NHD Conflation of Tribal High-Resolution Water Quality Standards

Ken Gilland, Peter Ilieve, and Paul Andrews, RTI International
Bill Kramer, U.S. Environmental Protection Agency Office of Science and Technology

Abstract

The U.S. Environmental Protection Agency (EPA) Office of Water is developing a national Water Quality Standards Database (WQSDB). The database will display state, tribal, and territorial water quality standards (WQS), designated uses, and criteria for the nation's surface waters. The WQSDB achieves consistency by reach addressing (georeferencing) EPA-approved water quality standards regulations to the medium-resolution, 1:100,000 National Hydrography Dataset (NHD). This study evaluates the feasibility of using high-resolution WQS tribal geographic information system coverages to prepare medium-resolution maps for the WQSDB. This effort highlights the Confederated Salish and Kootenai Tribes (CSKT) of the Flathead Reservation as a case study.

Introduction

The U.S. Environmental Protection Agency (EPA) Office of Water Standards and Health Protection Division is developing a National Water Quality Standards Database (WQSDB). The database, available to the public through the Internet, will display state, tribal, and territorial water quality standards (WQS) information (designated uses and criteria) for the nation's surface waters. An important feature of the WQSDB will be its ability to map information in a consistent way. At present, many jurisdictions employ varying scales to map waterways. The WQSDB will achieve consistency by modifying jurisdiction in-house mapping products to conform to the medium-resolution, 1:100,000 (1:100K) National Hydrography Dataset (NHD) (USGS and EPA, 2000). The NHD is based on the content of the U.S. Geological Survey (USGS) Digital Line Graph hydrography data, integrated with reach-related information from the EPA Reach File Version 3 (RF3). The NHD provides the most comprehensive hydrography for exchange of data among users at the national, state, and local levels, offering numerous advantages in the georeferencing (reach indexing) effort, particularly when reach indexing larger jurisdictions. For more information on the NHD, please see http://nhd.usgs.gov.

The purpose of this study was to evaluate the feasibility of using high-resolution tribal geographic information system (GIS) coverages to prepare medium-resolution maps of WQS data for inclusion in the WQSDB. This effort used the Confederated Salish and Kootenai Tribes of the Flathead Reservation (CSKT) as a case study.

To date, EPA's WQS reach indexing has focused on states and territories. Not all Indian tribes have developed WQS. Tribal participation in the WQS program requires two principal tasks. One task is for the tribe to submit an application to the EPA Regional Administrator to administrate the program. EPA then reviews the application to determine if the tribe meets all applicable requirements. The second task is the development of specific standards. A number of tribes are in the process of gathering water monitoring data to determine relevant WQS. Currently, EPA-approved WQS are available for 23 tribes. Table 1 shows a list of these tribes.

Table 1. Indial Tribes with EPA-Approved Water Quality Standards

Tribe	EPA Region	Standards document date
Seminole of Florida	4	2000
Miccosukee Tribe of Indians of Florida	4	1999
Mole Lake Band of the Lake Superior Tribe of the Chippewa Indians Sokaogon Chippewa Community	5	1996
The Fond du Lac Band of the Minnesota Chippewa Tribe	5	1998
Pueblo of Acoma	6	1998
Pueblo of Isleta	6	1992
Pueblo of Nambe	6	1995
Pueblo of Picuris	6	1995
Pueblo of Pojoaque	6	1999
Pueblo of Sandia	6	1991
Pueblo of San Juan	6	1998
Pueblo of Santa Clara	6	1995
Pueblo of Tesuque	6	1996
Confederated Salish and Kootenai Tribes of the Flathead Reservation	8	1995
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	8	1997
White Mountain Apache	9	1999
Hoopa Valley Tribe	9	2001
Puyallup Tribe of Indians	10	1994
Confederated Tribes of the Chehalis Reservation	10	1996
Confederated Tribes of the Colville Reservation	10	2000
Spokane Tribe of Indians	10	2003
Confederated Tribes of the Umatilla Reservation of Oregon	10	1999
Confederated Tribes of the Warm Springs Indian Reservation of Oregon	10	2001

Source: EPA Office of Water, available at http://www.epa.gov/waterscience/standards/wqslibrary/tribes.html

WQS reach indexing of tribal waters offers some unique challenges. First is the areal extent of tribes. Tribal lands are much smaller than states. Because of this, even small streams can be very important to the water quality of the tribe. To represent these waters accurately, the CSKT created a designated-uses data layer at the 1:24,000 (1:24K) scale to provide high-resolution representation of the tribes' waters. To create a nationally consistent mapping product based on the NHD, this 1:24K data layer must be conflated to the medium-resolution 1:100K NHD format. RTI and EPA have previously evaluated differences in 1:24K and 1:100K hydrography (Andrews et al., 2002; Ilieve et al., 2001).

