PNW River Reach File Documentation

Narrative section contents:

1. Abstract

The U.S. Geological Survey (USGS) in cooperation with Federal and state agencies, and NW Indian Tribes has produced a 1:100,000-scale River Reach data layer for the Pacific Northwest that will serve water-resource management applications for the next decade or more. The Pacific Northwest (PNW) River Reach Files are a geo-referenced river reach data layer that encompasses the Columbia River Basin within the conterminous United States, the coasts of Oregon and Washington, the Klamath and Goose Lake Basins in southern Oregon and the Bear Lake Basin in southeastern Idaho. A unique conflation algorithm was developed by the USGS-WRD in Portland, Oregon that transferred the reach identifiers from the USEPA 1:250,000-scale RF2 Files to the new 1:100,000-scale hydrography. This process was a primary task of the PNW River Reach Project because these reach identifiers are an integral hydrologic component in a regional Rivers Study known as the Northwest Environmental Data Base(NED). NED is an ongoing effort by Federal and state agencies within the region to compile reach-specific information on rivers in Oregon, Idaho, Washington, and Montana.The PNW Reach Files have been tagged with the U.S. Environmental Protection Agency's (USEPA) reach codes. The PNW Reach Files were designed so reach-specific information could be extracted from a stream network in an upstream or downstream direction using associated feature attribute tables or within a Geographic Information System.

1.1 Descriptors:

River Reach File, Hydrography, Catalog Unit, Hydrologic Unit, 100K-scale

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2. PNW Reach File Applications

2.1 Intended use of data

The PNW River Reach Files were constructed using ARC/INFO versions 4.0 and 5.0. ARC/INFO is a Geographic Infomation System developed by Environmental Systems Research Institute, Redlands, California. Each Reach File is one USGS hydrologic unit also known as a catalog unit and is designed to provide users with a 1:100,000-scale reach structure for performing various types of hydrologic applications. The PNW Reach Files are a linked stream network. ARC:NETWORK utilities were used on the Reach Files to provide attribute information that would allow a user to preform directional routing upstream or downstream from a given starting point using either a GIS or by using items, such as UPLINK1,2,3 PNTR# and DOWNLINK found in the Arc Attribute Table. Every reach in the Reach File has been assigned a unique but stable reach identifier. Water body features such as lakes, reservoirs, defined wetlands, double-banked streams, and others were moved to a seperate 'banks' coverage and replaced in the Reach

File with centerlines and tributary connectors. Many different types of GIS analysis can be performed on the Reach Files. These might include buffering around reaches, stream network routing, basin characteristics analysis or dynamic segmentation.

2.2 Limitations of data

The PNW River Reach Files were compiled from 1:100,000-scale Digital Line Graphs for hydrography, which were constructed from scanned 1:24,000 and 1:63,000-scale seperates and then edited. Most, but not all hydrographic features found on these two larger scale products will be found in the PNW Reach Files. The county boundaries coverage was at 1:500,000-scale. This lower resolution may have caused some reaches to be in-correctly coded for COUNTY and COUNTY-2. Not all stream reaches have been named. None of the water body features were named or coded with a unique identifier.

A final quality assurance review has been performed by several state agencies. This rev
included some or all of the following checks or updates:

I. Minor corrections to the graphics; in particular to the artificially added features, position of features relative to original DLG's

II. Mis-coded features

III. Arc direction

IV. Blockage of features from routing

V. Additional routing centers, where needed

VI. Direction of flow in man-made structures

VII. Results of the Conflation process

VIII. Proper capture of all headwater reaches within CU boundary.

IX. Addition of stream names, where known.

X. Water-body feature attribute checks.

PNW River Reach File Data Dictionary

3. Attribute discussion
The unique identifier in the Reach File is the Reach Number (RRN) consisting of three parts:
CU - the 8 digit USGS Hydrologic Cataloging Unit;
SEG - the 4-digit SEGment number
RMI - the milepoint along the CU-SEG as measured from the downstream end.
example RRN: 17110011001001.23
cu = 17110011 seg = 0010 rmi = 01.23
SEG values less than 500 were conflated from the EPA RF2+ Reach Files and

values 500 and higher were computer generated.

