digital representation of terrain modified for a more complete draining by adjusting (raising) elevation of all or selected depression areas and imperfections.
A result of digital manipulation GIS processes (such as FILL function).

- Generation of additional derived flow lines that may resemble flood condition.
- Creation of fully draining surface model for specific analysis.
- Allows for analysis and corrections of initial source and TOPO surface DEM, SLNET and hydropoly data. (eg adjustments to lake elevations underestimated in TOPO)

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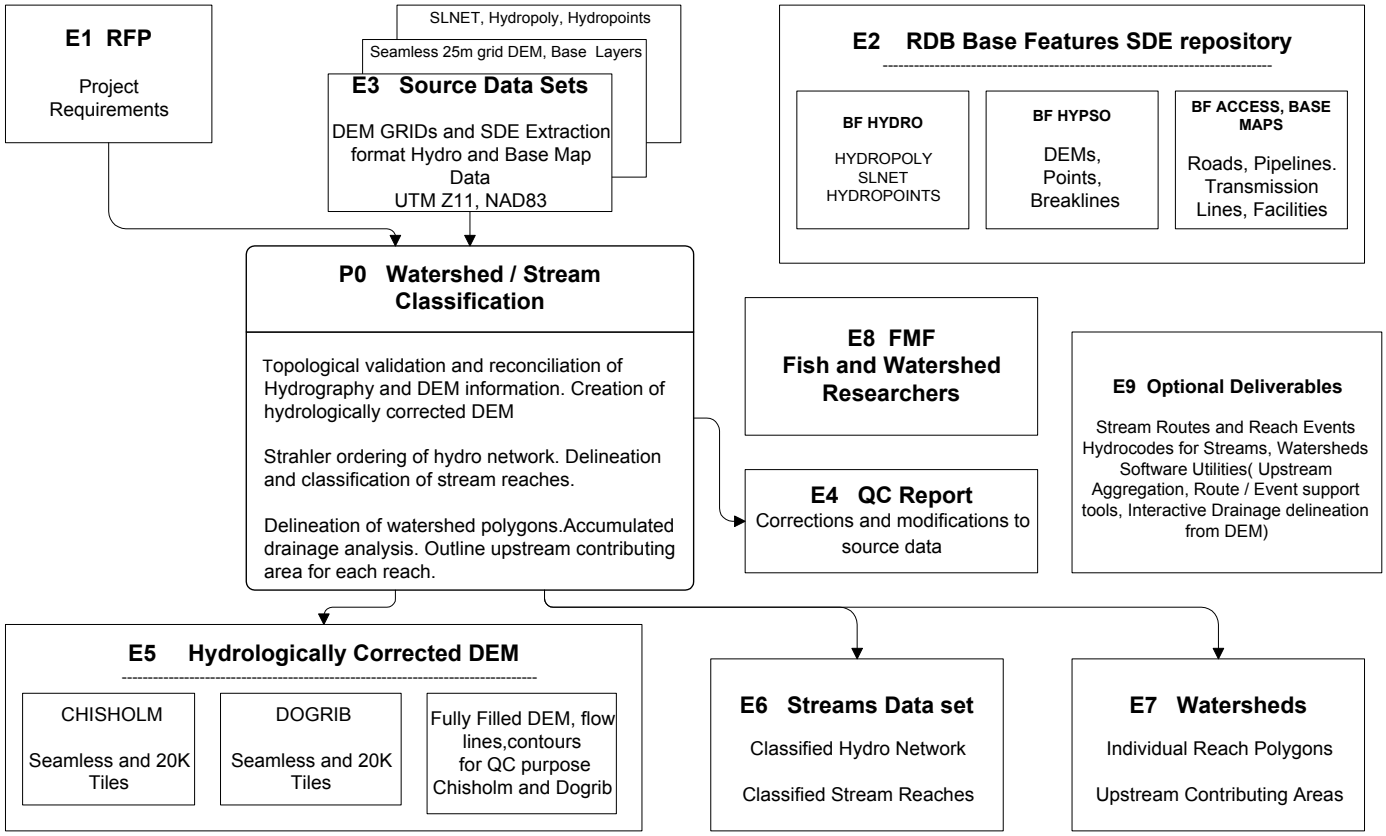
Project Context Diagram



