7.2 STREAM HABITAT CLASSIFICATION METHODS

The stream habitat analysis was conducted on the Judd Creek and Shinglemill Creek subbasins using a modification of the Tri-County Urban Issues Study: Urban Stream Baseline Evaluation Methods (USBEM) Phase 1 method (R2 Resource Consultants 2001). The USBEM Phase I method incorporated features of several methodologies commonly used in the Pacific Northwest to characterize fish habitat using physical, biological, and chemical indicators. Since the USBEM methodology was designed for an urban setting, and the Judd Creek and Shinglemill Creek basins are rural basins, the methodology was adapted to better fit this setting. The USBEM Phase I method served as a foundation; then additional criteria were added during the scoping process for the project. The selected criteria were relevant for indicating the health of the subbasin and stream habitat conditions. The criteria used in this investigation are described below.

7.2.1 General Characteristics

The general characteristics section of the evaluation provides a summary of descriptive information about each subbasin, identification of stream channel types, and the total length of each channel type in the subbasin. Lengths of each stream channel type were determined from existing mapping and aerial photographs.

The channel type was determined for each stream reach, according to the USBEM Phase I methods. The seven channel process groups described by Paustian et al. (1992) were identified by R2 Resource Consultants as representative of freshwater channel types found in northwestern Washington. The channel type descriptions presented below are from R2 Resource Consultants (2001):

- **Palustrine** —Wetland channels, beaver complexes or sloughs. Velocities are generally low, substrates are composed of fine sediment or organic matter, and channel morphology is sinuous or irregular and dominated by pools or glides. Stream gradient is very low (<1 percent).
- **Floodplain**—Low-gradient (<2 percent) depositional channel. Substrates are typically small gravel to cobble, and the bedform is typically regularly spaced pools and riffles. LWD is important for forming pools and providing cover. These channels migrate freely across floodplains, and off-channel habitats are normally abundant.
- **Alluvial Fan**—Moderate-gradient (2 to 8 percent) depositional channels located in the transitional area between steep slopes and valley floodplains. Stream power decreases longitudinally down the fan, and deposition results in channels that migrate freely across the fan. Substrates typically range from gravel to cobble, pools are often relatively small and shallow, and off-channel habitats typically do not persist over the long-term.
- **Large Contained**—Low- to moderate-gradient (1 to 3 percent) channels that are moderately to deeply incised. Stream power is moderate to high with coarse substrates. LWD is easily transported and generally located along channel margins. These channels rarely have extensive off-channel habitats.
- **Moderate Gradient Mixed Control**—Transport-dominated channels with moderate to high stream power. Gradients range from 2 to 8 percent. LWD is important for forming pools and storing sediment; thus substrates and bedforms are highly variable. Off-channel habitats may be present, but are not abundant.

- **Moderate Gradient Contained**—Transport-dominated channels with moderate to high stream power. Gradients are typically from 2 to 4 percent, but may reach 6 percent. LWD is important for forming pools and storing sediment; thus substrates and bedforms are highly variable. Off-channel habitats are rare.
- **High Gradient Contained**—Moderately to deeply incised channels with high stream power and gradients greater than 4 percent. Most sediment is easily transported; thus gravel and small cobbles deposit only in hydraulically protected areas. Pools tend to be small and shallow, although LWD and bedrock may form large deep pools.

7.2.2 Subbasin Alteration

An analysis was performed to identify significant alterations to the subbasin and/or stream channel. The criteria below and in Table 7-3 are indicators of biological, physical, or chemical parameters that can affect habitat quality, and function as indicators of the overall modification of the basin from forested conditions. The level of alteration is determined using a matrix of indices.

Effective Impervious Area

Effective impervious area (EIA) represents the percentage of impervious surface in a given area. This metric can indicate the relative change to a catchment by development. Values are presented in the land cover analysis portion of this report (Chapter 2), based on existing land use information supplied by King County.

Booth and Jackson (1997) studied the relationship between increased EIA and flow magnitudes in five watersheds in King County. The results indicated that an EIA of 10 percent can cause significant degradation to the aquatic system and that lower levels also cause significant degradation. Areas that were observed to be functioning at a high level typically had EIA values less than 3.6 percent. The following thresholds were used to classify the level of alteration to the subbasin indicated by the EIA:

- >10 percent EIA indicates a high level of alteration.
- 5 to 10 percent EIA indicates a moderate level of alteration.
- <5 percent EIA indicates a low level of alteration.

Landscape Alteration

Change to the landscape by anthropogenic activities was examined using the land cover analysis data from Chapter 2. The change to the landscape was assessed by calculating the percent of the remaining forested land cover compared to historical conditions for each subbasin. It was assumed that each subbasin was 100 percent forested prior to development. The thresholds for the low, moderate, and high levels of alteration for this criterion are presented in Table 7-3.

Impact from Culverts and Other Stream Crossings

Impact on the subbasin from culverts and other stream crossings was determined for each reach by determining the number of stream crossings per mile and the percentage of stream that is in a storm drainpipe or culvert. Known passage barriers at stream crossings were also reported.

