Freshwater Atlas

Watershed Boundary Drainage ID Requirements

Prepared for

Base Mapping & Geomatic Services
Integrated Land Management Bureau
Ministry of Agriculture and Lands

Prepared by

Refractions Research Inc.
#300 – 1207 Douglas Street
Victoria, BC
www.refractions.net

Document Tracking

Version: 3

Last Updated: July 24, 2007

REVISION HISTORY

Date	Version Number	Comments
July 24, 2007	4	Reformatted, renamed, and removed integration section to separate document. Updated the QA checks sections.
June 04, 2007	3	[EG] Updated the RWET-4, RSTREAM-1, RSTREAM-9 and RLAKE-5 requirements. Added an example for the RROUTE-1 requirement. These modifications are a result of generating watersheds on a sub-set of BC data and reviewing the results.
August 16, 2006	2	Requirement RSTREAM5 changed from not including 1410's at all, to including in-line 1410's and T 1410's but treating them differently for assigning drainage ids. Results in watershed boundaries being created at the sink of stream that flows into a T 1410. Requirement modified as a result of meeting between GE/MD/EG 2006-08-10 and subsequent discussions between GE/DG. In addition the construction lines rules were modified and a post processing section added.
August 1, 2006	1	Distributed to Technical Working Group.
July 17, 2006	0.6	Summarized requirements. Incorporated details of construction lines. Modified double-line river requirement.
June 29, 2006	0.5	Modified in-line lake requirement (RLAKE-2). Updated wetland requirements as per meeting decisions.
June 23, 2006	0.4	Incorporated comments from Martin.
June 15, 2006	0.3	Added addition wetland issues with proposed solutions.
April 3, 2005	0.2	Incorporated decisions/comments from March 31, 2006 technical meeting. Key item being watershed boundary lines will not be generated on the other side of double line rivers.
March 31, 2006	0.1	Initial Version.

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

1.1 PURPOSE

The FWA database contains data obeying a complex set of internal topological and hierarchical relationships. In order to ensure that the output from the Watershed Boundary Generator software produces correct and consistent boundaries, the hydrographic edges provided to it must be prepared in an appropriate fashion. This document specifies the requirements for preparation of the hydrographic edge dataset for input to the Watershed Boundary Generator software.

1.2 SCOPE

The requirements in this document are limited to the generation of watershed boundaries as specified for version 1.2 of the FWA.

This document does not provide detailed design specification for the generation of watershed boundary linework, which is provided in a separate document.

1.3 FWA EDGE TYPE CODES

Each edge has a corresponding code which describes information about the edge. The following table identifies the relevant codes and a short description of the code. Further information can be found in the FWA Technical Documentation.

Code	Description
100	Coastline
150	Construction line, coastline
1000	Single line blueline, main flow
1050	Single line blueline, main flow through wetland
1100	Single line blueline, secondary flow
1150	Single line blueline, secondary flow through wetland
1200	Construction line, main flow
1250	Construction line, double line river, main flow
1300	Construction line, secondary flow
1325	Construction line, segment delimiter
1350	Construction line, double line river, secondary flow
1375	Construction line, river delimiter

Code	Description
1550	Construction line, lakeshore
1600	Island shoreline
1625	Island shoreline shared with a wetland
1700	Wetland shoreline
1800	Double line blueline, right bank
1825	Double line blueline, right bank shared with wetland
1850	Double line blueline, left bank
1875	Double line blueline, left bank shared with wetland
1900	Island in river, right bank
1925	Island in river, right bank shared with wetland
1950	Island in river, left bank

Code	Description
1400	Construction line, other flow/inferred connection
1410	Construction line, network connector
1425	Construction line, subsurface flow
1450	Construction line, connection
1475	Construction line, lake arm
1500	Lake shoreline
1525	Lake shoreline shared with a wetland

Code	Description
1975	Island in river, left bank shared with wetland
2000	Single line, Canal
2100	Double line, Canal or Reservoir bank
2300	Single-line, Canal, secondary flow
6000	International/Provincial Boundary

2 REQUIREMENTS FOR HYDROGRAPHIC EDGE PREPARATION

2.1 CONCEPT

The preprocessing of the hydrographic network will produce a subset of edges with a drainage id attached. A drainage id is a number which identifies edges that should be in the same watershed. Any edges with the same drainage id will be a part of the same watershed. This input of hydrographic edges will be provided to the watershed generator to generate watershed boundaries.

2.2 REQUIREMENTS

RLAKE-1	Watershed boundaries will be generated around each input and output of a lake with multiple inputs or multiple outputs.
RLAKE-2	Watershed boundaries will not be generated for lake with a single inflow and a single outflow.
RLAKE-3	Watershed boundaries will not be generated for lake with a single outflow.
RLAKE-4	Watershed boundaries will be generated around isolated lakes.
RLAKE-5	Watershed boundaries will be generated at lakes that are broken by 1325 delimiter edges.

RSTREAM-1	At any single line stream confluence, watershed boundary linework will be generated on the opposite bank of the stream confluence.
RSTREAM-2	Where a single line stream flows into the left or right bank of a double line river, watershed boundary linework will NOT be generated on the opposite bank.
RSTREAM-3	Watershed boundaries will be generated around each input and output stream of a double line river with multiple inputs or outputs.
RSTREAM-4	Streams that widen into a double line river and back into a single line river with no inflows on either bank will not generate watershed boundaries.
RSTREAM-6	Non-isolated construction lines (1200, 1250, 1300, 1400, 1350, 1450, 1475) are used to determine connectivity and the location of stream confluences for the purposes of generating drainage ids, but are not provided as input to the watershed generator. Isolated construction lines are ignored.
RSTREAM-7	Known subsurface flows (1425's) are used to compute drainage ids and as input to the watershed generator.
RSTREAM-9	Watershed boundaries will be generated at double line rivers breaks that are broken by 1325 delimiter edges.

RINFER-1	Inline inferred edges (1410s) will be included as input to the watershed boundary software and treated similar to observed streams. As a result they will be given drainage id's that are the same as the input and output flow, and watershed boundaries will be generated around the entire stream.
RINFER-2	In cases where an observed stream or waterbody flows into a T inferred edges (1410s) the watershed boundaries should be generated from the sink node of the observed stream, or the waterbody outlet. To implement this, T inferred edges will be included as input to the watershed boundary software; however the drainage ids will be assigned to these such that the drainage id will be the same as the observed feature they flow into.
RINFER-3	In special T cases where a 1410 flows into two rivers the drainage id will be assigned as follows: If one stream is primary and the other is secondary the primary stream's drainage id will be assigned to the 1410 If both streams are secondary and new unique drainage id will be assigned to the 1410.

RROUTE-1	In absence of any other criteria, the watershed boundaries should respect the generated FWA routes. This rule affects both wetland construction lines (See Example 17) and inferred stream intersections.

RDELIM-1	Delimiter edges (codes 1550, 1325, 1375, 150) will not be included as input to the watershed boundary software.

RWET-1	Wetlands that contain or border only a single stream or lake will be treated similar to lakes and included as input to the watershed boundary software. Wetlands that border multiple in-line lakes that are given the same drainage id are also treated similar to lakes and included as input to the watershed boundary software. All other wetlands are excluded. The implications of this requirements are: Watershed boundaries will not be generated through included wetlands. All stream edges internal to a deliverable wetland and bank edges shared between a wetland and lake will not be included as input to the watershed boundary.
RWET-2	Watershed boundaries will be generated around isolated wetlands.
RWET-3	Wetlands with the same wb_key will be treated as a single wetland.
RWET-4	In cases where wetlands touch the ocean, the ocean will be treated similar to a lake with multiple inputs; however wetland bank edge that is shared with the coastline will be delivered.

2.3 EXAMPLES

The following examples show the outcomes (with artificial watershed boundary lines added) of the requirements listed above.

In these examples, the watershed boundary lines are drawn in light-grey dashed lines, the streams and banks are colored by the drainage area ids, the lake and double line river polygons are blue, and wetlands are in green. Any flow arrows represent the downstream direction.

2.3.1 Lakes

2.3.1.1 Example 1: General Case Lake

RLAKE-1	Watershed boundaries will be generated around each input and output of a lake with multiple inputs or multiple outputs.

In most cases if a 1410 flows into a lake it is not counted as an input to the lake. See Example 12 for the exception.

The following example shows how watershed boundary lines are generated at all lake inputs and outputs. The lake bank edges get a different drainage area id (20937) from any input or output flow edge (7022, 7656, 13408, 15905).

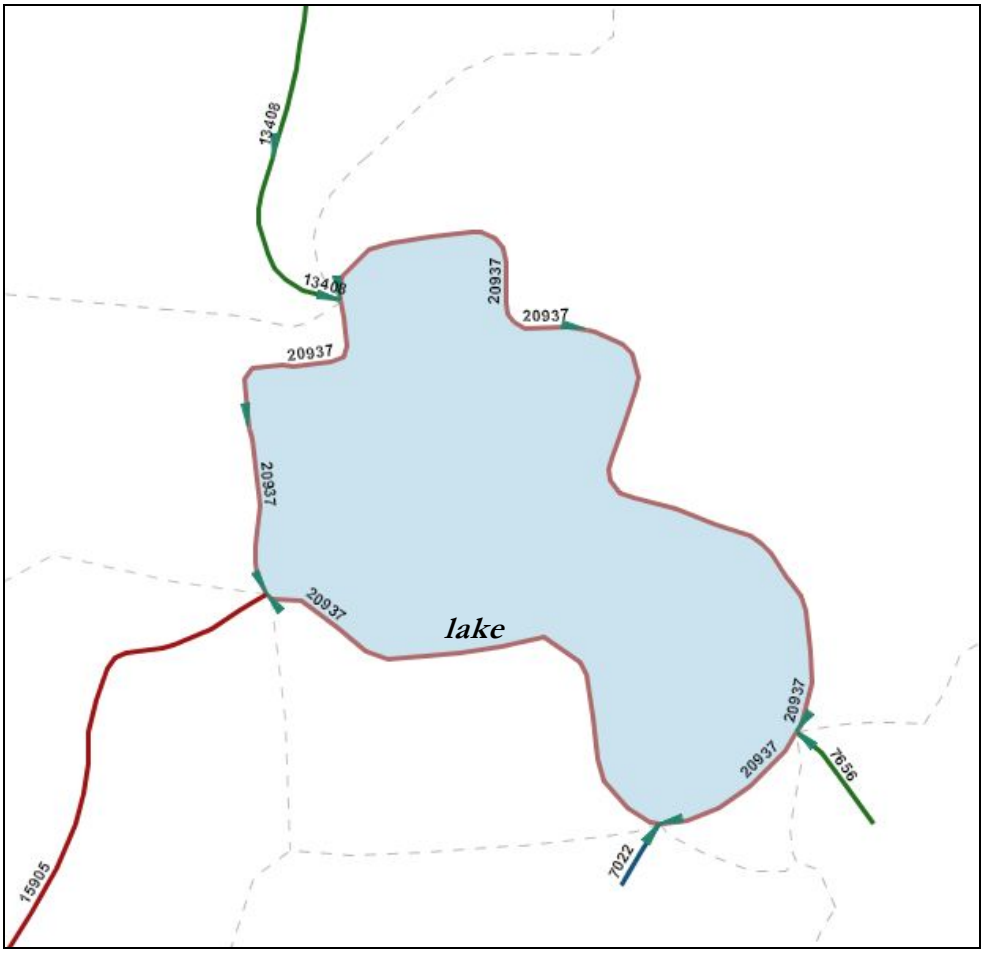


Figure 1: RLAKE1 – General Case Lake

2.3.1.2 Example 2: Source Lake

RLAKE-3	Watershed boundaries will not be generated for lake with a single outflow.

In Figure 2, the lake is the headwater of the stream so no watershed boundary lines are generated at the lake output. The lake bank edges get the same drainage area id as the output stream (8561)

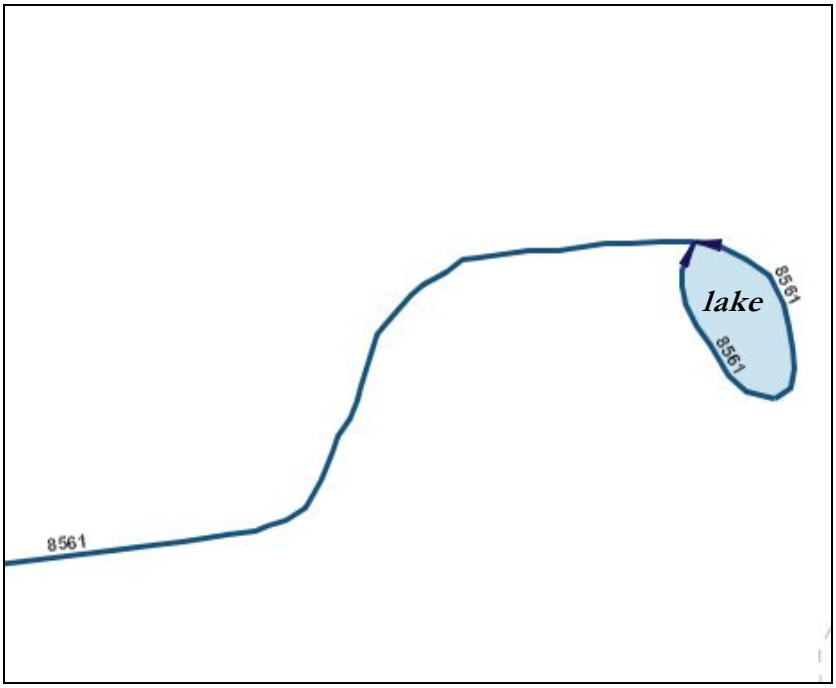


Figure 2: RLAKE-3 - Source Lake

2.3.1.3 Example 3: In Line Lake

RLAKE-2	Watershed boundaries will not be generated for lake with a single inflow and a single outflow.

In Figure 3, the lake has a single input and a single output. In these cases the lake banks and the input/output streams will be given the same drainage id. As a result watershed boundary lines will not be generated at the input or output to the lake.

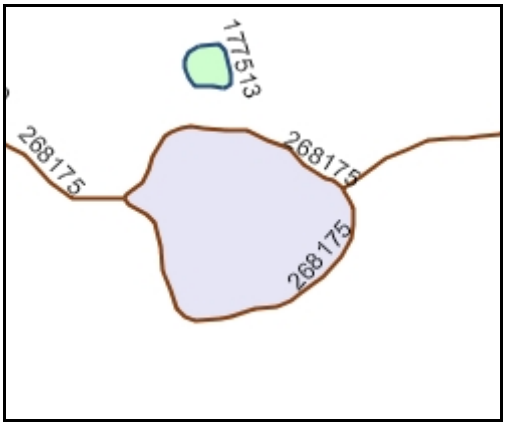


Figure 3: RLAKE-2 – In Line Lake

2.3.1.4 Example 4: Isolated Lakes

RLAKE-4	Watershed boundaries will be generated around isolated lakes.