RTI evaluated the practicality of preparing medium resolution maps based on the 1:24K coverage provided by the tribes. RTI then examined the properties of tribes' coverage and its relationship to the CSKT's WQS regulations, and evaluated the data loss associated with the preparation of medium-resolution coverages and the advantages of a consistent nation-wide approach when using spatial data. Based on this evaluation and consultation with EPA and the CSKT, WQS reach indexing was prepared. With the approval of the CSKT, the WQS reach indexing became available to the public in January 2003.

1.0 Background on the Confederated Salish and Kootenai Tribes of the Flathead Reservation

The Flathead Indian Reservation (1,244,000 acres) in western Montana is home to the Confederated Salish and Kootenai Tribes. The tribes consist of a confederation of Salish and Pend d'Orielles Tribes and the Kootenai, as an individual tribe. Of the approximately 6,800 enrolled tribal members, approximately 3,700 live on or near the reservation. The tribal headquarters of the CSKT are located in Pablo, Montana. Figure 1 shows the location of the CSKT study area. The CSKT reservation is shown in gray. Flathead Lake is shown in green.

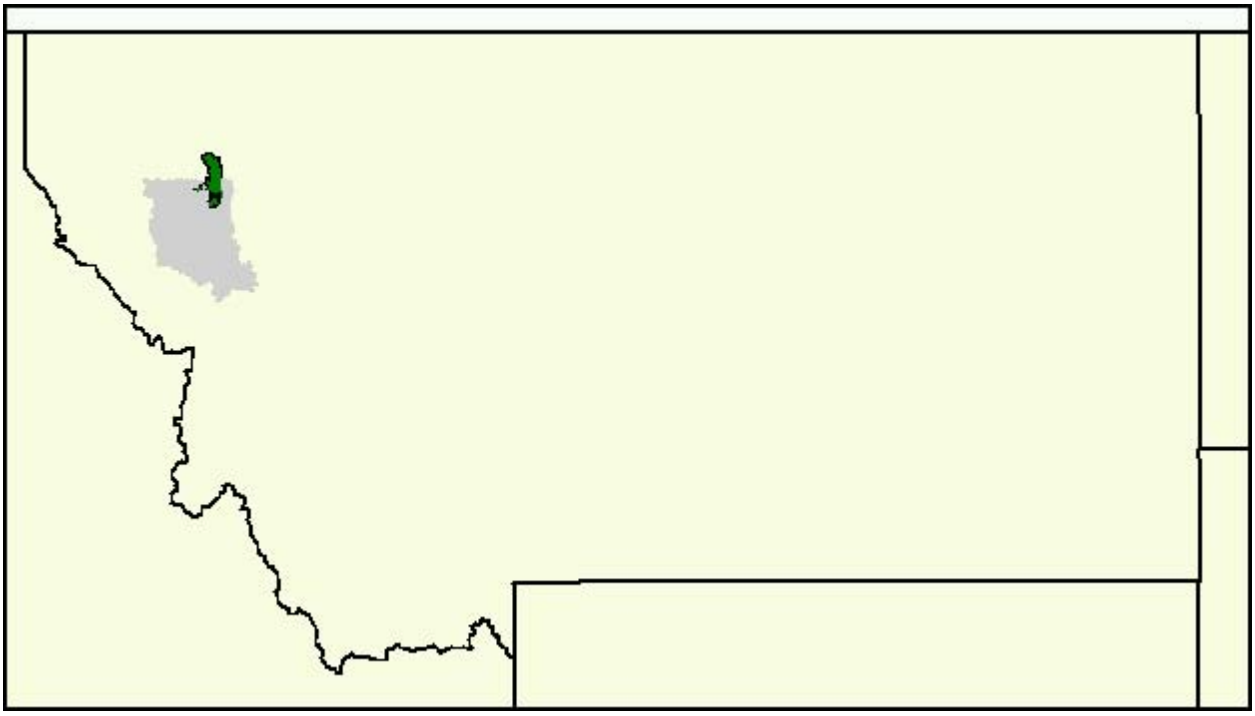

Figure 1. Study area for the Confederated Salish and Kootenai Tribes.