FMF_context

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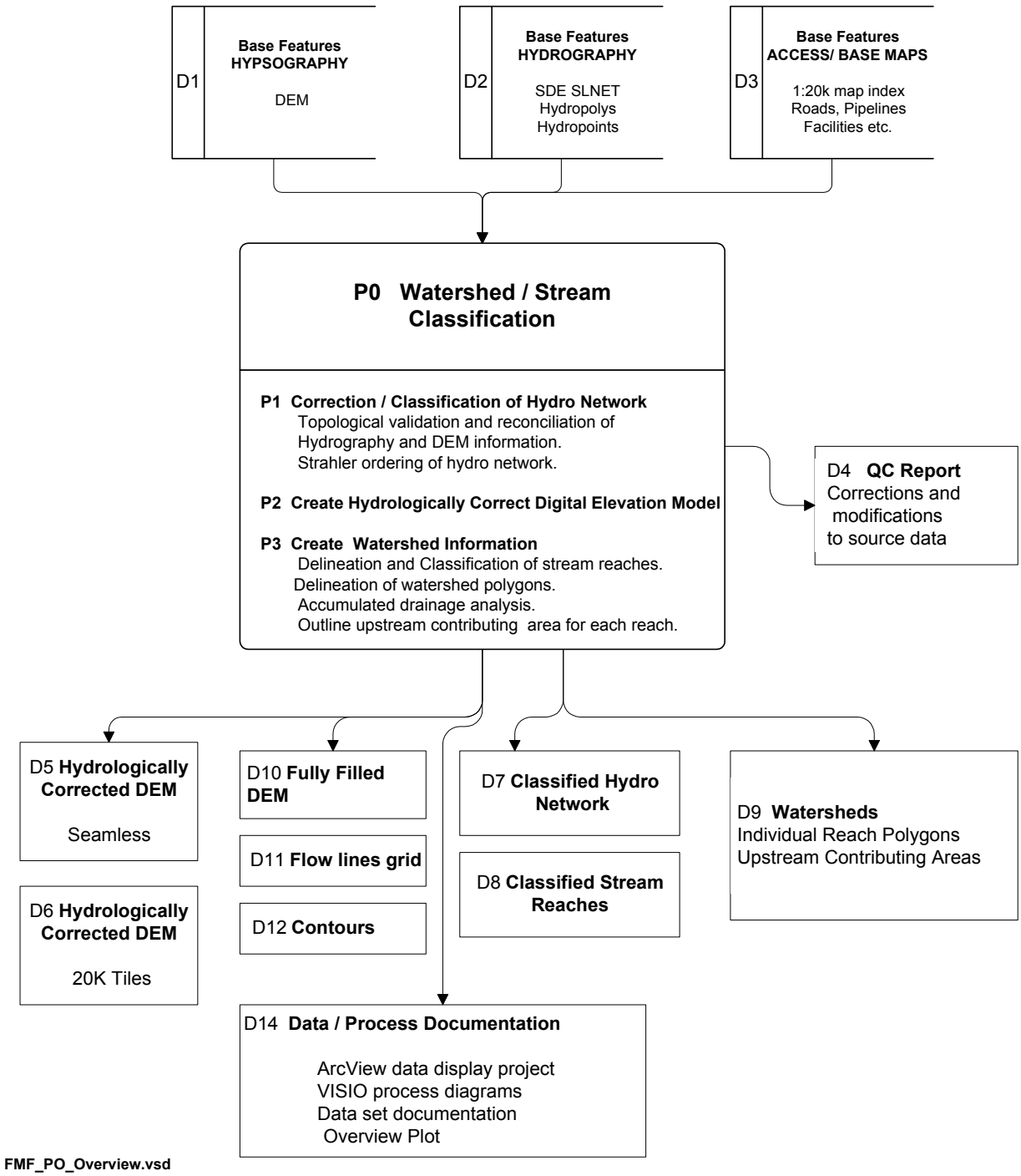
P0 - Overview



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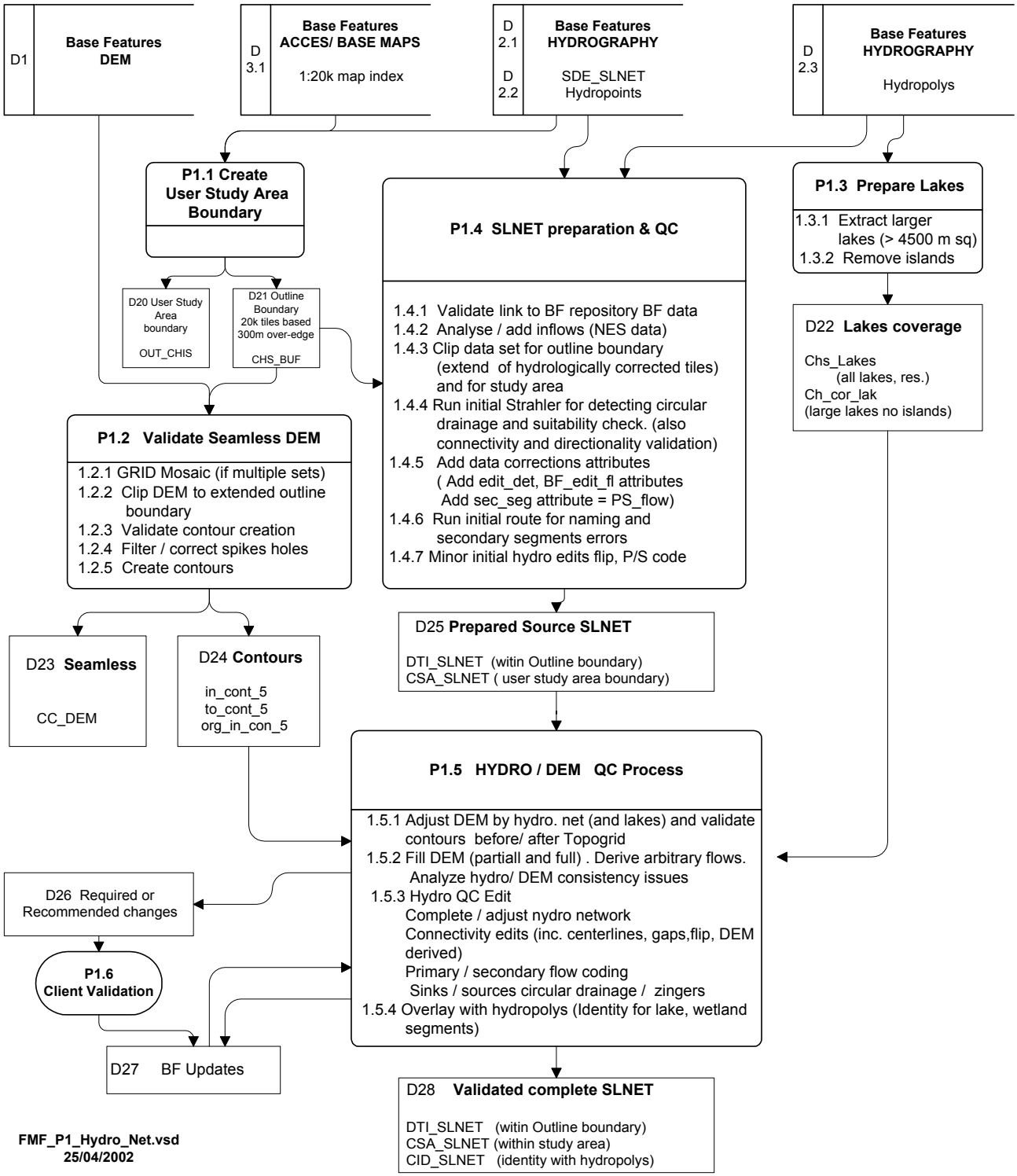
