Assessment of Road Crossings for Improving Migratory Fish Passage in the Winnicut River Watershed

The Nature Conservancy
Protecting nature. Preserving life.™

Ray Konisky, Director of Marine Science and Conservation
The Nature Conservancy, New Hampshire Chapter, Concord, NH

December 2009

Table of Contents

Cover Photo: Winnicut River mainstem looking South toward headwaters at Walnut Avenue, N. Hampton (R Konisky TNC)

Executive Summary

This report summarizes the results of a river continuity assessment focused on road-stream crossings. The Winnicut River is the site of a restoration project that removed a head-of-tide dam and resulted in the only free-flowing major tributary to the Great Bay Estuary. The river system currently supports a small annual run of river herring, and with the removal of the dam and ladder system, migratory fish will now have access to a total of 37 miles of potential upstream habitat.

In anticipation of improved access, The Nature Conservancy conducted a fish passage assessment for all stream crossings above the head-of-tide dam. We used an assessment methodology based on the Massachusetts Riverways Program, with adjustments following a similar crossing study in the Ashuelot River system (NH).

We assessed a total of 42 road crossings in the Winnicut watershed, and classified them as severe, moderate, minor, or passable for fish passage. One crossing was identified as severe, thirty-five were moderate, six were minor, and no crossings were determined to be fully passable for all fish.

To develop a priority list of crossings for improvements, we focused on culverts with moderate or severe barrier rankings and screened out crossings associated with major highway infrastructure. We then used GIS analysis to determine the habitat potential upstream of each crossing, and prioritized crossings with greater than 0.5 miles of upstream habitat. We ordered priority crossings from nearest to furthest from the dam site at the river mouth. Our analysis produced a final list of 11 crossings that, if all were improved, would reestablish 19.5 miles of unfragmented habitat for migratory fish.

We are sharing results of this study with local and state officials in hopes of securing funds and making structural enhancements to priority road crossings. Going forward, we hope that this information will lead to increases in migratory fish populations in the Winnicut River and throughout the entire Great Bay Estuary.

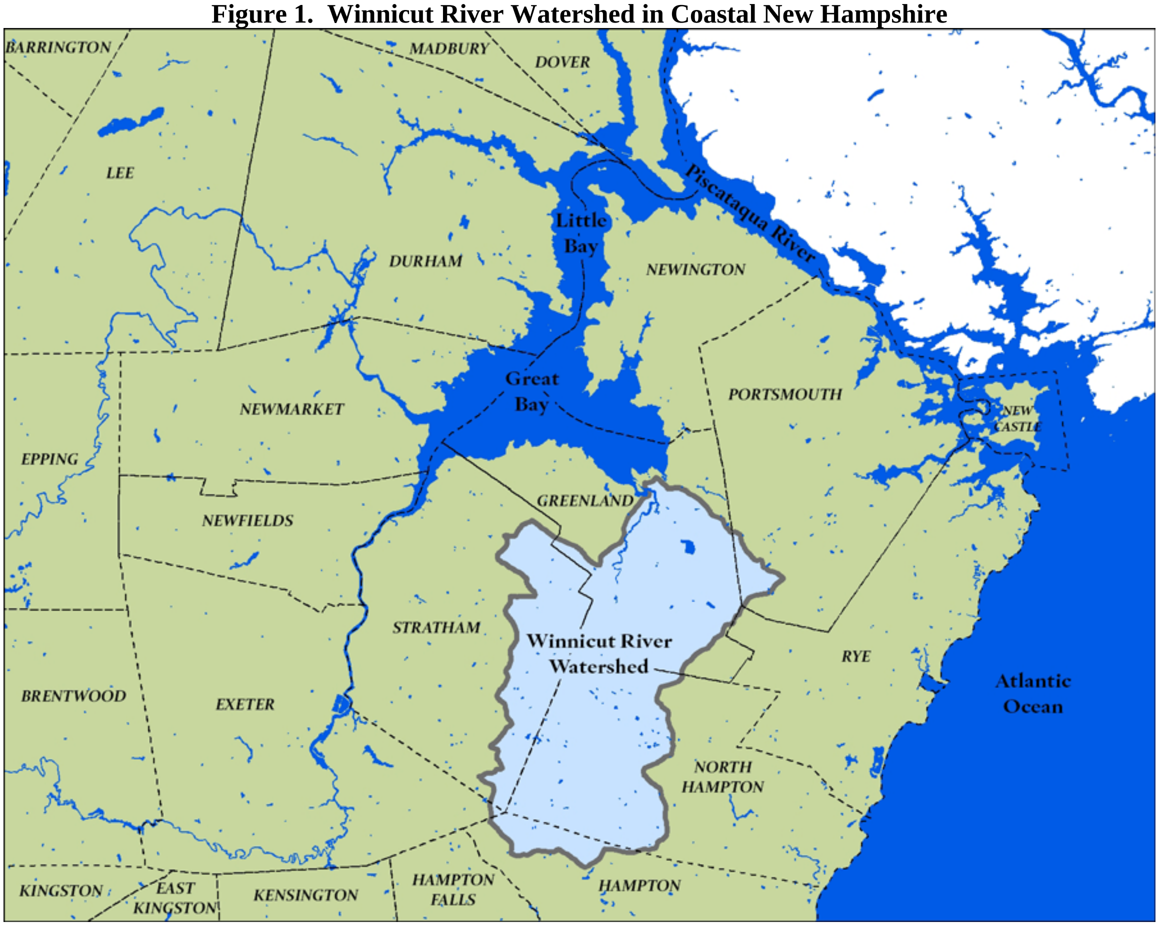
Crossing at Willowbrook Ave, Stratham (R Konisky TNC)

Background

The Winnicut River is one of seven major tributaries to the Great Bay Estuary of New Hampshire, originating in the state's southeastern coastal plain and flowing north into the Great Bay at the town of Greenland. The Winnicut watershed encompasses approximately 14.2 square miles, primarily in the towns of Greenland, Stratham, and North Hampton (Figure 1). The watershed consists of marshes bounded by low-lying hills, with no named ponds greater than 2 acres, a maximum elevation of only about 200 ft, and an average river slope of approximately 6 ft per mile (Woodlot Alternatives 2007).