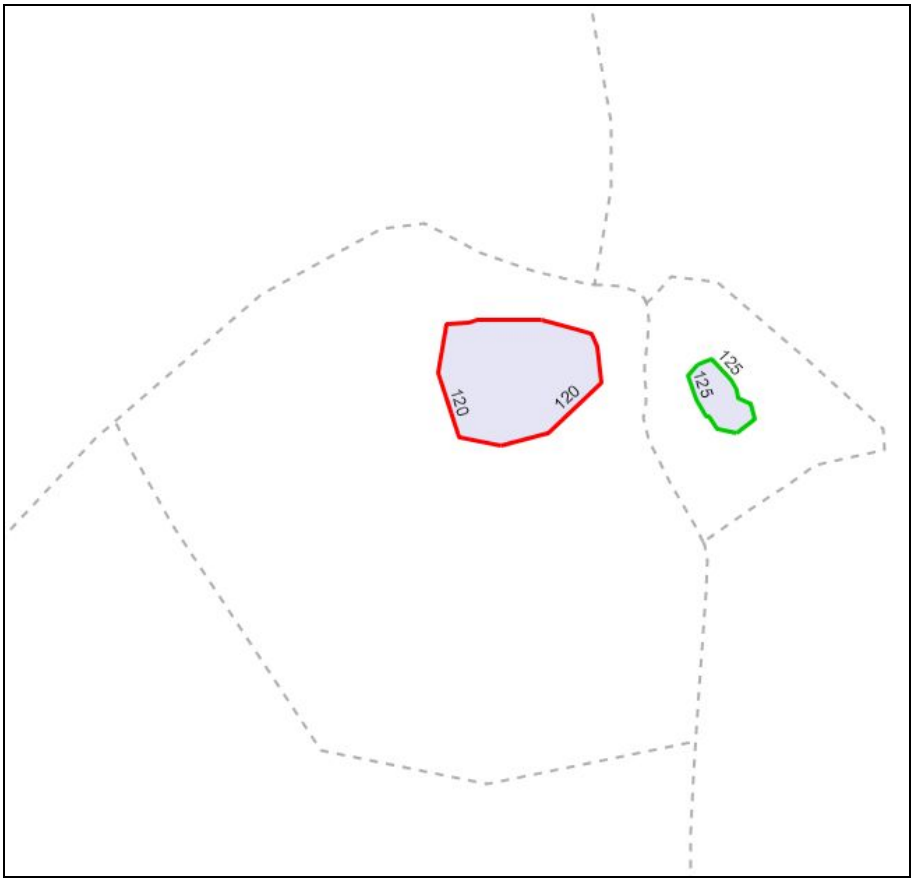


Figure 4: RLAKE-4 – Isolated Lakes

2.3.1.5 Example 5: Lake Delimiters

RLAKE-5	Watershed boundaries will be generated at lakes that are broken by 1325 delimiter edges.

In cases where a lake (or double line river) has been split by 1325's at a non-group boundary the split waterbodies must have different same drainage area id. In Figure 5 below the red line represents a 1325 waterbody split; therefore both the upper lake and lower lake would be given the different drainage ids and watershed boundaries would be generated at this lake confluence.

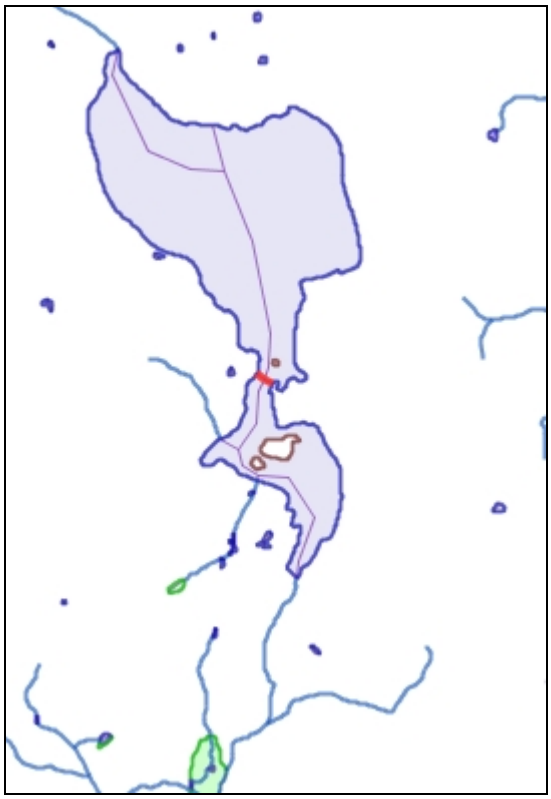


Figure 5: RLAKE-5 – Delimiter Edges

2.3.2 Single Line Rivers

2.3.2.1 Example 6: Single Line Streams

RSTREAM-1	At any single line stream confluence, watershed boundary linework will be generated on the opposite bank of the stream confluence.

As shown in Figure 6, watershed boundary lines will be generated at every stream confluence. Each stream segment is given a different drainage area id.

In cases where a degree 2 nodes exists in the stream network (in-degree = 1 and out-degree = 1) the drainage area id will be the same for both stream segments and watershed boundary lines will not be generated.

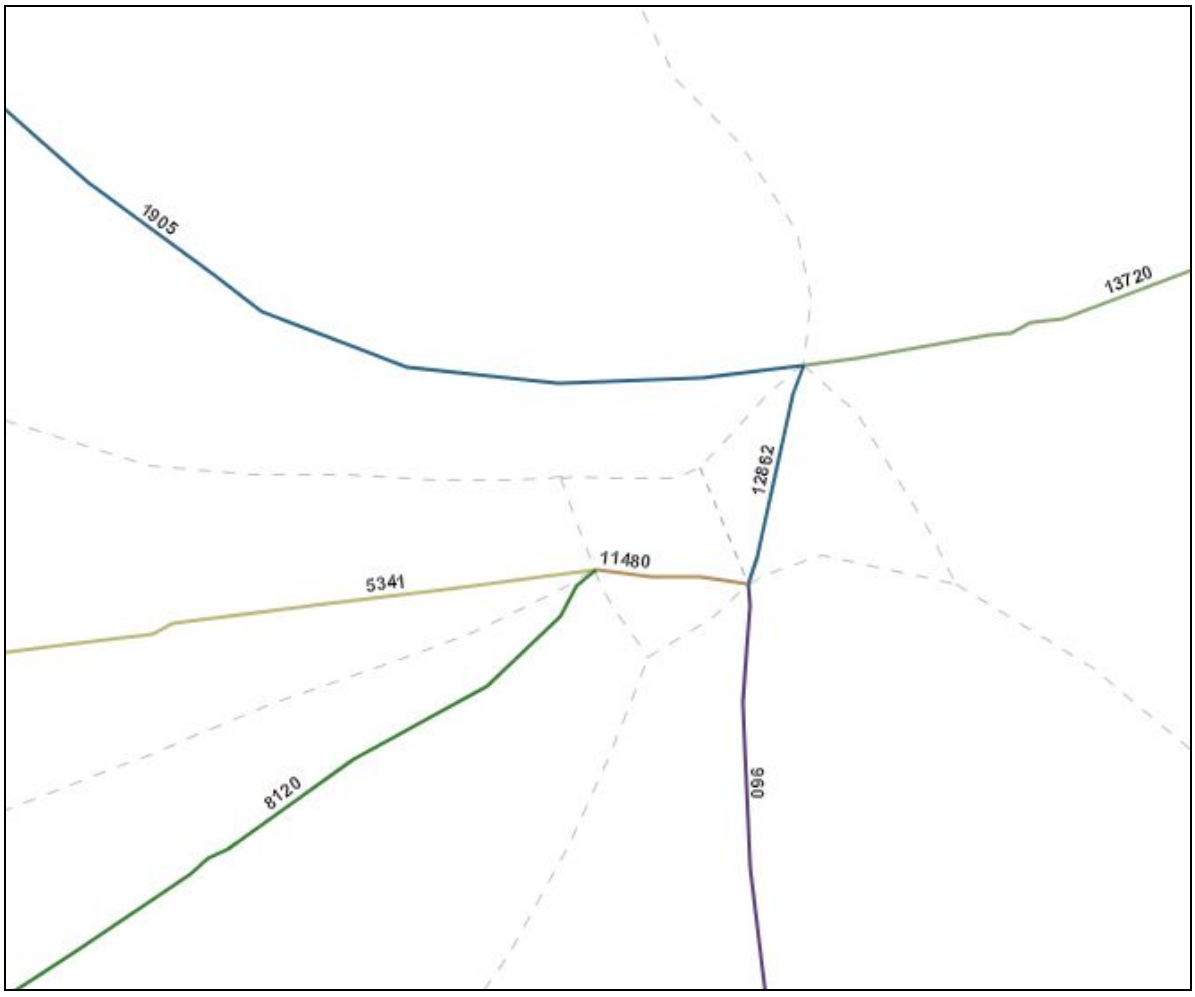


Figure 6: RSTREAM-1 – Single Line River

No differentiation is made between primary flows and side channels when generating watershed boundaries. As a result, different drainage area ids are given to streams segments at a confluence (as shown in the following figure).

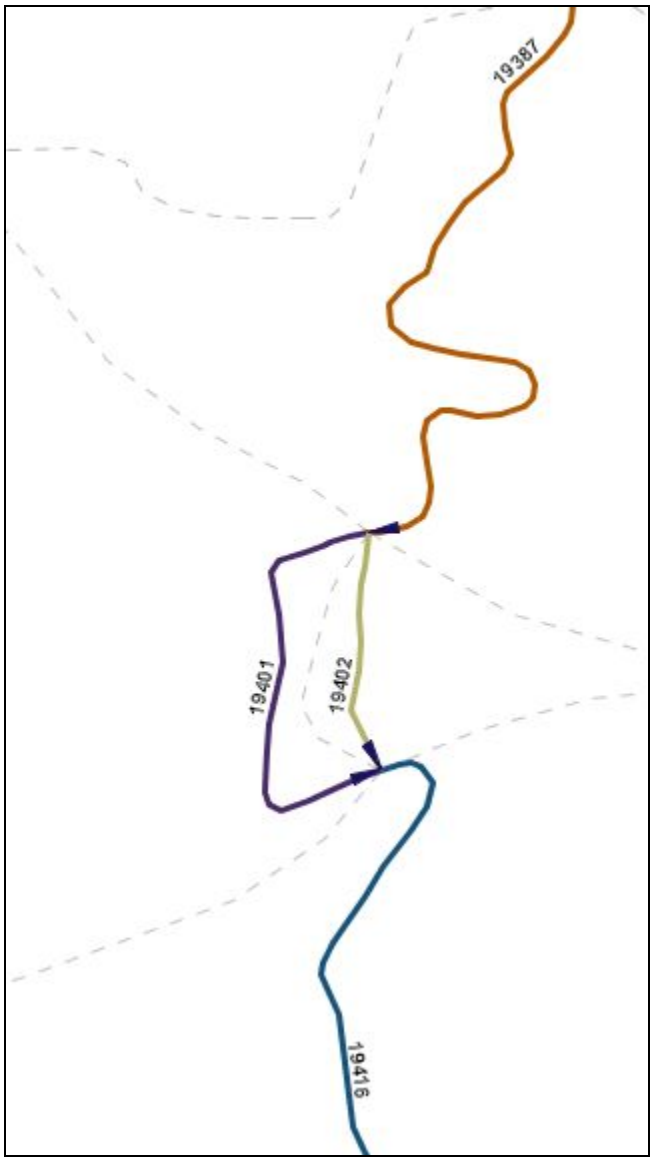


Figure 7: RSTREAM-1 – Side Channel

2.3.3 Double Line Rivers

2.3.3.1 Example 7: Double Line River

RSTREAM-3	Watershed boundaries will be generated around each input and output stream of a double line river with multiple inputs or outputs.

Figure 8 illustrates how the double line river has multiple inputs and a single output. Watershed boundary lines will be generated at each of the input confluences and at the output.

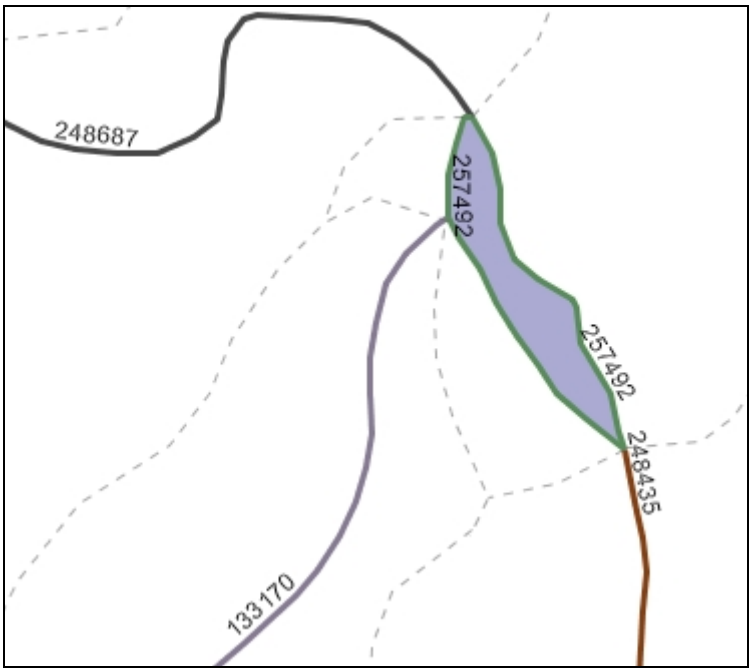


Figure 8: RSTREAM-3 – Double Line River

2.3.3.2 Example 8: In Line Double Line River

RSTREAM-4	Streams that widen into a double line river and back into a single line river with no inflows on either bank will not generate watershed boundaries.

In Figure 9, the double line river has one input single line stream and one output single line stream; therefore the input, output, and double line river banks will be given the same drainage id.

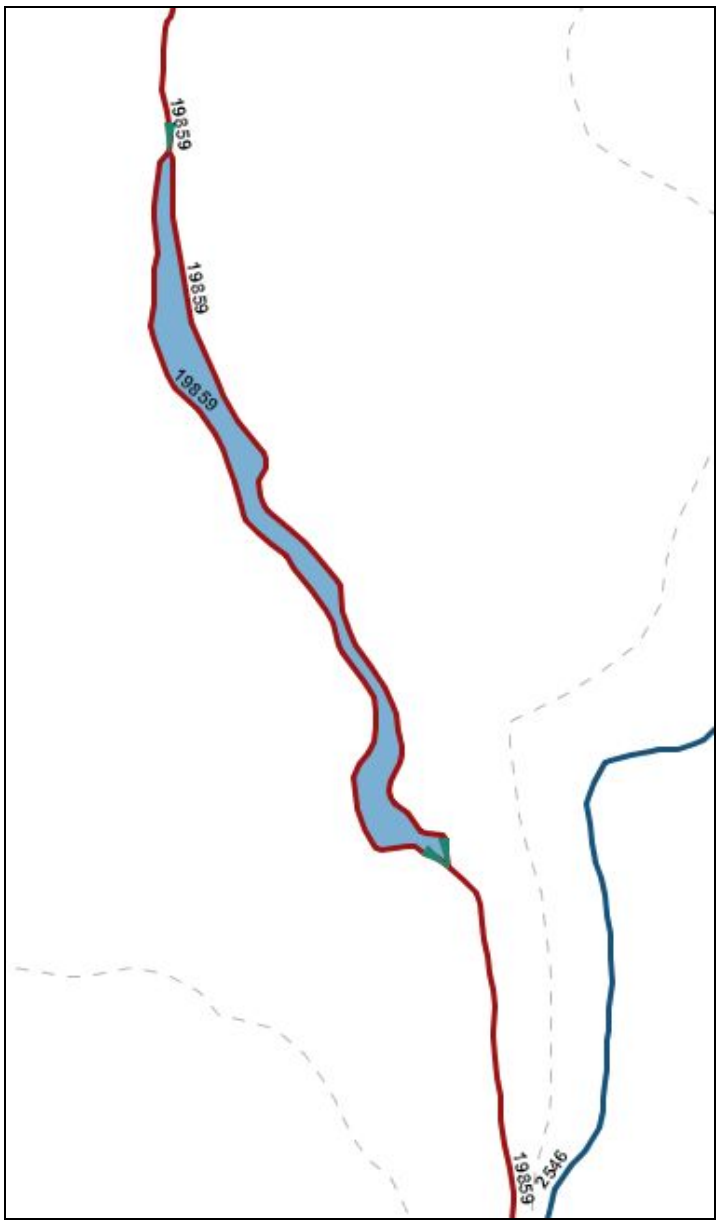


Figure 9: RSTREAM-4 – In-line Double Line River

2.3.3.3 Example 9: Double Line River with Side Channels

RSTREAM-2	Where a single line stream flows into the left or right bank of a double line river, watershed boundary linework will NOT be generated on the opposite bank.