P1- Correction / Classification of hydro network



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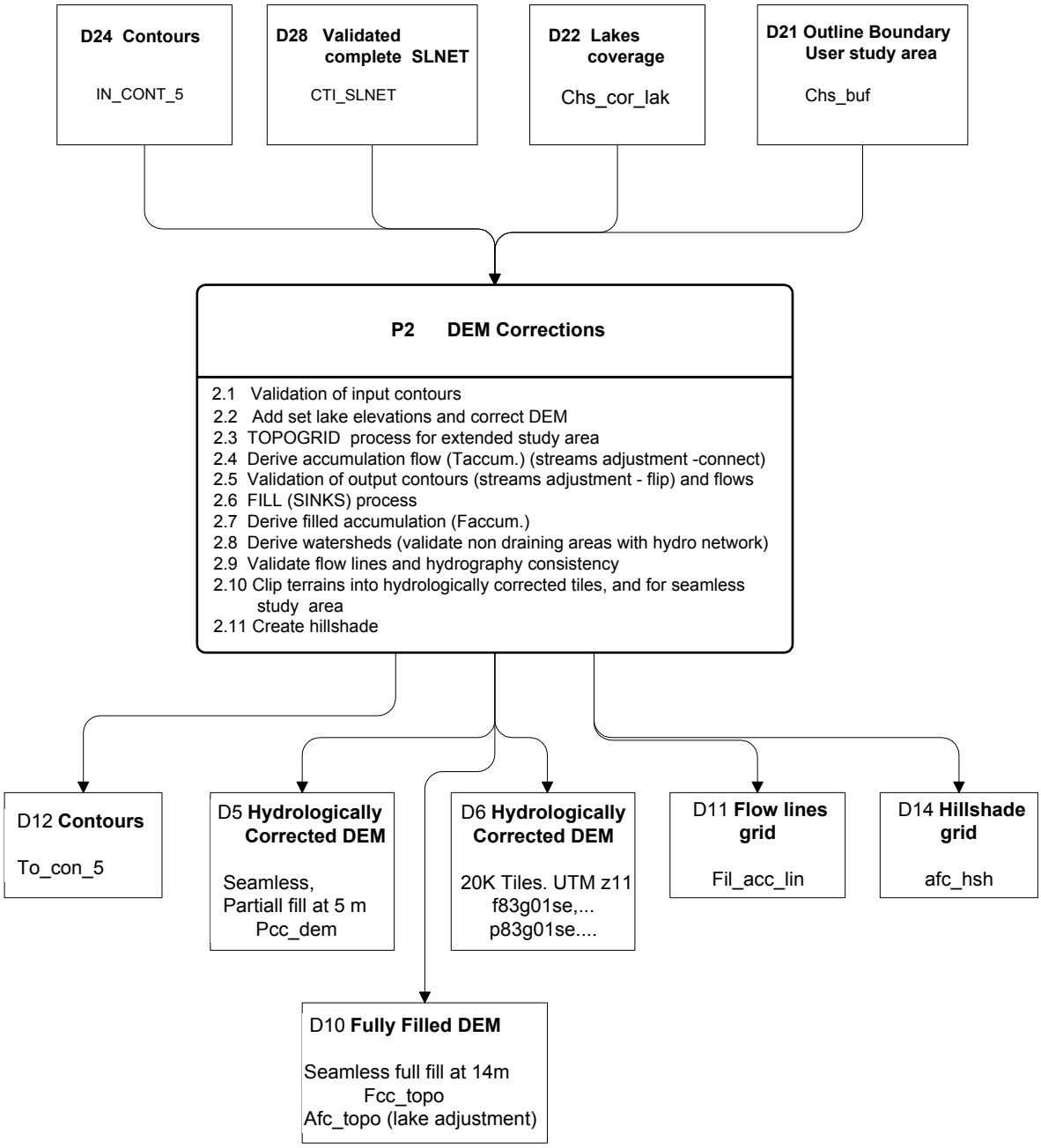
P2 - Create Hydrologically Correct Digital Elevation Model