The Winnicut River watershed contains significant ecological resources, including coastal and estuarine areas, forest ecosystems, freshwater systems, and plant and wildlife habitat. The Land Conservation Plan for New Hampshire's Coastal Watersheds identifies two core areas within the watershed: Winnicut River/Cornelius Brook and the Upper Winnicut River (Zankel et al. 2006).

Figure 1. Winnicut River Watershed in Coastal New Hampshire



Historically, the Winnicut provided access to 37.2 total miles of migratory fish habitat above the dam. In 1957, a dam with a Canadian step-weir fish ladder was constructed at the head-of-tide, but design of the ladder proved inefficient for passage of migrating fish. Anecdotal records indicate that many species of migratory fish used river habitat above the current dam location, including shad, salmon, alewife, blueback herring, eel, and rainbow smelt (Odell et al. 2006). In recent years, despite an adjustment of the ladder in 1997, as few as 800 and as many as 8000 river herring have passed annually through the ladder system (NH Fish and Game 2005). There are no survey records for passage of other migratory fish species into the watershed.

In October 2009, NH Fish and Game and other partners successfully removed the head-of-tide dam and the adjoining ladder. The project included removal of the dam and construction of a fish-pass run under the nearby Route 33 bridge, with the goal of returning migratory fish passage to the system. Following barrier removal, factors of water quality and availability of stream habitat now gain focus as next concerns for successful restoration of Winnicut fish runs.

In terms of water quality regime, the Winnicut appears to have relatively few direct alterations in base flows from surface water or groundwater withdrawals, and no point sources of commercial or municipal waste discharge (Woodlot Alternatives 2007). Nonpoint sources of nutrients, however, resulting from golf courses, residential development, and some agriculture within the watershed are likely significant. A recent GIS analysis showed about 30% of this small watershed is developed (Odell et al. 2006), suggesting that stream habitat quality may be impacted like other NH seacoast systems.

The study presented here provides a first analysis of connectivity for fish passage through the Winnicut stream network, based on a regional methodology for assessing road crossings. We conducted this analysis with the goal of identifying priority crossings in the Winnicut network that would benefit migratory fish if improved. By sharing these results with the watershed towns and coastal restoration community, we provide new information for directing resources to enhance fish passage in a system recently re-opened to the estuary.

Methods

Road-Stream Crossings Field Protocol

We adopted a road crossing assessment protocol developed by the River and Stream Continuity Partnership. In 2005, The Riverways Program, within the Massachusetts Department of Fish and Game, and The Nature Conservancy, Massachusetts Chapter joined with UMass Extension to form the River and Stream Continuity Partnership. UMass Extension maintains a website and online database structured around the field protocol, and our information, as well as information from multiple watersheds across the New England states, now populates this growing body of data on stream fragmentation.

We decided to use the field protocol developed by the River and Stream Continuity Partnership for several reasons. First, it was a local protocol developed for northeastern river systems and was being utilized in other watersheds that were priorities for The Nature Conservancy. Over time, this will allow us to not only compare sites within our watershed, but also across watersheds in New England. Second, it was designed for use at a watershed scale, with the goal of quickly prioritizing the most critical stream crossing restoration sites. It was not designed to fully assess habitat quality, nor stream geomorphology. This protocol should be recognized as a first step, or coarse scale, identification of the most fragmenting features. More highly detailed on-site assessments will be necessary at a later date as site-specific restoration activities are initiated. The protocol was also designed to be practical for volunteers, and we did take advantage of outside help with some of the initial field work.

Figure 2. Assessing Crossing at Route 33 Bridge, Greenland (D. Bechtel TNC)

Field Forms

The field protocol focuses on parameters that can be observed from the road right-of-way so that volunteers are not required to seek landowner permission. We drove to sites and were not required to walk along streams outside of the boundaries of the right-of-way. At each location, we collected information on both the road and on the crossing structure itself. Many field form questions required us to judge whether the conditions within the crossing were different than the natural stream channel. The only measuring tool required for field work was a measuring tape to record dimensions of the crossing. (See Appendix A for the field form and a full list of parameters). A quality assessment of methods was completed in a previous study conducted by The Nature Conservancy for the Ashuelot River watershed and reported in the Quality Assurance Project Plan section of the report (Bechtel and Ingraham 2008).

Crossing Locations

We identified road-stream crossings via GIS analysis. We refer to these generically as "sites" or "crossings." We intersected the NH Hydrography Dataset flowline feature class (*i.e.* streams; GRANIT, 2006) with NH Department of Transportation Roads data (GRANIT, 2005) and NH Railroad data (GRANIT, 1992). We used the INTERSECT ArcInfo command to create a point dataset of 48 road-stream crossings which were used as the basis for field survey work and all subsequent analyses.

Barrier Fragmentation Scoring Algorithm

The key parameters that indicate the extent of fragmentation at each crossing are scored using an algorithm that assigns a preliminary fragmentation score between zero and ten (Appendix 2). The fragmentation scoring algorithm combines multiple parameters and assigns relative fragmentation of a crossing on a scale from zero to ten, zero implying no passage and most fragmenting (Appendix 2). Scores are then translated into four fragmentation classes listed in Table 1.

Table 1. Road-stream crossings classifications

Algorithm Score	Barrier Class
1	Severe
2	Moderate
3 – 5	Minor
6 – 10	Passable[1]

The algorithm is structured in such a way as to ensure that the most challenging features are prioritized. For example, even if a culvert has all the correct features to allow passage, if there is some sort of permanent barrier, such as a screen at one end, the algorithm automatically scores the site a one (1), or Severe Barrier.

Spatial Analysis

In addition to the field measures, we used GIS to determine spatial characteristics of each culvert location relative to fish passage considerations. For each crossing, we analyzed the downstream path from the crossing to the head-of-tide dam site to determine the length of stream and to count the number of downstream road crossings encountered. Crossings were assigned sequential ID numbers from closest to furthest as an indicator of the relative likelihood of migratory fish reaching a given crossing. On the upstream side, we measured from each crossing to the furthest extent of stream in the watershed as the total stream network upstream, the amount of the total that was unblocked to the next crossing, and the number of upstream road crossings encountered. These upstream metrics are used as indicators of potential migratory fish habitat with crossing improvements. We used the ESRI ArcHydro extension, combined with a USGS elevation dataset, to delineate upstream and downstream subwatersheds for each crossing.