Tribes represented in the CSKT reservation are the modern representatives of Native Americans who lived in western Montana, eastern Idaho, and eastern Washington in the early 1800s. In 1855, tribes in the CSKT surrendered their claims to western Montana and northern Idaho, but reserved an area in the Bitterroot Valley as their homeland. Within a generation, they were resettled to the lower Flathead River Basin.

Today, farmers on the reservation produce hay and grain for the livestock industry. Other crops grown on the reservation include potatoes and cherries. Tribal members also own timber areas in the nearby mountains. Flathead Lake provides excellent fishing and recreational opportunities (Char-Koosta News, 2002). Because of the importance of the CSKT's water resources to their economy, the tribe has devoted extensive resources to ensure the continued quality of their surface waters.

CSKT produced two digital coverages (line and polygon) representing all designated use waters for the entire tribal area at a resolution of 1:24K. These coverages were delineated based on the tribe's waterbody classification system. Not all of these features were identified by name. Figure 2 shows the CSKT Tribal WQS coverages. The stream coverage is shown in gray, and the lakes coverage is shown in green. With the designated use coverages overlaid on the NHD, the PC-based Reach Indexing Tool (NHD-RIT) was used to select NHD reaches and waterbodies that corresponded to the line or polygon features contained in the designated use coverage. These selected features were then re-created in an NHD event theme as either linear or waterbody features. Segments of the designated use coverages without a corresponding NHD feature were not reach indexed unless they represented named waterbodies in the tribal coverage.