As shown in following figures watershed boundary lines are not generated on the other side of the double line river for locations where a single line river meets a double line river. These examples also show that there is no differentiation between primary and secondary flows. Each double line river channel gets a distinct drainage id.

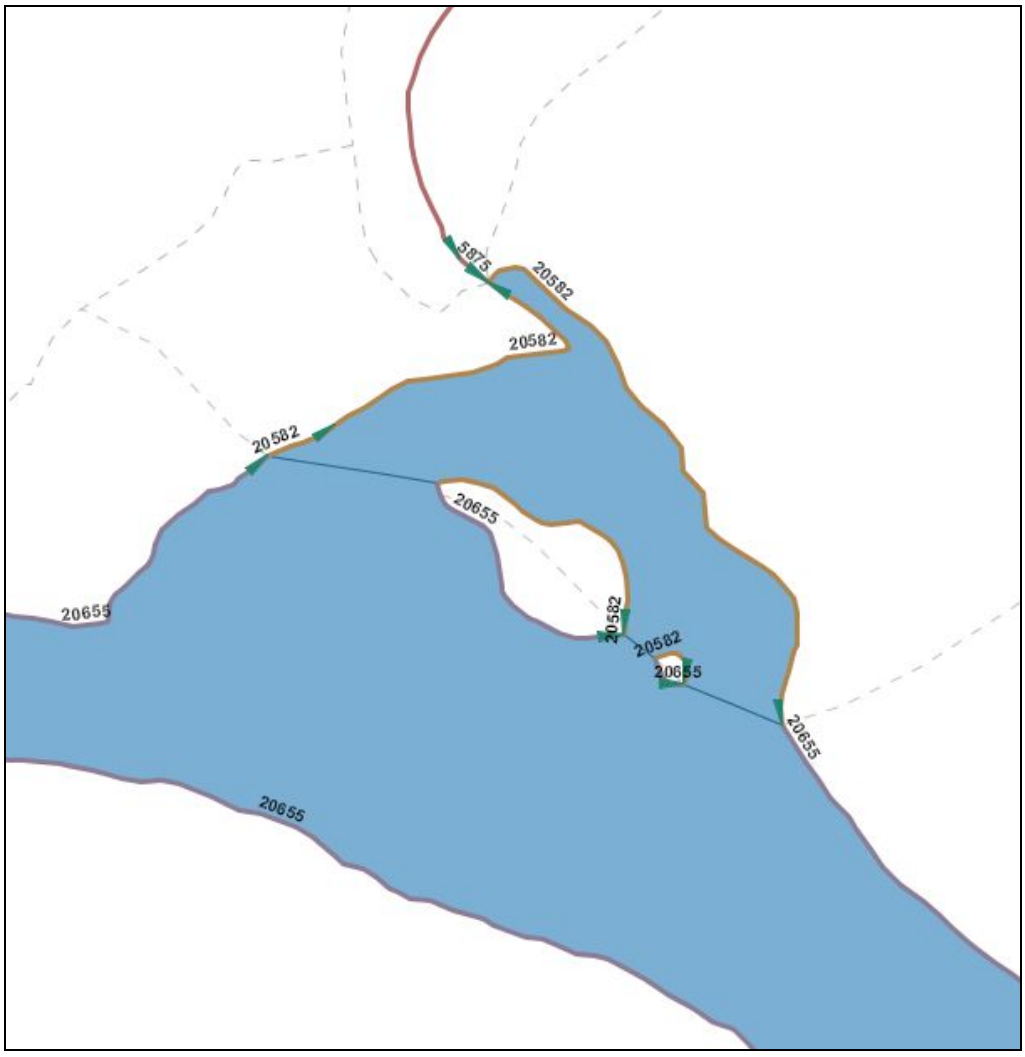


Figure 10: RSTREAM-2 – Side Channel

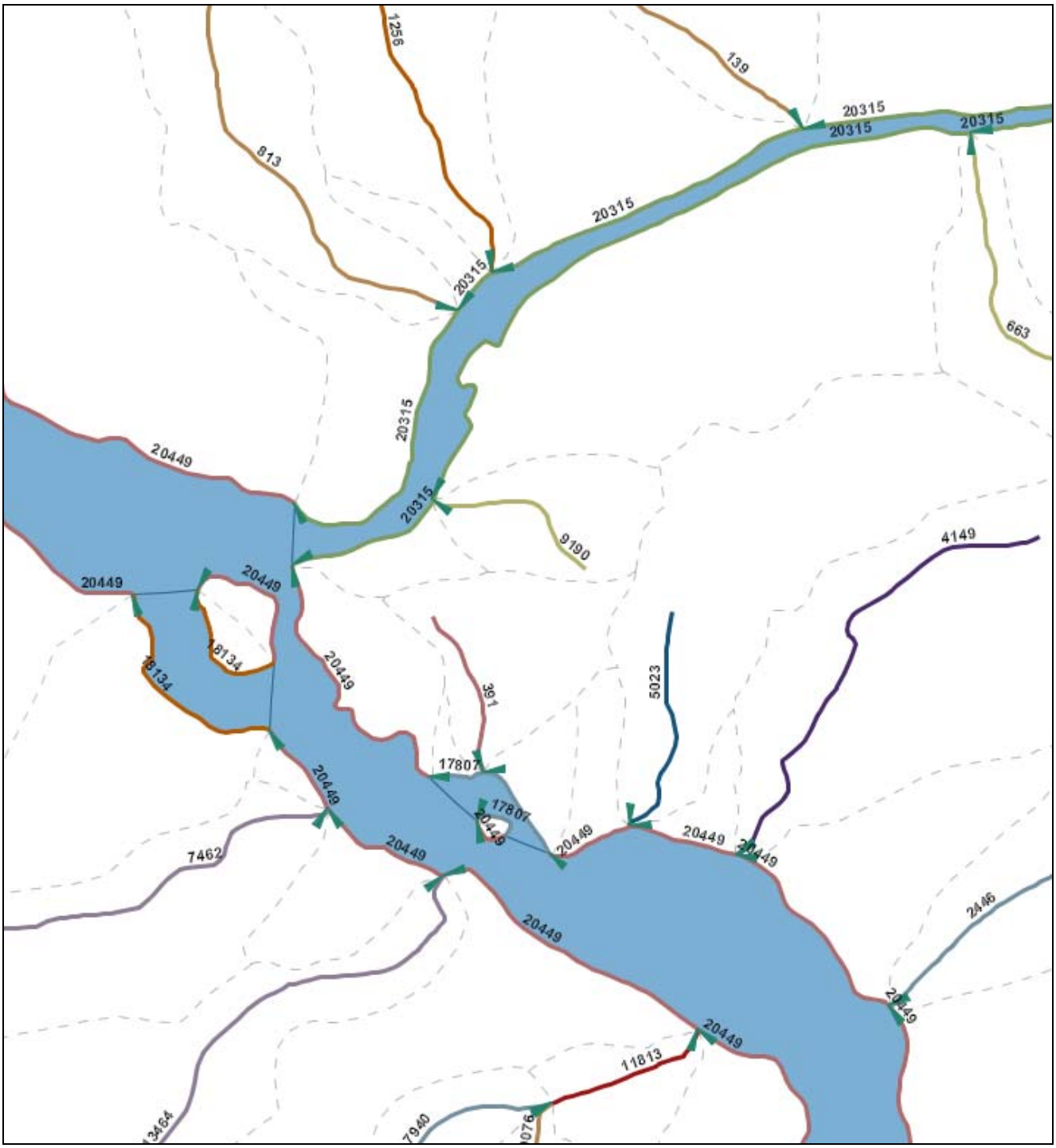


Figure 11: RSTREAM-2 – Side Channel

2.3.4 Inferred Streams

RINFER-1	Inline inferred edges (1410s) will be included as input to the watershed boundary software and treated similar to observed streams. As a result they will be given drainage id's that are the same as the input and output flow, and watershed boundaries will be generated around the entire stream.
RINFER-2	In cases where an observed stream or waterbody flows into a T inferred edges (1410s) the watershed boundaries should be generated from the sink node of the observed stream, or the waterbody outlet. To implement this, T inferred edges will be included as input to the watershed boundary software; however the drainage ids will be assigned to these such that the drainage id will be the same as the observed feature they flow into.
RINFER-3	In special T cases where a 1410 flows into two rivers the drainage id will be assigned as follows: • If one stream is primary and the other is secondary the primary stream's drainage id will be assigned to the 1410 • If both streams are secondary and new unique drainage id will be assigned to the 1410.

2.3.4.1 Definitions

Inline 1410	Occur when one or more 1410 edges are inline with two observed features (edges or waterbodies).
T-1410	Occur where an observed feature (waterbody or stream) flows via a 1410 into another observed feature at a confluence of valence 3 or greater.

Below are three figures that show examples of both inline and T 1410s.

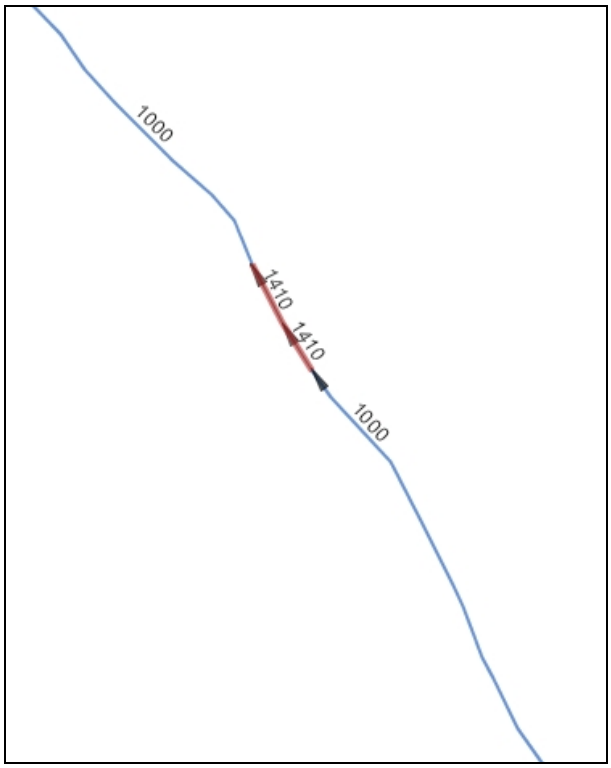


Figure 12: RINFER1 – Inline 1410

These 1410s are considered inline as they do not interact with more than a single stream or waterbody.

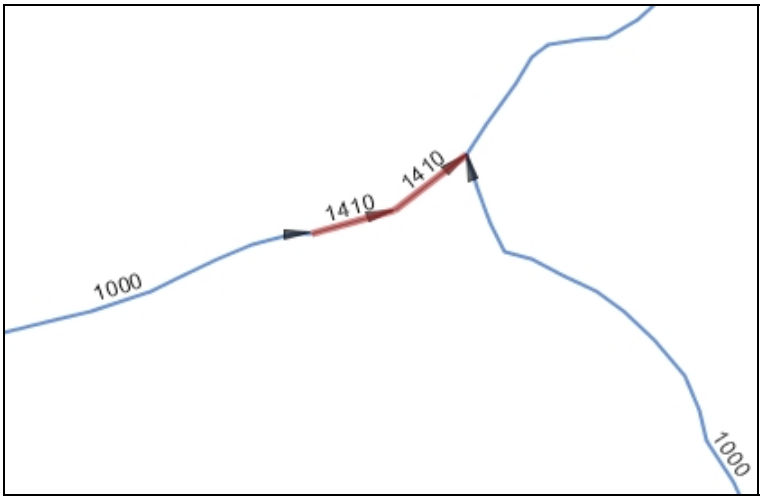
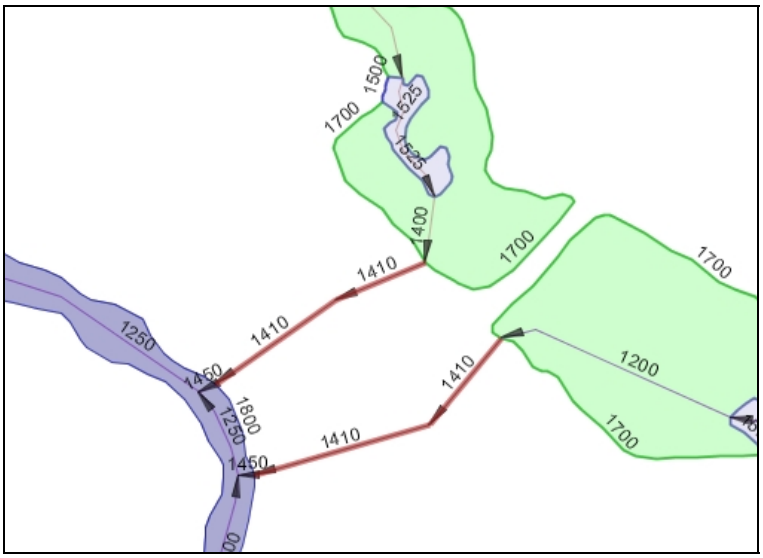


Figure 13: RINFER2– T 1410

These 1410s are considered T 1410s as they interact with multiple streams (or waterbodies)



Another example of two sets of T 1410s.

Figure 14: RINFER2– T 1410

2.3.4.2 Background Information

In order to generate the desired topology for watershed boundaries around 1410 edges ("Inferred flow edges"), two different rules are used depending on the nature of the 1410 edge (inline or T edge).

In the case of "Inline 1410s" the watersheds should respect the 1410 edges. To achieve this, the 1410's are simply included and treated as if they are observed flows.

In the case of "T-1410s" the desired topology of the watershed boundary between the entering observed feature and the entered on is to originate at the sink node of the entering feature. To achieve this behavior, the 1410 edges are included in the input data and are assigned to the same drainage area as the entered edges.