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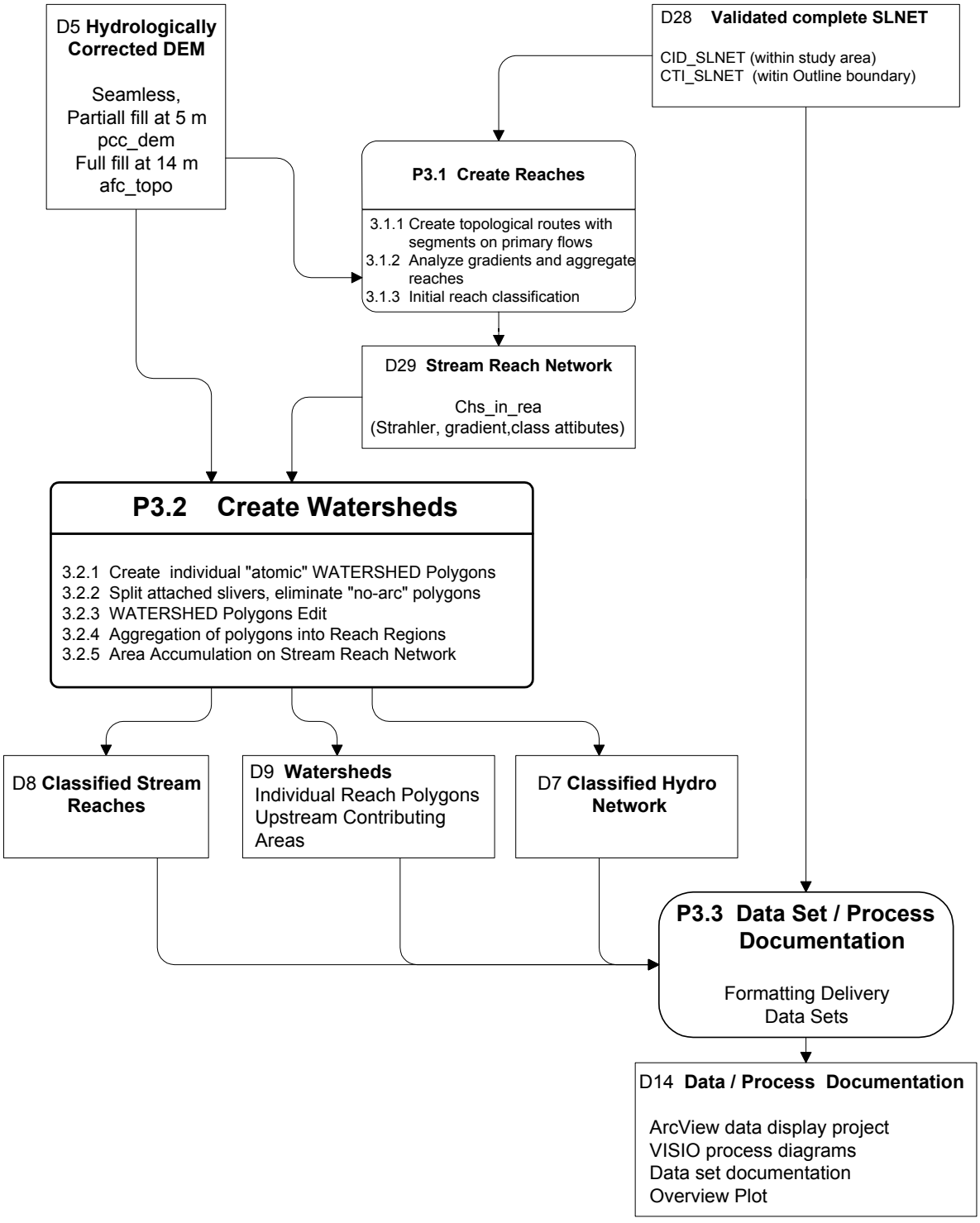
P3 - Create Watershed Information



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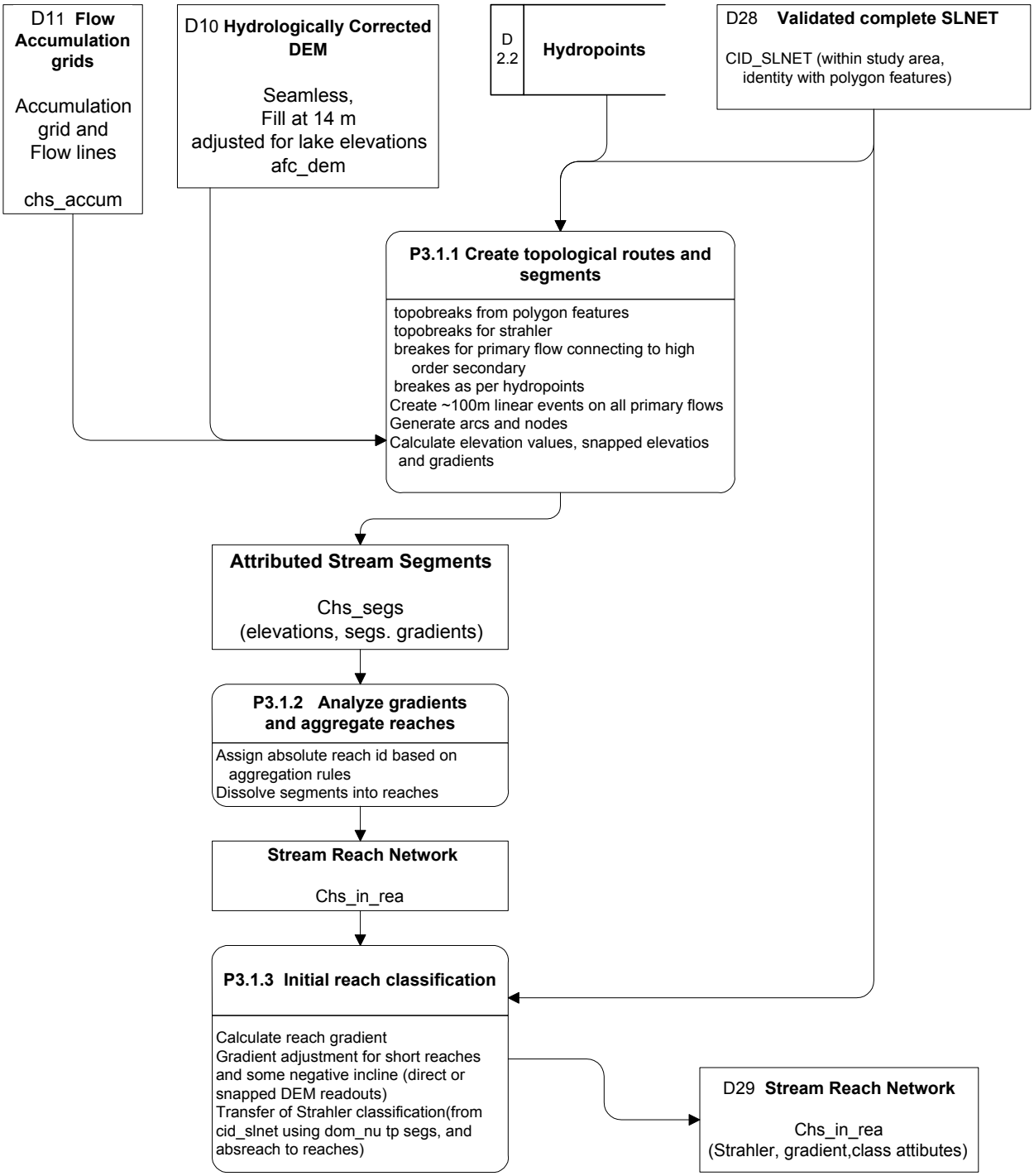