Flow Modification

This criterion evaluated changes to the hydrology, which can be an indicator of alterations to a watershed. Hydrologic data presented in Chapter 4 were examined for significant changes to the hydrologic regime from pre-development to existing conditions. The analysis was based on results of a study by Bledsoe and Watson (2001) on the effects of urbanization on stream channel stability. They used the ratio of 2-year flow after development to 2-year flow prior to development ($Q2_{post}/Q2_{pre}$) to compare changes in flows to effects on channel stability. The study indicated that EIAs from 10 to 20 percent could cause a two-fold increase in 2-year flow events, and result in severe destabilization of streams. Furthermore, the effects of increased EIA were more pronounced with smaller watersheds.

These results were parallel to Booth and Jackson (1997), suggesting that an EIA as low as 10 percent can have a dramatic impact on stream habitat. The $Q2_{post}/Q2_{pre}$ ratio was used to evaluate the level of hydrologic change to the Judd Creek and Shinglemill Creek subbasins. The $Q2_{post}/Q2_{pre}$ ratio was calculated for each hydraulic modeling reach (RCHRES). The following thresholds were used to classify the level of alteration:

- High level of modification: $Q2_{post}/Q2_{pre}$ ratio > 1.75
- Moderate level of modification: $Q2_{post}/Q2_{pre}$ ratio 1.25-1.75
- Low level of flow modification: $Q2_{post}/Q2_{pre}$ ratio <1.25

Channel Modifications and Floodplain Connectivity

This criterion was used to indicate the relative level of alterations to the stream channel and floodplain within each segment. The level of alteration was determined by estimating the percent of stream length enclosed in storm drainage pipes, culverts, armored, channelized, diked, or constricted. This information was collected from aerial photographs and other existing information. Thresholds for this criterion are presented in Table 7-3.

Riparian Alteration

Riparian areas are the one of the most complex ecological systems and are an essential component to healthy stream habitat conditions (Naiman et al. 2000). The riparian area provides thermal insulation for the stream, prevents stream-bank erosion, traps sediment from runoff, provides overhead cover for fish, and is a significant source of LWD to the stream (Wenger 1999). Riparian vegetation also contributes to the food web of the stream by depositing leaves and other debris as well as providing habitat for terrestrial insects, which can be a significant source of food for fish (Rondorf et al. 1990). Throughout the Pacific Northwest, riparian forests historically formed a continuous corridor of vegetation along a stream channel (Naiman et al. 1992), but human impacts have altered these conditions (Naiman et al. 2000).

Two methods were used to analyze riparian habitat. The first method calculated the percent of the total riparian area for each land cover type using data from the land cover analysis section of this report. These data provide a relative comparison of the land cover types within the 200-foot riparian corridor. It was assumed that prior to development the riparian corridor was 100 percent forested. The ratio of existing forested land cover to predevelopment conditions was used to indicate the magnitude of alteration. Thresholds for this analysis are presented in Table 7-3.

In the second method, the frequency of riparian breaks was used as an indicator of the longitudinal integrity of the riparian corridor. Riparian breaks included road-crossings, pipelines, or other areas where the riparian vegetation was removed. For this, the number of riparian breaks per mile of stream was calculated. Thresholds for this analysis are shown in Table 7-3.

Subbasin Alteration Matrix

The subbasin alteration matrix (Table 7-3) was used to indicate the overall level of alteration and classification of existing habitat conditions, and to identify the most significant factors for habitat degradation in each subbasin. Criteria indicating higher levels of alteration function as a guide for prioritizing habitat improvement projects.

TABLE 7-3.
SUBBASIN ALTERATION MATRIX.

	Level of Alteration		
Criteria	High: Two or more of the following	Moderate: One or more of the following	Low: All of the following
Effective Impervious Area	>10%	5-10%	<5%
Landscape Alteration	<60% of subbasin forested	60-75% of subbasin forested	>75% of subbasin forested
Impact from Culverts and Other Stream Crossings	>5 per mile	2-5 per mile	<2 per mile
Flow Modification (Q2post/Q2pre ratio)	$Q2_{post}/Q2_{pre} > 1.75$	$Q2_{post}/Q2_{pre} = 1.25 - 1.75$	$Q2_{post}/Q2_{pre} < 1.25$
Channel Modifications and Floodplain Connectivity	>25 % of the stream length is modified	10-25% of stream length is modified	<10% of stream length is modified
Riparian Alteration	<60% of corridor forested or >5 riparian breaks/mile	60-80% of corridor forested or 2-5 breaks/mile	>80% of corridor forested and <2 breaks/mile

7.2.3 Benthic Index of Biotic Integrity

Indices of biotic integrity use biological data to numerically depict a stream's relative health. The benthic index of biotic integrity (B-IBI) used by King County (King County 2002) accomplishes this by comparing the existing abundance of invertebrate taxa to what would be expected under pristine conditions. Taxa of particular interest are the aquatic insect families Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddis flies). These three taxa are associated with healthy or pristine systems, and reduced levels can indicate impacts such as sedimentation, water pollution, or increased water temperatures. The B-IBI methodology used by the King County Road Services Division was developed specifically for Western Washington. These B-IBI data were not available for all of the Shinglemill Creek and Judd Creek subbasins and the samples were collected only at road crossings.