Results

Data Collection and Database Compilation

Between July 2007 and October 2008, we traveled to each of the identified road crossing sites, conducted the assessment protocol, and recorded results on field data sheets. Road crossings for the study area of the watershed, all above the Winnicut dam site, are shown in Figures 3a (northern portion) and 3b (southern portion).

[1] Some of the 6-10 scores may pose challenges for certain species, or may impair certain ecological functions. We intend to assess this in future studies.

Stream crossings were not found at two locations, presumably due to new construction, and/or inaccurate or outdated GIS layers. Crossings not found were coded with ID 99. Also, three crossings at Route 95 were identified as double-crossings, locations where a single culvert pipe under double sections of highway ramp was counted twice by the GIS analysis. The double crossings were assessed as a single crossing and assigned the same culvert code (ID 25, 41, 42). In a slight deviation from the field protocol for safety reasons, the lengths of eight culverts that ran under the double section of Route 95 were sized by GIS measures.

Lastly, GIS ArcHydro analysis determined that two of the highway ramp crossings in the far southern reach of the study area were actually outside the watershed, with altered drainage away from the Winnicut system. Due to these elevation alterations, crossings ID 41 and 42 could not be subject to spatial drainage analysis.

In total, 42 independent crossings were inventoried and assessed. Data were entered into a spreadsheet and reviewed for consistency. The assessment algorithm was then used to generate a preliminary score based on crossing characteristics and a final score considering culvert dimensions, resulting in assignment of a Barrier Class. Table 2 shows the final inventory of road crossings, classifications, and spatial statistics.

Figure 3a. Winnicut watershed crossings (northern portion)

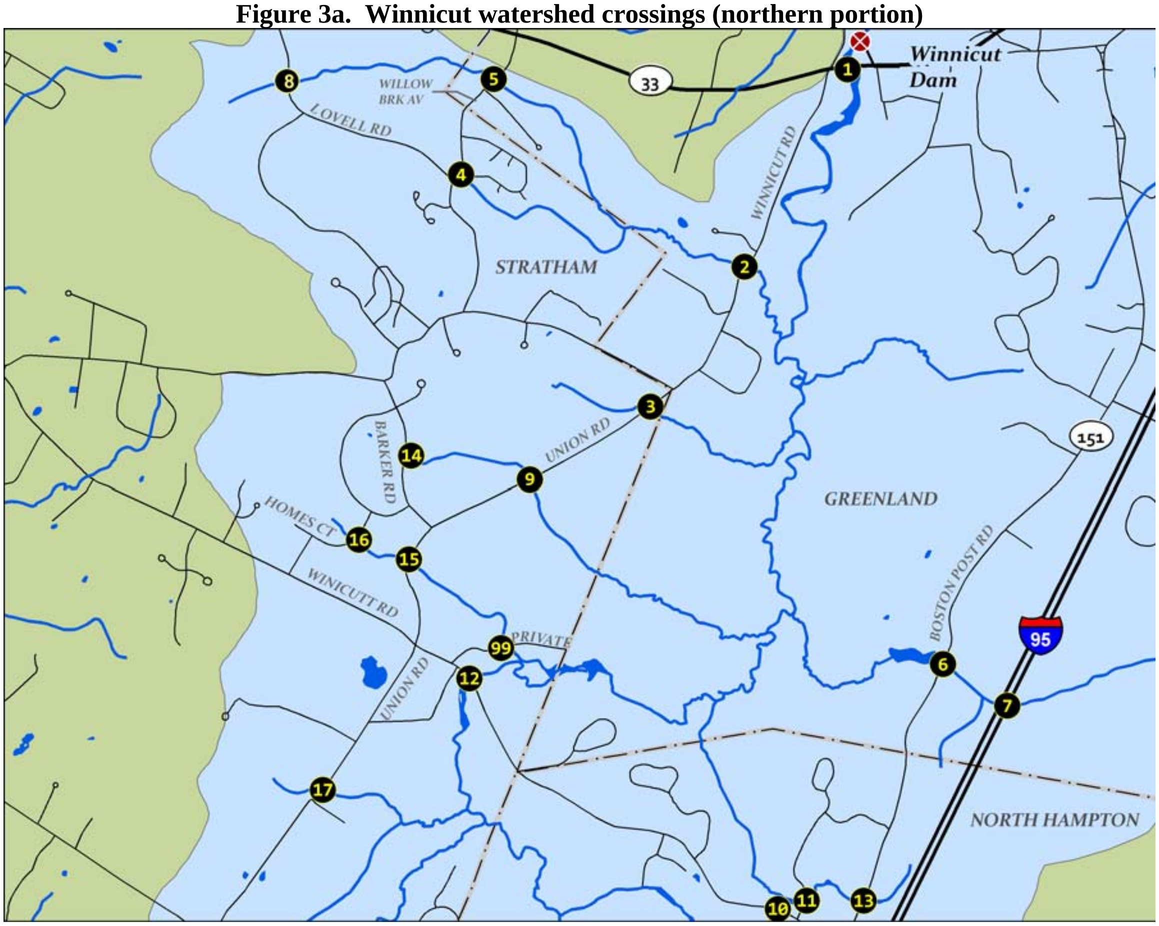
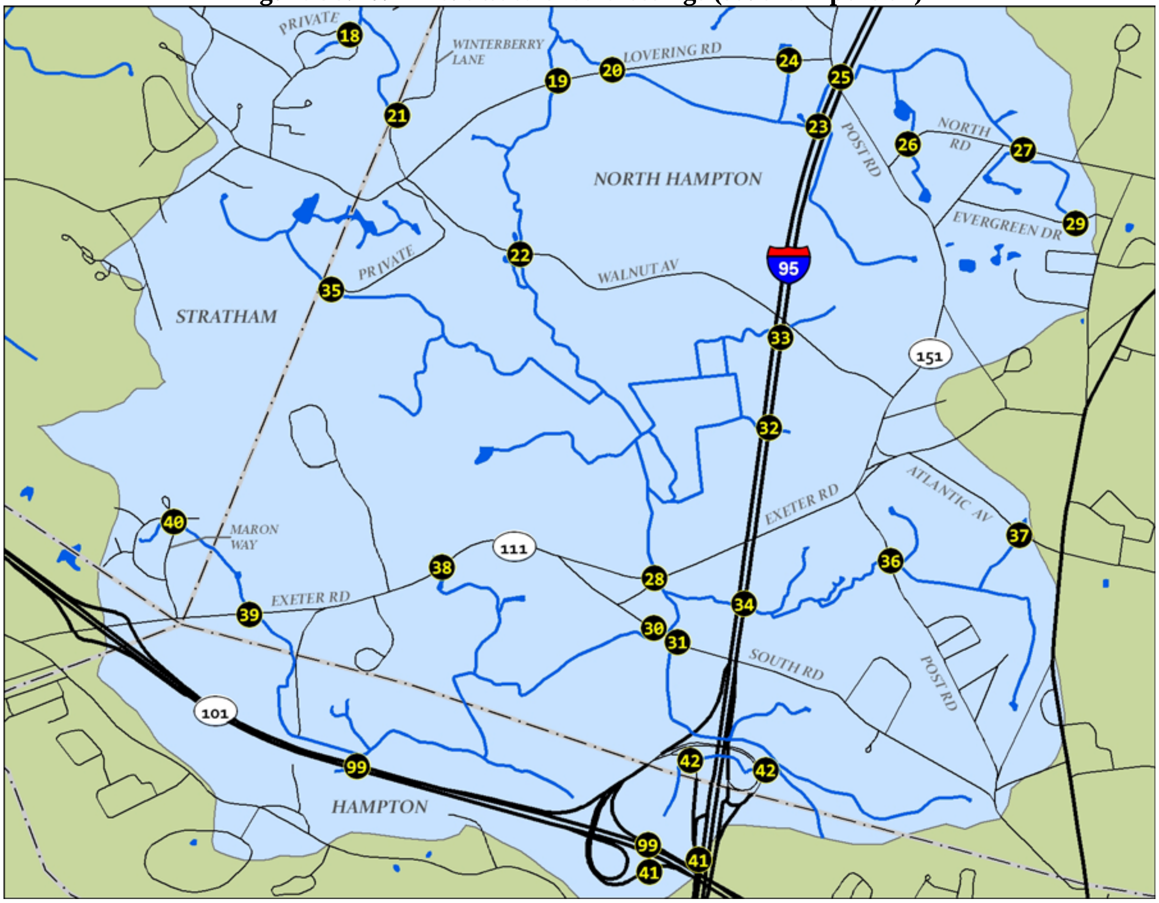


