

UNIVERSITY OF WASHINGTON

Updating the River Mile System in Washington State:

Considerations, Ramifications, and Recommended
Solutions

**Grant Novak
Jon Walker**

8/23/2013

TABLE OF CONTENTS

I. Problem Statement.....2

II. Introduction2

III. The River Mile System.....8

 History.....8

 Need for Updates.....9

IV. Proposed Alternatives.....11

 Alternative 1 – Keep current USGS river miles, and add major tributaries11

 Alternative 2 – Replace River Mile Dataset with NHD.....12

 Alternative 3 – Replace River Mile Dataset with NHD and develop online river miles application12

 Financial Analysis Of Alternatives.....14

V. Proof of Concept16

 Recommended Solution.....26

VI. Sustainability.....27

VII. Summary28

VIII. References29

IX. Process Workflow30

X. Appendix A. Python Code for River Mile Update Tools.31

XI. Appendix B - USGS River Mile Shapefile Metadata42

XII. Appendix C – NHD Flowline Shapefile Metadata.....52

Table 1. Pros and Cons of Proposed Alternatives.....14

Table 2. Cost Comparison of Alternatives15

Table 3. Sample Location Data.20

Figure 1. Legacy USGS river mile system bordering the Spokane Indian Reservation10

Figure 2. Comparison of Proposed Alternatives13

Figure 3. Study Area, Lower Spokane HUC 08 and Spokane Indian Reservation16

Figure 4. Model diagram depicting process used to create Lower Spokane river miles layer.17

Figure 5. Artificial path segments to be removed due to inundation.18

Figure 6. New sample river miles layer compared with USGS river miles.19

Figure 7. Sample Route Events.21

Figure 8. General function of Assign River Miles tool.....23

Figure 9. Sample output from Assign River Miles tool.23

Figure 10. General function of Update Table River Miles tool.24

Figure 11. Table transformation resulting from Update Table River Miles.25

Figure 12. Sample river miles toolbox25

I. PROBLEM STATEMENT

The current USGS river mile layer contains errors, has no measurement reference system, and is absent from many rivers and streams. This prompts a need to investigate options for upgrading the river mile representation for Washington State in GIS.

Challenges:

- Does the currently-used river mile system need to be replaced, updated, or fixed?
- Should errors in the system be fixed?
- Should areas that have no river mile system in WA State be updated with measures and, if so, what dataset should be employed and at what scale?
- What are the ramifications of making changes/edits/updates to the existing river mile layer?
- What would a system look like for updating the old USGS river mile layer and maintaining the new layer?
- How should the trans-boundary issue be handled?

II. INTRODUCTION

Joe was excited by the prospects and challenges afforded by his new position as a fisheries biologist with the Fish Conservancy. He had a lifelong interest in fish; their biology, ecology, interactions with their habitat and other species and, after a lengthy but informative 8 years at the School of Aquatic and Fishery Sciences at UW, he had graduated with a Master's degree in fisheries science and found a salaried position with the Fish Conservancy. He was filled with visions of how he would make fisheries science better and, through his hard work and energetic innovation, help to manage fisheries in the Columbia Basin in a sustainable and responsible manner.

As he rode the van pool on his way to work he considered the task that had been laid before him earlier in the week. His supervisor was looking for some help in graphing much of their past fish survey and aquatic habitat data on charts and maps. He was interested in seeing some of the habitat trends and patterns that might become evident if he could chart and map the data. Joe felt he was particularly well-suited to this task as his studies had included a minor in geography focused on GIS. The skills he had built during his GIS studies allowed him to map data on the landscape which he found very effective as a story-telling aid when trying to describe fish and habitat status and trends. He was already thinking ahead about how to map out the data when he asked his boss what format the habitat and fish survey data were in. He was envisioning a

robust geodatabase housing a geometric network of stream reaches and tabular data associated with the reaches through database relationship classes. He was met with a confused stare. “Format? I don’t really know what format the field data is stored in. Probably some sort of electronic format don’t you think? I suppose I have become a little removed from the on-the-ground field data collection and storage as a program director but talk to Jen, the field crew lead, and she’ll point you to the data. Do you suppose you could have some charts of the impacts that our habitat restoration projects have had on the density of rearing juvenile fish by Friday?” Joe was a little surprised that his supervisor was unaware of the standard protocol for storing data but was sure he could work with whatever data was available. He was a born problem-solver and, with a good grasp of databases, spreadsheets, and GIS was undaunted by the task before him.

His classes in GIS and fisheries had repeatedly stressed the importance of good planning to make data collection efficient and useful. By first understanding how the data would ultimately be put to use one could work backward to lay out a method for collection, organization, and storage that would allow for efficient analysis and use by a variety of sources. He expected the Conservancy’s fisheries program would have well-organized data and it would be a quick effort to geo-reference their data and display some informative charts so he was initially unconcerned. Jen was in a hurry to get into the field that morning when he approached her so he wasn’t able to do more than wonder when she rolled her eyes and gave a frustrated wrinkle of her nose when he asked for the location of the data he needed. She quickly jotted down a network folder address and said with a glib tone “It’s all in there.” He now knew where his data was located! All that remained was to get to work figuring out the data organization and structure, where the reach shapefiles were located, and start charting and mapping the data. “This fisheries biologist stuff is fun and exciting work!” he thought as he slid into his workstation and fired up his computer, ready to save the world.

As Joe left work later that day he thought over what he had just been through. He was baffled. He’d located the folder Jen pointed him to easily. Everything after that was a confusion of disorganized folders, Excel spreadsheets, Word documents, Access databases, and more shapefiles, feature classes, and geodatabases than he could wrap his brain around in a hundred years. There was no doubt that the field biologists had been hard at work. They’d collected voluminous field data and written annual reports outlining their efforts but it seemed that everyone had a different idea about what was needed and how to go about it. Some data were in Excel spreadsheets which initially set him at ease. He was very comfortable analyzing tabular data in spreadsheets and had some ideas about how to get the information displayed on GIS maps. The spreadsheet tables were, for the most part, attractively formatted for inclusion in reports but none of the data was structured in a way that made it easily analyzed. For starters, cells were merged together and multiple data points were in individual cells making the data difficult to filter or analyze using pivot tables or summary statistics. Neither could that data be

joined to a GIS reach layer. Another disturbing detail was that every spreadsheet seemed to have a different structure. Were all of the spreadsheets of a similar structure he could build a VBA macro that would at least help to reformat the data into a structure that was useful for analysis and display. What could he do with this data but start at the beginning? It was clear that somewhere along the way, someone had realized that their data collection and organization methods could use some standardization as several Access databases were also stored in the folders with the rest of the field data. The Access databases appeared to have originated at the Oregon Department of Fish and Wildlife as the ODFW insignia and an ODFW were found on the splash page of the database. It seemed no one had taken the time to personalize the database to the Conservancy's needs. Initially he was hopeful that much of the data he needed might be found in the databases but that turned out not to be the case. Some years, data had been entered into the database; other years' data was in spreadsheets. Some years' data could only be found in tables in Word documents. To make matters worse, there was no consistent method for collecting the location of the data. Many of the data points were referenced to a reach name. "That's good news" he thought. All he had to do was find the reach shapefile, spend a couple of days re-formatting the data into a well-structured table, and join the table to the shapefile. When he dug into the GIS layers, however, he again became dismayed. There were more so many shapefiles and they all had cryptic names. What was reaches_2010.shp? It was obviously a stream layer from 2010 that had been broken into distinct reaches but when he displayed it in ArcMap it was only a portion of the streams within the reservation and none of the reach names matched the reach names in the data tables he was looking at. What to do? Some of the data tables had river mile references. He knew a little bit about routes in GIS. They have measure values so could be used to place events along a line based on the distance that the event is located along the line. If a tabular data point was collected at river mile 1.2 on the Spokane River then ArcGIS could be used to place a point on the Spokane River at mile 1.2 along with the associated attributes just by having a route layer and the data table. He looked a little more closely and found a reach layer that had measures and, using the linear referencing tools in ArcMap, went about displaying the tabular data along the route. Some of the stream names matched and the table data was displayed cleanly, other stream names weren't found in his shapefile, while others were found but the river mile listed in the data table was greater than the length of the reach feature. There were more errors returned than there were useful data points. The icing on the cake was when he discovered all of the data from Ecology, WDFW, and neighboring tribes that was in a similar state of affairs. If no one collects data in the same manner, how can it be used effectively to manage across regulatory boundaries? "This just keeps getting worse and worse." He glumly thought to himself as he rode the van pool bus home at the end of the day. I must be missing something. Jen will surely be able to set me on the correct path in the morning.

Jen smiled knowingly as he described his previous days' antics. "Yeah, there's a lot of data collection going on but the organization leaves something to be desired. "We were really interested in hiring you because of your understanding of databases, GIS, and data analysis. Do you have any ideas about how we could fix our system?" Joe thought back to what he had learned in school. First, there needed to be some decisions made regarding standardization; standard procedures for data collection, for data analysis, and for data display at the very least. His mind churning, he began to draft an outline of what an effective and efficient data collection process might look like. Late that day when Jen approached him about his ideas and progress he was still thinking hard but he was more excited than he had originally been when he found the state of the data. "This is going to be a monumental effort. There are going to have to be some high-level decisions made regarding the path forward. Let's get the team together tomorrow to outline what a potential field data collection program could look like. We can start with how the data is used then work backward to"

Months later Joe was happily reviewing a memo that he was about to send to his program director outlining the progress that had been made toward constructing a program that would allow for organized data collection, storage, analysis, and display. One glaring item that remained was what layer to use as the standard river reach layer. The Washington Department of Fish and Wildlife had been using the 100K PNW Reach File for some time but had shelved the layer. It was a standardized layer that agencies in Idaho, Oregon, Montana, and Washington had worked to construct across state boundaries so that a standardized layer could be used throughout the region. While it had been retired and archived in 2009, the Oregon Department of Environmental Quality was still using it. Joe had initially been excited to learn that the ODEQ had an online system that they used to display river miles of Oregon's rivers. He was less excited when he learned that it was built on the 100K PNW Reach layer that had been archived in preference of the USGS National Hydrography Dataset (NHD). How to go about standardizing a river reach layer had snowballed into an entity of its own. Oregon was already using a defunct layer, WDFW was in favor of the NHD layer, but what about those streams in Canada that flowed into the US? The situation was further muddled by the fact that the USGS had drawn river mile labels on the USGS quadrangle maps back in the 1970s and the labels had subsequently been used by a number of entities in the data collection efforts. The USGS labels were arbitrarily drawn on some rivers but not on others and there were many mistakes leading to confusion and reduced utility. There was even an international facet to the issue. Several of the streams in the area, not to mention the mighty Columbia River, originated in Canada. Was a trans-boundary layer necessary? This was clearly going to need much more discussion so he opened another Word Document and got to work penning a second memo. This one was asking for permission from his supervisor to spend some time putting together a business case for updating the river mile system being used in the region. He proposed spending up to 25% of his time over the next 3 months constructing a business case that would outline the current usage of the river mile

system; who used it and why, the future utility of having a standardized system, and a recommended solution and approach to implementation. When he hit send on the memo he felt confident that, if approved, the time he spent over the coming months building a business case supporting a method for updating the river mile system in use in the PNW would be time well-spent.

Although fictional, Joe's story has been experienced by a number of individuals and organizations in recent years. River miles are a commonly used convention for describing where something occurs on the riverine landscape. Without a common, static river mile system how can data be collected, organized, analyzed, and shared in a meaningful manner?

When a problem requires a solution, the benefits and costs need to be balanced against each other. Who makes the decision regarding the solution path? If it's a single individual then the decision is quick and easy. Changes to the solution process further down the road don't lead to substantial inefficiency if there is a single individual involved in the decision making process but what happens when there are many involved parties? Planning is essential so a business case must be made regarding the path forward. Cost/benefit, financial analysis, and decision authority all must be considered. By constructing a business case we outline our work plan thereby adding efficiency. Also, during construction of the business case challenges may become evident leading to in depth consideration of the associated hurdles and their potential solutions.

Implementation of a GIS process to implement and standardize procedures to create, manage, and make available a regional river reach system to be used for the purpose of measuring river miles is a complicated investment. Multiple stakeholders might realize a variety of tangible as well as intangible benefits and comparisons of solution scenarios for one stakeholder may have entirely different outcomes for other stakeholders due to different costs and benefits. Technical intricacies can be difficult to balance against costs and benefits without a detailed and comprehensive summary.

Conducting a complete assessment of the costs, tangible and intangible benefits, proposed solutions, time lines, and associated challenges is a necessary step that should not be skipped when looking to determine the most efficient solution to a GIS problem. The implementation of a GIS solution can be a long-term undertaking of time, effort, and money. An organization can greatly improve the value of its time and effort by taking a well-reasoned and logical approach to planning out processes. It is no secret that much of the effort applied by GIS practitioners is duplicated by practitioners in other organizations. The process of putting together a business case for a GIS process should help to reveal areas of redundancy and provide an opportunity to plan for enterprise architecture that meets the needs of a variety of end-users (Lerner et al 2007). Identification of cross-department or cross-agency benefits leads to an opportunity to

share costs. While costs may be prohibitive to a single entity, when shared across multiple entities, cost may be reduced to a reasonable amount that makes the cost/benefit ratio more reasonable. Additionally, planning processes of this nature often lead to the identification of other subject areas where efficiencies could be gained. Identification of common needs and implementation of joint plans and efforts can help different stakeholders to meet their individual mandates in the face of shrinking budgets through cost-sharing and reduction of duplicate effort.