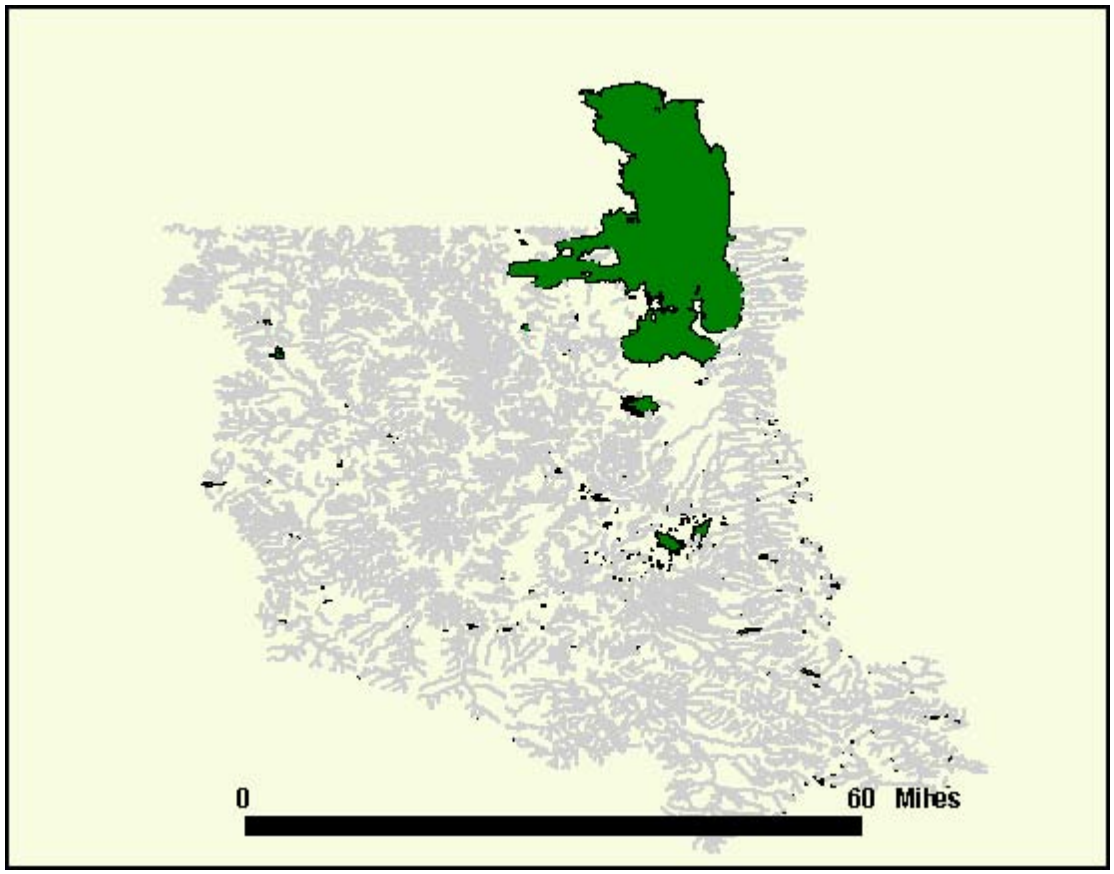

Figure 2. The CSKT 1:24K WQS coverage (including Flathead Lake).

2.0 Confederated Salish and Kootenai Tribes of the Flathead Reservation Water Quality Standards

Waterbodies in the CSKT reservation can be assigned to a variety of uses. The following summary is a simplified explanation of these uses (CSKT, 1995). Please refer to the tribe's WQS regulations for a complete explanation of use criteria.

- Class A-Closed waters are suitable for drinking, culinary, and food processing after simple disinfection. Water quality is suitable for swimming, bathing, recreation, growth and propagation of fish and associated wildlife, although access restrictions may limit actual use of Class A-Closed waters for these uses.

- Class A-1 waters are suitable for drinking, culinary, and food processing after conventional treatment for removal of naturally present impurities. Water quality is suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

- Class B-1 waters are suitable for drinking, culinary, and food processing after conventional treatment for removal of naturally present impurities. Water quality is suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

- Class B-2 waters are suitable for drinking, culinary, and food processing after conventional treatment for removal of naturally present impurities. Water quality is suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

- Class B-3 waters are suitable for drinking, culinary, and food processing after conventional treatment for removal of naturally present impurities. Water quality is suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

- Class C-1 waters are suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

- Class C-2 waters are suitable for swimming; bathing; recreation; growth and propagation of salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply. The quality of these waters is naturally marginal for drinking, culinary, and food processing purposes, agriculture, and industrial water supply.

- Class C-3 waters are suitable for swimming; bathing and recreation; marginal growth and propagation of non-salmonid fishes and associated wildlife, waterfowl and furbearers; as well as agricultural and industrial water supply.

Differences between Class A-1 and Class B waters relate to specific water quality parameters, such as pH, dissolved oxygen, turbidity, and maximum allowable contaminant concentrations. The tribe states that currently no waters are classified as B-3, C-1, or C-2.

3.0 NHD Reach Indexing Technical Approach for the Confederated Salish and Kootenai Tribes of the Flathead Reservation Water Quality Standards

Linear events were created to replicate the linear coverage features, waterbody shapefiles represented polygonal coverage features, and point events were created to represent named features of the coverage that did not exist in the NHD. The linear event feature was defined using the from and to position of each stream segment along an NHD route reach. Waterbody mapping was accomplished using shapefiles to store the geographic properties. In such cases, the reach code came from the waterbody region reach feature in NHD rather than the NHD route reach (Spoerri et al, 2000). The point event feature was defined with a point position along the NHD route reach. Linear and waterbody NHD events represent successful conflations. Point events represent conflation failures for named waterbodies only. Unnamed waterbodies and linear coverage features that did not exist in NHD were not represented due to small areal extent and large number of such features. It was determined that creating point events to represent these events would have been inefficient and impractical.

The CSKT coverage spans a number of subbasins. Reach indexing was performed on the following subbasins:

Subbasin 17010203
Subbasin 17010208
Subbasin 17010211
Subbasin 17010212

4.0 Results

When reach indexing was completed, the proportion of non-conflated events was calculated by querying all coverage features without corresponding NHD events and comparing that result with the total number of coverage features. Based strictly on the number of unique entities represented in the CSKT coverage, the overall success rate for the conflation of linear features for the CSKT coverage is approximately 40%. The success rate for the conflation of waterbody features is much lower, at approximately 5%. However, it should be noted that most of the features that were not represented in NHD are relatively small. Figure 3 shows a representative area of the study area. The 1:100K NHD is shown in dark blue with light blue lakes. The CSKT coverage is shown in gray.