3.1 STR100-PNW.AAT
Following is a description of attributes for a given reach in the Arc Attribute Table:
File name: [PNWRRF].AAT

ATTRIBUTE NAME	DESCRIPTION
FNODE#	ARC attribute - downstream node number
TNODE#	ARC attribute - upstream node number
LPOLY#	ARC attribute - identifies polygon number to the left of the arc when polygon topology has been computed.
RPOLY#	ARC attribute - identifies polygon number to the right of the arc when polygon topology has been computed.
LENGTH	Arc length (in meters in Reach File).
STR100-PNW#	ARC attribute - internal record number.
STR100-PNW-ID	ARC attribute - assignable User-ID number
MAJOR1	NMD DLG base category identifier. 50 identifies feature as hydrography.
MINOR1	NMD feature classifier. 412 identifies the feature as a stream 999 was used to indicate artificial features such as center-
MINOR2	NMD feature classifier. Descriptive code of 610 identifies the featurestream, (412) as intermittent.
MINOR3	NMD feature classifier. Rarely used for hydrography. Code of 111111 was used to indicate outlet reach for the basin, 888888 indicated headwater reach.
HUC	8 digit USGS Hydrologic Unit Code number.
SEG	Reach segment number.
RMI	River Mile marker. Distance in miles. Lowest reach of each unique SEG number has an RMI value of 00.00.
FEAT_NAME	Hydrographic feature name. Sources for stream names were from USEPA 1:250,000 scale Trace graphic files, 1:100,000-scale manuscripts, and NMD Geographic Names database. Additional stream names were added from available map resources.
FEAT_SRC	Source of hydrographic feature. A1 - Origin of feature was from NMD 1:100,000-scale DLG, A2 - digitized from 1:100,000-scale manuscript, A9 - manually added feature using GIS editor. B1 - Origin was from NMD 1:24,000-scale DLG, B2 - feature was digitized from 1:24,000-scale manuscript, * note: these codes can be expanded to include features obtained from larger scale maps or GPS acquired data.
STATE	Predominant state that a particular reach falls within.
STATE-2	Second most predominant state a particular reach falls within.
COUNTY	Predominant county a particular reach falls within.
COUNTY-2	Second most predominant county a particular reach falls within.
QUAD100	Predominant 1:100,000-scale quad a particular reach falls within.
QUAD100-2	Second most predominant quad particular reach falls within .
QUAD75	Predominant 1:24,000-scale quad a particular reach falls within.
QUAD75-2	Second most predominant quad a particular reach falls within .

CEN	Node number of allocation center a reach was allocated from. Non -Allocated reaches have a CEN value of 0. Results from ALLOCATE can be displayed in ARCPLOT.
CUMLENGTH	Cumulative length of arcs traversed from any allocation center.
DNARC	Down arc. The internal record number (cover#) of the previously allocated arc.
PNTR#	A record of the order of the Arc Attribute Table at the time
SAVENEG	Flag item that preserves a record of the features that were blocked prior to ALLOCATION. Value of 1 means a feature has been blocked.
SINUOUS	Ratio of the true distance of a reach over its straight line
UHUC1	Hydrologic Unit Code number of the first upstream reach for a particular reach.
UPNTR1	Pointer number (PNTR#) of first upstream reach.
UHUC2	Hydrologic Unit Code number of the second upstream reach for a particular reach.
UPNTR2	PNTR# of second upstream reach.
UHUC3	Hydrologic Unit Code number of the third upstream reach for a particular reach.
UPNTR3	PNTR# of third upstream reach
UFLAG	Flag item to indicate the presence of a fourth upstream reach for a particular reach. If true, UFLAG is set to 1.
DHUC	Hydrologic Unit Code number of downstream reach.
DPNTR	PNTR# of downstream reach.
CSEG	Northwest Power Planning Council (NPPC) added reach code.
CRMI	River mile designation assigned to NPPC reaches.
CNAME	Stream name of NPPC reaches.