Figure 3b. Winnicut watershed crossings (southern portion)



Barrier Summary

Algorithm results had one crossing classified as severe, thirty-five ranked as moderate, and six determined to be only minor impediments to fish passage. No crossings were classified as fully "passable". Figure 4 shows a summary of these results.

Figure 4. Barrier Fragmentation Score Distribution

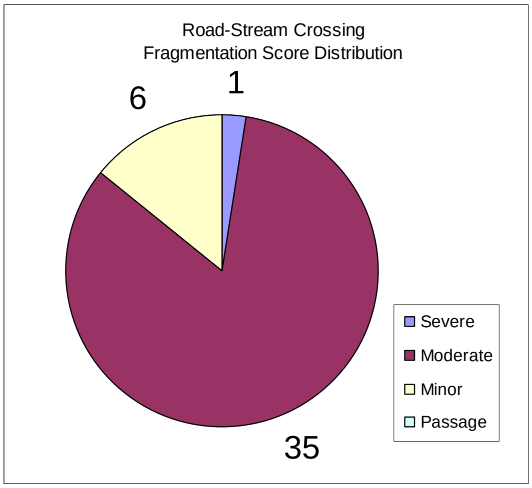


Table 2. Road Crossing Barrier Class and Spatial Statistics

Crossing Id	Barrier Class	Stream Distance to Dam Site (mi)	Number Downstream Crossings to Dam Site	Total Stream Network Upstream (mi)	Unblocked Stream Network Upstream (mi)	Number Crossings Upstream	Town
1	Moderate	0.06	0	37.19	8.53	42	Greenland
2	Moderate	1.52	1	2.63	1.17	3	Greenland
3	Moderate	2.19	1	0.34	0.34	0	Greenland
4	Severe	2.60	2	0.05	0.05	0	Stratham
5	Moderate	2.63	2	0.88	0.66	1	Greenland
6	Moderate	2.96	1	1.05	0.50	1	Greenland
7	Moderate	3.20	2	0.63	0.63	0	Greenland
8	Moderate	3.31	3	0.21	0.21	0	Stratham
9	Moderate	3.33	1	0.45	0.45	1	Stratham
10	Minor	3.41	1	0.22	0.22	0	North Hampton
11	Minor	3.46	1	0.45	0.24	1	North Hampton
12	Moderate	3.62	1	22.70	4.14	26	Stratham
13	Moderate	3.69	2	0.22	0.22	0	North Hampton
14	Moderate	3.80	2	0.00	0.00	0	Stratham
15	Moderate	3.97	2	0.28	0.17	1	Stratham
16	Moderate	4.16	3	0.11	0.10	0	Stratham
17	Moderate	4.59	2	0.17	0.17	0	Stratham
18	Moderate	4.81	2	0.08	0.08	0	Stratham
19	Minor	4.90	2	14.53	0.81	14	North Hampton
20	Moderate	4.95	2	3.71	1.06	7	North Hampton
21	Moderate	5.08	2	0.07	0.07	0	Stratham
22	Moderate	5.52	3	13.73	5.34	13	North Hampton
23	Moderate	5.66	3	0.68	0.68	0	North Hampton
24	Minor	5.71	3	0.04	0.04	0	North Hampton
25	Moderate	5.80	3	1.90	0.02	4	North Hampton
26	Moderate	6.25	6	0.20	0.20	0	North Hampton
27	Moderate	6.55	5	0.67	0.64	1	North Hampton
28	Moderate	6.71	4	6.89	0.48	9	North Hampton
29	Moderate	6.92	6	0.03	0.03	0	North Hampton
30	Moderate	6.93	5	3.96	3.29	4	North Hampton
31	Minor	6.95	5	0.39	0.38	0	North Hampton
32	Moderate	6.95	4	0.08	0.08	0	North Hampton
33	Moderate	6.96	4	0.21	0.21	0	North Hampton
34	Moderate	6.98	5	2.21	0.94	2	North Hampton
35	Moderate	7.10	4	1.06	1.06	0	North Hampton
36	Moderate	7.52	6	1.21	1.19	1	North Hampton
37	Moderate	8.03	7	0.08	0.08	0	North Hampton
38	Minor	8.13	6	0.04	0.05	0	North Hampton
39	Moderate	9.07	6	0.50	0.36	1	North Hampton
40	Moderate	9.45	7	0.15	0.15	0	Stratham
41	Moderate	no data	no data	no data	no data	no data	Hampton
42	Moderate	no data	no data	no data	no data	no data	North Hampton