The reason for the "T" rule is that in many cases the inferred flow is only topologically correct. The actual location of the confluence may be unknown. An example of this is an icefield, where the 1410 connects an entering stream to the skeletonized flow through the icefield. The confluence point indicated by the 1410 edge is only approximately correct. Other examples include dryland areas where the observed side stream ends at a sink point, and there is no way to know where the below-ground flow actually goes. The "boundary originates at observed sink" rule ensures that the generated watershed boundary reflects only the observed waterbody edges.

2.3.4.3 Example 10: Inline 1410s and Drainage IDs

Inline 1410's area treated similar to observed streams. In the simple case, shown in Figure 15, where the 1410 connects to observed streams all features are given the same drainage it. Figure 16 shows a slightly more complex example that involves a waterbody.

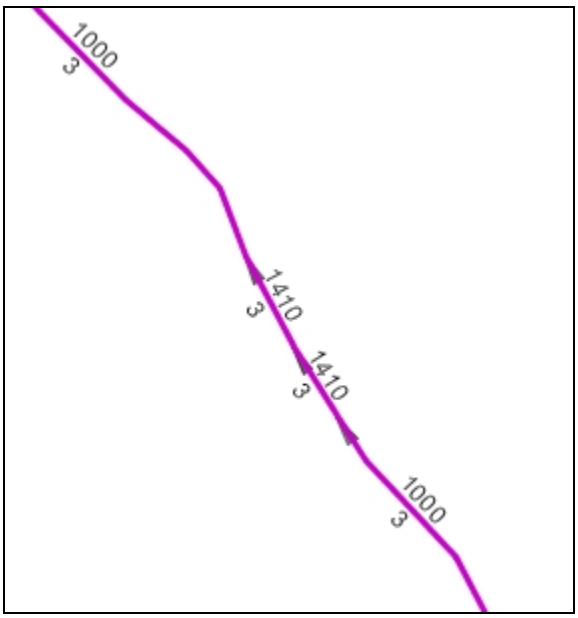


Figure 15: RINFER1 – In-Line 1410 and Drainage IDs

Figure 16: RINFER1 – Inline 1410 and Drainage IDs

2.3.4.4 Example 11: T 1410s and Drainage IDs

In order to generate watershed boundaries from the sink node of an observed feature that flows into a T 1410 the T 1410's will be included as input into the watershed generator, however drainage ids will be assigned using different rules from in-line 1410's. In T cases the 1410's will be given the same drainage id as the feature they flow into and any features which flow into the 1410 will be given different drainage ids.

As shown below T-1410s are given the same drainage id as the river they flow into. The single line stream that flows into the 1410's is given a different drainage id; therefore the watershed boundary lines starts at the location where the observed single line streams meets the inferred edges.

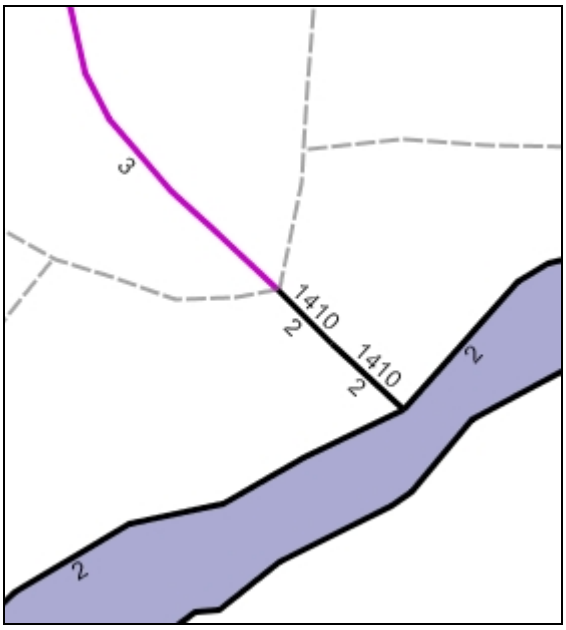


Figure 17: RINFER2 – T 1410s and Drainage IDs

Figure 18 shows two cases where waterbody features are connect to other waterbody features via T 1410s. In these cases the waterbody boundary lines originate from the output of the waterbody feature; and the 1410's are given the same drainage id as the features they flow into.

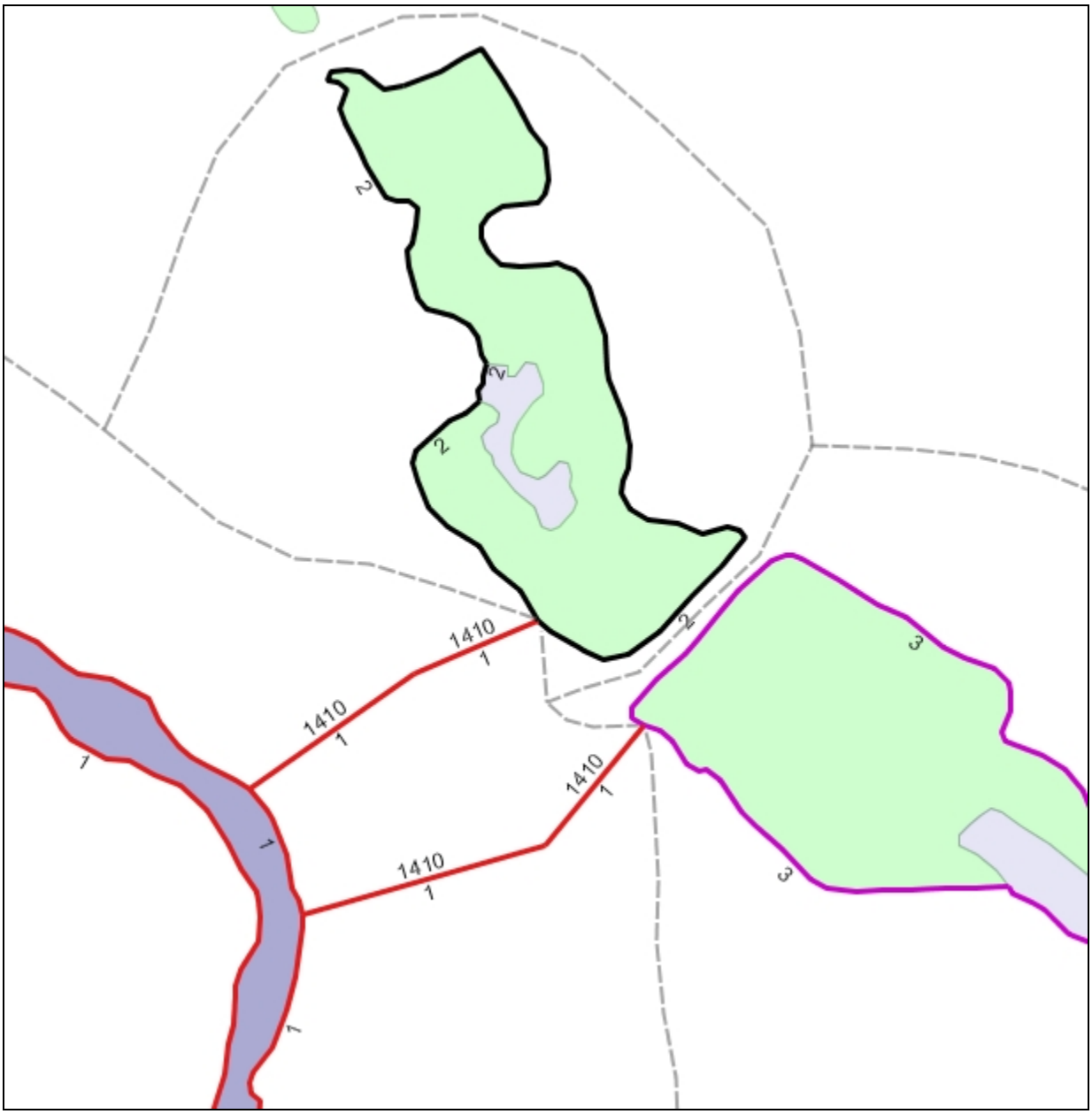


Figure 18: RINFER2 – T 1410s and Drainage IDs

2.3.4.5 Example 12: T 1410s, Routes, and Drainage Ids

RROUTE-1	In absence of any other criteria, the watershed boundaries should respect the generated FWA routes. This rule affects both wetland construction lines (See Example 17) and inferred stream intersections (Example 13).

There are some cases in the province where a lake has two inputs, one observed and one 1410, and a single observed output. The route through the lake follows the 1410. If treated as a plain 1410, the 1410 would be ignored, the lake treated as a single input and single

output lake with the observed input, observed output, and lake all given the same drainage id. This would not allow unique watersheds to be generated for each route; thus in this case the 1410 needs to be included an input to the waterbody resulting in each input and output getting a different drainage id.

In the picture below, the stream edges are labeled with the code and the stream edges color coded by route. The red route follows through the lake and up the 1410.

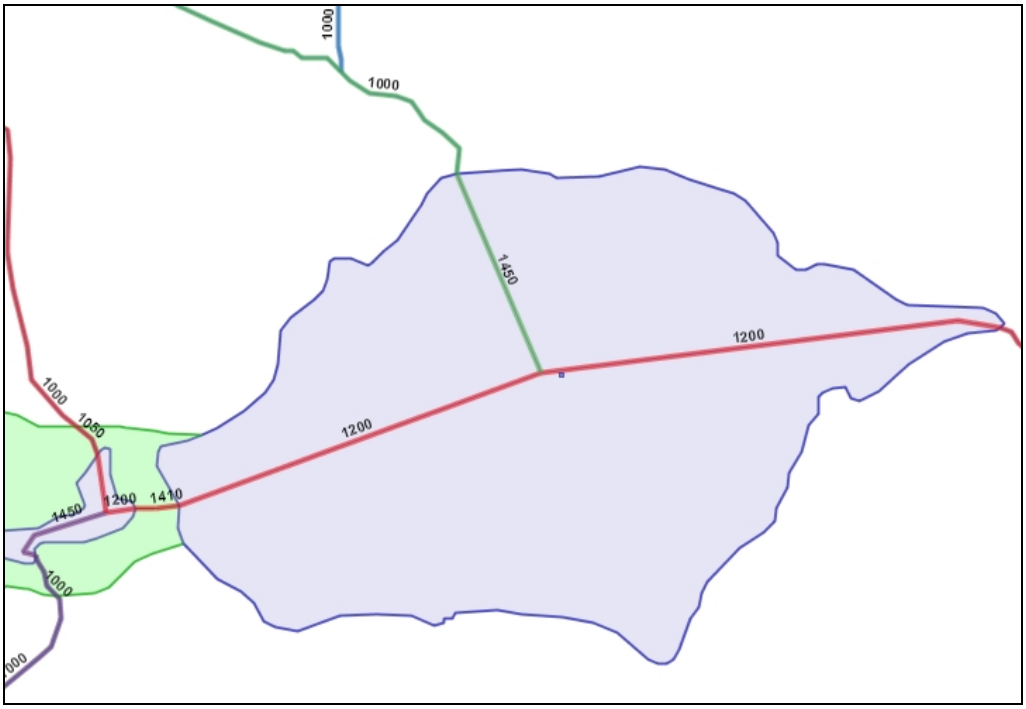


Figure 19: RROUTE1 – Routes and Inferred Edges

The drainage ids will be generated such that the observed input (green route) is given a different drainage id from the 1410 input and lake output (red route).

2.3.4.6 Example 13: Special Case T 1410s and Drainage IDs

Special case T 1410's occur where a 1410 flows into two streams. Depending on the primary/secondary coding of the streams the 1410 flows into one of two rules will be used to assign drainage ids. If both one stream is primary and the other is secondary the 1410 will be assigned the same drainage id as the primary stream, otherwise the 1410 will be given a unique drainage id.

In Figure 20 below the red lines are the special case T 1410's. In this case the 1410 flows into a primary and a secondary flow, so the drainage is of the 1410 will be the same as the drainage id of the primary edge it flows into (drainage id 1 in this example).

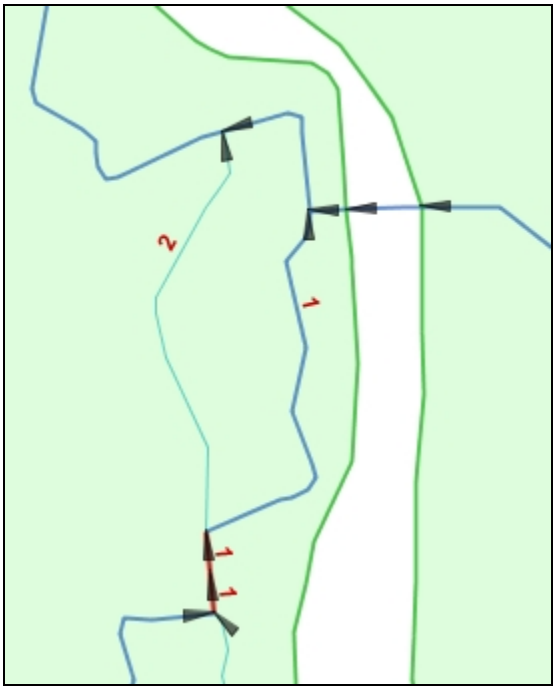


Figure 20: INFER-3 - Special Case T 1410s

In Figure 21 the other special case is shown. In this case the 1410 (red edge) flows into two secondary flows, thus is given it's own unique drainage id.