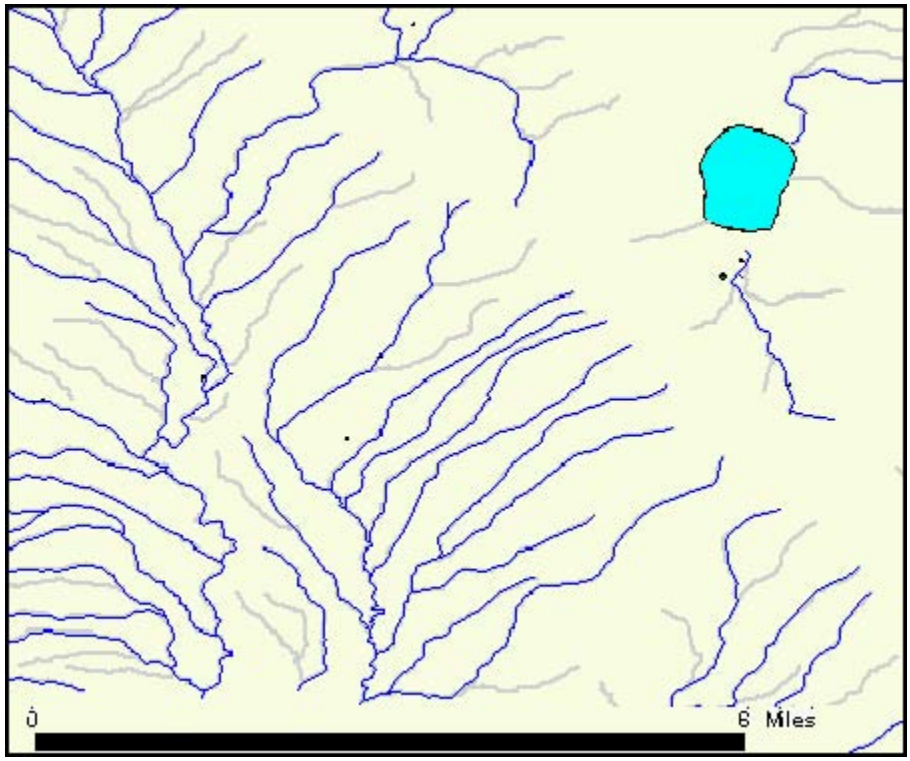

Figure 3. The CSKT WQS coverage overlain with 1:100K NHD.

Reach Indexing of Linear Reaches

The CSKT coverage contained 6,153 linear features, including both perennial and intermittent streams. The total length of linear features represented in the CSKT coverage was 6,367,416 meters. In subbasin 17010212, a total of 2,303 linear features were reach indexed by RTI. The total length of the linear reaches indexed in this subbasin was 3,865,462 meters. In subbasin 17010203, a total of four linear reaches were indexed. The total length of linear reaches indexed was 485 meters. Subbasin 17010208 included Flathead Lake, which was reach indexed by the CSKT as a polygon only. Subtracting this total from the WQS reach indexing yields a result of 131 indexed reaches in the subbasin with a total length of 257,616 meters.

The results of the WQS reach indexing are shown in Table 2. While only about 40% of the reaches were indexed, this represents almost 65% of the total length of the CSKT coverage. From this it is concluded that medium-resolution NHD reach indexing can represent a majority of the waters included in the CSKT WQS coverage.

Table 2. Linear Reach Indexing of CSKT Waters

Coverage	Total number of reaches	Total length of reaches
RTI Reach Indexing		
Subbasin 17010212	2,303	3,865,462 meters
Subbasin 17010203	4	485 meters
Subbasin 17010208 (not including Flathead Lake)	131	257,616 meters
Total Linear Reached Indexed	2,438	4,123,563 meters
CSKT 24K Shapefile	6,153	6,367,416 meters
Total Reaches Not Reach indexed	3,715	2,243,853 meters
Percent Not Reach indexed	60.4%	35.2%

Reach Indexing of Waterbodies

The CSKT coverage contained 3,362 waterbodies. The largest of these waterbodies is Flathead Lake, which has an areal extent of almost 500 square kilometers. Figure 4 shows the CSKT coverage of Flathead Lake in green. The lake extends beyond the boundaries of the reservation, so the WQS reach indexing (shown in orange) only covers a portion of the total lake area.