Crossing Prioritization

We used a combination of barrier assessment, spatial analysis, and practical considerations to identify a subset of crossings that we believe should be priorities for improving migratory fish passage in the system. Prioritization was conducted in a three step process based on a cascading series of exclusions, as follows:

1. Barrier Exclusions

The six crossings identified as minor barriers were eliminated first from consideration based on the results of the assessment algorithm (ID 10, 11, 19, 24, 31 and 38). Although these crossings may still limit fish movement, the larger and better-sited culvert pipes result in low rank for improvement. We did, however, observe pipe corrosion at crossing 10 (Winnicut Road at Barton Brook, N Hampton) and at crossing 24 (Lovering Road at Cornelius Brook, N Hampton). In addition, mainstem crossing 19 (Lovering Road, N Hampton) is critically located as the gateway to 14.5 miles of upstream habitat. Even though migratory fish passage may be adequate now, the risk of future degradation remains a concern and continued monitoring of these crossings is recommended.

2. Practical Exclusions

Nine crossings were eliminated from priority listing due to practical considerations. The first crossing on the river, at Route 33 (Figure 1, ID 1), is a heavily-traveled bridge just upstream of the head-of-tide dam. During bridge construction, abutment and piling placement in the channel has led to compromised fish passage. For this reason, a new fishway is being constructed under the bridge as part of the dam removal process. We therefore removed this crossing from our wish-list of future improvements.

In addition, economic infrastructure considerations are significant for the multiple stream crossings that flow under Route 95 (ID 7, 23, 25, 32, 33, 34, 41, and 42). These eight crossings are fairly new, heavy-duty box culverts, typically 200-ft long, that extend under 8 lanes of interstate highway. Recognizing the low practicality of replacing any of these culverts for fish passage considerations, we simply excluded all Route 95 crossings from our priority list.

3. Limited Upstream Potential

Our spatial analysis showed that many crossings were at or very near terminal points in the stream network. For these crossings, improvements to passage would result in very marginal benefits of increased access to migratory fish spawning and nursery habitat. Those locations with 0.5 miles or less of potential upstream habitat were determined to be low priority for improvements, with sixteen crossings excluded from the priority list (Table 2, ID 3, 4, 8, 9, 13, 14, 15, 16, 17, 18, 21, 26, 29, 37, 39 and 40). It should be noted that crossing 4 (Willowbrook Avenue in Stratham) was the only crossing assessed as a “severe” barrier, but the location of the culvert at the network terminus resulted in a lowered overall priority ranking. A downstream image of crossing 4 is also shown on the Executive Summary page, as it drains a small firepond with twin perched culvert pipes.

4. Priority Crossings

Following all exclusions, we determined that eleven crossings should be considered priorities for future structural improvements that enhance migratory fish passage. These crossings all represent moderate barriers to fish passage, flow under residential or state roads, and offer substantial potential for access to upstream fish habitat. Table 3 shows priority crossings, ordered by downstream distance from the dam site, with additional descriptive information about the location, type, dimensions, and condition of each crossing.

Table 3. Priority crossings for improving migratory fish passage in the Winnicut River watershed

Id	Unblocked Stream Network Upstream (mi)	Town	Road Location	Mainstem or Brook	Type	Size	Len (ft)	Notes on Condition
2	1.17	Greenland	Winnicut Rd	Thompson Brook	Single steel pipe	6-ft diam	38	Some pipe corrosion and rusting
5	0.66	Greenland	Willowbrook Ave	Willow Brook	Single steel pipe	3-ft diam	46	2-ft section of outlet rusted away
6	0.50	Greenland	Post Rd	Newton Brook	Single plastic pipe	4-ft diam	54	New reinforced plastic materials
12	4.14	Stratham	Winnicut Rd	Mainstem	Triple bridge sections	20-ft x 10-ft	21	Span includes old mill and cribworks
20	1.06	North Hampton	Lovering Rd	Cornelius Brook	Double plastic pipes	2-ft diam	40	Plastic pipes with stone abutments and debris grates
22	5.34	North Hampton	Walnut Ave	Mainstem	Single steel pipe	5-ft diam	66	Some pipe corrosion and rusting
27	0.64	North Hampton	North Rd	Cornelius Brook	Single steel pipe	1.5-ft diam	42	Substantial corrosion and rusting
28	0.48	North Hampton	Exeter Rd	Mainstem	Single concrete pipe	2-ft diam	117	Old concrete materials
30	3.29	North Hampton	South Rd	Mainstem	Single concrete pipe	2-ft diam	88	Old concrete materials
35	1.06	North Hampton	Private woods road	Pine Hill Brook	Single concrete pipe	1-ft diam	59	Beaver dam on outlet with old concrete pipe
36	1.19	North Hampton	Post Rd	Un-named brook	Single concrete pipe	2-ft diam	52	Old concrete materials

Priority Crossing Photos and Notes

The following section provides brief field observations and photos of the eleven crossings targeted as priority culverts for replacement or enhancement. All images shown are for upstream inlet (left) and downstream outlet (right) openings. Photos taken by R Konisky (TNC).