REDEFINED ITEMS		DESCRIPTION
RRN	HUC + SEG + RMI	River Reach Number
UPLINK1	UHUC1 + UPNTR1	
UPLINK2	UHUC2 + UPNTR2	
UPLINK3	UHUC3 + UPNTR3	
DOWNLINK	DHUC + DPNTR	

Following is a list of items contained in the water body Polygon Attribute and Arc Attribute Tables:

File name: BANKS-PNW.PAT

ITEM	DESCRIPTION
AREA	ARC attribute. Area of a polygon in map units.
PERIMETER	ARC attribute. Perimeter of a polygon in map units.
BANKS-PNW#	ARC attribute. Polygon internal number.
BANKS-PNW-ID	ARC attribute. User assignable polygon-ID number.
MAJOR1	NMD category code. Value of 50 indicates hydrography
MINOR1	NMD feature code identifier.
MINOR2	NMD feature code identifier
MINOR3	NMD feature code identifier.
HUC	Hydrologic Unit Code

File name:BANKS-PNW.AAT

ITEM	DESCRIPTION
FNODE#	ARC attribute. From-node number.
TNODE#	ARC attribute. To-node number.
LPOLY#	ARC attribute. Polygon to left of arc in F-T node direction.
RPOLY#	ARC attribute. Polygon to right of arc in F-T node direction.
LENGTH	ARC attribute. Length of arc in map units.
BANKS-PNW#	ARC attribute. Arc internal number.
BANKS-PNW-ID	ARC attribute. User assignable arc -ID number.

MAJOR1 NMD category code.
MINOR1 NMD feature code identifier.
MINOR2 NMD feature code identifier.
MINOR3 NMD feature code identifier.

Following are the Item format tables for the Reach File and associated coverages.
Datafile name: [PNWRRF].AAT

44 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	ALTERNATE NAME
1	FNODE#	4	5	B	-	
5	TNODE#	4	5	B	-	
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	STR100-PNW#	4	5	B	-	
25	STR100-PNW-ID	4	5	B	-	
29	MAJOR1	6	6	I	-	
35	MINOR1	6	6	I	-	
41	MINOR2	6	6	I	-	
47	MINOR3	6	6	I	-	
53	HUC	8	8	I	-	
61	SEG	4	4	I	-	
65	RMI	5	5	N	2	
70	FEAT_NAME	60	60	C	-	
130	FEAT_SRC	2	2	I	-	
132	STATE	4	4	C	-	
136	STATE-2	4	4	C	-	
140	COUNTY	15	15	C	-	
154	COUNTY-2	15	15	C	-	
170	QUAD100	26	26	C	-	
196	QUAD100-2	26	26	C	-	
222	QUAD75	25	25	C	-	
247	QUAD75-2	25	25	C	-	
272	CEN	4	5	B	-	
276	CUMLENGTH	4	12	F	2	
280	DNARC	4	5	B	-	
284	PNTR#	4	5	B	-	
288	SAVENEG	1	1	I	-	
289	SINUOUS	5	5	N	2	
294	UHUC1	8	8	I	-	
302	UPNTR1	5	5	I	-	
307	UHUC2	8	8	I	-	
315	UPNTR2	5	5	I	-	
320	UHUC3	8	8	I	-	
328	UPNTR3	5	5	I	-	
333	UFLAG	1	1	I	-	
334	DHUC	8	8	I	-	
342	DPNTR	5	5	I	-	
347	CSEG	3	3	I	-	
350	CRMI	5	5	N	2	
355	CNAME	30	30	C	-	
	** REDEFINED ITEMS **					
53	RRN	17	17	C	-	
294	UPLINK1	13	13	I	-	
307	UPLINK2	13	13	I	-	
320	UPLINK3	13	13	I	-	
334	DOWNLINK	13	13	I	-	