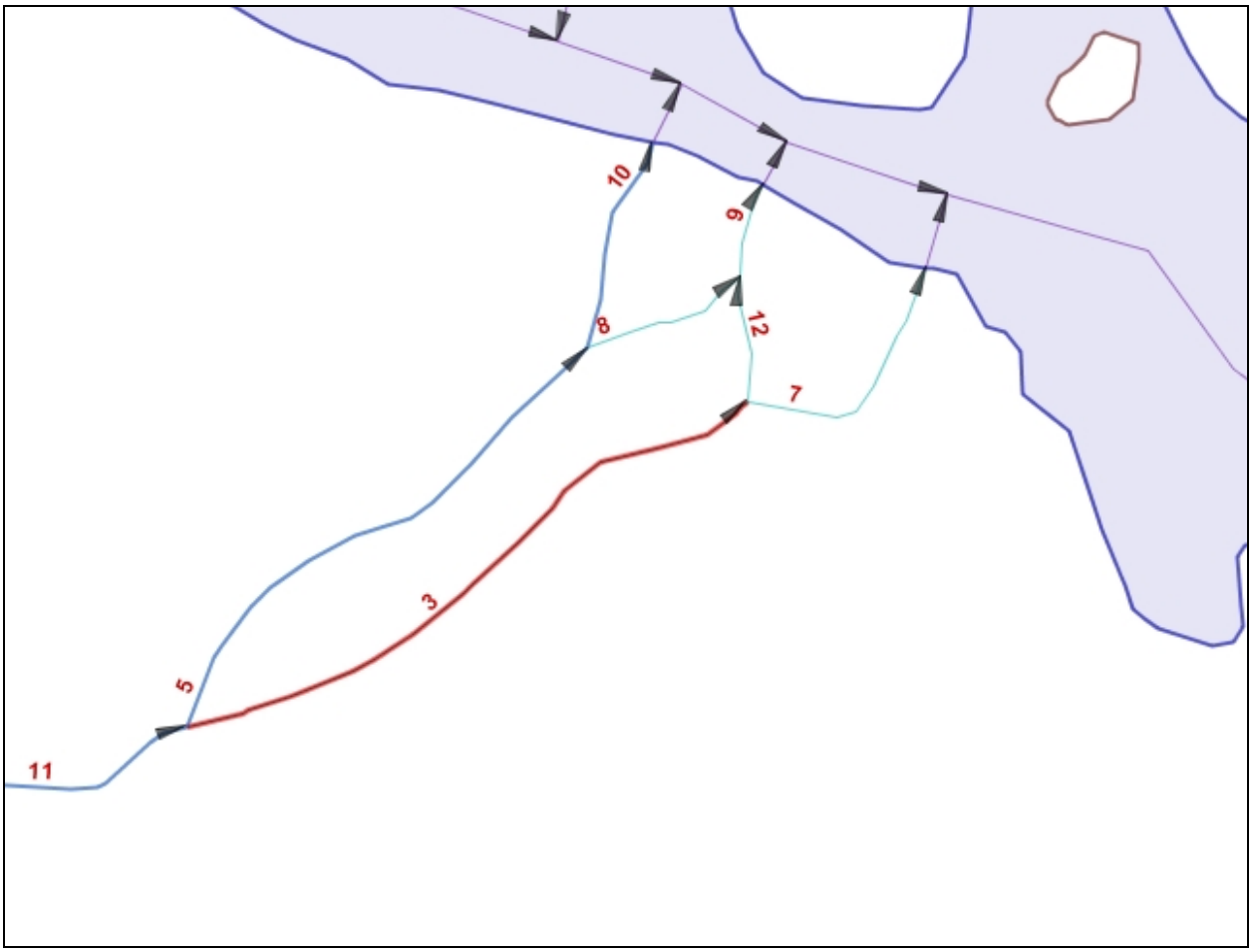


Figure 21: INFER-3 - Special Case T 1410

2.3.5 Group Boundaries

2.3.5.1 Example 14: Group Boundary Delimiters

RSTREAM-9	Watershed boundaries will be generated at double line rivers breaks that are broken by 1325.

In cases where double line rivers or lakes are split at group boundaries the bank edges on either side of the watershed group must have different drainage ids to the watershed groups can be regenerated.

In this example the double line river bank in HARR will be assigned a different drainage id from the double line river banks in LFRA.

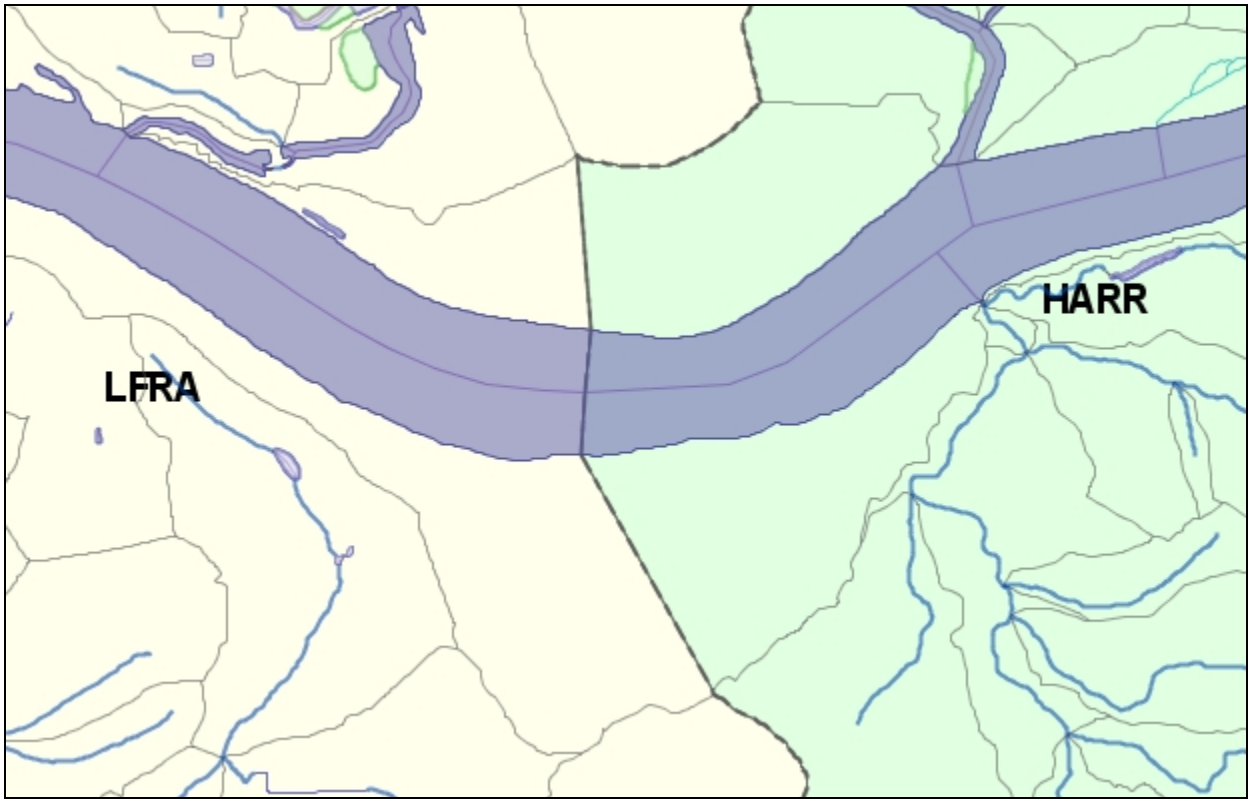


Figure 22: RSTREAM-9 – Group Boundaries

2.3.6 Wetlands

2.3.6.1 Example 15: Included Wetlands

RWET-1	Wetlands that contain or border only a single stream or lake will be treated similar to lakes and included as input to the watershed boundary software. Wetlands that touch multiple in-line lakes that are given the same drainage id are also treated similar to lakes and included as input to the watershed boundary software. All other wetlands are excluded.

In the example below, Wetland A would be included as input to the watershed generate, whereas wetlands B and C would not be excluded (because they touch both a river and a lake). In processing, Wetland A would be merged with the lake so the edge shared between the wetland and lake would not be included in the input dataset.

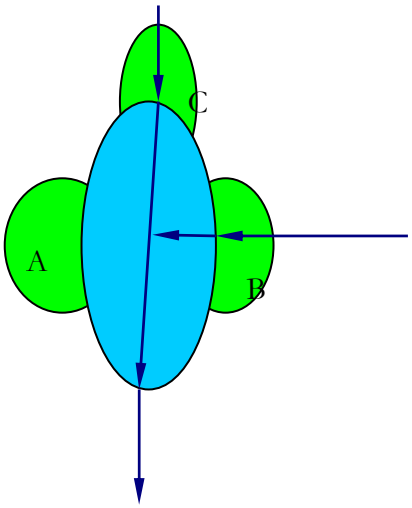


Figure 23: RWET-1 – Deliverable Wetlands

In Figure 24, there are two wetlands that contain only a single stream. As a result these wetlands will be included as input to the watershed generator and attributed in a similar manner to lakes. The flow lines inside these wetlands will not be included as input to the watershed boundary software.

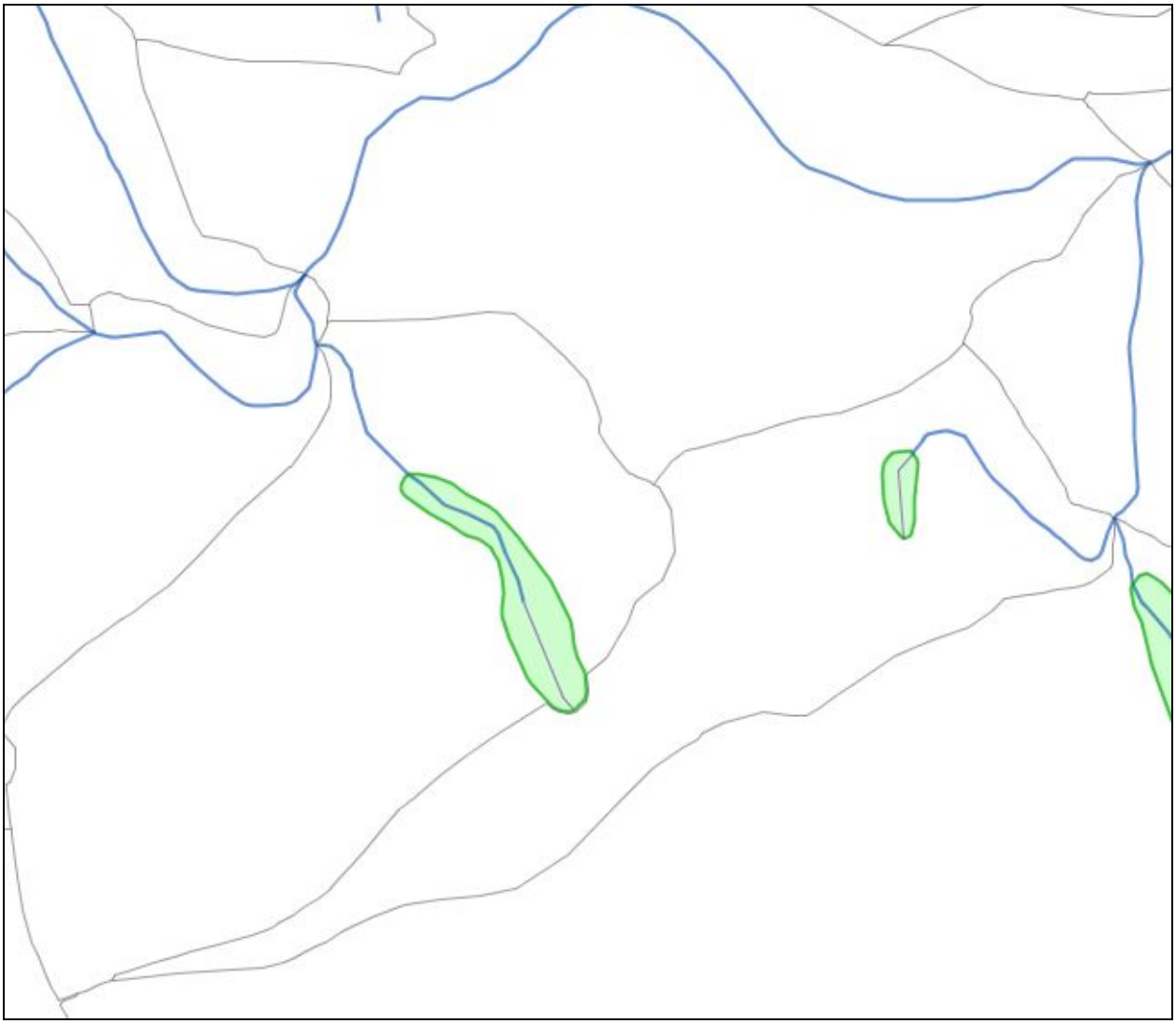


Figure 24: RWET-1 – Deliverable Wetlands

In this example both wetlands touch multiple rivers and lakes, thus would not be considered a deliverable wetland.

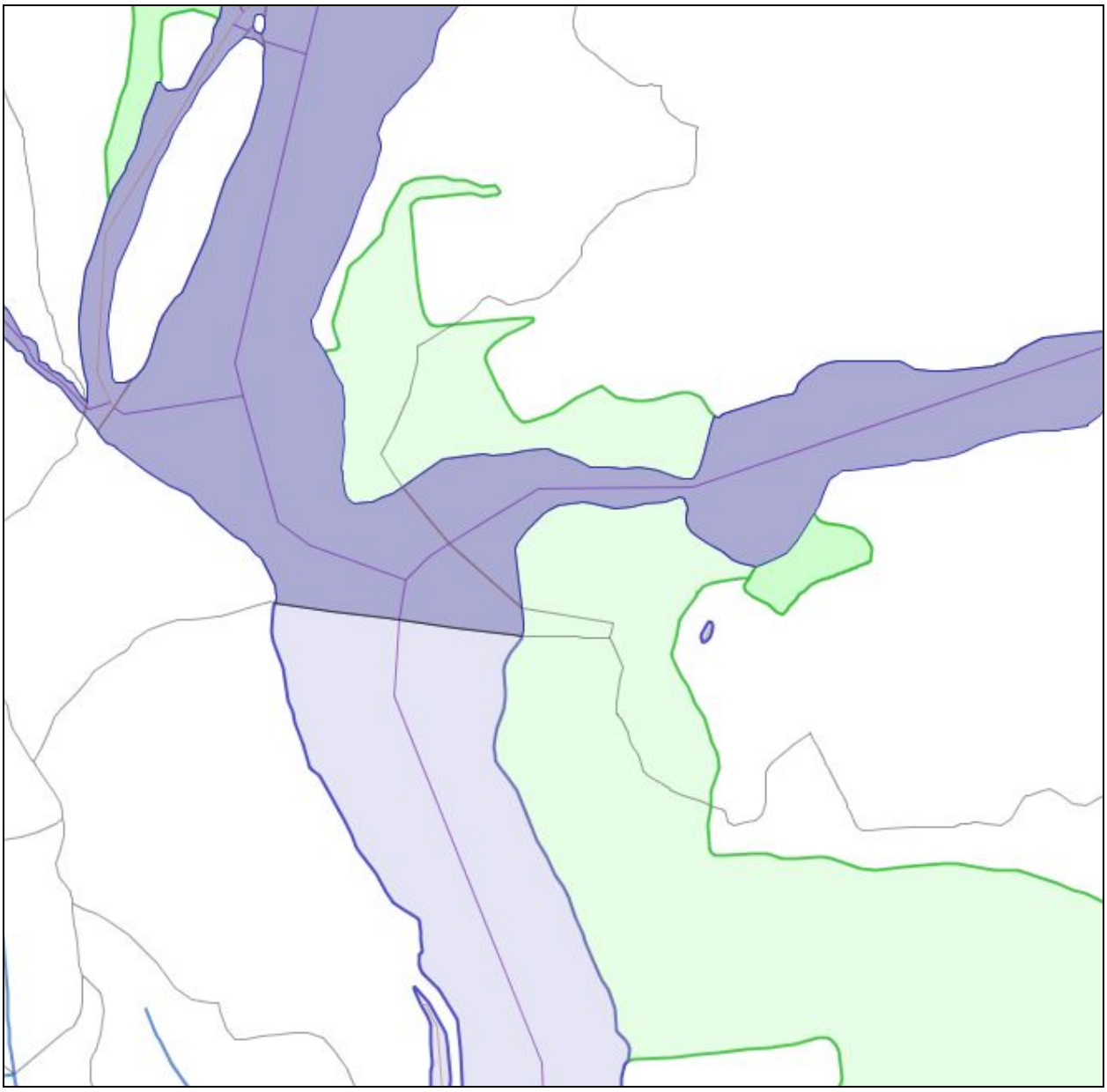


Figure 25: RWET-1 – Non-deliverable Wetlands

Below is an example of a wetland that contains multiple rivers and would not be included as input to the watershed generator.