Crossing 2: Thompson Brook at Winnicut Rd, Greenland
Notes: Dense vegetation surrounding upstream brook and inlet; slight outlet perch

Crossing 5: Willow Brook at Willowbrook Ave, Greenland
Notes: Slight outlet perch with two foot section of outlet pipe bottom rusted away

Crossing 6: Norton Brook at Post Rd, Greenland
Notes: Terraced inlet drop into large deepwater impoundment downstream of crossing

Crossing 12: Winnicut River at Winnicut Rd, Stratham
Notes: Three span bridge with multiple downstream impediments associated with old mill structures


Crossing 20: Cornelius Brook at Lovering Rd, North Hampton
Notes: Twin plastic pipes (about 70’ apart) near headwaters, signs of removable debris grates at inflow


Crossing 22: Winnicut River at Walnut Ave, North Hampton
Notes: Near headwaters, slow flowing mainstem with some ponding


Crossing 27: Cornelius Brook at North Rd, North Hampton
Notes: Rusted and corroding culvert pipe with slight outlet perch, flows into golf course


Crossing 28: Winnicut River at Exeter Rd, North Hampton
Notes: Dense scrub vegetation upstream and downstream; very slow flows and ponded conditions


Crossing 30: Winnicut River at South Rd, North Hampton
Notes: Dense scrub vegetation upstream and downstream; very slow flows and ponded conditions


Crossing 35: Pine Hill Brook at private woods road, North Hampton
Notes: Beaver dam at crossing; impeded flows and eroded concrete pipe

Crossing 36: Unknown brook at Post Rd, North Hampton
Notes: Dense vegetation upstream and downstream; slow flows and cattail downstream

Conclusions and Next Steps

Our assessment of road crossings in the Winnicut River above the head-of-tide dam site indicates that the overwhelming majority of crossings are moderate impediments to fish passage. Of forty-two crossings assessed, we found only one culvert with severe passage conditions, but no crossings were scored to be fully passable for all species. Clearly, connectivity of the system is compromised by existing infrastructure and would benefit from a less-restrictive network of culvert crossings.

Following dam removal, the Winnicut River stream network is now reopened to migratory fish species, especially river herring, eel, and shad. Based on the results of our assessment, we are concerned about the pervasive level of moderately difficult fish passage throughout the system. We encourage town, state, and regional agencies to consider our list of priority crossings when funds for replacing culverts become available, and when new road crossing projects are designed.

The priority list of crossings includes several culverts that are currently in degraded or poor condition. Several others appear to be structurally functional but use older concrete materials. Structures degraded due to corrosion and rusting are at increased risk of failure during storm events and therefore also represent a public safety concern. These factors obviously need to be considered when planning and budgeting for culvert replacement. Still, the rationale for improvements solely based on fish passage is compelling. If all 11 priority culverts were to be improved, a total of 19.5 miles of unimpeded stream habitat would be reopened for migrating fish (Table 3, Unblocked Stream Network Upstream total).

This report is being shared with New Hampshire Fish and Game Department, as well as local officials in the towns of Greenland, Stratham, and North Hampton, as a planning guide for culvert work in the watershed. In addition, we have provided the crossing database to researchers at Antioch University as background for a planned modeling assessment of flood-failure potential under extreme storm scenarios. We envision that flood modeling can be combined with the fish passage assessment presented here as an expanded scope for prioritizing culverts in expectation of future enhancements.

Going forward from this assessment, we hope that enhancement of connectivity for migratory fish will improve long-term availability and quality of stream habitat, and lead directly to increased migratory fish populations throughout the entire estuarine system of New Hampshire.

Literature Cited

Bechtel, D., and P. Ingraham. 2008. River Continuity Assessment of the Ashuelot River Basin. The Nature Conservancy. Prepared for New Hampshire Department of Environmental Services, Rivers Management and Protection Program. Concord, NH.

GRANIT, 2005. New Hampshire Department of Transportation Roads data. Complex Systems Research Center, University of New Hampshire. Durham, NH. Accessed June, 2007:http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/database/d-webdata/roads_dot/nh/roads_dot.html

GRANIT, 2002. New Hampshire Landcover Assessment. Complex Systems Research Center, University of New Hampshire. Durham, NH. Accessed June, 2007: http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/database/d-webdata/nhlc01/nh/nhlc01.html

GRANIT, 1992. New Hampshire Railroads data. Complex Systems Research Center, University of New Hampshire. Durham, NH. Accessed June, 2007: http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/database/d-webdata/rr/nh/rr.html

NHDES; New Hampshire Department of Environmental Services; Dam Bureau. 2006. New Hampshire state dam database; GIS shapefile and database

NHF&G (2005) New Hampshire's Marine Fisheries Investigations, Anadromous Fish Investigations, Grant F-61-R. NH Fish and Game Department, Marine Fisheries Division, Durham, NH. 2005.

Odell, J., A. Eberhardt, D. Burdick, and P. Ingraham. 2006. Great Bay Restoration Compendium. The Nature Conservancy, University of New Hampshire, and the New Hampshire Estuaries Project. Concord, NH, USA.

Woodlot Alternatives Inc. 2007. Winnicut Dam Removal Feasibility Study, *now* Stantec, 30 Park Drive, Topsham, ME 04086

Zankel, M., C. Copeland, P. Ingraham, J. Robinson, C. Sinnott, D. Sundquist, T. Walker, and J. Alford. 2006. The Land Conservation Plan for New Hampshire's Coastal Watersheds. The Nature Conservancy, Society for the Protection of New Hampshire Forests, Rockingham Planning Commission, and Strafford Region Planning Commission. Prepared for the New Hampshire Coastal Program and the New Hampshire Estuaries Project, Concord, NH, USA.