Datafile name: BANKS-PNW.PAT

8 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	ALTERNATE NAME
1	AREA	4	12	F	3	
5	PERIMETER	4	12	F	3	
9	BANKS-PNW#	4	5	B	-	
13	BANKS-PNW-ID	4	5	B	-	
17	MAJOR1	6	6	I	-	
23	MINOR1	6	6	I	-	
29	MINOR2	6	6	I	-	
35	MINOR3	6	6	I	-	
40	HUC	8	8	I	-	

Datafile name: BANKS-PNW.AAT

11 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	ALTERNATE NAME
1	FNODE#	4	5	B	-	
5	TNODE#	4	5	B	-	
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	BANKS-PNW#	4	5	B	-	
25	BANKS-PNW-ID	4	5	B	-	
29	MAJOR1	6	6	I	-	
35	MINOR1	6	6	I	-	
41	MINOR2	6	6	I	-	
47	MINOR3	6	6	I	-	

Datafile name: STR-CNTRS.PAT

15 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	ALTERNATE NAME
1	AREA	4	12	F	3	
5	PERIMETER	4	12	F	3	
9	STR-CNTRS#	4	5	B	-	
13	STR-CNTRS-ID	4	5	B	-	
17	NODE#	4	5	B	-	
21	CAPACITY	4	12	F	2	
25	IMPED-LIMIT	4	12	F	2	
29	IMPED-DELAY	4	12	F	2	
33	LINE-SYMBOL	4	5	B	-	
37	MAXIMUM-IMPED	4	12	F	2	
41	AVERAGE-IMPED	4	12	F	2	
45	ARCS-ALLOCATED	4	5	B	-	
49	UTILIZED	4	12	F	2	
53	ALLOCATED	4	12	F	2	
57	POINT-SYMBOL	4	5	B	-	

* Note: Items are NETWORK:ALLOCATION default, units are in meters

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Map projection parameters for PNW Reach Files:

PROJECTION	ALBERS EQUAL AREA
UNITS	METERS
1st lat	43 30 00
2nd lat	47 30 00
cm	-114 00 00
lat org	41 45 00
easting	0.0

northing 0.0

Narrative continued...

4. Procedures used to create or automate data.
   The following is a generalized list of procedures followed to construct the PNW River Reach Files. The USGS Open File report mentioned in the .DOC will include all of the processing macros written to assist in the Reach File development.

Generalized procedures for constructing 100K scale Reach Files

1. Read 100K hydrography DLG's for each map into GIS.
2. Edgematch north and west edges of each map to adjacent 100K quads.
3. CLIP each 100K quad with adjusted Hydrologic Unit boundary.
4. APPEND clipped quad pieces together.
5. Correct internal node errors using automated snapping.
6. Remove non-attributed pseudo nodes.
7. Copy polygons to Waterbody coverage.
8. Edit out double-banked streams, shorelines,and braided areas and put into Water bodies coverage.
9. Add centerlines through waterbodies and wide streams and connector arcs from centerlines to tributaries.
10. Create Trace coverage from EPA Reach File.
11. Edit Trace, correcting stream names and topologic structure where
12. Adjust Trace segment endpoints to align with corresponding 100K endpoint.
13. CONFLATE (Transfer) Trace-ID from Trace reaches to corresponding reaches in 100K coverage.
14. Make check plots to verify results of conflation.
15. Transfer EPA extended attributes (SEG, LEVEL, SEQNUM, FLAG) to 100K reaches.
16. Assign unconflated 100K reaches a provisionary reach code.
17. Move provisionary codes to SEG.
18. Add State, County, and quad boundary items to reaches in 100K-scale Reach File.
19. Compute sinuosity for each reach.
20. Block man-made waterways, braided reaches, and other features determined as not part of the basin network by calculating their LENGTH item to negative.
21. Determine allocation centers. Usually mouth of basin.
22. ALLOCATE from centers.
23. WRITEALLOCATION ROUTING results to Reach File Arc Attribute Table.
24. Use DIRECTION item to flip reaches to flow in a downstream direction
25. Calculate PNTR# to internal record number of Arc Attribute Table
26. Unblock previously blocked arcs.
27. Calculate river mile for allocated reaches.
28. Compute upstream linkage. INFO program.
29. Order attributes in Reach Files and Water bodies coverage for consistency among Files.
30. Check Reach File using checking programs.
31. Manually add Northwest Power Planning Council reach codes, stream names and river miles.
32. Run final check programs
33. Archive Reach Files.
34. Distribute to states for review.

