Section 3.3

Watershed Assessment and Inventory

A watershed assessment protocol was prepared to support the development of the Upper Neversink Stream Management Plan. The protocol was meant to provide the project team with a general baseline inventory of conditions throughout the stream corridor.

Management Unit Delineation

To describe the current conditions and recommendations for the stream corridor, the 24 miles of Neversink River and East and Wet Branch mainstems were divided into eighteen management units based on the following criteria:

1) Valley Slope - A profile of the valley slope was created using United States Geologic Survey contour data. This profile was divided into segments based on common slope characteristics.

2) Valley Confinement - The width of the 100-year floodplain was measured perpendicular to the valley fall line at each of the cross-sections along the mainstream, and the ratio of the width to bankfull and floodprone width at each was determined. A graph of these ratios was generated and analyzed to identify segments exhibiting common valley confinement characteristics.

3) Historical Channel Alignment - Stream alignments were created from 1959, 1967, 1980, 2001 and 2009 aerial photographs (as described above). These alignments were overlaid to determine segments of historical stream instability.

4) Vertical and Lateral Controls - Bedrock channels and banks, revetments, bridges and berm locations were documented in the 2006 GPS walkover. Frequency of occurrence of these controls influenced management segment breaks.

The resulting 33 management units are described in Section 4. The data were then compiled by management unit to facilitate interpretation of conditions, trends and to make recommendations.

Channel Morphology & Valley Topography

Summary statistics pertaining to the Neversink River's channel morphology and valley topography were derived in ArcGIS using the State of Vermont's Phase 1 Stream Geomorphic Assessment protocol (Table 1).

Mgt Unit	Channel Length (ft)	Channel Slope (%)	Valley Length (ft)	Average Valley Width (ft)	Valley Slope	Sinuosity
MB1	3165	0.00	1764	1488	0.00	1.79
MB2	3187	0.61	2546	1751	0.76	1.25
MB3	3004	0.59	2871	961	0.62	1.05
MB4	2357	0.41	2330	243	0.41	1.01
MB5	3061	0.69	3105	655	0.68	0.99
MB6	2512	1.48	2253	1386	1.65	1.12
MB7	1278	0.06	1267	1417	0.06	1.01
MB8	3377	0.01	3116	1501	0.01	1.08
MB9	4603	0.75	3051	1950	1.13	1.51
MB10	2965	0.62	2688	1439	0.68	1.10
EB1	1469	0.22	1388	1366	0.24	1.06
EB2	3719	1.08	3709	995	1.08	1.00
EB3	3892	0.99	3777	1189	1.02	1.03
EB4	4359	0.88	4192	658	0.92	1.04
EB5	5100	1.20	5018	796	1.22	1.02
EB6	6266	0.98	5084	1395	1.21	1.23
EB7	2826	0.78	2565	721	0.86	1.10
EB8	2751	1.14	2670	270	1.18	1.03
EB9	4009	1.58	3739	724	1.69	1.07
EB10	5104	1.01	4809	559	1.07	1.06
EB11	2078	2.16	1987	594	2.26	1.05
EB12	1412	0.74	1333	784	0.79	1.06
EB13	3209	1.71	3099	1090	1.77	1.04
EB14	3105	1.02	3071	635	1.04	1.01
EB15	5256	1.62	4938	506	1.72	1.06
EB16	14845	2.68	13965	479	2.84	1.06
WB1	2279	2.68	2008	275	0.21	1.14
WB2	3387	1.07	3250	365	1.11	1.04
WB3	4540	0.98	4297	340	1.04	1.06
WB4	4772	1.15	4299	533	1.28	1.11
WB5	5939	1.01	5753	378	1.04	1.03
WB6	3614	0.61	3524	550	0.62	1.03
WB7	2384	1.20	2225	673	1.28	1.07
WB8	4613	0.64	3796	777	0.78	1.22
WB9	2178	0.95	1918	824	1.08	1.14
WB10	5697	1.04	5525	915	1.07	1.03
WB11	3821	1.67	3571	643	1.79	1.07
WB12	5323	4.97	5232	246	1.54	0.31
WB13	5227	1.34	4595	971	1.53	1.14
WB14	4686	2.53	4263	527	2.79	1.10
WB15	5279	1.91	4677	513	2.16	1.13
WB16	4993	5.87	4790	511	6.12	1.04
WB17	6598	12.99	6572	50	13.05	1.00

Table 1. Selected characteristics of valley morphology, by management unit.

One of the first steps in this process is the measurement of the *channel length* and *valley length*. Because valley length does not include the common meandering pattern of a stream, it is often a shorter measured distance than the stream channel length. In reaches where the stream channel does not meander, the valley length will be close to the channel length. The stream's meander, or *sinuosity*, is calculated by dividing the stream channel length by the valley length. *Channel slope* is a calculation of the change in elevation over the length of the stream channel from the top of a management unit to the bottom. *Valley slope* is determined in the same manner, and is often steeper than channel slope due to its shorter length. *Valley width* calculations are an average of ten measurements throughout each of the management units. For each of these measurements, the total valley length of the management unit was divided by ten to provide a measurement interval (ie. valley width in a 300 ft. long reach would be measured every 30 ft.). A random starting point of 1-10 feet from the beginning of a management unit was chosen, and valley width was measured ten times at the defined interval and averaged. By dividing valley width by the width of the channel, the *confinement* of the reach can be determined. The steepness of the valley walls on each stream bank, or *valley side slope*, are defined as the change in valley elevation from within the floodplain to the stream channel.