Field Data Form: Road-Stream Crossing Inventory

Crossing ID#

Date:_________ **Stream/River:**____________________ **Road:**______________________________ **Town:** __________________

Location:__________________________________ ____

Observer:_________________________ **Phone #:**________________ **Email address:** ___________________________________

Photo IDs:____**Bearing US**__________**Bearing DS**_____________ __________

Road/Railway Characteristics

1. Number of Travel Lanes: ___ **Shoulder/ Breakdown lanes:** ☐ Yes ☐ No **Road Surface:** ☐ Paved ☐ Unpaved

2. Are any of the following conditions present that would significantly inhibit wildlife crossing over the road?

High traffic volume (> 50 cars per minute)	☐ Yes	☐ No
Steep embankments	☐ Yes	☐ No
Retaining walls	☐ Yes	☐ No
Jersey barriers	☐ Yes	☐ No
Fencing	☐ Yes	☐ No
Guard Rail	☐ Yes	☐ No
Curbs	☐ Yes	☐ No

Other (specify) ____

Crossing/Stream Characteristics (during generally low-flow conditions)

3. **Crossing Type:** ☐ Ford ☐ Bridge ☐ Open Bottom Arch ☐ Single Culvert ☐ Multiple culverts (# of culverts)______

3a. **Construction material** ☐ Plastic ☐ Concrete ☐ Stone ☐ Steel ☐ Other________________________

4. **Condition of crossing:** ☐ New ☐ Old ☐ Collapsing ☐ Eroding ☐ Rusted

Describe condition ____

5. **Is the stream flowing (in the natural channel)?** ☐ Flowing ☐ Ponded ☐ Dry

6. **Flow conditions are:** ☐ Unusually low ☐ Typical low-flow ☐ Average flow ☐ Higher than average

7. **Are any of the following conditions present? (see attached glossary and illustrations)**

Inlet drop ☐ _______ in. ☐ 0-6” ☐ 6-12” ☐ 12-24” ☐ >24” NONE

Outlet perch ☐ _______ in. ☐ 0-6” ☐ 6-12” ☐ 12-24” ☐ >24” NONE

With a perched outlet, circle one: Cascade Freefall

Flow contraction ☐ Yes ☐ No

8. **Tailwater armoring:** ☐ Extensive ☐ Not Extensive ☐ None

9. **Tailwater scour pool:** ☐ Large ☐ Small ☐ None

10. **Physical barriers to fish and wildlife passage:** ☐ Permanent ☐ Temporary ☐ None

Describe any barriers:____

11. **Substrate in crossing?** ☐ No substrate ☐ Partial substrate ☐ Substrate < 1’ ☐ Substrate > 1’

12. **Crossing substrate:** ☐ Natural ☐ Non-natural ☐ Contrasting ☐ Comparable

Substrate comments:____

13. Water depth matches that of the stream? ☐ Yes (comparable) ☐ No (significantly deeper) ☐ No (significantly shallower)

14. Water velocity matches that of the stream? ☐ Yes (comparable) ☐ No (significantly faster) ☐ No (significantly slower)

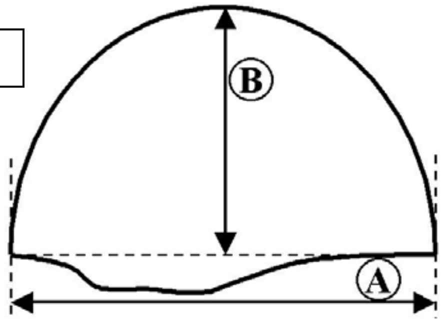
15. Crossing slope matches that of the stream? ☐ Yes (comparable) ☐ No (significantly steeper) ☐ No (significantly flatter)

16. **Crossing span:** ☐ Constricts channel ☐ Spans active channel ☐Spans bankfull width ☐ Spans channel & banks

17. **Minimum structure height at low water** ☐ > 6 ft. ☐ 4-6 ft. ☐ < 4 ft.
(from water level to the roof inside the structure)

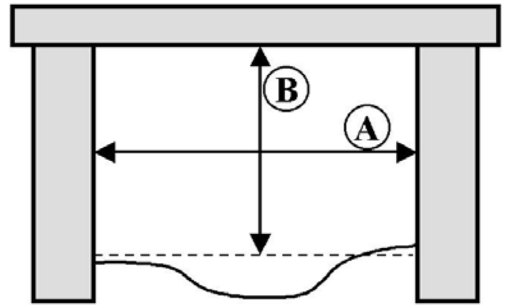
18. Comments

1.

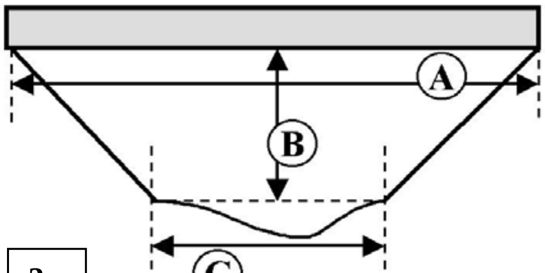


Open Bottom Arch

2.

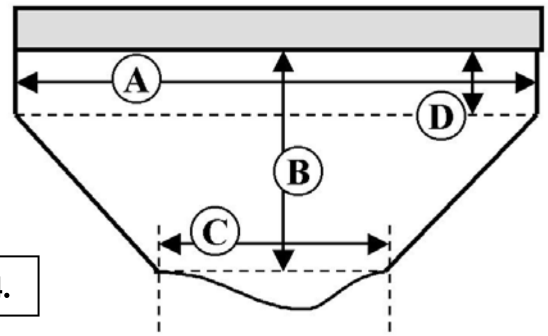


Bridge with Abutments



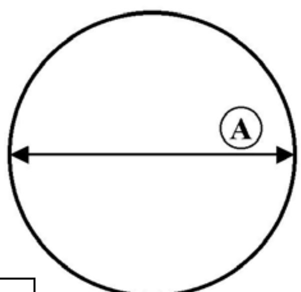
3.

Bridge with Side Slopes

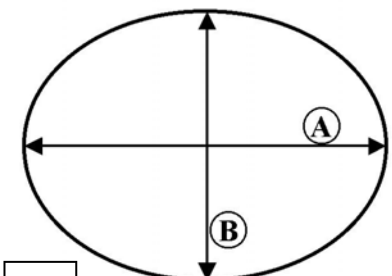


4.