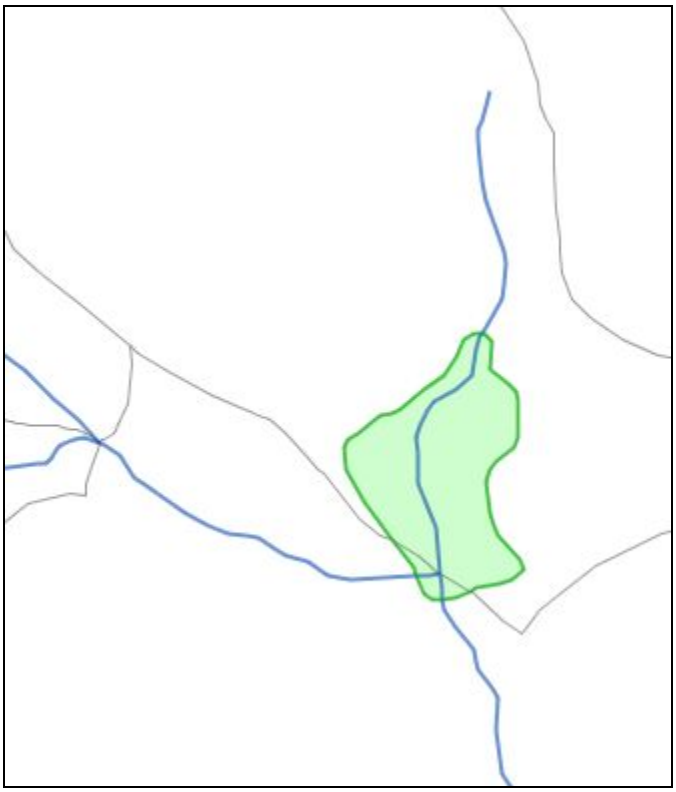


Figure 26: RWET-1 – Non-deliverable Wetlands

In cases where a deliverable wetland bounds a lake, the wetland and lake can be merged into a single feature with a single drainage id. In the example below the deliverable edges are red and labeled with their associated drainage id (in this case all the drainage ids are the same). The lake bank edges and stream edges inside the wetlands are not delivered as input to the watershed generator. This example also highlights a wetland that touches multiple in-line lakes that is deliverable.

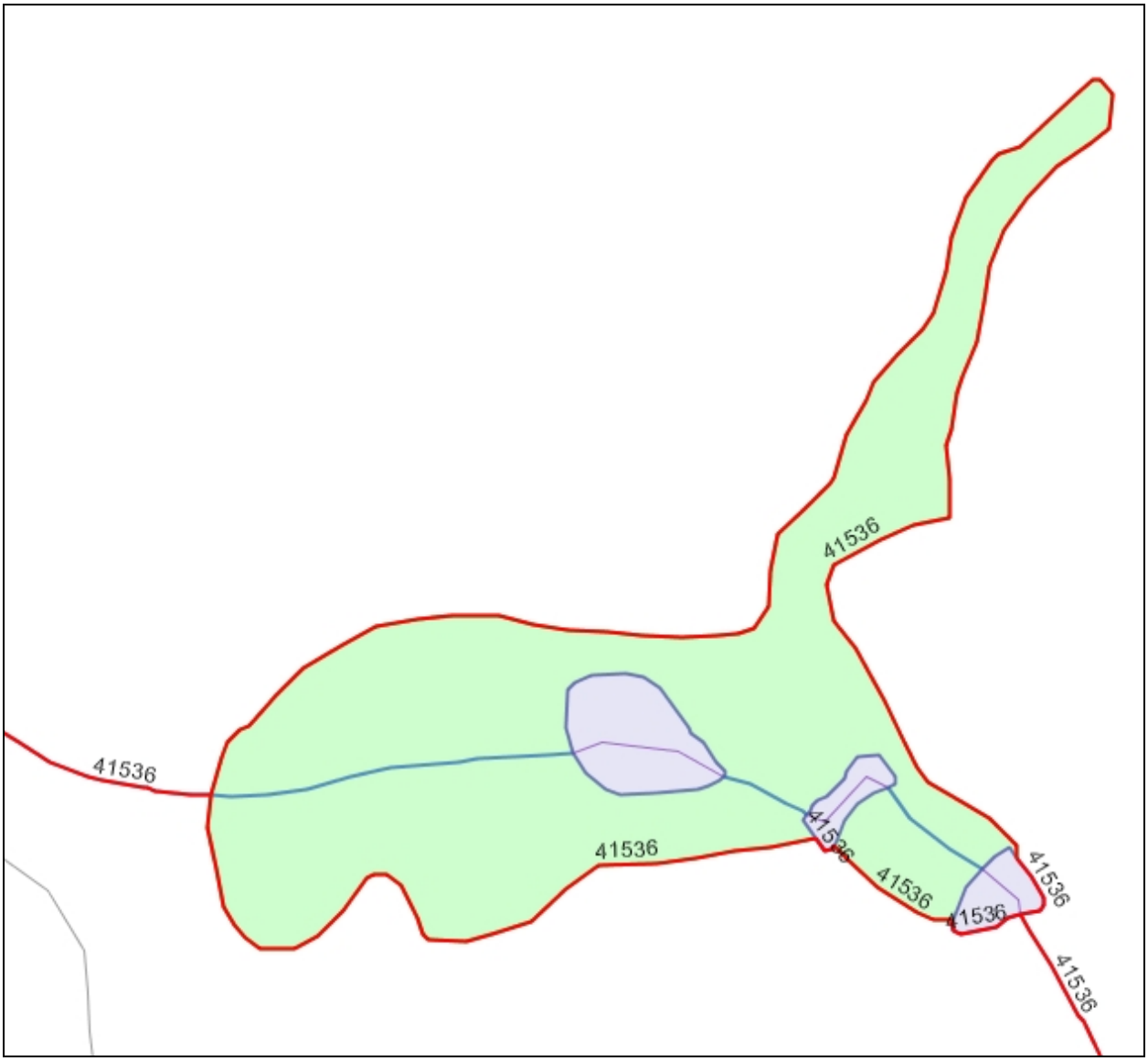


Figure 27: RWET-1 – Wetlands Containing Lakes

2.3.6.2 Example 16: Stream Confluence Touching Wetland

In this particular example there is a stream confluence located on the boundary of the wetland. In determining if the wetland contains multiple streams or waterbodies only streams/waterbodies that bound or are contained within the wetland are included. Streams that touch at a single point are not considered to be contained within the wetland; however a stream edge that bounds the bank of the wetland will be considered to be contained within the wetland.

In this example the edge highlighted by the red arrow is considered contained within the wetland, but the two edges highlighted by purple arrows are not considered contained within the wetland even though they touch the wetland at a single point. As a result this wetland will be deliverable and the flow arc that bounds the wetland will be treated as a bank edge. The flow arc inside the wetland will be removed from the input dataset.

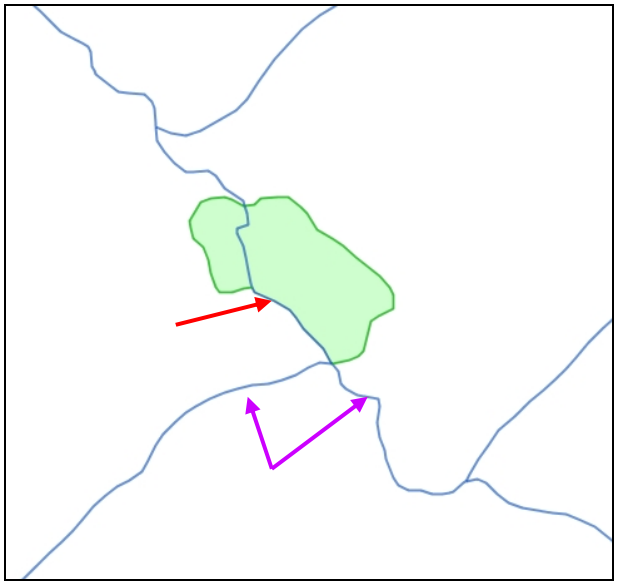


Figure 28: RWET1 – Wetland Bounded by Observed Stream

2.3.6.3 Example 17: Wetland Construction Lines

RSTREAM-6	Construction lines (1200, 1250, 1300, 1350, 1450, 1475) are used to determine connectivity and the location of stream confluences for the purposes of generating drainage ids, but are not provided as input to the watershed generator.

RROUTE-1	In absence of any other criteria, the watershed boundaries should respect the generated FWA routes. See Example 17.

Construction lines inside wetlands (codes 1200, 1300) will not be provided as input to the watershed generator; however they will be used in determining the drainage ids. Including them is necessary to ensure that in certain situations generated watershed boundary lines will respect existing routes. (Isolated construction lines, 1400, are ignored. See RSTREAM-9).

Consider the following example. This example contains two routes; the red route and a purple route. In each image the black numbers are the edge codes, the red numbers are the drainage ids. Grey dashed lines represent the watershed boundary lines. The black dashed flow lines are flow lines that would not be included as input to the watershed generator.

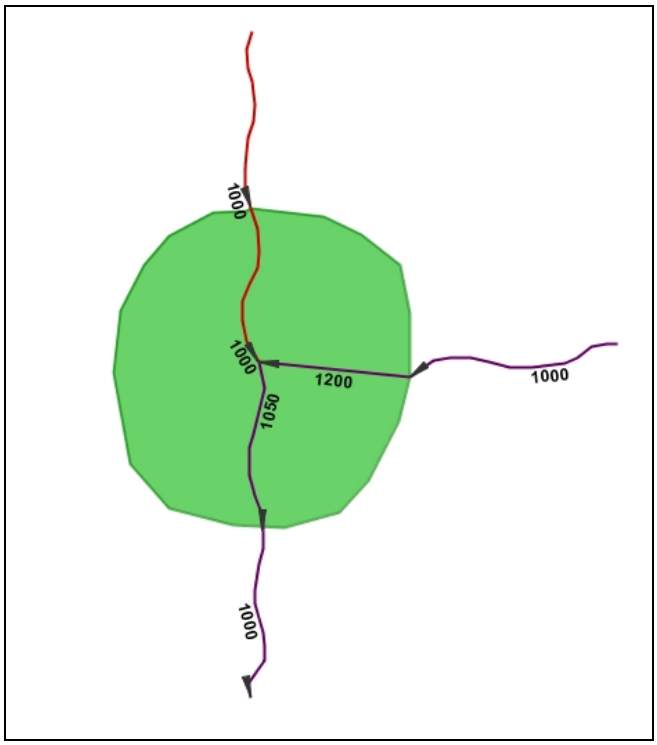


Figure 29A: RSTREAM-6 – Wetland Construction Line

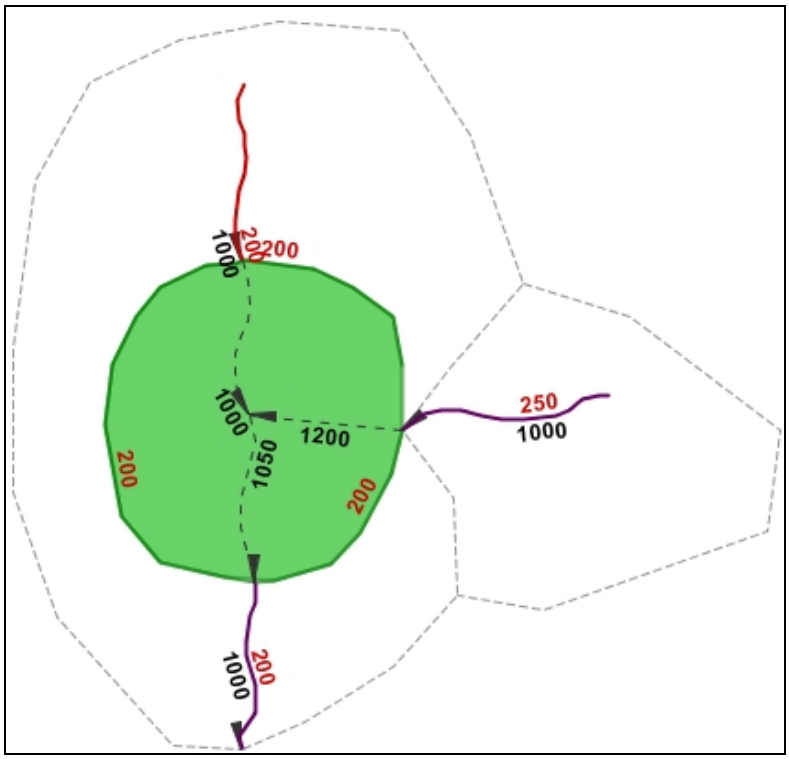


Figure 30B: RSTREAM-6

The figure to the left shows the results of not considering the 1200 when generating drainage ids.

- the wetland would be included (RWET-1 – the wetland would only contain a single stream);
- the wetland would be given the same drainge id as the input red edge and output purple edge (in-line wetland)
- watershed boundary lines would not be generated around the red route.

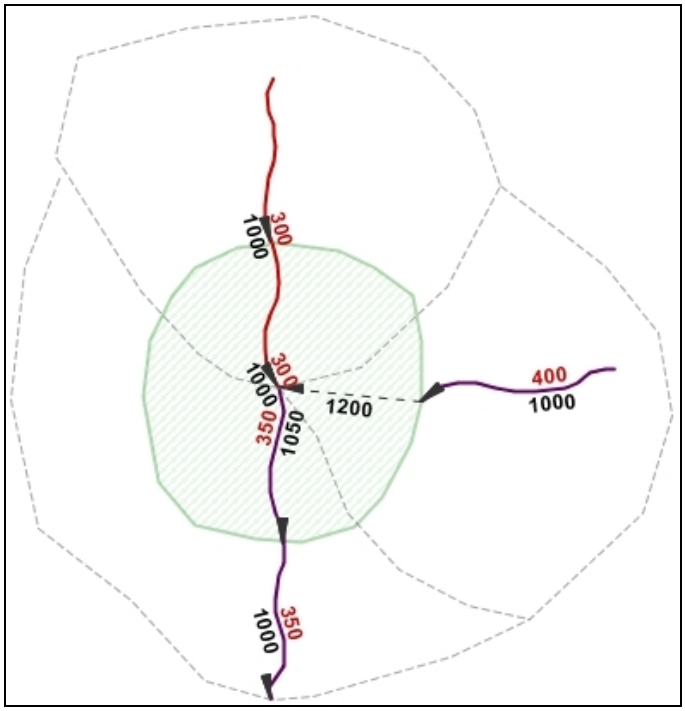


Figure 31C: RSTREAM-6

This figure shows the results of considering the 1200 when generating drainge ids.

- the wetland is not included;
- different drainage ids are given to the red and purple edges at the stream confluence; and
- watershed boundary lines will be generated around the red route.

Figure 32 shows a simple case of a deliverable wetland. Since the construction lines connects the input and output of the wetland, the wetland and the input/output flow edges would get the same drainage id (as a result they would all be contained within the same watershed).