Mgt Unit	DA	W	D	A	Qbfl
MB1	70.40	122	4.3	525	4268
MB2	70.09	121	4.3	523	4254
MB3	68.84	120	4.3	516	4197
MB4	68.64	120	4.3	515	4188
MB5	67.98	120	4.3	512	4158
MB6	66.60	119	4.2	504	4094
MB7	66.46	119	4.2	503	4088
MB8	65.57	118	4.2	499	4047
MB9	63.20	116	4.2	486	3937
MB10	62.00	115	4.1	479	3880
EB1	27.50	83	3.2	267	2109
EB2	26.80	82	3.2	262	2069
EB3	25.20	80	3.1	250	1975
EB4	23.00	77	3.0	234	1844
EB5	21.40	75	3.0	223	1747
EB6	19.90	72	2.9	211	1655
EB7	18.70	71	2.9	202	1579
EB8	16.70	67	2.8	186	1451
EB9	15.40	65	2.7	176	1365
EB10	13.30	61	2.6	158	1223
EB11	12.60	60	2.5	152	1174
EB12	12.20	59	2.5	149	1146
EB13	10.70	56	2.4	135	1039
EB14	8.90	52	2.3	118	905
EB15	7.80	49	2.2	108	820
EB16	1.80	27	1.4	37	273
WB1	33.90	90	3.4	310	2467
WB2	33.50	90	3.4	307	2445
WB3	32.50	89	3.4	301	2390
WB4	31.30	87	3.3	293	2324
WB5	25.10	80	3.1	250	1969
WB6	22.90	77	3.0	234	1838
WB7	22.20	76	3.0	229	1796
WB8	21.20	74	3.0	221	1735
WB9	17.40	69	2.8	192	1496
WB10	9.40	53	2.3	123	943
WB11	8.50	51	2.2	115	874
WB12	7.30	48	2.1	103	780
WB13	4.60	40	1.8	74	552
WB14	3.40	35	1.7	59	440
WB15	1.60	26	1.3	34	250
WB16	0.80	19	1.1	21	149
WB17	0.02	4	0.3	1	9

Table 2. Hydraulic geometry and bankfull discharge estimates at the bottom of each managemnt unit.

Hydraulic Geometry

The hydraulic geometry of the stream channel was calculated using regression equations relating drainage area to bankfull discharge, channel cross-sectional area, depth & width in the Catskill mountain streams specified by Miller & Davis (2003) (Table 2). The predictive variable in the hydraulic geometry equations, drainage area, was determined at the upstream end of each management unit break to create independent geometry calculations for each management unit. Miller & Davis (2003) indicate that reaches with a higher mean annual runoff (MAR) will generally fall above the regression line and that bankfull channel geometry is predicted more accurately by drainage area when locations are stratified into two classes by MAR. Data from USGS indicates that MAR within the Neversink drainage basin falls into the “high” MAR class. Therefore, hydraulic geometry for this management plan was calculated using both the Catskill mountain regional regression equation and the adjusted high MAR regression equation for the Neversink drainage basin.

These values for width, depth and cross-sectional area can be used in post-flood emergency situations as rough guides to support rapid dimensioning of channels in stream work performed in post-flood, emergency situations where avulsions or other channel shifts require a temporary channel to be constructed. **They are not intended to substitute for reference reach data, sediment supply characterization and shear stress equations in stream restoration design in non-emergency situations.**

Historical Channel Alignments

A series of historical stream channel alignments was used to determine the frequency and magnitude of historical channel avulsions. ArcGIS 9.2 was used to georeference aerial photographs, when necessary, and then used to digitize each stream channel alignment. The alignment from each flight series was compared to locate areas of historic lateral instability. This characterization was also one criteria used to divide the stream corridor into management units. Historic stream channel alignments from 1959, 1967, 1980, 2001 and 2009 aerial photographs can be viewed in management units which have displayed channel realignments during this time. The alignments are overlayed on 2001 aerial imagery. Where there was significant lateral shifting, these maps were included in the individual Management Unit descriptions in Section 4.

Flood Frequency Analysis

Using USGS historic gage records, the Program Team conducted a flood frequency analysis to determine discharge that corresponds with different high flow events (e.g. 5-year flood, 10-year flood, 25-year flood, etc.). This information will help highway departments and other stream managers with appropriate sizing of bridges, culverts and other stream related activities.