The Spokane Tribe of Indians, located in north eastern Washington, is an example of an entity that relies heavily upon river mile measures. The tribe has historically utilized the USGS river mile markers to help them catalog their fishery survey data. River miles are also used to legally define tribal treaty trust water rights. The tribes reliance on a standard river mile system is a good example of why a standard system of river mile measures is necessary. Last year's fish survey data needs to be aligned to this year's data so the system of measures used between the two survey years needs to remain the same or, if the system is altered, the measures of the survey data need to be updated to match the new system. Additionally, fish survey data should align to other data, such as legal water rights definitions, to make cross-discipline discussions and analyses match efficiently.

A socio-economic system defined by the needs, interests, influence, and geographic extent of the Spokane Tribe is one point from which to define an assessment of an appropriate river mile system but perhaps this lens is too focused on the needs of the Tribe and would benefit from a broader assessment. The Tribe is a member of the Upper Columbia United Tribes (UCUT). UCUT is a collaborative group of five, upper Columbia River tribes, and provides for a common voice to ensure a healthy future for all of the tribes. UCUT "takes a proactive and collaborative approach to promoting Indian culture, fish, water, wildlife and habitat." (UCUT 2013). The Spokane Tribe's membership in UCUT leads to the question of whether the socio-economic extent of the river mile system should include the needs and considerations of the UCUT membership tribes. Additionally, the Spokane Tribe manages the recovery of white sturgeon in the Columbia River bordering their lands. This project is a multi-agency responsibility in collaboration with the Bonneville Power Administration (BPA), Washington Department of Fish and Wildlife (WDFW), and the Colville Confederated Tribes. This leads to even broader considerations. BPA provides funding for fish and wildlife recovery projects throughout the Columbia River in areas impacted by hydro-power projects. WDFW manages a suite of programs throughout the state. This leads to the prospect that the socio-economic system that needs to be considered should be the entire state of Washington. In order to recover the upper Columbia River sturgeon population trans-boundary coordination with Canadian tribes and fish and wildlife management agencies is of critical importance. Because the populations do not recognize political boundaries, the geographic extent of the socio-economic system stretches upstream in the Columbia River to include the Columbia River in British Columbia as well.

When reflecting upon the socio-economic extent of the management activities of fish and wildlife entities responsible for management and recovery of Columbia River species, it is easy to consider only the geographic extent of the river and/or agencies involved in management but what of the history involved in a socio-economic extent? How does the tribal history and importance of fish and wildlife to the social needs and responsibly of the Tribe fit into the overall cost/benefit assessment of a business case for an updated river mile system? Does the socio-economic extent have a time component as well? Are the tangible as well as the intangible benefits to be taken into consideration of cost versus benefit?

The following pages outline a business case for adopting a standardized process for instituting a standard river reach route layer, updating the layer, and making the layer available to the public.

III. THE RIVER MILE SYSTEM

HISTORY

In 1884 the United States Geologic Survey (USGS) implemented the topographic mapping program with the intent of creating a standard set of topographic maps of the nation. The best known and most-used USGS maps are the 1:24,000-scale topographic maps, also known as the 7.5-minute quadrangle series. Between 1972 and 1975 river mile measurements were hand drawn on the topo maps. These labels were subsequently used by many agencies to establish and index positions of water discharges, establish water rights boundaries, locate various fishing regulations, and stratify environmental data surveys (USGS 2013, Anita Stohr pers. comm. 2013). The river mile labels on the USGS topos never changed so they provided a well-distributed standard source for river mile designations that were subsequently used by many entities for water resource management exercises. For instance, in the 1970s the USGS 1:24,000 topographic maps were used to determine legal definitions of water rights. Regulatory personnel would gather around the USGS topos with a stack of legal water rights documentation and use the river mile labels on the maps to measure and define the extent of water rights along major waterways (Anita Stohr pers. comm. 2013).

With the increased application of geographic information systems in environmental resource management and, because the USGS river mile labels were being used by so many entities in Washington State, the Washington Department of Ecology (Ecology) chose to create a digital GIS layer of the points in the 1990s. This layer, which exists for only major streams and tributaries in Washington State, remains publicly available on Ecology's GIS data download site and is often used to provide river mile measures for a variety of projects.

The USGS river miles align to the Pacific Northwest 100K Hydrography layer; a river reach file that was constructed collaboratively by the U.S. Geological Survey (USGS) in Portland, in cooperation with BPA, the Northwest Power and Conservation Council, and other Federal and state agencies as well as NW Indian Tribes. The 1:100,000-scale Hydrography layer for the Pacific Northwest was initially constructed in the early 1990s. 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, Puget Sound in Washington, the Klamath and Goose Lake Basins in southern Oregon and the Bear Lake Basin in southeastern Idaho. The system is a 1:100,000 scale enhancement of the pre-existing 1:250,000 scale EPA River Reach File 2. This dataset was phased out of use in May 2009 and was subsequently replaced by the National Hydrography Dataset (NHD).

The NHD in Oregon and Washington is the result of over a decade of data development work. Partners within the two-state area initially collaborated on development of a high resolution dataset that was based on the "LLID" identifier. This is the 100K River Reach dataset mentioned previously which was maintained within the Pacific Northwest Hydrography Framework (PNWHF) infrastructure. In 2005, the PNWHF partnership made a decision to migrate to the National Hydrography Framework format and this transition was completed by 2009. The precursor 100K PNW River Reach dataset was the source for the NHD in Oregon and Washington.

The Columbia River originates in British Columbia Canada. A complete river reach layer for measuring river miles in conjunction with fishery restoration efforts in the Columbia River might be more useful if it included Canadian river reaches. Currently, those tribes responsible for upper Columbia River utilize a portion of the National Atlas of Canada – 1:1,000,000 national framework data hydrology layer. The International Joint Commission (IJC) is in charge of entities to avoid transboundary problems concerning water resources. The IJC is currently working to standardize a dataset that will align with the NHD at international boundaries (Jason McLellan, personal communication, 07/09/ 2013).

NEED FOR UPDATES

Should the current river mile system be overhauled? Should mistakes be corrected and should the extent of the system be broadened to include all rivers and streams and should the extent reach into Canada?

The extent of the USGS river mile system is limited to the major rivers in Washington State. This limits the usefulness of the system to those rivers and streams that have been labeled with USGS river miles. Also there are some known mistakes in the measures of river mile. For instance, the USGS river miles on the Columbia River step directly from 680 to 682 immediately upstream of

the Spokane tribal reservation. Additionally, the USGS river miles are simply a point feature class rather than a routed river reach network with measures. The USGS point layer is useful only for hand drawing and measuring locations. Because the original measures were hand drawn on the USGS topo maps, the measures are not very accurate leading to measures between mile points that are often greater than or less than one mile. A sample field map overlaid with USGS river miles can be seen in Figure 1.

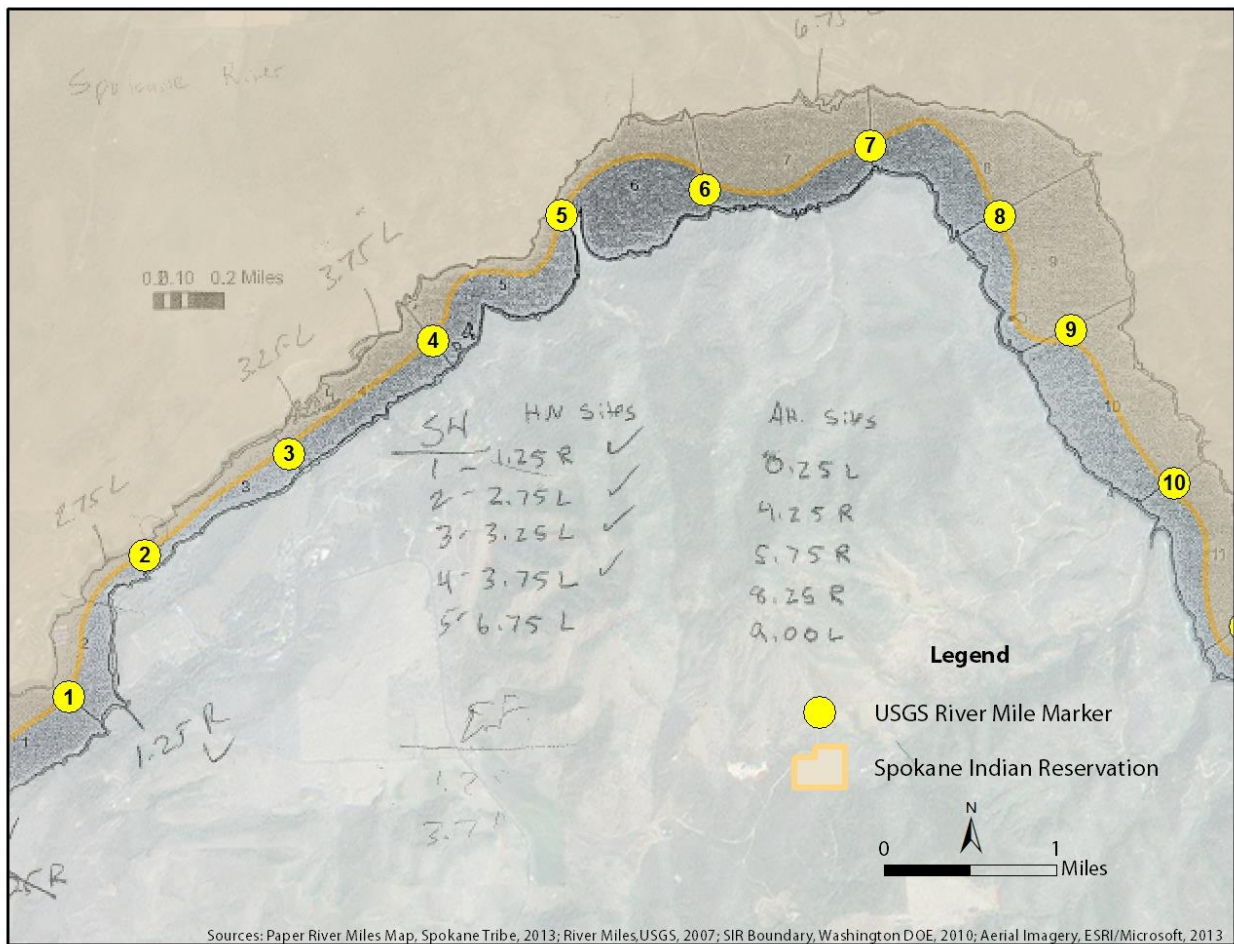


Figure 1. Legacy USGS river mile system bordering the Spokane Indian Reservation

A switch to a GIS river reach layer that includes measures would allow end users to accurately display their tabular data using linear referencing tools found in ESRI’s ArcGIS suite of software. These tools allow tabular data, such as that collected on field forms by fisheries biologists and entered into databases of compiled fisheries data, to be displayed quickly and easily based solely on the stream name and river mile measure.

By having a standard river reach system with measures, fishery biologists in charge of developing random stratified sampling regimes could use their standard tools, such as Excel spreadsheets, to generate random distances along a reach that would be associated with real world locations.

This would lead to increased efficiency when developing survey programs and would also lead to increased efficiency when displaying the resulting data and conducting spatial analyses on the data.

This line of evidence leads to the conclusion that the current USGS river mile point layer should be archived and a standardized river reach layer with measures should replace it.

IV. PROPOSED ALTERNATIVES

Numerous options for revamping the river mile system exist; from the creation of an entirely new hydrography system based on LiDAR elevation data of Spokane Tribal lands, to construction of river reaches from aerial photos, but research indicates that there are currently available products that will lead to simplification of the effort and increased efficiency in implementation and use.

The NHD river dataset that is currently being forwarded by the PNWHF as the standard hydrographic reach layer has measure values and, as such, can be used to determine river miles along rivers. This layer could be utilized to fill in areas of the current USGS river mile layer where measures do not exist. Alternatively, the USGS river mile layer could be retired and the NHD measures be forwarded as the standard measures. This, of course would require consideration about how to bring historic data forward onto the new system so that data collected prior to the implementation of a new system is not lost.

Below are presented three potential alternatives intended to make the Spokane tribe's data collection, display, and analysis efforts to be more effective and efficient.

ALTERNATIVE 1 – KEEP CURRENT USGS RIVER MILES, AND ADD MAJOR TRIBUTARIES

This alternative proposes to use the current USGS river mile points to update measures on a stream layer of the user's choice. Additional river mile data can be added to those rivers and streams not included in the USGS river mile point layer. This solution allows users with historic data based on the original USGS system to continue to collect data using the same measurement system.

By beginning with the NHD dataset users would already have measures in the river outside of the USGS point layer measure areas which would lead to a reduced cost of time and money. Using the linear referencing tools in ArcGIS along with the USGS river mile point layer one could update the NHD measures in those areas overlapped by the USGS river mile points. This process could lead to considerable confusion. Visually the river layer would match the NHD but measures would be edited in areas where overlaps between the USGS system existed. While this would allow matches between historical water rights permits it would deliver inappropriate results when making actual measurements. This would, essentially, become a single-purpose layer meeting the needs of a very few individuals. Also, because measures would be altered to

match a system that had errors since its inception, this process would continue to perpetuate errors. Perpetuation of these errors may seem like an acceptable option to those who rely upon the historical measures provided by the USGS point layer but this should not occur without much consideration of the ramifications. See the following section Sample Implementation for examples and further discussion about the implementation of this process.