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5. Revisions made to data
   These Reach Files are considered REV 1.0. Any subsequent updates could result in a new revision number, as determined by the extent of the update.

Reviews applied to data (review type, date, person, description)

During their production, the PNW Reach Files were run through a number of diagnostic test programs. These check programs looked at the results of the conflation process, the connectedness of the stream segments, the transfer of items from the overlay process, stream name checks and the linkage of the basin.

Final reviews and corrections were performed by regional Federal and state agencies. These agencies were:

Bonneville Power Administration, Washington Dept. of Wildlife, Washington State Energy Office, Oregon Dept. of Water Resources, Oregon Dept. of Energy (State GIS Service Center), Idaho Dept. of Water Resources, Idaho Fish, Game and Parks, Montana State Library, Montana Fish and Game.

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6. Related spatial and tabular data sets and programs

Related spatial data sets include:

1. USGS-NMD 1:100,000-scale Digital Line Graphs (DLG) for hydrography
2. USGS 1:2,000,000-scale CU boundaries coverage
3. USEPA 1:250,000-scale RF2 (enhanced version) Trace Files

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7. Minor Attibute Codes found in PNW River Reach Files:

7.A A list of attribute codes for hydrography can be obtained from Appendix D.
in the Data Users Guide 2, Digital Line Graphs from 1:100,000-scale Maps, USGS NMD.

Minor feature codes:

The type of element described by a feature code can be determined from the value of these following digits:

- node: 001 - 099
- line: 100 - 199
- area 200 - 299
- general purpose codes (apply to multiple feature types) 400 - 499
- descriptive codes 600 - 699
- artificially added feature 990-999

* Includes centerlines added through water bodies and braided sections, and connector segments.

Recommended general purpose and descriptive code combinations for Reach File features found in the RRF.

Braided stream	412	413	0
In-line canal	414	412	0
Centerline thru reservoir	999	101	412
Centerline thru a lake	999	421	412
Centerline thru marsh	999	111	0
Centerline thru braids	999	413	0
Closure line	999	412	202
Connector arc to tributary	990	412	0
Headwater reach	412	0	888888 for inter-connecting CU's
Terminal reach	412	0	111111 for inter-connecting CU's

Recommended descriptive code combinations for the Water body coverage Polygon (.PAT) codes

	MINOR1	MINOR2	MINOR3
Islands	199		
Island in a river	199	412	0
Island in a lake	199	421	0

Line (.AAT) codes

Left bank of a stream	605	412	0	
Right bank of a stream	606	412	0	
Island shoreline	200	412	0	In a stream

8. References

Horn, C. Robert, Reach File Manual (Draft), U.S. Environmental Protection Agency, july 25, 1986

Knutson, Lea Evaluation of the 1:100,000-scale River Reach Data, (Unpub.) Washington Department of Wildlife, April 5, 1989

U.S. Environmental Protection Agency, 1994, River Reach File Version 3.0, Office of Water, Excerpts from the accompanying README document.

U.S. Geological Survey, Digital Cartographic Data Standards, Digital Line Graph Attribute Coding Standards, Circular 895-G. 1983, 31p.

Seaber, Paul R., Kapinos, F. Paul, Knapp, George L., 1984, State Hydroligic Unit Maps: U.S. Geological Survey Open File Report 84-708, 200 p.

Note:

Each Reach File is constructed by hydrologic unit and is referenced by the eight-digit USGS hydrologic unit code. Each hydrologic unit directory contains the Reach File - S(HUC) or STR100-PNW and possibly a water body coverage - B(HUC) or BANKS-PNW.