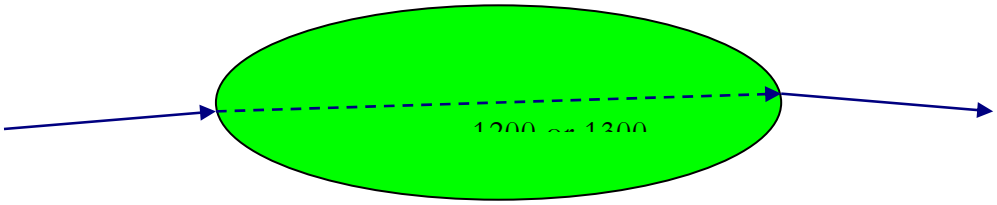


Figure 32: RSTREAM-6 – Wetland Construction Line

In Figure 33 neither the wetland nor the 1200 construction line will be included as input to the watershed generator. This results from the 1200 being treated as a stream, so the wetland contains two streams.

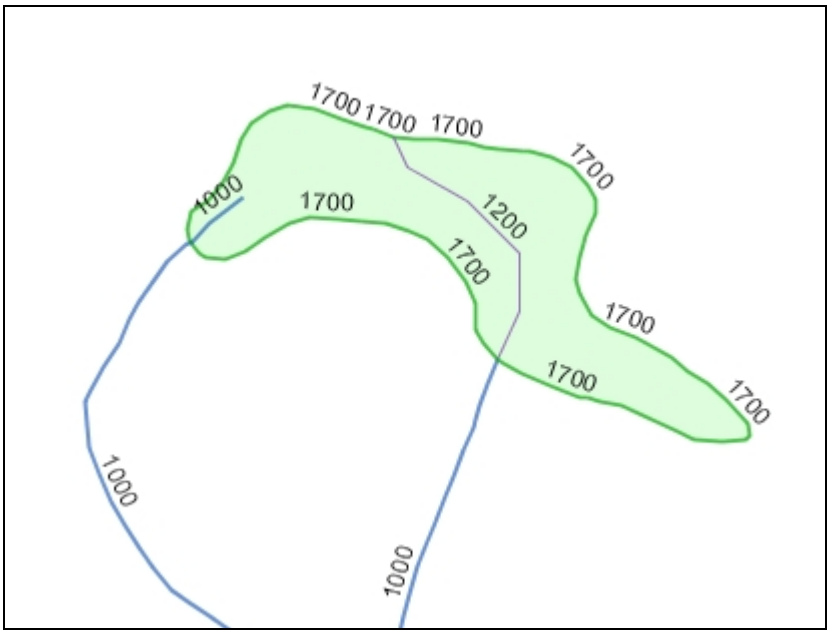


Figure 33: RSTREAM-6 – Wetland Construction Line

Below is another example where neither the wetland nor the construction line is deliverable.

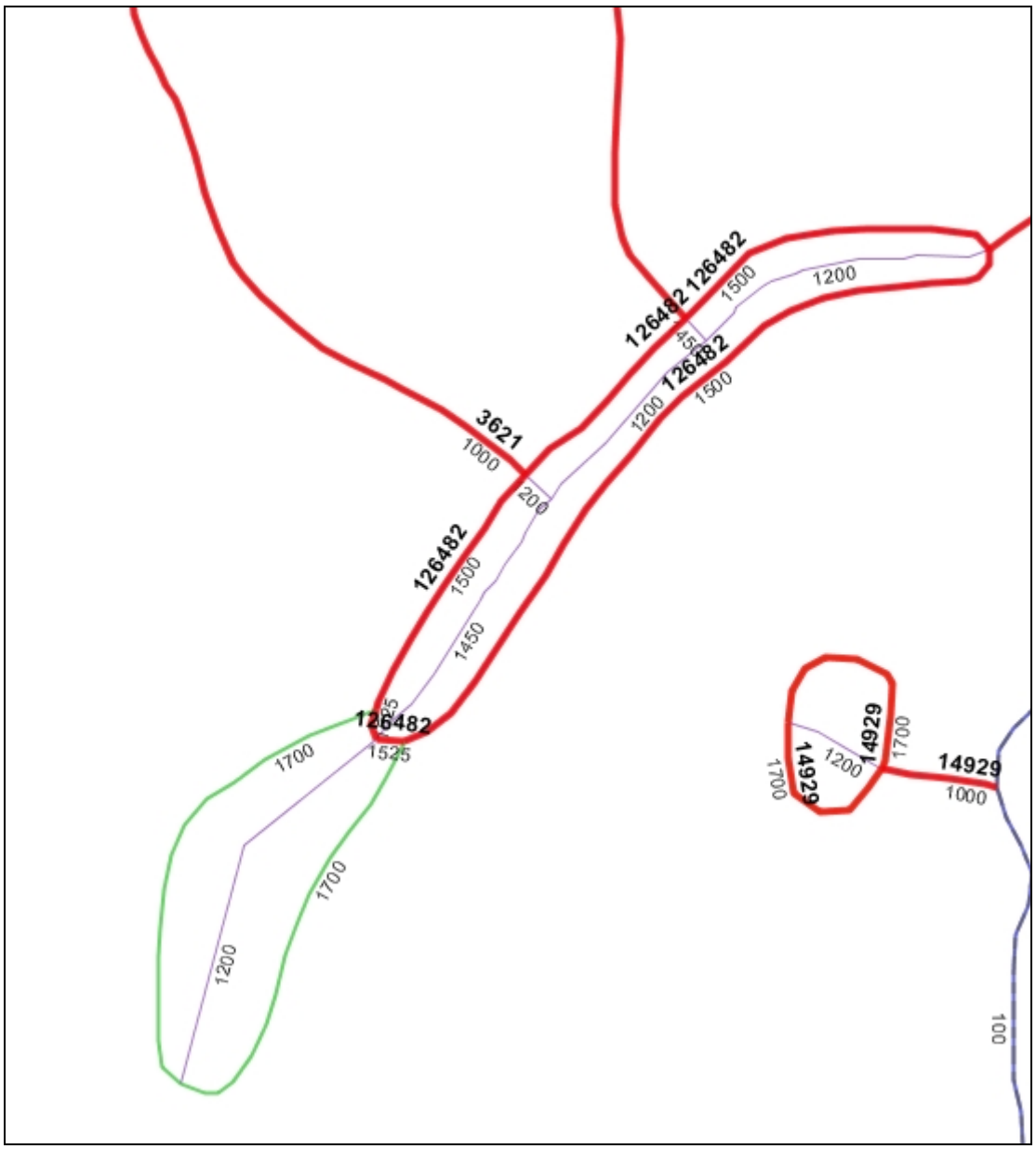


Figure 34: RSTREAM-6 – Wetland Construction Line

2.3.6.4 Example 18: Isolated Wetlands

RWET-2	Watershed boundaries will be generated around isolated wetlands.

Isolated wetlands will be treated similar to isolated lakes. They will be included and given a unique drainage id. As a result watershed boundary lines will not traverse through isolated lakes. The resulting isolated watersheds can be merged using post-process.

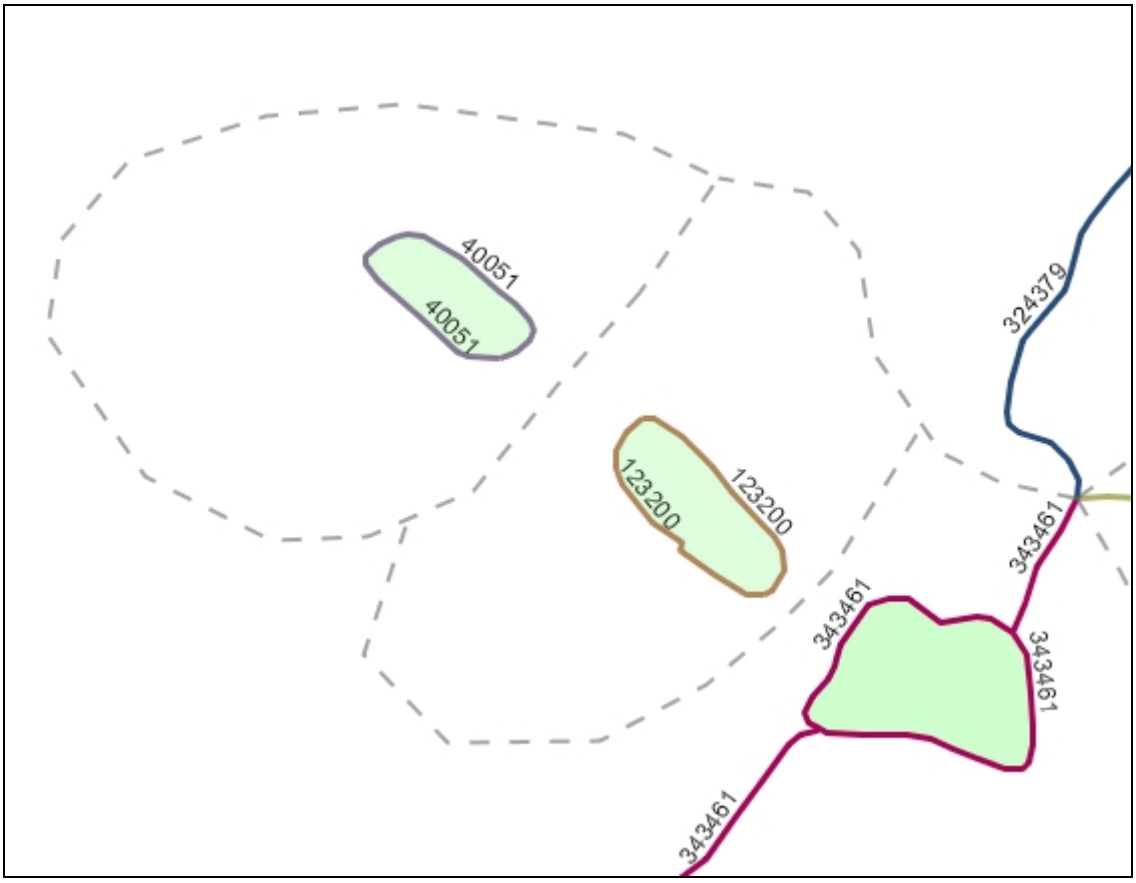


Figure 35: RWET-2 – Isolated Wetland

2.3.6.5 Example 19: Wetland WB_KEYs

RWET-3	Wetlands with the same wb_key will be treated as a single wetland.

When determining how many streams/waterbodies the wetland touches, wetlands with the same wb_key will be treated as a single wetland. In most cases, using the wb_key results in wetlands of different types that touch being treated as a single wetland, however there are some exceptions (especially when names are involved). In Figure 36 the two shades of green represent wetlands of different types, however they have the same wb_key so they are treated as a single wetland. Since it touches more than one stream it would be excluded.

Figure 36: RWET-3 – Wetland WB_KEYs

In cases where two wetlands touch, but have different wb_keys as shown in Figure 37 there is a potential to have two touching wetlands with different drainage ids. This would cause a problem for the watershed generation program. However after some testing it was determined there are only 4 of these cases in the FWA dataset and none of them will cause problems. As a result the solution for this version of this software is to not deal with this case, but to implement a QA Check to ensure it doesn't happen.

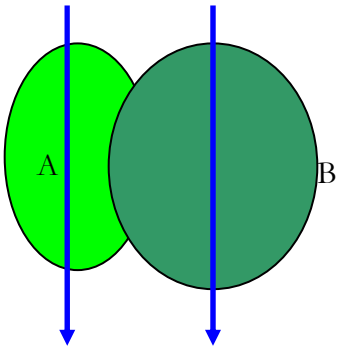


Figure 37: Wetland Touching Wetland II

2.3.6.6 Example 20: Wetlands and the Coastline

RWET-4	In cases where wetlands touch the ocean, the ocean will be treated similar to a lake with multiple inputs; however wetland bank edge that is shared with the coastline will be delivered.

The implication of this requirement is that wetlands that touch the coastline and have no observed streams or lakes will have the same drainage id as the coastline they share. This will ensure no watershed boundary lines are drawn through them. Each edge that bounds the deliverable wetland is included as input (including the coastline edges).

In the example below the wetland highlighted by the red arrow will be included with the same drainage id as the coastline it bounds. However the lower wetland would not be included as it touches both a stream and the coastline.

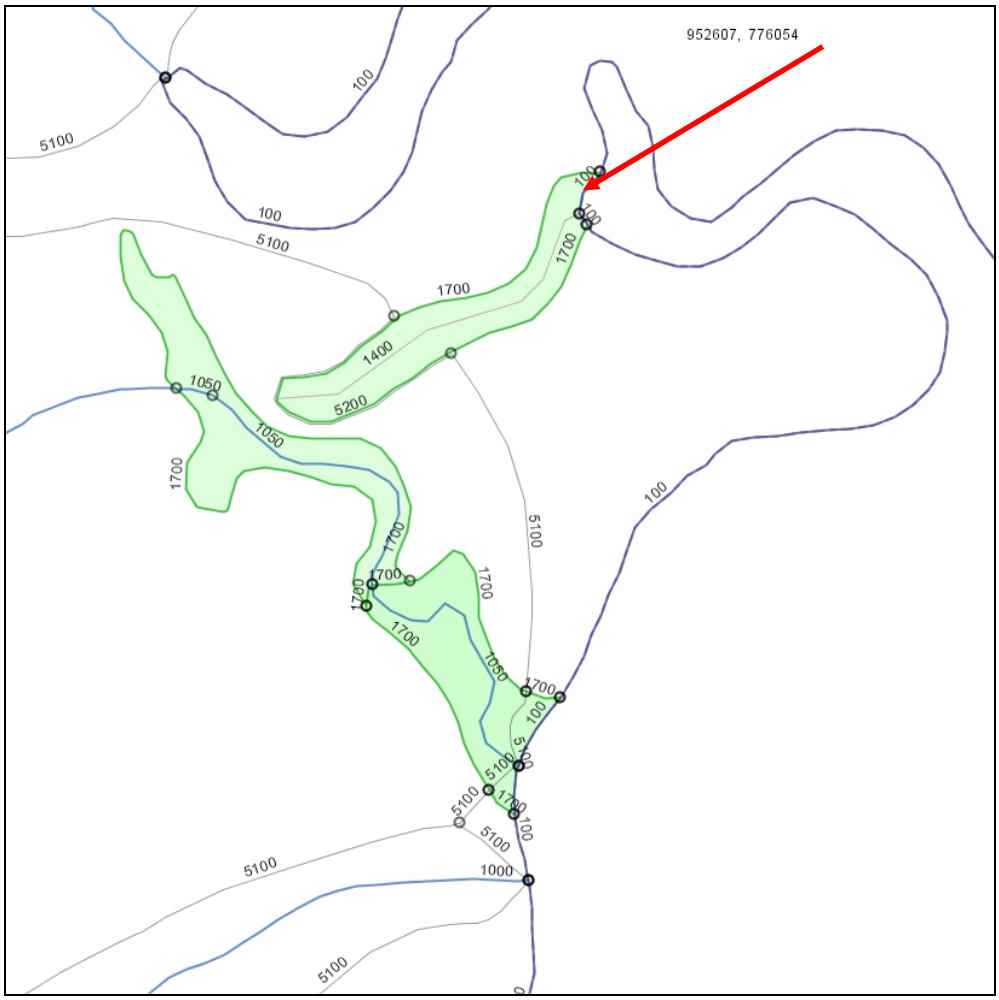


Figure 38: RWET-4 –Wetland bounded by coastline

3 DATA ISSUES

3.1 WETLAND DATA ISSUES

Wetlands bounded by existing watershed boundary lines. These cases are errors in the source data, however it is out of the scope to fix these so the existing watershed boundary line will be treated as a wetland bank and given the same drainage id as other wetland bank edges.