ALTERNATIVE 2 – REPLACE RIVER MILE DATASET WITH NHD

By archiving the USGS river mile point layer and moving forward with an entirely new dataset the errors of the old system can be left behind. Additionally, because the NHD river layer is already the standard river layer for the agencies and major entities responsible for water quality and fish and wildlife protection and restoration, there is no cost associated with data layer construction. Of course, data collected using the USGS river mile system would need to be updated to make comparisons between historical and current data possible. To that end, the authors have created ArcGIS tools to update measures in tabular event tables with the latest NHD layers. These tools add columns to current data tables, extract the river mile measure from the NHD at the current location, and input that measure into the new table column. The data relating the measure to the historical system is not lost and the data can now be related to the new, standardized data layer.

This solution is the most easily implemented. Because the NHD stewardship roles, responsibilities, funding, and methodologies have already been determined, the layer is created and edited under a well-formulated and responsible process. However, this solution requires that end-users wishing to access the river mile measures have some familiarity with linear referencing of route measures and access to specialized and expensive GIS software. The possibility that end-users may not have such training and software leads to Alternative 3 which provides a framework for making the dataset and its measures web-accessible.

ALTERNATIVE 3 – REPLACE RIVER MILE DATASET WITH NHD AND DEVELOP ONLINE RIVER MILES APPLICATION

Similarly to Alternative 2, this solution relies upon the measures found in the NHD river layer and tools to update the measures associated with tabular survey data collected using the USGS system. This alternative takes the solution a step further in order to make the river mile measures accessible by end-user without access to sophisticated GIS software. By creating a website with tools that allow users to click on a stream point and have a river mile returned, the general public as well as tribal and agency personnel without access to GIS software would be able to use and employ the new river mile system in their daily workflow.

This solution requires the purchase of expensive hardware and software. It also requires technically demanding programming to build the website interface and tools that make the river

mile data accessible through a website. Semi-annual maintenance of this type of system would likely be necessary.

Because Oregon DEQ has already implemented a similar system, and because Ecology and the PNWHF are interested in making river mile information standardized and readily available, there is potential for cost sharing agreements between stakeholders. If the OR DEQ shifted from their currently-utilized PNW 100K Hydro Layer to the national-standard NHD data for Washington and Oregon then efficiency could be realized by all parties involved. DEQ would not have to base their tool on a now-archived dataset, the Tribe and other stakeholders would have access to standard datasets, and costs could be shared by the various stakeholders involved.

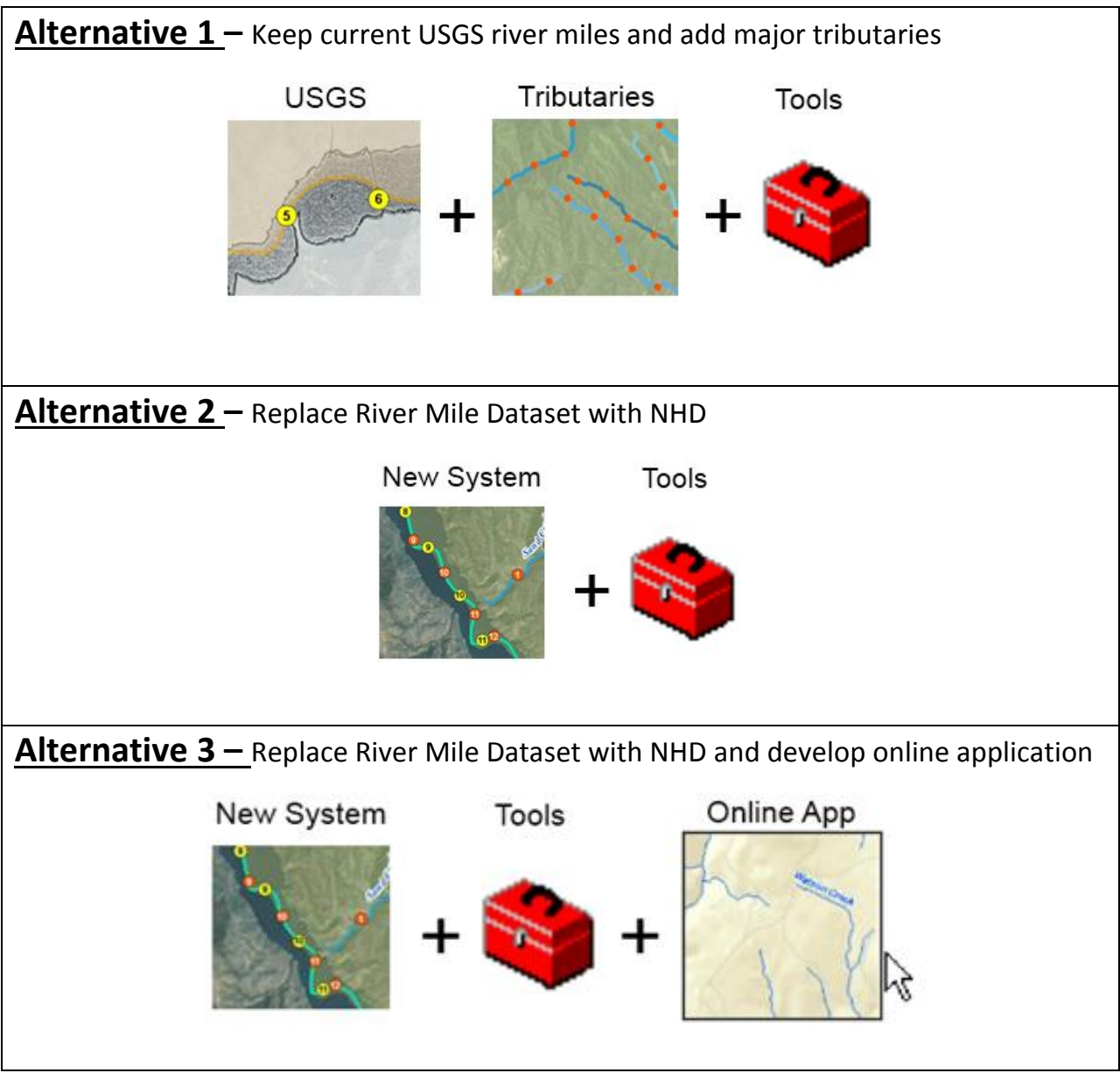


Figure 2. Comparison of Proposed Alternatives

Table 1. Pros and Cons of Proposed Alternatives.

	Description	+ Pros +	- Cons -
Alternative 1	Keep USGS river miles, add major tributaries	<ul style="list-style-type: none"> - Maintains current system - ‘Low tech’ option, wouldn’t require historical data conversion 	<ul style="list-style-type: none"> - Maintains inaccurate system - USGS layer not based on actual route distance - Accessible to only select technical personnel
Alternative 2	Replace River Mile Dataset with NHD	<ul style="list-style-type: none"> - Simple to implement - River miles based on actual route distances - Many are already creating local systems from NHD layer - Would encourage cohesion and easy buy in from users - Cheapest option 	<ul style="list-style-type: none"> - Accessible to only select technical personnel - Would require historical data conversion
Alternative 3	Replace River Mile Dataset with NHD and Develop Online Application	<ul style="list-style-type: none"> - Easily accessible to all - Easy for users to understand and explore prior to download 	<ul style="list-style-type: none"> - Requires the most technical maintenance, hosting - Would require historical data conversion

FINANCIAL ANALYSIS OF ALTERNATIVES

Any discussion concerning alternatives needs to include an assessment of the financial costs versus financial benefits in order to be complete. As with any analysis of financial costs, assumptions must be made concerning the duration of the project, stakeholders, labor costs, and equipment costs.

In our analysis we assessed only the implementation phase. The duration of the implementation phase is of short duration in terms of labor and upkeep. No annual upkeep is considered in our comparison of alternatives. There are numerous directions that the subject of river mile measures could go that would necessitate revisiting the financial analysis. Until decisions are made regarding which alternative would be chosen for implementation, assessment of subsequent phases will be postponed.

The Spokane Tribe of Indians is the only stakeholder considered into this financial analysis. Cost sharing collaborative agreements might be made between the Spokane Tribe and other stakeholders that would reduce the costs incurred by the Tribe individually.

Labor costs in our assessment were assumed to be \$30/hr. This rate is not based on any salary surveys and is meant only to aid in comparison between alternatives rather than to imply an actual cost. Actual cost of programming and/or GIS analyses may be more or less than the \$30/hr forwarded in our assessment.

Equipment costs are based on web searches of appropriate equipment. Qualitative assessments were made by the authors to select affordable equipment that was neither the cheapest nor the most expensive. Further research into the equipment prior to actual implementation is advised.

Software costs were determined based upon agreed-upon ESRI price schedules for the state of New York. These price schedules are publicly available and were used as a representation of what software costs could be. Actual pricing should be researched more fully prior to making the decision to implement any projects assessed here.

Table 2. Cost Comparison of Alternatives

	Alternative 1	Alternative 2	Alternative 3
Hardware:			
Server	\$ -	\$ -	\$ 4,000.00
Desktop station	\$ 1,200.00	\$ 1,200.00	\$ 1,200.00
Software and misc:			
ArcGIS for Server	\$ -	\$ -	\$ 32,643.00
ArcGIS for Desktop	\$ 7,295.00	\$ 7,295.00	\$ 7,295.00
AsGIS Extensions for Desktop (Spatial Analyst)	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00
Inernet Service Provider Fees	\$ -	\$ -	\$ 250.00
Effort:*			
River mile system updates	\$ 1,800.00	\$ 1,800.00	\$ 1,800.00
Website construction	\$ -	\$ 2,400.00	\$ 4,800.00
Website updates	\$ -	\$ -	\$ 1,200.00
Total:	\$ 11,795.00	\$ 14,195.00	\$ 57,088.00

* assume \$30/hr for labor

V. PROOF OF CONCEPT

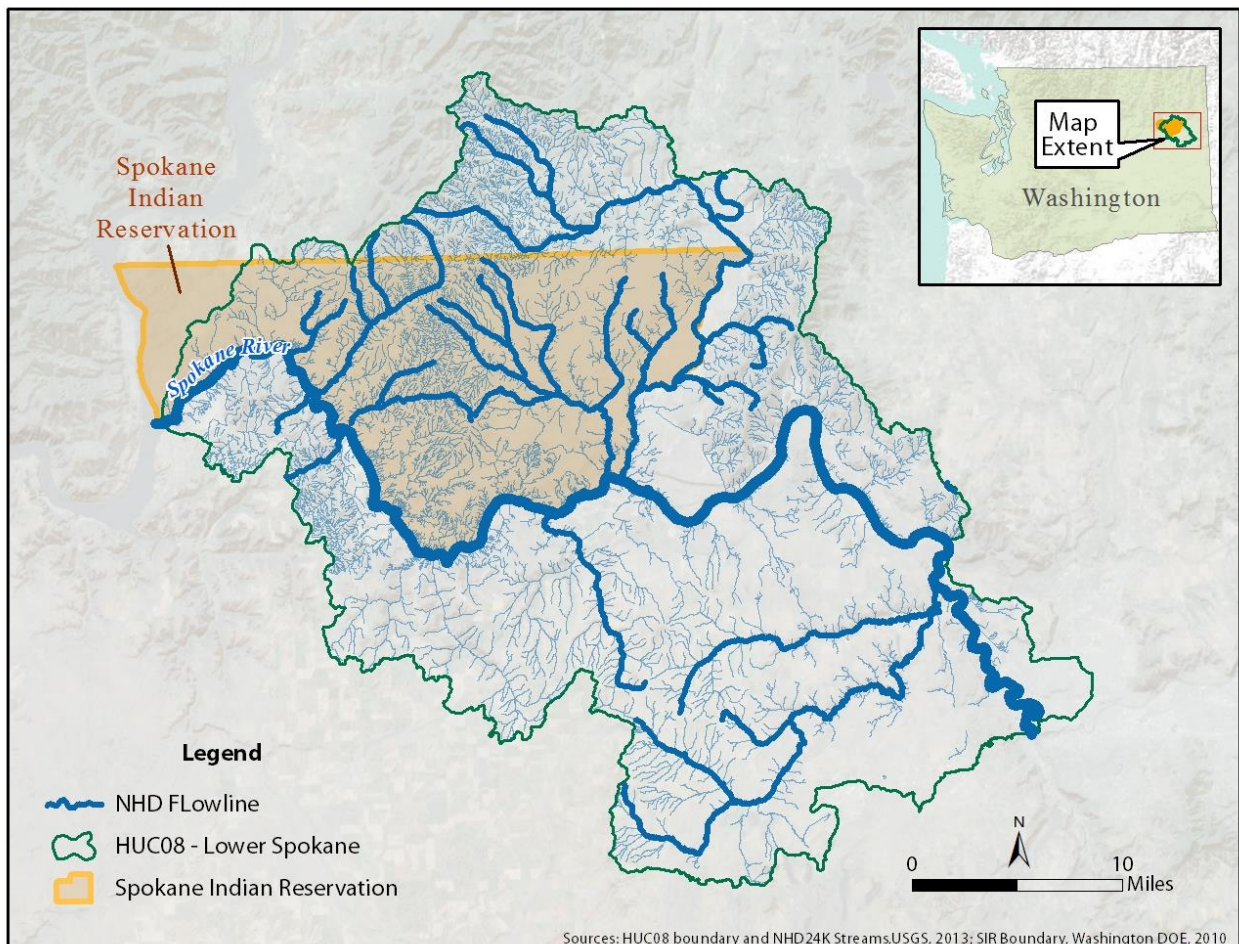


Figure 3. Study Area, Lower Spokane HUC 08 and Spokane Indian Reservation

In an effort to gain a deeper understanding of the challenges faced when creating a new river miles system, we constructed a new sample river mile system along the NHD 24K flowline for the Lower Spokane HUC-08, which covers the drainage area for the majority of the Spokane Indian Reservation as seen in Figure 3. It is important to mention that this layer makes up only a small portion Columbia River drainage basin, and for this reason is not intended for practical use. To use this layer without the appropriate stewardship would only serve to introduce yet another local system unrecognized by others in the region, further adding to the problem.