The King County Roads Division used a 5-metric scoring method in 1999 and a 10-metric method in 2000 and 2001. Although the number of metrics used was different, the interpretation of the scores is the same (see Table 7-4). The individual metric scores are also indicators of stream health; values of "5" represent a range of results indicative of an undisturbed site, "3" indicates a somewhat degraded site, and "1" indicates severely degraded sites (Table 7-5).

TABLE 7-4.
INTERPRETATION OF B-IBI TOTAL SCORES.

10-Metric Score	5-Metric Score	Stream Condition
46-50	23-25	Excellent
38-44	19-22	Good
28-36	14-18	Fair
18-26	9-13	Poor
10-16	5-8	Very Poor

7.2.4 Subbasin Summary

Field Investigation and Verification

A field investigation was conducted to verify the results of the above analysis using a modification of Phase II of the USBEM methodology (R2 Resources 2001). The habitat condition of each subbasin was evaluated near road crossings or other easy access points.

Criteria used to classify the habitat included fish passage, riparian condition and embeddedness, substrate composition in spawning areas, stream bank condition, pool frequency, channel pattern/bedform, and large woody debris abundance. At each evaluation site, these criteria were classified as good, fair, or poor according to Table 5-7 of the USBEM methodology (R2 Resources 2001), which provides ranges of values for each criterion according to the channel types.

TABLE 7-5.
THE I-IBI SCORING METHOD (FROM KING COUNTY 2002).

Metric	Score[a] 1	3	5
Taxa richness and composition			
Total number of taxa[b]	0-14	15-28	≥29
Number of Ephemeroptera species	0-4	5-8	≥9
Number of Plecoptera species	0-3	4-7	≥8
Number of Trichoptera species	0-4	5-9	≥10
Number of long-lived taxa	0-2	3-4	≥5
Tolerance			
Number of intolerant taxa[b]	0-2	3	≥4
% of individuals in tolerant taxa[b]	≥50	20-49	0-19
Feeding ecology			
% of predator individuals	0-9	10-19	≥20
Number of clinger taxa	0-8	9-18	≥19
Population attributes			
% Dominance (3 taxa)[b]	≥80	60-79	0-59

a. Metrics are scored as 1 (severely degraded), 3 (somewhat degraded), or 5 (undisturbed) depending on the range of values indicated for each metric.
b. Chironomids were not included in these metrics.

The "good" condition rating represents values that are within the range known to support salmonid production; a "fair" rating indicates that salmonid production could be diminished; and the "poor" rating represents unsuitable conditions for sustaining salmonid populations or life stages due to degraded conditions. The thresholds for these criteria are provided in Table 7-6. Evaluation of these criteria was based on professional judgment. These data were collected to provide representative information for each subbasin based on observations made at major access points and under the assumption that conditions at these locations were representative of the subbasin.

TABLE 7-6.
FIELD ASSESSMENT CRITERIA AND THRESHOLDS (FROM R2 RESOURCES 2001).

Habitat Parameter	Habitat Condition		
	Good	Fair	Poor
All Streams			
Passage barriers	Upstream and downstream movement by species of concern is not restricted by barriers	Upstream and downstream movement by species of concern is restricted by barriers at some flows	Upstream and downstream movement by species of concern is restricted by barriers at most flows.
Water Temperature	50-57°F For bull trout: 39-48°F (spawning); 36-41°F (incubation); 39-54°F (rearing); <59°F (adult migration)	57-60°F (spawning) 57-64°F (migration and rearing) For bull trout: <39 or 50°F (spawning); <36 or 43°F (incubation); <39 or 55-59°F (rearing); sometimes >59°F (adult migration)	>60°F (spawning) >64°F (migration and rearing) For bull trout: <39 or >50°F (spawning); <34 or >43°F (incubation); >59°F (rearing); regularly >59°F (adult migration)
Palustrine Channels			
Riparian condition	Riparian vegetation is continuous and dominated by native species typical of the channel type.	Riparian vegetation is discontinuous or <50% are native species typical of the channel type	Riparian area is dominated by land use alterations or invasive non-native vegetation
Substrate composition in spawning areas	N/A	N/A	N/A
Embeddedness	N/A	N/A	N/A
Bank condition	N/A	N/A	N/A
Pool frequency	N/A	N/A	N/A
Channel pattern/ bedform	Sinuous pattern with intact connections to adjacent wetlands or side-channels	Sinuous pattern with few connections to adjacent wetlands or side-channels	Straightened pattern; channel is disconnected from adjacent wetlands or side-channels
Large woody debris	N/A	N/A	N/A