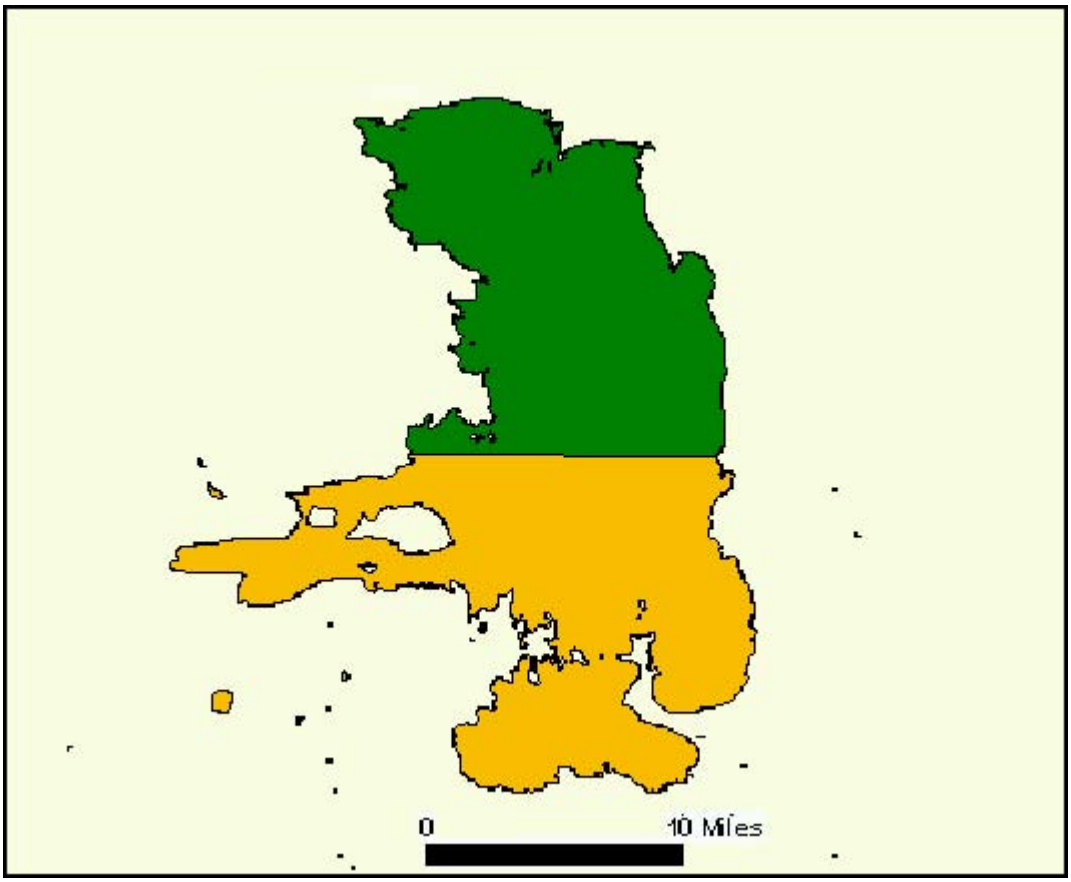

Figure 4. Flathead Lake, showing the CSKT coverage and the WQS indexing.

RTI reach indexed 155 waterbodies, including a portion of Flathead Lake. Three additional waterbodies were reach indexed as point events in subbasin 17010212. While the WQS reach indexing contains only 5% of the waterbodies contained in the CSKT coverage, the vast majority of the lakes that could not be represented in medium-resolution NHD covered very small areas. This is illustrated in Figure 5. The CSKT coverage is shown in green and the WQS reach indexing is an overlay in orange. The largest lake is Horte Reservoir. It has an reach indexed area of 0.383 square kilometers. There are two smaller lakes reach indexed on the left side of the view. The upper lake has a total area of 0.019 square kilometers, and the lower lake has a total area of 0.013 square kilometers. Note that there are shape differences between the WQS reach indexing and the CSKT shapefile. This is shown by the green CSKT coverage extending beyond the boundaries of the WQS reach indexing.