Assumptions needed to be made throughout this process, such as the decision to only use named rivers and creeks (or those containing a GNIS ID). If a creek is unnamed, it is likely intermittent and not of significant biological interest. Also, without a GNIS ID or GNIS name,

there would be no practical way to link up field data with the NHD layer. Figure 4 displays all steps required in the creation of the river miles and event route layers within the Spokane Indian Reservation

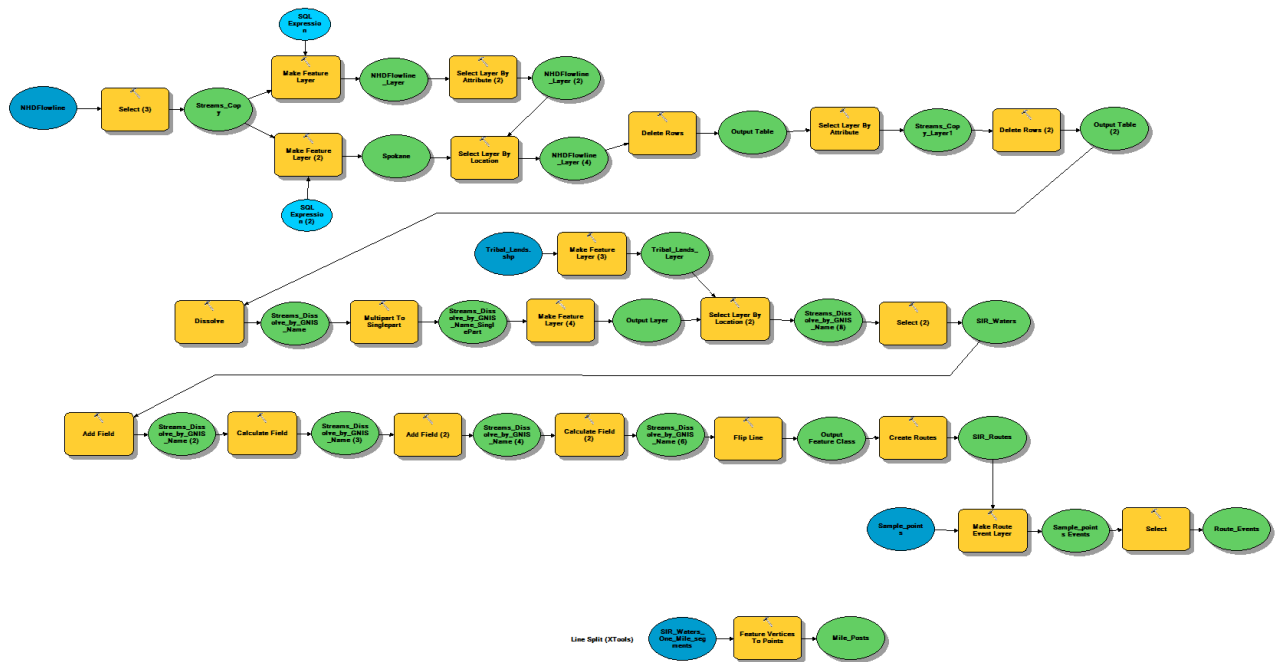


Figure 4. Model diagram depicting process used to create Lower Spokane river miles layer.

When considering the Columbia River Hydrologic system and its tributaries it is important to understand the impacts that the hydroelectric system has had. One interesting impact that occurred with the construction of Grand Coulee Dam is the increased water surface levels upstream of the dam. The waters behind the dam are backed up and flow is reduced. This area is now referred to as Lake Roosevelt. By backing up the water behind the dam, the lower 29 miles of the Spokane River has been inundated by Lake Roosevelt, as can be viewed in Figure 5. While the GIS layer represents the Spokane River with a line, in actuality the river is a wide polygon. The NHD layer is made up of polylines, meaning that the actual width of the river is not accounted for in the polyline layer. The connection of the Spokane River to the Columbia River is with the flowline of the Columbia River, meaning that somewhere from 0 – 2,500 feet of river mile can either be considered part of the Columbia River or the Spokane River, depending on where the line is drawn. The issue persists upstream where major tributaries meet the main stem of the Spokane River. This begs the question of whether the tributary miles should start at the Spokane River centerline, or perhaps more logically at the river bank. For purposes of this exercise, it was decided to start tributary miles at the Spokane River bank, requiring the removal of the ‘artificial path’ segments of the NHD layer connecting tributaries to the centerline of the

Spokane River. It was also decided to remove the first segment of the Spokane River, rather than start it from the centerline of the Columbia River.

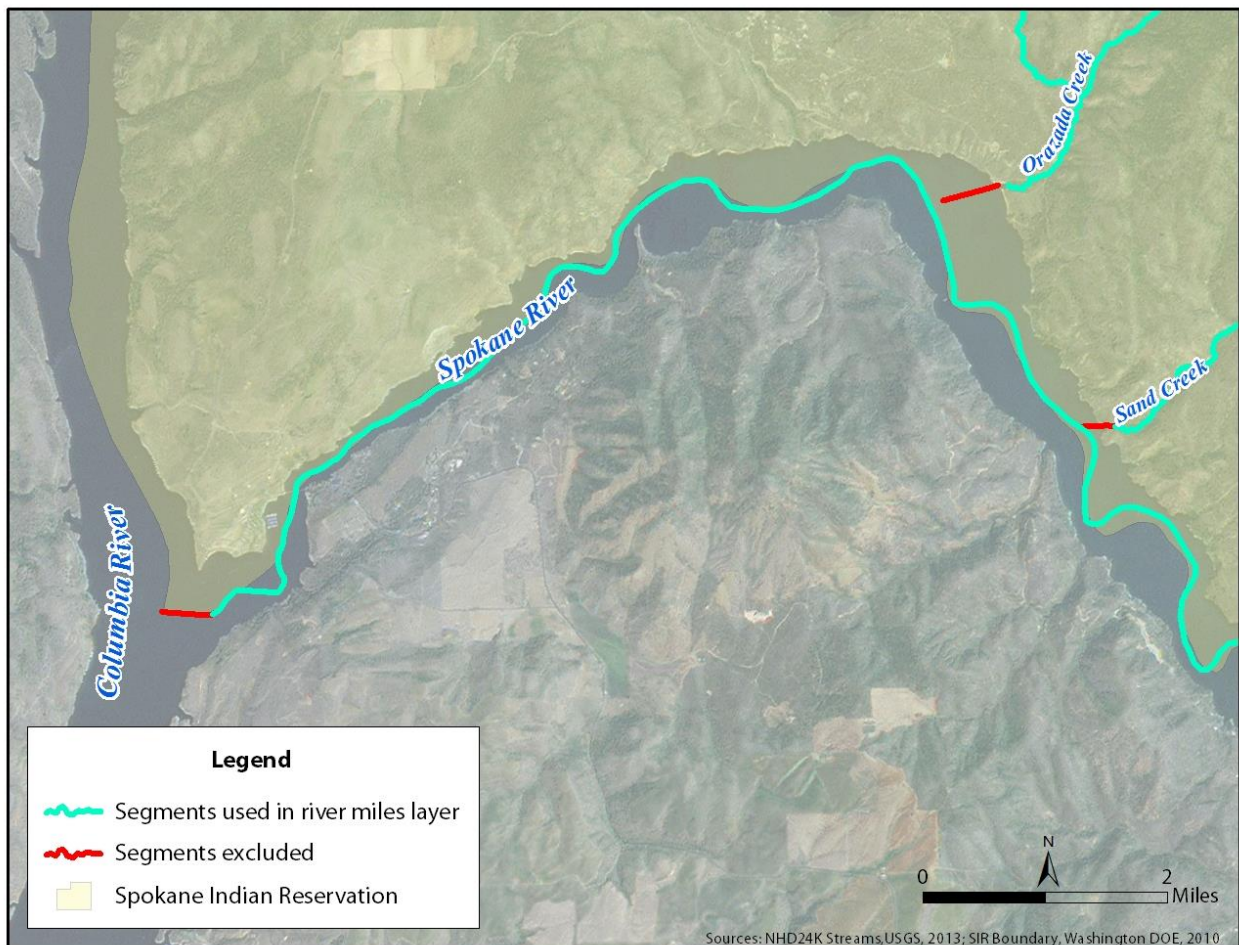


Figure 5. Artificial path segments to be removed due to inundation.

After the removal of the artificial tributary segments overlapping with the Spokane River, the layer was dissolved by stream name to allow for river miles to begin at the start of each stream. Multipart features were split up into single parts as some stream names were found multiple times within the Lower Spokane. To split up the new stream layer into both 1 mile and 1/10th mile segments, the X-Tools Pro 'Split Polylines' tool was utilized. From the 1 mile segment layer, end vertices were transformed to points and are representative of the mile post markers depicted in Figure 6. Differences between the newly created river miles layer using recent NHD data and the historic USGS river miles are quite apparent. Mile posts remain close until about mile 5, and from then on the new mile post markers appear more frequently than the USGS mile markers. This is likely due to the increased sinuosity of the current flow line as compared with the line used to create the legacy mile markers. The differences between the two layers further

the need for appropriate management and stewardship of a new river miles layer prior to its release, as the overhaul will likely have significant implications on existing data.

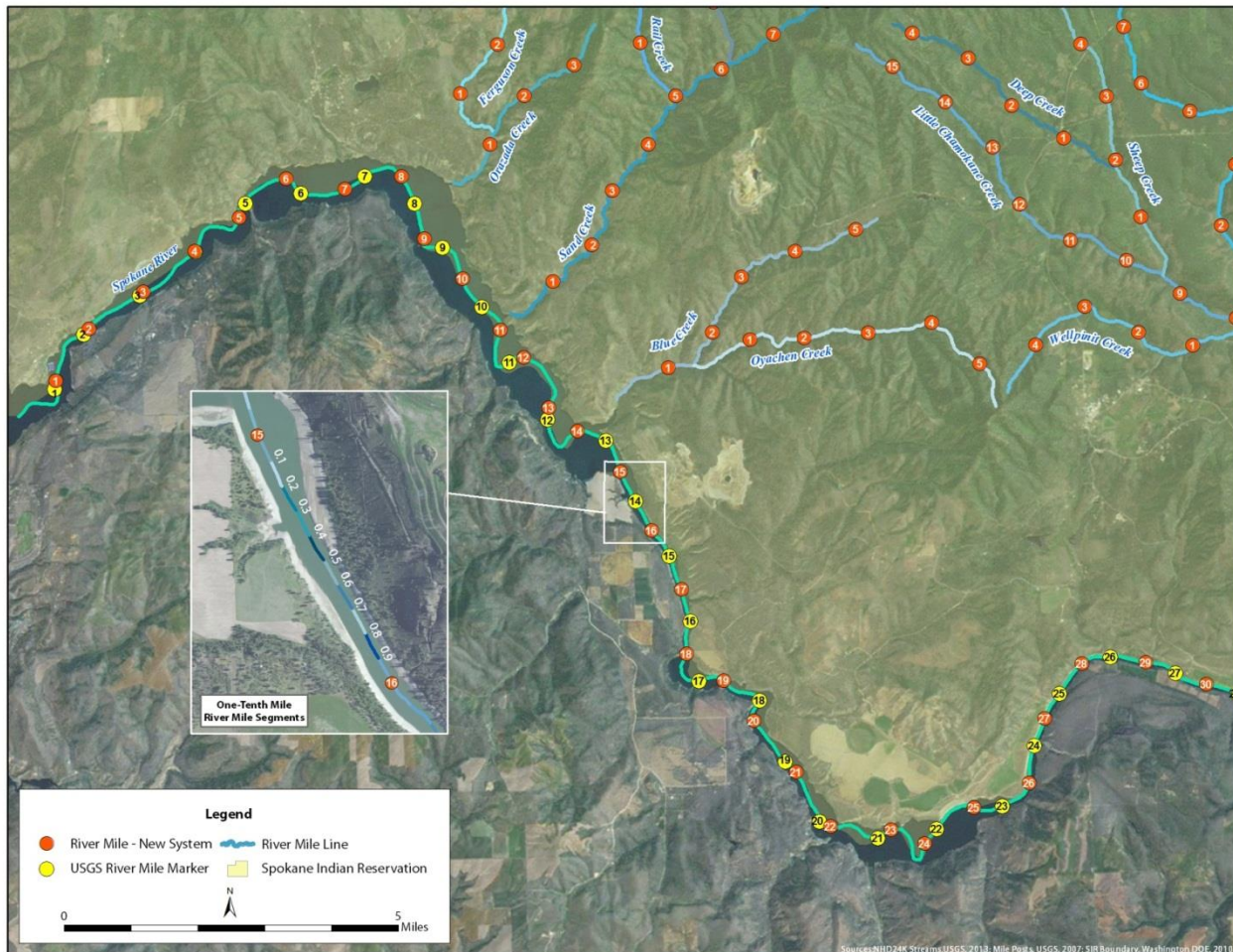


Figure 6. New sample river miles layer compared with USGS river miles.