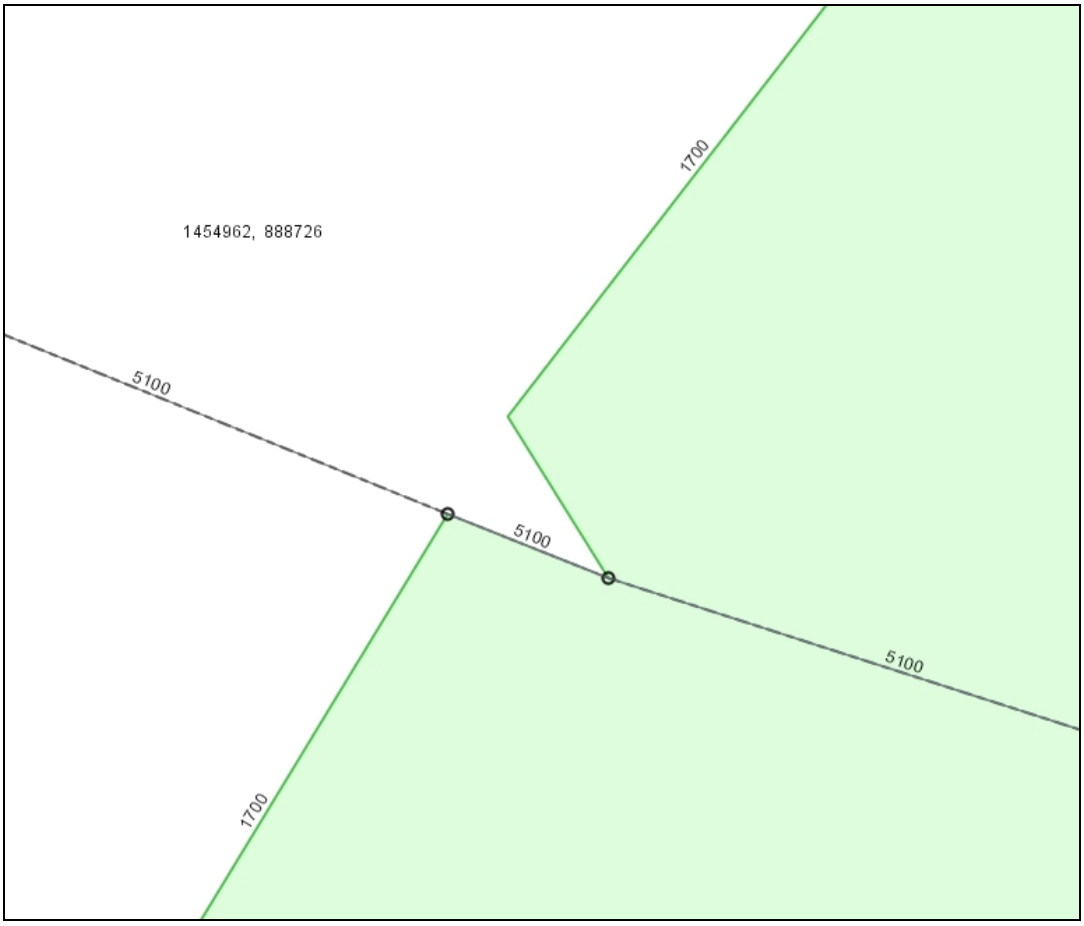


Figure 39: Wetland Bounded By Watershed Boundary I

These cases should be flagged before replacing the watershed boundaries in the FWA dataset. Once the watershed boundaries are replaced it will become more difficult to locate these data issues.

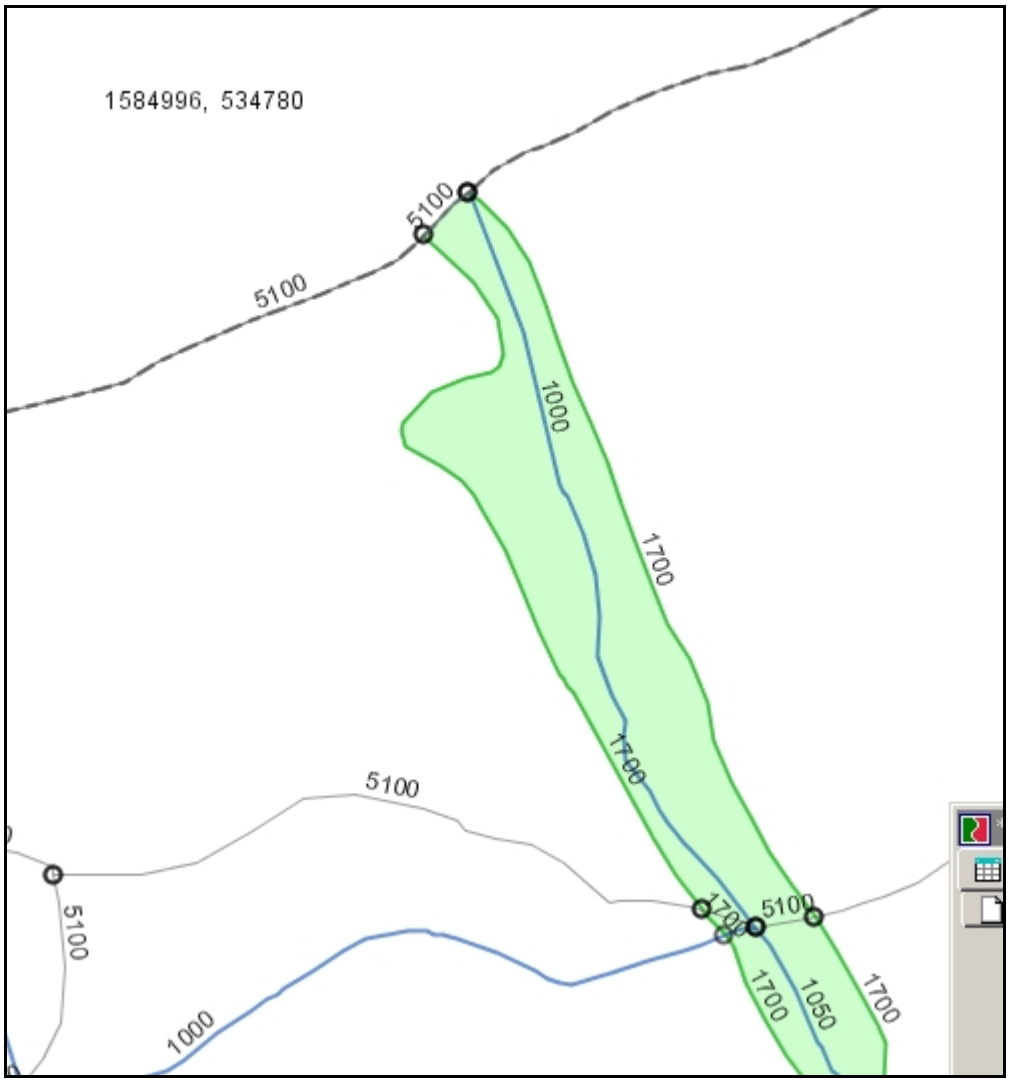


Figure 40: Wetland Bounded By Watershed Boundary II

4 QA CHECKS

The input dataset computed from the above requirements should obey by the following constraints:

- Each deliverable edge have a single, valid drainage id.
- Each waterbody should only be associated with a single drainage id (bank edges that make up the waterbody).
- No skeletons or flow edges within deliverable wetlands should be included.
- No duplicate geometries.
- No delimiter edges should be delivered.

5 DETAILED VERSION HISTORY

5.1 VERSION 3 – JUNE 04, 2007

5.1.1 Modification 1 – RSTREAM-1

5.1.1.1 Background

This modification was made to better reflect the intentions of the initial requirement. Watershed boundary lines are being generated for all streams at a single line stream confluence regardless of stream order.

5.1.1.2 Modified Requirements

RSTREAM-1	Where first order streams flow into higher order streams represented as a single line, watershed boundary linework will be generated on the opposite bank to the stream confluence.

modified to

RSTREAM-1	At any single line stream confluence, watershed boundary linework will be generated on the opposite bank of the stream confluence.

5.1.2 Modification 2 – RINFER-2

5.1.2.1 Background

This modification was made to provide another example where drainage ids may not follow other rules because of the route attribution. This will ensure a watershed can be generated for each route. See Example 13 for further information.

5.1.2.2 Modified Requirements

RROUTE-1	In absence of any other criteria, the watershed boundaries should respect the generated FWA routes. See Example 17.

modified to

RROUTE-1	In absence of any other criteria, the watershed boundaries should respect the generated FWA routes. This rule affects both wetland construction lines (See Example 17) and inferred stream intersections (Example 13).

5.1.3 Modification 3 – 1325 delimiter edges

5.1.3.1 Background

These modifications were made to ensure that all waterbodies split by 1325 delimiter edges have different drainage ids regardless of what watershed group they are contained within. This was done as there is at least one case in the province where a lake is split by a 1325; but the waterbodies on both sides of 1325 split have different controlling routes. In order to generate watersheds for both routes, watershed boundary lines are required where the 1325 split occurs.

5.1.3.2 Modified Requirement

RLAKE-5	Watershed boundaries will not be generated at lakes that are broken by 1325 delimiter edges, except in cases where the 1325 delimiter also delimits watershed groups.

modified to

RLAKE-5	Watershed boundaries will be generated at lakes that are broken by 1325 delimiter edges.

5.1.3.3 Modified Requirement

RSTREAM-9	Watershed boundaries will not be generated at double line rivers breaks that are broken by 1325 delimiter edges, except in cases where the 1325 delimiter also delimit watershed groups.

modified to

RSTREAM-9	Watershed boundaries will be generated at double line rivers breaks that are broken by 1325 delimiter edges.

5.1.4 Modification 4 – wetland/coastline shared edges (RWET-4)

5.1.4.1 Background

Originally wetlands edges that are shared with the coastline and part of a deliverable wetland were not included as input to the watershed generator. However the watershed generator needs to know not to draw lines through these wetlands so these edges are included as input, with the same drainage id as the coastline.

5.1.4.2 Modified Requirement

RWET-4	In cases where wetlands touch the ocean, the ocean will be treated similar to a lake with multiple inputs.

modified to

RWET-4	In cases where wetlands touch the ocean, the ocean will be treated similar to a lake with multiple inputs; however wetland bank edge that is shared with the coastline will be delivered.

5.2 VERSION 2 - AUGUST 16, 2006

5.2.1 Modification 1 – Inferred Edges

5.2.1.1 Background

This requirement was modified as a result of a meetings and subsequent e-mails between George Eade, Emily Gouge, Martin Davis, Dan Grant, and Mark Sondheim. Initial meeting occurred August 10, 2006.

5.2.1.2 Retired Requirements

RSTREAM5	Inferred edges (1410) are ignored, both in computing the drainage id and as input to the watershed boundary software.

As shown in the figure below this requirement resulted in 1410's being ignored and watershed boundary lines drawn 'between' features connected with 1410's.

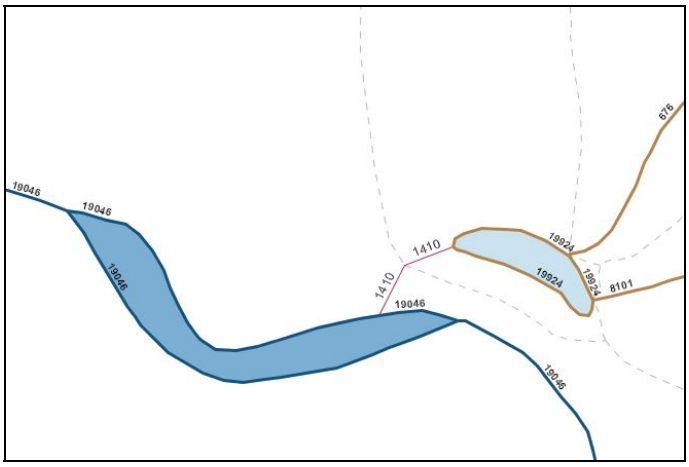


Figure 41: Retired Requirement Example

5.2.1.3 Added Requirements

RINFER-1	Inline inferred edges (1410s) will be included as input to the watershed boundary software and treated similar to observed streams. As a result they will be given drainage id's that are the same as the input and output flow, and watershed boundaries will be generated around the entire stream.
RINFER-2	In cases where an observed stream or waterbody flows into a T inferred edges (1410s) the watershed boundaries should be generated from the sink node of the observed stream, or the waterbody outlet. To implement this, T inferred edges will be included as input to the watershed boundary software; however the drainage ids will be assigned to these such that the drainage id will be the same as the observed feature they flow into.
RINFER-3	In special T cases where a 1410 flows into two rivers the drainage id will be assigned as follows: • If one stream is primary and the other is secondary the primary stream's drainage id will be assigned to the 1410 • If both streams are secondary and new unique drainage id will be assigned to the 1410.

5.2.2 Modification 2 – Construction Lines

5.2.2.1 Background

The following modifications were made as a result of the modifications to the inferred edges. Some 1400 construction lines are connected by 1410s, and in order to ensure connectivity of these 1400 and 1410s is respected the requirements were modified to include the 1400 construction lines. However in cases where these constructions (and other construction lines) are isolated they are not used for computing drainage ids. This ensures that wetlands that straddle group boundaries and have a construction lines on either side are processed correctly. [See figure below for an example. If the disconnected construction line is included in the wetland would be excluded from the watershed generator when it should be included.]

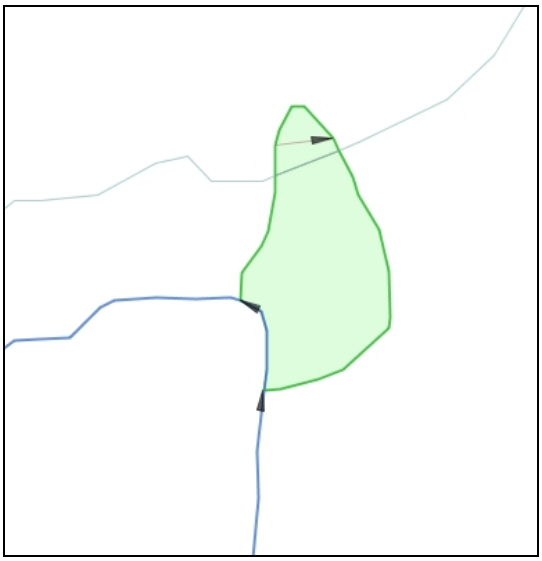


Figure 42: Wetland Data Issue

5.2.2.2 Retired Requirement

RSTREAM-8	Isolated construction lines (1400) are ignored both in computing the drainage id and as input to the watershed boundary software.

5.2.2.3 Modified Requirement

RSTREAM-6	Construction lines (1200, 1250, 1300, 1350, 1450, 1475) are used to determine connectivity and the location of stream confluences for the purposes of generating drainage ids, but are not provided as input to the watershed generator.

modified to

RSTREAM-6	Non-isolated construction lines (1200, 1250, 1300, 1400, 1350, 1450, 1475) are used to determine connectivity and the location of stream confluences for the purposes of generating drainage ids, but are not provided as input to the watershed generator. Isolated construction lines are ignored.