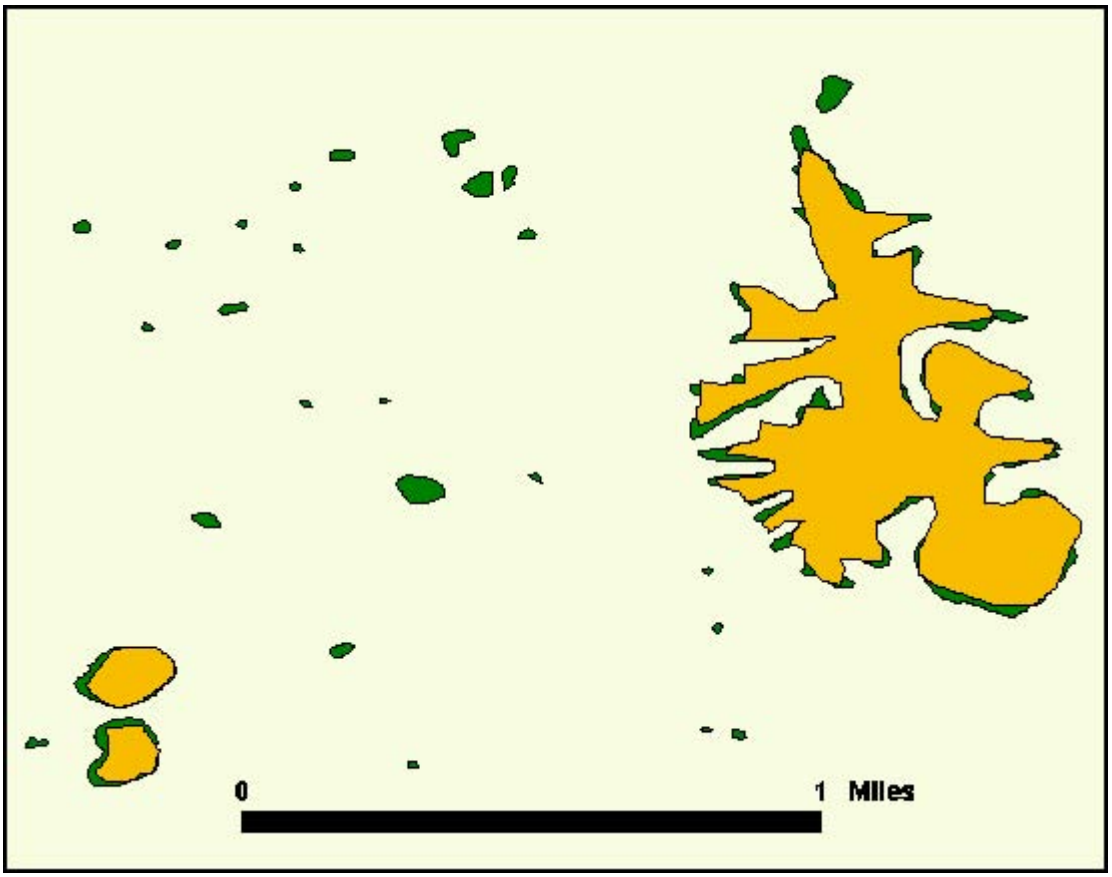

Figure 5. Waterbodies in the area of the Horte Reservoir.

The results of the WQS reach indexing are shown in Table 3.

Table 3. Waterbody Reach indexing of CSKT Waters

Coverage	Total number of reaches	Total area of waterbodies
RTI Reach Indexing		
Subbasin 17010212 (not including point events)	143	27.135 square kilometers
Subbasin 17010203	1	0.041 square kilometers
Subbasin 17010208 (not including Flathead Lake)	9	1.944 square kilometers
Subbasin 17010211	1	0.35 square kilometers
Total Waterbodies Reach Indexed	154	29.47 square kilometers
CSKT 24K Shapefile (Not including Flathead Lake)	3,361	35.765 square kilometers
Total Waterbodies Not Reach Indexed	3,207	6.295 square kilometers
Percent Waterbodies Not Reach Indexed	95.4%	17.6%

5.0 Advantages of Preparing a 1:100K NHD Water Quality Standards Coverage

Although there are inherent limitations in representing CSKT's 1:24K data using 1:100K NHD reach indexing, doing so provides some advantages to the tribal group and EPA. The first advantage is the ability to perform nationwide comparisons of WQS data. Because EPA has developed 1:100K WQS coverages for a majority of the states in the United States, 1:24K WQS reach indexing for CSKT would skew nationwide data. Until reach indexing to higher resolution NHD is available nationwide, the continued use of 1:100K NHD provides the most useful data for EPA.