The modified NHD river miles layer required a few steps to prepare it to become a routes layer. First, the direction of the lines needed to be reversed. Typically stream layer line segments travel in the flow direction, however with river miles we are interested in the reverse of this, the path from the mouth of the Spokane River upstream. Two additional fields were needed to be able to use the “Two-Fields” option under the “Measure Source” within the Create Routes tool. First, a “START_ZERO” field was added and assigned the value of 0 for all segments. Second, a “DISTANCE” field was added with the length of the segment in miles.

To test the new river miles layer as a routes layer, a sample table was constructed to represent data collection points, seen in Table 3. If a field biologist were to use paper maps to do surveys

(with river miles shown), this table is a realistic representation of what might be constructed in the real world.

Table 3. Sample Location Data.

GNIS NAME	RIVER MILE	Activity
Spokane River	0.6	Water Quality Monitoring
Spokane River	0.9	Water Quality Monitoring
Spokane River	1.6	Water Quality Monitoring
Spokane River	1.8	Hatchery Release Point
Spokane River	3.2	Fyke Net
Spokane River	3.5	Video Survey
Spokane River	4.7	Fyke Net
Spokane River	5.0	Water Quality Monitoring
Spokane River	7.2	Water Quality Monitoring
Spokane River	10.3	Water Quality Monitoring
Sand Creek	0.2	Fyke Net
Sand Creek	0.8	Hatchery Release Point
Sand Creek	1.6	Video Survey
Sand Creek	2.3	Fyke Net
Little Chamokane Creek	0.3	Water Quality Monitoring
Little Chamokane Creek	0.6	Hatchery Release Point
Little Chamokane Creek	1.2	Water Quality Monitoring
Little Chamokane Creek	3.6	Water Quality Monitoring
Cottonwood Creek	0.6	Video Survey
Cottonwood Creek	0.9	Water Quality Monitoring
Cottonwood Creek	1.6	Hatchery Release Point
Moss Creek	0.5	Water Quality Monitoring
Moss Creek	1.4	Video Survey

It is important to ensure that stream names match that of the NHD24K routes layer. Using the GNIS ID would be a preferred method, as it might help avoid spelling or issues with multiple streams having the same name. To create route events, the “Make Route Events Layer” tool was used. Figure 7 provides a visual of the output route event layers along the new river miles layer.

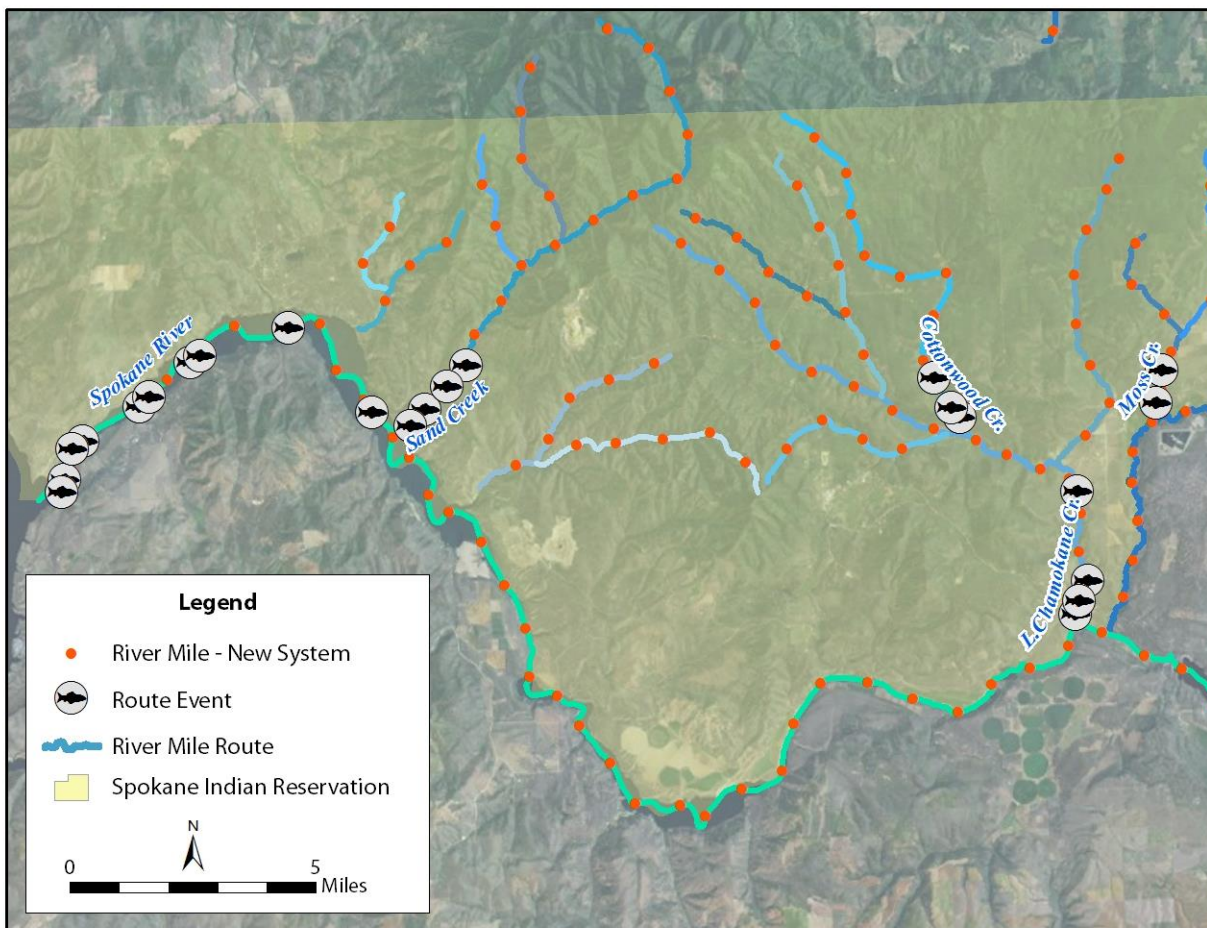


Figure 7. Sample Route Events.

A changing river mile system poses a challenge for making use of historical data and tracking trends over time. If data exists as points and is assigned river miles based on a historic river mile system, when a new system is introduced or updated, slight changes may occur in geometry and one cannot say that river mile X in the previous system is still river mile X on the updated system.

To address this issue, it will be necessary for a suite of tools to be made freely available along with current and historical river mile systems. The USGS currently releases a “Hydrography Events Management Tool” that allows the user to make use of event data along the NHD layer. Similar tools to this can be built and distributed that take into account historic and current river mile systems, and provide the technical crosswalk to enable a 1-to-1 comparison of stream data over time.

These tools can accomplish such actions as the following:

- If data exists at points, snap points to new river mile routes layer and assign current river mile label. The user will be required to review data to ensure accuracy, as stream geometry may present a problem at confluences. For example, a point may lie at the start of a tributary but may actually be intended for the main stem.
- If data exists as a table using an outdated river mile system, it will be important to know which river mile system the data is using. If the outdated system is known, data can be assigned coordinates, and then assigned river miles using the new system.

The following tools are samples that begin to address the issues described above. These tools are only intended as examples with further testing and error handling required before they can be deemed usable on a broad scale geographic area.

Tool – *Assign River Miles*

Inputs – Point shapefile, river miles layer (polyline)

Output – A new shapefile with a new river miles field.

The *Assign River Miles* tool assigns new river miles to an existing point feature class. This tool will make it easy for an analyst to update historical data with new river miles so that he may be able to compare it to new data at the same location. The functionality of this tool will be useful in the event that a new river mile system is released for assigning new river miles to old data. The tool will require a polyline river miles layer and a distance value for snapping points to the river miles layer. The point layer is assigned the new river mile through a Spatial Join, as seen in Figure 8. Checking the output will be essential, as points that are close to confluences are at risk of assignment to the wrong stream. A sample output from this tool can be seen in Figure 9. This map displayed four sample data points along two different river miles system. The ‘old’ system in this example is the new river miles layer discussed previously, and the ‘new’ river miles system is similar to except that it now connects to the centerline of the Columbia River. These two layers are purely used for example purposes to show how a change in river mile geometry is captured in the attributes of the point data through use of the *Assign River Miles Tool*.

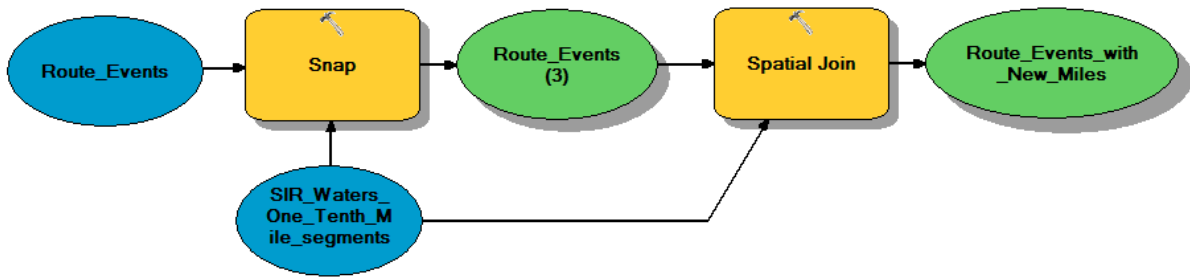


Figure 8. General function of Assign River Miles tool

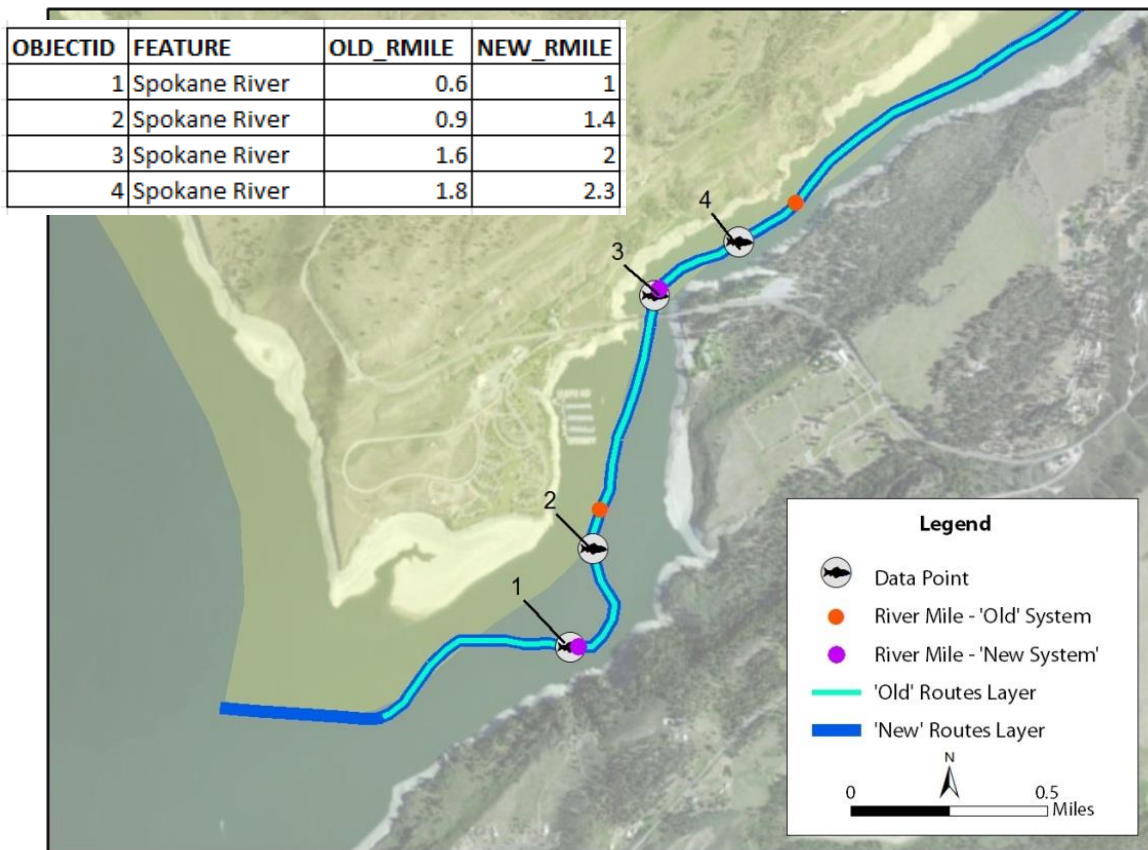


Figure 9. Sample output from Assign River Miles tool.