P3.1 - Create Reaches



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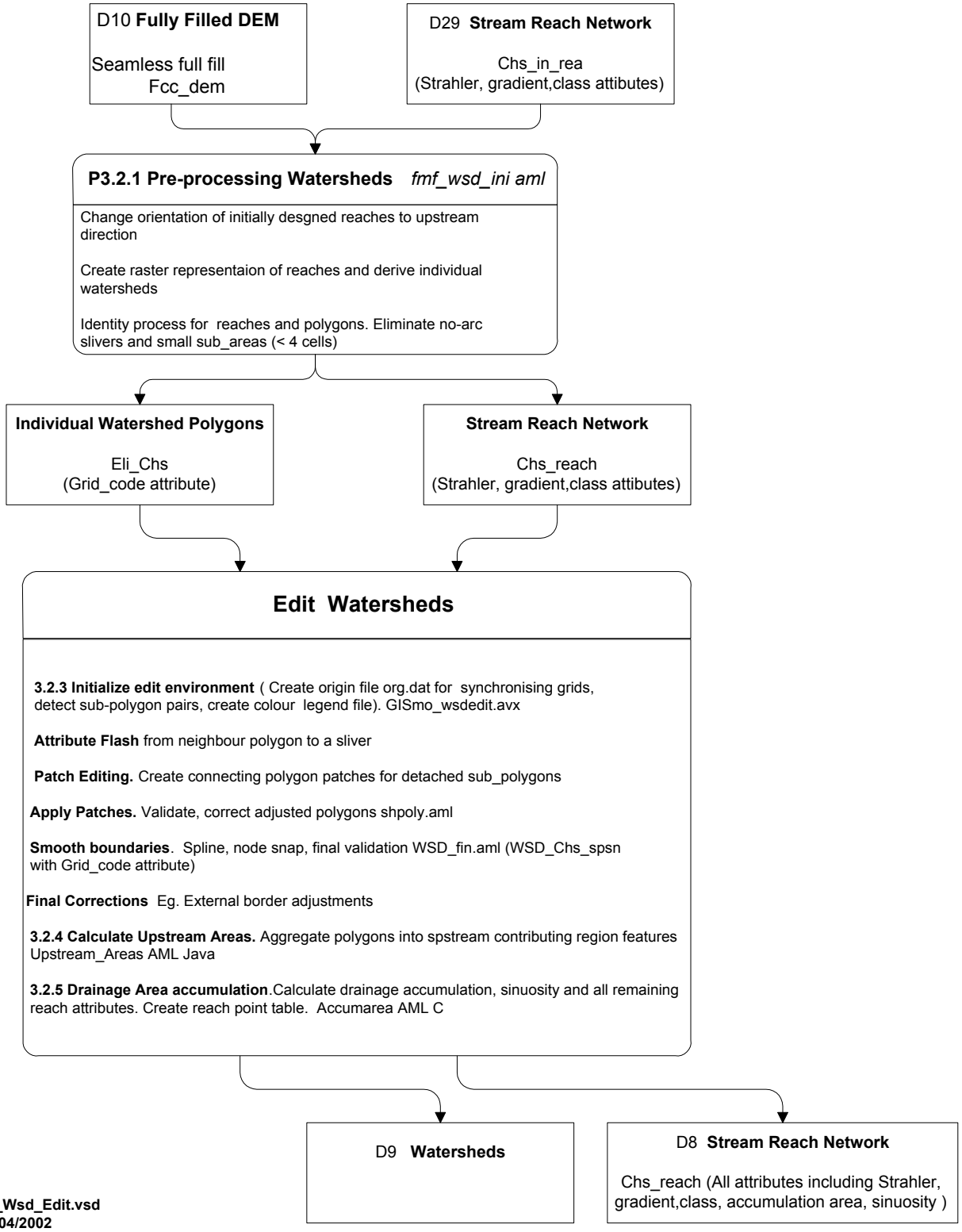
P3.2 - Watershed Editing Process



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