Also, it should be noted that CSKT is bordered by the State of Montana. EPA is in the process of developing a 1:100K NHD WQS coverage for the state. Because one of the goals of the EPA's WQSDB is to make this information available to the public, consistency in data presentation is extremely important. For example, if a user of the EnviroMapper (the EPA's public mapping application for the WQSDB) looked at the border of CSKT and Montana and saw many small streams either terminating or starting at the border between these entities, they would be confused.

Preparation of WQS reach indexing in this format also allows water quality reach indexing to be directly compared with reach indexing for other EPA water programs. EPA has prepared 1:100K reach indexing for waters assessed under section 305(b) of the Clean Water Act, impaired waters listed under section 303(d) of the Clean Water Act, water quality information listed in the STOrage and RETrieval database (STORET) and nonpoint source pollution sites listed in the Grants Reporting and Tracking System (GRTS). All of these programs have been combined in EPA's Watershed Assessment, Tracking, and Environmental Results (WATERS) integrated information system. More information about WATERS can be found at the following URL: http://www.epa.gov/waters/.

6.0 Conclusions

Preparation of WQS reach indexing for the CSKT provided several challenges. The WQS coverage provided by the tribes was extremely helpful and contained a great deal of information that could be useful to several programs in EPA. The shapefile provided by the tribes provided information on a number of waterbodies, not all of which had associated names.

During RTI's reach indexing effort, it was observed that some data losses were inevitable when representing a 1:24K coverage using 1:100K NHD. The missing waterbodies consisted primarily of small streams and ponds. Where possible, data losses were minimized through the use of point events for waterbodies named in the CSKT WQS document.

There are several advantages to proceeding with WQS reach indexing of tribal WQS using 1:100K NHD. These advantages include the ability to make nationwide comparisons, consistency with neighboring entities, and the capacity to compare reach indexing from different EPA water programs.

7.0 Acknowledgments

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Author Information

Ken Gilland
Research Geologist
RTI International
3040 Cornwallis Road
RTP, NC 27709-2194
phone: (919) 485-2601
fax: (919) 541-8830
e-mail: krg@rti.org (To whom inquiries should be addressed)

Peter Ilieve
Research Environmental Engineer
RTI International
3040 Cornwallis Road
RTP, NC 27709-2194
phone: (919) 316-3727
fax: (919) 541-7155
e-mail: pii@rti.org

Paul Andrews
Environmental Scientist

RTI International
3040 Cornwallis Road
RTP, NC 27709-2194
phone: (919) 316-3718
fax: (919) 541-7155
e-mail: andrewsp@rti.org

Bill Kramer
Manager, Water Quality Standards Database
US EPA Office of Science and Technology
EPA West
1200 Pennsylvania Ave. NW
Room 5233T
Mail Code 4305T
Washington, DC 20460
phone: (202) 566-0385
fax: (202) 566-0409
e-mail Kramer.Bill@epamail.epa.gov

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National Hydrography Dataset

The National Hydrography Dataset (NHD) is a comprehensive set of digital spatial data that contains information about surface water features such as lakes, ponds, streams, rivers, springs and wells. Within the NHD, surface water features are combined to form "reaches," which provide the framework for linking water-related data to the NHD surface water drainage network. These linkages enable the analysis and display of these water-related data in upstream and downstream order.

The NHD is based upon the content of USGS Digital Line Graph (DLG) hydrography data integrated with reach-related information from the EPA Reach File Version 3 (RF3). The NHD supersedes DLG and RF3 by incorporating them, not by replacing them. Users of DLG or RF3 will find the National Hydrography Dataset both familiar and greatly expanded and refined.

While initially based on 1:100,000-scale data, the NHD is designed to incorporate and encourage the development of higher resolution data required by many users.

NHD News

See the latest NHD Newsletter and the High Resolution Production Status Map.

Updated Watershed Tool, now with a metadata template. 07/30/03

NHD ArcView Toolkit Version 7.0.0 now available
What has changed? NHD Migrate component has been added which updates events linked to the NHD as the NHD changes. 07/30/03

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