Tool – Update Table River Miles

Input – Table with river miles, old river mile polyline layer, new river mile polyline layer

Output – Shapefile with new river miles

The *Update Table River Miles* is similar in functionality to the *Assign River Miles* tool, except that it takes a few steps back. If the analyst has only old tables of old river miles data, she can easily make use of this data through this tool by first generating a shapefile, and then assigning new river miles to this data. This tool assumes that the user knows the appropriate legacy river miles system to which the table data applies. This tool also assumes the legacy layer is made readily available for download. The functionality of this tool is shown in the Model Builder diagram in Figure 10, with the table transformation accomplished through these steps shown in Figure 11. Note that in this example, only the Spokane River miles are transformed since the only change in geometry is along the main stem. Tributary geometry remains the same in the sample ‘new’ river miles system.

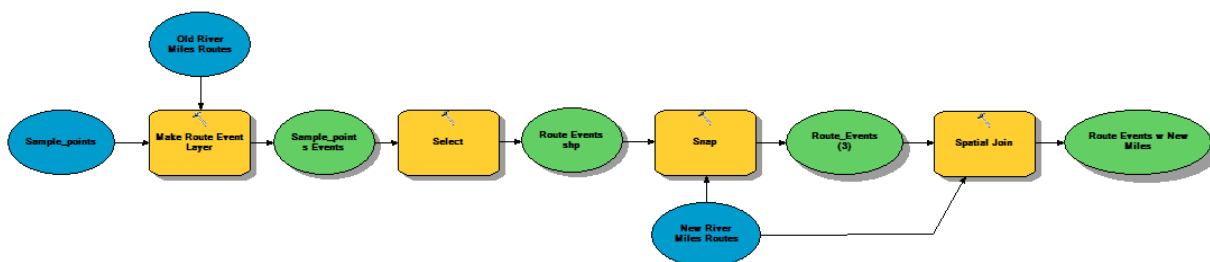


Figure 10. General function of Update Table River Miles tool.

GNIS NAME	RIVER MILE		GNIS NAME	RIVER MILE	NEW R_MILE
Spokane River	0.6		Spokane River	0.6	1.1
Spokane River	0.9		Spokane River	0.9	1.4
Spokane River	1.6		Spokane River	1.6	2.1
Spokane River	1.8		Spokane River	1.8	2.3
Spokane River	3.2		Spokane River	3.2	3.7
Spokane River	3.5		Spokane River	3.5	4.0
Spokane River	4.7		Spokane River	4.7	5.2
Spokane River	5.0		Spokane River	5.0	5.5
Spokane River	7.2		Spokane River	7.2	7.7
Spokane River	10.3		Spokane River	10.3	10.8
Sand Creek	0.2		Sand Creek	0.2	0.2
Sand Creek	0.8		Sand Creek	0.8	0.8
Sand Creek	1.6		Sand Creek	1.6	1.6
Sand Creek	2.3		Sand Creek	2.3	2.3
Little Chamokane Creek	0.3		Little Chamokane Creek	0.3	0.3
Little Chamokane Creek	0.6		Little Chamokane Creek	0.6	0.6
Little Chamokane Creek	1.2		Little Chamokane Creek	1.2	1.2
Little Chamokane Creek	3.6		Little Chamokane Creek	3.6	3.6
Cottonwood Creek	0.6		Cottonwood Creek	0.6	0.6
Cottonwood Creek	0.9		Cottonwood Creek	0.9	0.9
Cottonwood Creek	1.6		Cottonwood Creek	1.6	1.6
Moss Creek	0.5		Moss Creek	0.5	0.5
Moss Creek	1.4		Moss Creek	1.4	1.4

Figure 11. Table transformation resulting from Update Table River Miles.

Tools such as the *Assign River Miles* and *Update Table River Miles* can be made available for download alongside releases of river mile system updates. For easy functionality, tools can come packaged in a toolbox format as seen in Figure 12, or be made part of a customized toolbar on the main ArcGIS dashboard.

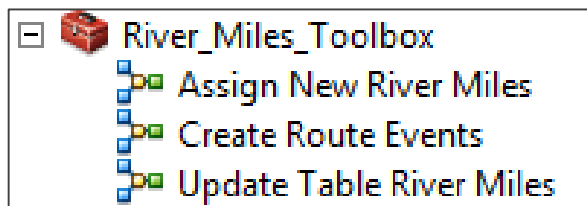


Figure 12. Sample river miles toolbox

RECOMMENDED SOLUTION

Research of the USGS river mile system; its history, usage, associated challenges, and the need for a river mile system to continue into the future has led to the development and comparison of the previously described alternatives. A comparison of these options leads these authors to conclude that Alternatives 2 or 3 should be implemented and forwarded as the system for standardized river mile measures for the Spokane Tribe in the future.

Essentially, Alternative 2 and 3 employ the same solution for creating river mile measures. These two proposed solutions utilize the measure values in the National Hydrography Dataset river reach layers. Because the NHD is currently under the stewardship of the PNWHF it has a well-structured stewardship methodology in place to identify changes, make determinations, release edits, and align data to cross-boundary data. The stewardship plan allows for increased efficiency. The Spokane Tribe does not have to create their own stream reach network, measurement mistakes as a result of hand drawing the USGS river miles on the 1:24,000 scale topographic maps are fixed, and the human element associated with this type of mistake is removed making future mistakes of this nature less likely. Once the NHD river reach layer is utilized, the potential for mismatch of historic data locations becomes likely. Because the new measures are made on a different river network with differing lengths and measures, the measures will be different between the two systems. This requires an update of the river mile measures associated with already-collected data. This challenge is solved by the application of a suite of tools described previously that will place historical data on the system upon which it was collected, reference the new river mile system and update the tabular event data with a new column describing the river mile measure of the NHD. We recommend that the Spokane Tribe update all of their historic data in this manner. This wholesale shift to move the data aligned to the USGS river miles to the NHD system will require an upfront investment of time and effort but will allow for a single set of measures to be utilized in the future.

While the two solutions are based on measures of the same river reach layer, there is one substantial difference between the two proposed alternatives. Alternative 2 is a solution that allows only advanced users of GIS with specialized software to make use of the data. While this solution may benefit knowledgeable biologists and GIS technicians, stakeholders without GIS software and experience will find it difficult to utilize the river mile measures. Alternative 3 is intended to serve up the river mile system through the web as an easy-to-use tool allowing for those without the expensive software and specialized GIS training to access the measures in the data. While the upfront cost of Alternative 3 is more expensive because it includes the hardware, software, programming time, and maintenance costs associated with the construction of a website, the benefit to non-GIS users has the potential to be very beneficial.

The Oregon Department of Environmental Quality (DEQ) currently utilizes such a system. It is based on the now-archived PNW 100K Hydrography layer for Oregon. Any user with web access

capabilities can access the website, launch the Silverlight-based mapping application, select a location on their stream of interest, and determine the river mile measure of that point quickly and easily by simply clicking on the map. DEQ's collaborative position within the PNWHF offers some opportunity for code and application sharing. It may be possible to work with DEQ to display the Washington information within the same application as the DEQ. This will require some cost sharing between Washington entities and the Oregon DEQ but the reduced costs associated with managing a single application may make this an attractive solution to the various entities.

VI. SUSTAINABILITY

The Spokane Tribe, along with WDFW, and the Confederated Tribe of Colville Indians, co-manages fish populations within their usual and customary tribal fishing areas. Randomly stratified surveys of fish density, habitat surveys, and studies of fish movements and habitat usage are often based upon the USGS river mile point shapefile. These studies are conducted by Spokane Tribal biologists within the Spokane Arm of the Columbia River (personal Communication, Andy Miller, 08/12/2013).

A local management scheme cannot be considered sustainable even if it is well-managed at the local scale. At the local scale coping mechanisms may take on the role and appearance of sustainable practices but, without including all aspects of process disturbances, one cannot truly implement a sustainable practice (Elmqvist 2013). Taking fisheries management in the Columbia Basin as an example, the various co-managers of salmon, sturgeon, and resident trout need to work together to develop management plans that lead to sustainable populations that reach across their respective jurisdictional boundaries.

A narrow focus on a single population or a single locale is counterproductive and may even be destructive since the actions of neighboring managers, if not taken into account, may have unanticipated impacts. For instance, if downstream fisheries fail to take into account upstream population escapement requirements then a population could find itself at risk even though responsible upstream management scenarios are being practiced.

Sharing of information between co-managers is essential to a well-managed fisheries management schema. The very definition of co-manage implies sharing; data, responsibilities, and decision-making. By putting in place a well-organized system of data collection and analysis based on a standardized river reach layer we hope to ensure a more sustainable system of fisheries management in the Columbia Basin and PNW at large.

With data collected under a structured program, WDFW can share their information with the Colville tribe who can share their data with the Spokane Tribe who can share their data with the

WDFW. Of course, there's nothing stopping each of the co-managers from currently sharing their data. The current hindrance is in a lack of standard data collection and analysis methodologies. A standard data collection and analysis methodology should begin with the standardization of a river reach layer that has measures so that river miles can be efficiently utilized.

Historical data is difficult to compare to more recent data. This makes it difficult to display trends and without trends you cannot manage effectively. By transforming river mile data to ensure proper spatial reference to previously collected data or data collected by other entities, data trends can be assessed and a more sustainable management process can be realized.

VII. SUMMARY

The practice of using river miles has a long history in the Pacific Northwest, making an overhaul of the river miles system a complex endeavor. Geometry and data issues aside, creating a system that can be agreed upon by a large number of stakeholders will require the appropriate business case, committee, and steward. Creating the GIS layer and accompanying tools for updating river miles begins to address the issues, but has its limitations in terms of who can access and use the river miles in a meaningful way. Creating an online river mile mapping portal is a potential solution that begins to break down technological barriers and will serve to incorporate all river mile users.

VIII. REFERENCES

Elmqvist, T. Urban Sustainability and Resilience—Why We Need to Focus on Scales. Website accessed 08/05/2013:
<http://www.thenatureofcities.com/author/thomaselmqvist/> Article posted: March 27, 2013

Lerenr, L., Ancel, S., DeSera, D. Building a Business Case for Geospatial Information Technology, 2007, IWA Publishing

Marti, Jeff. Water Resources Program, 360-407-6627, jeff.marti@ecy.wa.gov

McLellan, Jason, Fish Biologist, Colville Tribe, 509-209-2418,
jason.mclellan@colvilletribes.com

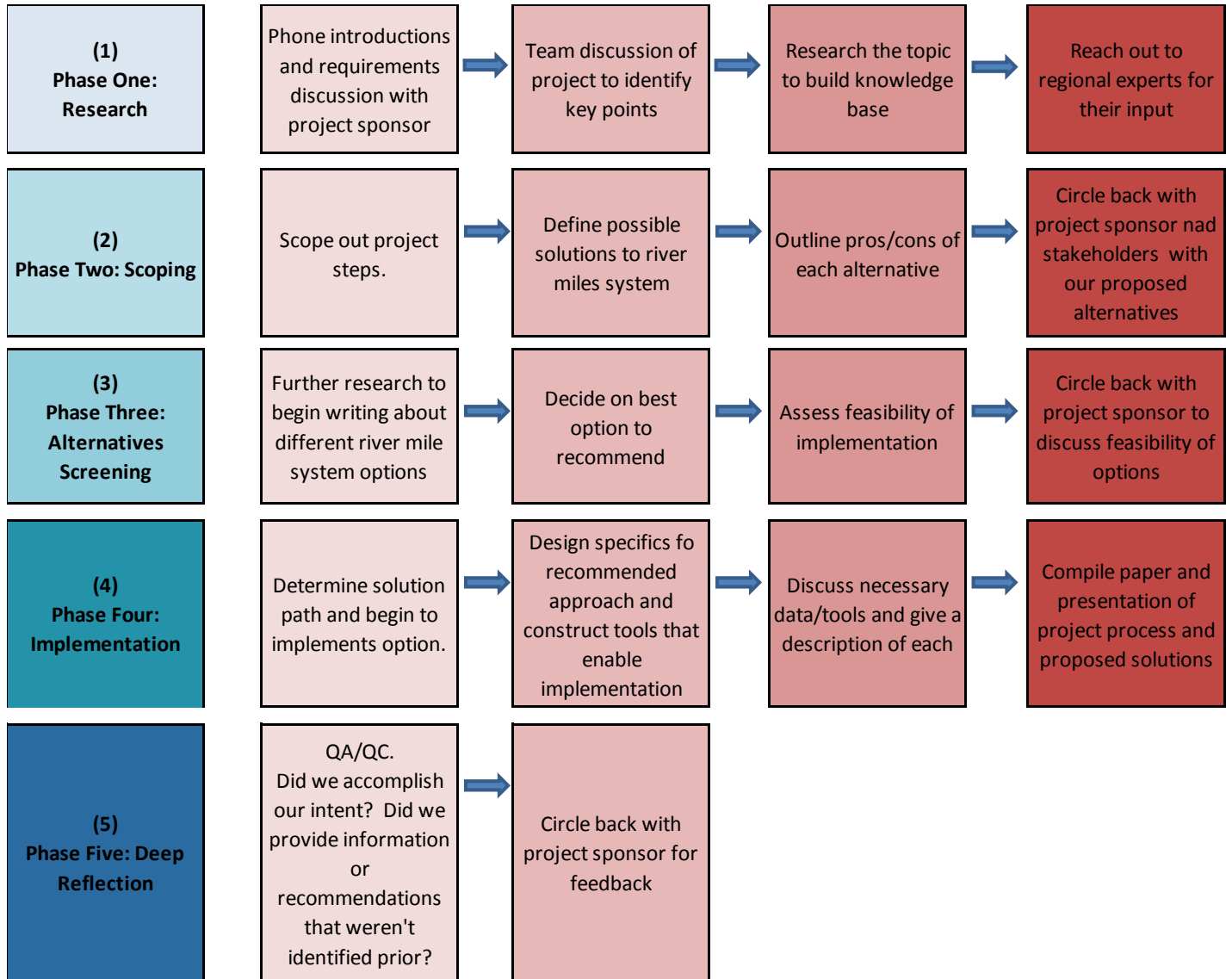
Miller, Andy, fish Biologist, Spokane Tribe, 509-626-4416, amiller@spokanetribe.com