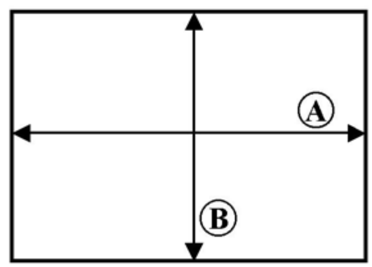
Bridge w/ Side Slopes & Abutments



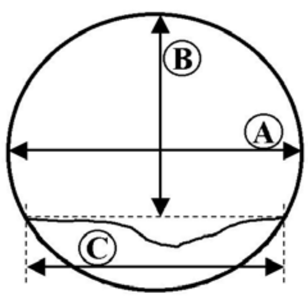
5. **Round Culvert**



6. **Elliptical Culvert**

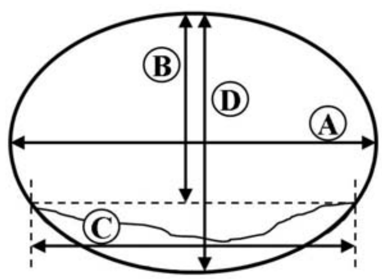


Box Culvert **7.**



8.

Embedded Round Culvert



Embedded Elliptical Culvert

9.

Crossing Type (from above): □ 1. □ 2. □ 3. □ 4. □ 5. □ 6. □ 7. □ 8. □ 9. □ Ford

Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): ________________________

DIMENSIONS WORKSHEET FOR MULTIPLE CULVERT CROSSINGS

Crossing ID# ___________

Note: *When inventorying multiple culverts, label left culvert 1 and go in increasing order from left to right from downstream end (outlet) looking upstream.*

Number of Culverts or Bridge Cells __________

Culvert or Bridge Cell 2 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): _________________________

Culvert or Bridge Cell 3 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): _________________________

Culvert or Bridge Cell 4 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): _________________________

Culvert or Bridge Cell 5 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): _________________________

Culvert or Bridge Cell 6 of _______

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

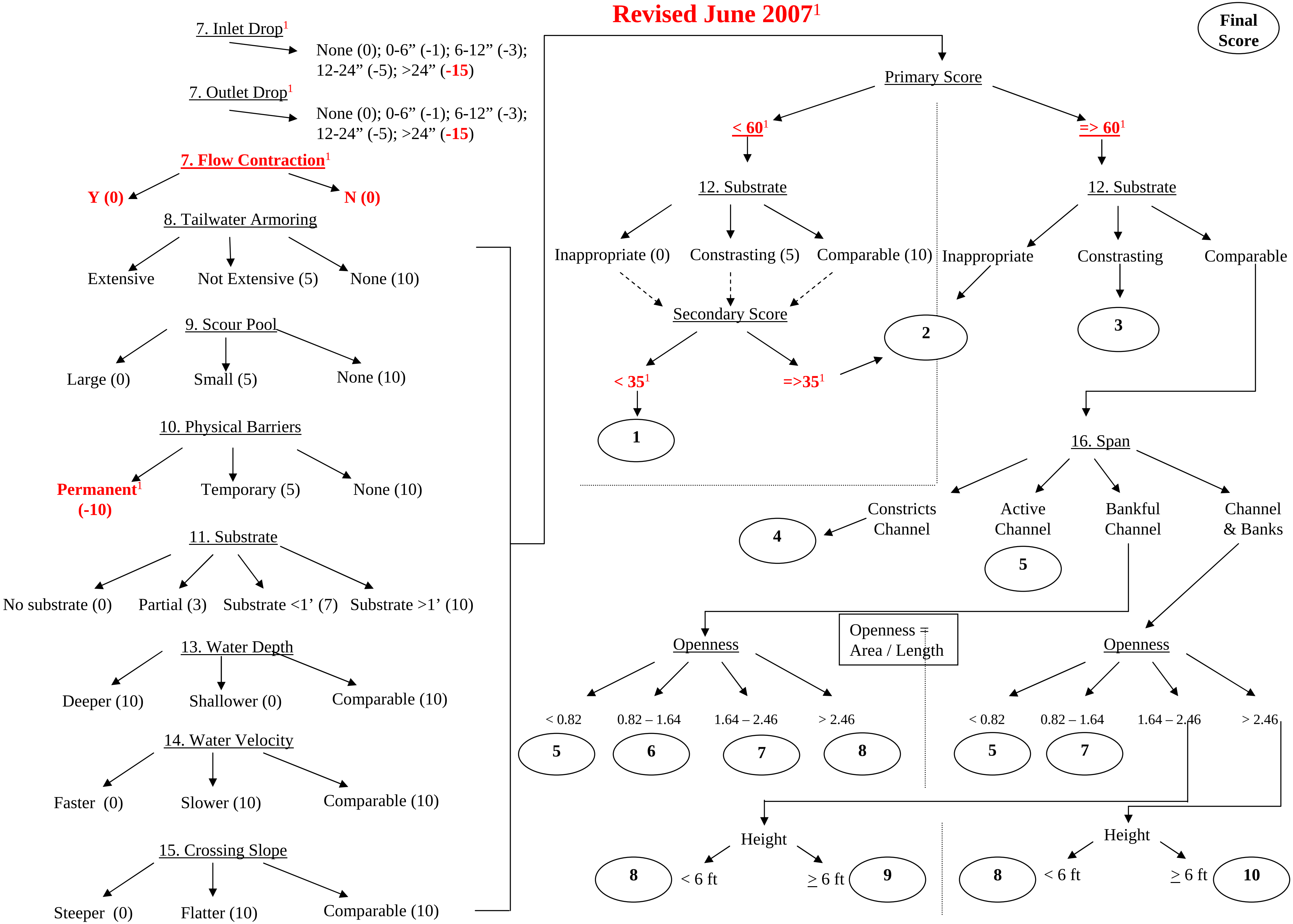
Upstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Downstream Dimensions (ft.): A) ______________ B)_______________ C) ______________ D) ______________

Length of stream through crossing (ft.): _________________________

NH Crossing Structures Scoring System

Revised June 2007[1]



1. Parameter edits June, 2007

NH Crossing Structures Scoring System