Stream Feature Inventory

In the initial stages of a watershed assessment and planning effort, it is necessary to gain a basic familiarity with the stream corridor and surrounding watershed. An inventory of stream features can reveal trends important to understanding the stream system. The stream feature inventory protocol provided an inventory of the following features:

1) Conditions that affect hydraulic function, particularly sediment transport function such as bedrock sills and banks, cultural and natural grade controls, berms, and rip-rap or other revetment, and inadequate riparian vegetation;

2) Potential sources of water quality impairment in the corridor, especially eroding banks, clay exposures, road runoff outfalls, dumps sites, and exposed septic leach fields or other hazards;

3) Locations of bank erosion monitoring sites to be monumented and surveyed for study of bank erosion rates;

4) Infrastructure, including road crossings, bridge abutments, culverts and outfalls, and utility lines or poles;

5) Other features such as tributary confluences, water intakes, springs, wells, diversions, and invasive species.

This stream feature inventory was also used to help define and prioritize further assessment, and scope the issues to be addressed in the management plan. Most of the data presented in the Management Unit

Descriptions in Section 4 was derived from the stream feature inventory walkover conducted during the summer of 2010. Trimble GeoXH Global Positioning System (GPS) units were used to map locations of features described above. Photographs and attribute data were also taken at each feature. The protocol used for attribute collection is detailed in Appendix D, Stream Management Data Dictionary Guide.

Following collection, all data was integrated into a common geodatabase using the Stream Analyst ArcGIS extension. The *geodatabase* is the common data storage and management framework for ArcGIS. It supports all the different types of data that can be used by ArcGIS such as; attribute tables, geographic features, and survey measurements.

Utilizing GPS coordinates, each feature was then linked to the management unit in which it was located creating an improved organizational structure and allowing for the reporting of stream feature statistics based on management unit. The first page of each of the Management Unit Descriptions in Section 4 presents the results of this data for each individual management unit. The summary statistics for the Neversink River are provided below in Table 1.

Table 3. Summary Statistics for all streams walked (Neversink River, East Branch, West Branch) in Neversink watershed; this excludes state-owned land adjacent to streams. Data represent ~33 miles of stream walked in the summers of 2010.

Stream Feature	**Results**
Bank Erosion	18,053 ft. or 5% of stream banks
Clay Exposures	1,069 ft. or 0.3% of stream banks
Berms	9900 ft. or 2.9% of stream banks
Revetments	12,959 ft. or 3.74% of stream banks
Inadequate Vegetation	516 acres within 100 ft. buffer of stream
Potential Riparian Buffer Improvement Area	416 acres within 100 ft. buffer of stream
Knotweed Occurrences	No occurrences observed.
Bridges	21
Culverts	8
Obstructions	280
Stream within 50 ft. of road	12,716^
Houses within 100-year floodplain boundary	51

^This includes State-owned land.

Japanese Knotweed Mapping

As part of stream feature inventory, locations of Japanese knotweed (*Fallopia japonica*) along the streambank were identified. This invasive species has become a widespread problem in recent years, shading out other species and not providing adequate root structure to stabilize the soil in streambanks. The results may include rapid streambank erosion and decreased community richness. Japanese knotweed occurrences are discussed in each management unit (Section 4) and included on the riparian vegetation maps.

Riparian Vegetation

Riparian vegetation mapping of a 300-foot stream corridor was conducted to identify the status of the vegetative community, and identify areas in need of enhancement. This protocol provided a characterization of the vegetative community (physiognomic) structure of riparian areas from remotely-sensed data. Characterizing riparian vegetation supported the assessment of the capacity of the riparian buffer to mitigate potentially deleterious water quality impacts from upland land uses. In addition, riparian classification defines the role of vegetation in the cohesiveness of stream bank soils and the integrity of the stream and riparian ecosystems. This analysis will lead to recommendations of where improvements to the riparian buffer may be most critical and/or effective, and locations of reference riparian vegetative communities within the watershed. The mapping also provided the area of impervious surfaces (e.g. roofs, driveways, roads) within the 300 foot buffer. Riparian vegetation maps are located in individual Management Unit descriptions. Planting recommendations and descriptions of the existing riparian community are presented in each management unit (Section 4).

High Watermark Verification of Bankfull Stage

The Neversink watershed received high water in January, 2010 which resulted in a slightly larger than bankfull event (i.e., 1.5 year storm). During Stream Feature Inventory, the Program Team documented signs of high water in order to calibrate bankfull stage throughout the watershed, and to identify reaches whose channel morphology is not in equilibrium, a possible indicator of future instability.

Reconnaissance Trips with Highway Departments

The Program Team accompanied the four highway departments with jurisdiction in the Neversink River watershed – Town of Neversink Highway Department, Town of Denning Highway Department, Ulster County Department of Public Works and Sullivan County Department of Public Works – to various locations of stream/road interactions. These site visits provided discrete points of concern along the Neversink River, Sundown Creek and Sugarloaf Brook of primary interest for the highway departments. Additionally, the Program Team gleaned valuable information about historic road impacts by the streams and "repeat offenders". Section 5.2 provides details about these specific points of interest.