Stohr, Anita, WA State NHD Hydrography Data Steward, GIS Technical Services, WA Dept. of Ecology, anita.stohr@ecy.wa.gov , P 360-407-7128 F 360-407-6493

UCUT website - <http://www.ucut.org/> accessed 08/10/2013

Weiss, Andrew, Fish Program GIS Lead, WDFW, 360-902-2487, andrew.weiss@dfw.wa.gov

IX. PROCESS WORKFLOW



X. APPENDIX A. PYTHON CODE FOR RIVER MILE UPDATE TOOLS.

Routes Layer

```
# -----  
  
# Routes.py  
  
# Created on: 2013-08-19 18:45:16.00000  
  
# (generated by ArcGIS/ModelBuilder)  
  
# Description:  
# -----  
  
# Set the necessary product code  
  
# import arcinfo  
  
  
  
# Import arcpy module  
  
import arcpy  
  
  
  
# Local variables:  
  
NHDFlowline =  
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Incoming\\USGS_NHD24K_8042013\\NHD252  
638.gdb\\Hydrography\\NHDFlowline"  
  
SQL_Expression = "\"GNIS_Name\" <> ' '"  
  
Sample_points =  
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Sample_points"  
  
SQL_Expression__2_ = "\"GNIS_Name\" = 'Spokane River'"
```


Tribal_Lands_shp =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Incoming\\DOE\\tribal\\Tribal_Lands.shp"

SIR_Waters_One_Mile_segments =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Waters_One_Mile_segments"

Output_Table__2_ = "Streams_Copy_Layer1"

Streams_Dissolve_by_GNIS_Name =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\Streams_Dissolve_by_GNIS_Name"

Streams_Copy =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\Streams_Copy"

NHDFlowline_Layer = "Streams_Copy_Layer1"

SIR_Waters =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

Streams_Dissolve_by_GNIS_Name__2_ =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

SIR_Routes =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Routes"

Sample_points_Events = "Sample_points Events1"

Output_Feature_Class =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

Streams_Dissolve_by_GNIS_Name__3_ =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

Streams_Dissolve_by_GNIS_Name__4_ =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

```

Route_Events =
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events"

NHDFlowline_Layer__2_ = "Streams_Copy_Layer1"

Spokane = "Spokane"

NHDFlowline_Layer__4_ = "Streams_Copy_Layer1"

Output_Layer = "Streams_Dissolve_by_GNIS_Nam"

Tribal_Lands_Layer = "Tribal_Lands_Layer"

Streams_Dissolve_by_GNIS_Name_SinglePart =
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\Streams_Dissolve_by_GNIS_Name_SinglePart"

Streams_Dissolve_by_GNIS_Name__8_ = "Streams_Dissolve_by_GNIS_Nam"

Output_Table = "Streams_Copy_Layer1"

Streams_Copy_Layer1 = "Streams_Copy_Layer1"

Streams_Dissolve_by_GNIS_Name__6_ =
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Working\\SIR_Waters"

Mile_Posts =
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Mile_Posts"

# Process: Select (3)

arcpy.Select_analysis(NHDFlowline, Streams_Copy, "")

# Process: Make Feature Layer

arcpy.MakeFeatureLayer_management(Streams_Copy, NHDFlowline_Layer, SQL_Expression, "",
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;Permanent_Identifier
Permanent_Identifier VISIBLE NONE;FDate FDate VISIBLE NONE;Resolution Resolution VISIBLE
NONE;GNIS_ID GNIS_ID VISIBLE NONE;GNIS_Name GNIS_Name VISIBLE NONE;LengthKM
LengthKM VISIBLE NONE;ReachCode ReachCode VISIBLE NONE;FlowDir FlowDir VISIBLE

```

```
NONE;WBArea_Permanent_Identifier WBArea_Permanent_Identifier VISIBLE NONE;FType FType
VISIBLE NONE;FCode FCode VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Enabled
Enabled VISIBLE NONE;Shape_length Shape_length VISIBLE NONE")
```

Process: Select Layer By Attribute (2)

```
arcpy.SelectLayerByAttribute_management(NHDFlowline_Layer, "NEW_SELECTION", "\"FType\"
= 558 AND \"GNIS_Name\" <> 'Spokane River' AND \"GNIS_Name\" <> 'Columbia River'")
```

Process: Make Feature Layer (2)

```
arcpy.MakeFeatureLayer_management(Streams_Copy, Spokane, SQL_Expression__2_, "",
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;Permanent_Identifier
Permanent_Identifier VISIBLE NONE;FDate FDate VISIBLE NONE;Resolution Resolution VISIBLE
NONE;GNIS_ID GNIS_ID VISIBLE NONE;GNIS_Name GNIS_Name VISIBLE NONE;LengthKM
LengthKM VISIBLE NONE;ReachCode ReachCode VISIBLE NONE;FlowDir FlowDir VISIBLE
NONE;WBArea_Permanent_Identifier WBArea_Permanent_Identifier VISIBLE NONE;FType FType
VISIBLE NONE;FCode FCode VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Enabled
Enabled VISIBLE NONE;Shape_length Shape_length VISIBLE NONE")
```

Process: Select Layer By Location

```
arcpy.SelectLayerByLocation_management(NHDFlowline_Layer__2_, "WITHIN_A_DISTANCE",
Spokane, "10 Feet", "SUBSET_SELECTION")
```

Process: Delete Rows

```
arcpy.DeleteRows_management(NHDFlowline_Layer__4_)
```

Process: Select Layer By Attribute

```
arcpy.SelectLayerByAttribute_management(Output_Table, "NEW_SELECTION",
 "\"Permanent_Identifier\" = 'bb4988b0-9a7c-4840-94b8-040a7ffd35fc'")
```

Process: Delete Rows (2)

```
arcpy.DeleteRows_management(Streams_Copy_Layer1)
```

Process: Dissolve

```
arcpy.Dissolve_management(Output_Table__2_, Streams_Dissolve_by_GNIS_Name,
"GNIS_Name", "", "MULTI_PART", "DISSOLVE_LINES")
```

Process: Multipart To Singlepart

```
arcpy.MultipartToSinglepart_management(Streams_Dissolve_by_GNIS_Name,
Streams_Dissolve_by_GNIS_Name_SinglePart)
```

Process: Make Feature Layer (4)

```
arcpy.MakeFeatureLayer_management(Streams_Dissolve_by_GNIS_Name_SinglePart,
Output_Layer, "", "", "GNIS_Name GNIS_Name VISIBLE NONE;Shape_length Shape_length
VISIBLE NONE;ORIG_FID ORIG_FID VISIBLE NONE")
```

Process: Make Feature Layer (3)

```
arcpy.MakeFeatureLayer_management(Tribal_Lands_shp, Tribal_Lands_Layer, "\"TRIBAL_NM\"
= 'Spokane'", "", "FID FID VISIBLE NONE;Shape Shape VISIBLE NONE;TRIBAL_NM TRIBAL_NM
VISIBLE NONE;TRIBAL_NM1 TRIBAL_NM1 VISIBLE NONE;TRIBAL_NM2 TRIBAL_NM2 VISIBLE
NONE;TREATY_NM TREATY_NM VISIBLE NONE;TREATY_DT TREATY_DT VISIBLE NONE;MPL_CD
MPL_CD VISIBLE NONE;LAND_TYPE LAND_TYPE VISIBLE NONE;OLD_RES_NM OLD_RES_NM
VISIBLE NONE;WEBLINK WEBLINK VISIBLE NONE;SYMBOL SYMBOL VISIBLE NONE;SYMBOL2
SYMBOL2 VISIBLE NONE;Shape_area Shape_area VISIBLE NONE;Shape_len Shape_len VISIBLE
NONE")
```

Process: Select Layer By Location (2)

```
arcpy.SelectLayerByLocation_management(Output_Layer, "WITHIN_A_DISTANCE",
Tribal_Lands_Layer, "200 Feet", "NEW_SELECTION")
```

Process: Select (2)

```
arcpy.Select_analysis(Streams_Dissolve_by_GNIS_Name__8_, SIR_Waters, "")
```

Process: Add Field

```
arcpy.AddField_management(SIR_Waters, "START_ZERO", "SHORT", "1", "", "", "", "NULLABLE",  
"NON_REQUIRED", "")
```

Process: Calculate Field

```
arcpy.CalculateField_management(Streams_Dissolve_by_GNIS_Name__2_, "START_ZERO", "0",  
"VB", "")
```

Process: Add Field (2)

```
arcpy.AddField_management(Streams_Dissolve_by_GNIS_Name__3_, "MILES", "FLOAT", "10",  
"4", "", "", "NULLABLE", "NON_REQUIRED", "")
```

Process: Calculate Field (2)

```
arcpy.CalculateField_management(Streams_Dissolve_by_GNIS_Name__4_, "MILES",  
"!shape.length@miles!", "PYTHON", "")
```

Process: Flip Line

```
arcpy.FlipLine_edit(Streams_Dissolve_by_GNIS_Name__6_)
```

Process: Create Routes

```
arcpy.CreateRoutes_lr(Output_Feature_Class, "GNIS_Name", SIR_Routes, "TWO_FIELDS",  
"START_ZERO", "MILES", "UPPER_LEFT", "1", "0", "IGNORE", "INDEX")
```

Process: Make Route Event Layer

```
arcpy.MakeRouteEventLayer_lr(SIR_Routes, "GNIS_Name", Sample_points, "FEATURE POINT  
point", Sample_points_Events, "", "NO_ERROR_FIELD", "NO_ANGLE_FIELD", "NORMAL",  
"ANGLE", "LEFT", "POINT")
```

Process: Select

```
arcpy.Select_analysis(Sample_points_Events, Route_Events, "")
```

Process: Feature Vertices To Points

```
arcpy.FeatureVerticesToPoints_management(SIR_Waters_One_Mile_segments, Mile_Posts,  
"END")
```

Assign New River Miles Tool

AssignNew.py

Created on: 2013-08-19 18:48:59.00000

(generated by ArcGIS/ModelBuilder)

Description:

Set the necessary product code

```
import arceditor
```

```
# Import arcpy module
```

```
import arcpy
```

```
# Local variables:
```

```
Route_Events =
```

```
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events"
```

```
SIR_Waters_One_Tenth_Mile_segments_V2 = "SIR_Waters_One_Tenth_Mile_segments_V2"
```

```
Route_Events__3_ =
```

```
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events"
```

```
Route_Events_with_New_Miles =
```

```
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events_with_New_Miles"
```

```
# Process: Snap
```

```
arcpy.Snap_edit(Route_Events, "SIR_Waters_One_Tenth_Mile_segments_V2 EDGE '10 Feet'")
```

```
# Process: Spatial Join
```

```
arcpy.SpatialJoin_analysis(Route_Events__3_, SIR_Waters_One_Tenth_Mile_segments_V2,
Route_Events_with_New_Miles, "JOIN_ONE_TO_ONE", "KEEP_ALL", "FEATURE \\\"FEATURE\\\"
true true false 255 Text 0 0
```

```
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events,FEATURE,-1,-1;POINT \\\"POINT\\\" true true false 8 Double 0 0
```

```
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events,POINT,-1,-1;GNIS_Name \\\"GNIS_Name\\\" true true false 65 Text 0 0
```

```
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Waters_One_Tenth_Mile_segments_V2,GNIS_Name,-1,-1;ORIG_FID \\\"ORIG_FID\\\" true true false 4 Long 0 0
```

```
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
```

```

Waters_One_Tenth_Mile_segments_V2,ORIG_FID,-1,-1;START_ZERO \"START_ZERO\" true true
false 2 Short 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,START_ZERO,-1,-1;MILES \"MILES\" true true false 4
Float 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,MILES,-1,-1;ID \"ID\" true true false 4 Long 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,ID,-1,-1;Shape_Length \"Shape_Length\" false true true
8 Double 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,Shape_Length,-1,-1, \"INTERSECT\", \"\", \"\")

```

Update Table River Miles Tool

```

# -----
# UpdateTable.py
# Created on: 2013-08-19 18:50:32.00000
# (generated by ArcGIS/ModelBuilder)
# Description:
# -----

# Set the necessary product code

import arceditor

# Import arcpy module

import arcpy

```


Local variables:

New_River_Miles_Routes =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Waters_One_Tenth_Mile_segments_V2"

Sample_points =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Sample_points"

Old_River_Miles_Routes =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Routes"

Route_Events_shp =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events_V2"

Route_Events__3_ =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events_V2"

Route_Events_w_New_Miles =

"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route_Events_with_New_Miles_V2"

Sample_points_Events = "Sample_points Events"

Process: Make Route Event Layer

```
arcpy.MakeRouteEventLayer_lr(Old_River_Miles_Routes, "GNIS_Name", Sample_points,
"FEATURE POINT point", Sample_points_Events, "", "NO_ERROR_FIELD", "NO_ANGLE_FIELD",
"NORMAL", "ANGLE", "LEFT", "POINT")
```

Process: Select

```
arcpy.Select_analysis(Sample_points_Events, Route_Events_shp, "")
```

Process: Snap

```
arcpy.Snap_edit(Route_Events_shp,
"K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_Waters
_One_Tenth_Mile_segments_V2 EDGE '10 Feet'")
```

Process: Spatial Join

```
arcpy.SpatialJoin_analysis(Route_Events__3_, New_River_Miles_Routes,
Route_Events_w_New_Miles, "JOIN_ONE_TO_ONE", "KEEP_ALL", "FEATURE \"FEATURE\" true
true false 255 Text 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route
_Events_V2,FEATURE,-1,-1;POINT \"POINT\" true true false 8 Double 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\Route
_Events_V2,POINT,-1,-1;GNIS_Name \"GNIS_Name\" true true false 65 Text 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,GNIS_Name,-1,-1;ORIG_FID \"ORIG_FID\" true true
false 4 Long 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,ORIG_FID,-1,-1;START_ZERO \"START_ZERO\" true true
false 2 Short 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,START_ZERO,-1,-1;MILES \"MILES\" true true false 4
Float 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,MILES,-1,-1;ID \"ID\" true true false 4 Long 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,ID,-1,-1;Shape_Length \"Shape_Length\" false true true
8 Double 0 0
,First,#,K:\\Working\\Walker_Jon\\Masters\\Capstone\\Working\\Working.gdb\\Output\\SIR_
Waters_One_Tenth_Mile_segments_V2,Shape_Length,-1,-1, \"INTERSECT\", \"\", \"\")
```

XI. APPENDIX B - USGS RIVER MILE SHAPEFILE METADATA

IDENTIFICATION_INFORMATION:

CITATION:

CITATION_INFORMATION:

ORIGINATOR: United States Geological Survey (USGS)

PUBLICATION_DATE: 20070322

TITLE: USGS_River_Miles

GEOSPATIAL_DATA_PRESENTATION_FORM: vector digital data

SERIES_INFORMATION:

PUBLICATION_INFORMATION:

ONLINE_LINKAGE: <http://ecy.wa.gov/services/gis/data/data.htm#r>

DESCRIPTION:

ABSTRACT:

Point layer showing river mile points where they are depicted on the USGS 7½ minute quadrangles. Only those water bodies that show river miles are in this layer.

PURPOSE: Show river mile locations for hydrology projects.

SUPPLEMENTAL_INFORMATION:

Note that some water bodies have gaps in the river miles order. These mile points are missing in certain USGS quadrangle maps.

7½ minutes USGS quadrangle maps that lack USGS river miles:

Aberdeen SE, Auburn, Bacon Peak, Big Devil Creek, Black Diamond, Burnt Peak, Carlisle, Cathlamet Bay, Chinook, Clark Mtn, Colfax North, Copalis Crossing, Des Moines, Diamond, Elberton, Everett, Fort Simcoe, Glacier, Glacier Peak West, Glacier Peak East, Gold Bar, Grant Orchards, Greenwater, Groat Mountain, Index, Lake Lawrence, Mabton East, McKays Butte, Maltby, Maple Valley, Moses Lake NW, Mount Vernon, Mt Blum, Mt Juniper, Mt Larabee, Mt Lyall, Mt Sefrit, Naches, Newaukum Lake, Onalaska, Onalaska NW, Poverty Bay, Prosser, Puyallup, Renton, Rosburg, Seattle South, Smith Creek Butte, Snohomish, Snoqualmie Lake, South Bend, Stanwood, Tacoma North, Tacoma South, Thorp, Toppenish Mtn, Trinity, Vail, Warrenton, Western, White Swan, Whitstram

TIME_PERIOD_OF_CONTENT:

TIME_PERIOD_INFORMATION:

SINGLE_DATE/TIME:

CALENDAR_DATE: 20070322

CURRENTNESS_REFERENCE: ground condition

STATUS:

PROGRESS: In work

MAINTENANCE_AND_UPDATE_FREQUENCY: As needed

SPATIAL_DOMAIN:

BOUNDING_COORDINATES:

WEST_BOUNDING_COORDINATE: -124.726385

EAST_BOUNDING_COORDINATE: -115.941494

NORTH_BOUNDING_COORDINATE: 49.034246

SOUTH_BOUNDING_COORDINATE: 45.175752

KEYWORDS:

THEME:

THEME_KEYWORD_THESAURUS: None

THEME_KEYWORD: river
THEME_KEYWORD: stream
THEME_KEYWORD: lake
THEME_KEYWORD: waterbody
THEME_KEYWORD: mile
THEME_KEYWORD: navigation
THEME_KEYWORD: distance
PLACE:
PLACE_KEYWORD_THESAURUS: None
PLACE_KEYWORD: Washington
PLACE_KEYWORD: Pacific
PLACE_KEYWORD: northwest
PLACE_KEYWORD: United States
PLACE_KEYWORD: WA
PLACE_KEYWORD: USA
ACCESS_CONSTRAINTS: None
USE_CONSTRAINTS: <http://www.ecy.wa.gov/copyright.html>
POINT_OF_CONTACT:
CONTACT_INFORMATION:
CONTACT_ORGANIZATION_PRIMARY:
CONTACT_ORGANIZATION: Washington State Department of Ecology
CONTACT_POSITION: Spatial Database Administrator
CONTACT_ADDRESS:
ADDRESS_TYPE: mailing address
ADDRESS: PO Box 47600
CITY: Olympia
STATE_OR_PROVINCE: Washington
POSTAL_CODE: 98504-7600
COUNTRY: United States of America
CONTACT_ADDRESS:
ADDRESS_TYPE: physical address
ADDRESS: 300 Desmond Drive
CITY: Olympia
STATE_OR_PROVINCE: Washington
POSTAL_CODE: 98503
COUNTRY: United States of America
CONTACT_VOICE_TELEPHONE: (360) 407-6121
CONTACT_FACSIMILE_TELEPHONE: (360) 407-6493
CONTACT_ELECTRONIC_MAIL_ADDRESS: gis@ecy.wa.gov
HOURS_OF_SERVICE: 0800-1700 Pacific
CONTACT_INSTRUCTIONS: Electronic mail, telephone, or fax
BROWSE_GRAPHIC:
BROWSE_GRAPHIC_FILE_NAME:
http://aww.ecology/services/gis/gis_meta/hydrog/rivermiles.jpg
BROWSE_GRAPHIC_FILE_DESCRIPTION: Simple image
BROWSE_GRAPHIC_FILE_TYPE: JPG
DATA_SET_CREDIT: Washington State Department of Ecology

NATIVE_DATA_SET_ENVIRONMENT:

Microsoft Windows 2000 Version 5.2 (Build 3790) Service Pack 2; ESRI ArcCatalog 9.3.1.4000

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR: U.S. Geological Survey

PUBLICATION_DATE: 1966

TITLE: Digital Raster Graphic (DRG)

GEOSPATIAL_DATA_PRESENTATION_FORM: map

SERIES_INFORMATION:

SERIES_NAME: USGS Digital Raster Graphics

ISSUE_IDENTIFICATION: 1966

PUBLICATION_INFORMATION:

PUBLICATION_PLACE: Sioux Falls, South Dakota

PUBLISHER: EROS Data Center, U.S. Geological Survey

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: June 1976

TITLE: River Mile Index: Clark Fork, Pend Oreille River

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS:

Columbia River Basin: Washington, Idaho, Montana, British Columbia

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Clark Fork Pend Oreille River, Revised June 1976.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: July 1969

TITLE: River Mile Index: Coastal Tributaries

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Pacific Coast Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Coastal Tributaries, July 1969.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: March 1967

TITLE:

River Mile Index: Cowlitz Lewis Klickitat and Minor Right Bank Columbia River Tributaries

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Columbia River Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Cowlitz Lewis Klickitat and Minor Right Bank Columbia River Tributaries, March 1967.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: May 1969

TITLE:

River Mile Index: Deschutes River Nisqually River Puyallup River Green River Lake Washington Snohomish River

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Puget Sound Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Deschutes River Nisqually River Puyallup River Green River Lake Washington Snohomish River, May 1969.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: December 1969

TITLE:

River Mile Index: Elwha dungeness Little Quilcene Big Quilcene Dosewallips Duckabush Hamma Hamma Skokomish Rivers

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: West Puget Sound Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Elwha dungeness Little Quilcene Big Quilcene Dosewallips Duckabush Hamma Hamma Skokomish Rivers, December 1969.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: November 1966

TITLE:

River Mile Index: Klaskanine Sandy Hood Umatilla Walla Walla Rivers Minor Left Bank Columbia River Tributaries

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Columbia River Basin: Oregon and Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Klaskanine Sandy Hood Umatilla Walla Walla Rivers Minor Left Bank Columbia River Tributaries, Nov 1966.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: July 1972

TITLE: River Mile Index: Main Stem Columbia River
GEOSPATIAL_DATA_PRESENTATION_FORM: document
ONLINE_LINKAGE:
X:\River Mile Documents\River Mile Index Main Stem Columbia River, Revised July 1972.pdf
CROSS_REFERENCE:
CITATION_INFORMATION:
ORIGINATOR:
Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee
PUBLICATION_DATE: August 1968
TITLE:
River Mile Index: Moses Coulee, Crab & Foster Creeks, Okanogan (Okanagan), Sanpoil, Colville,
& Kettle Rivers
GEOSPATIAL_DATA_PRESENTATION_FORM: document
OTHER_CITATION_DETAILS: Columbia River Basin: British Columbia and
Washington
ONLINE_LINKAGE:
X:\River Mile Documents\River Mile Index Moses Coulee Crab Foster Creeks Okanogan
(Okanagan) Sanpoil Colville Kettle Rivers, August 1968.pdf
CROSS_REFERENCE:
CITATION_INFORMATION:
ORIGINATOR:
Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee
PUBLICATION_DATE: January 1965
TITLE: River Mile Index: Snake River Part I and Part II above Weiser,
GEOSPATIAL_DATA_PRESENTATION_FORM: document
OTHER_CITATION_DETAILS:
Part I: Snake River below Weiser, Part II: Snake River above Weiser, Columbia River Basin:
Oregon, Washington, Idaho, Nevada, Utah, Wyoming
ONLINE_LINKAGE:
X:\River Mile Documents\River Mile Index Snake River Part I and Part II above Weiser, January
1965.pdf
CROSS_REFERENCE:
CITATION_INFORMATION:
ORIGINATOR:
Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee
PUBLICATION_DATE: April 1964
TITLE: River Mile Index: Spokane River
GEOSPATIAL_DATA_PRESENTATION_FORM: document
OTHER_CITATION_DETAILS: Columbia River Basin: Washington - Idaho
ONLINE_LINKAGE:
X:\River Mile Documents\River Mile Index Spokane River, April 1964.pdf
CROSS_REFERENCE:
CITATION_INFORMATION:
ORIGINATOR:
Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee
PUBLICATION_DATE: April 1968

TITLE:

River Mile Index: Stillaguamish River, Skagit River, Samish River, Nooksack River

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Puget Sound Basin: British Columbia and Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Stillaguamish Skagit Samish Nooksack Rivers, April 1968.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: September 1964

TITLE:

River Mile Index: Wenatchee River, Entiat River, Chelan River, Methow River

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Columbia River Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Wenatchee Entiat Chelan Methow, Sept 1964.pdf

CROSS_REFERENCE:

CITATION_INFORMATION:

ORIGINATOR:

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee

PUBLICATION_DATE: October 1964

TITLE: River Mile Index: Yakima River

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: Columbia Basin: Washington

ONLINE_LINKAGE:

X:\River Mile Documents\River Mile Index Yakima River, October 1964.pdf

DATA_QUALITY_INFORMATION:

COMPLETENESS_REPORT: Data set is complete.

LINEAGE:

SOURCE_INFORMATION:

SOURCE_CITATION:

CITATION_INFORMATION:

ORIGINATOR: United States Geological Survey

PUBLICATION_DATE: 1996

TITLE: USGS Digital Raster Graphics

EDITION: 1

GEOSPATIAL_DATA_PRESENTATION_FORM: document

OTHER_CITATION_DETAILS: USGS 7½ minute quadrangles

SOURCE_SCALE_DENOMINATOR: 24000

TYPE_OF_SOURCE_MEDIA: paper

SOURCE_TIME_PERIOD_OF_CONTENT:

TIME_PERIOD_INFORMATION:

SINGLE_DATE/TIME:

CALENDAR_DATE: 1996
SOURCE_CURRENTNESS_REFERENCE: publication date
SOURCE_CONTRIBUTION: USGS Digital Raster Graphics (DRG)
PROCESS_STEP:
PROCESS_DESCRIPTION:
River mile point locations were digitized "on-screen" using the USGS 7½ minute quadrangles (24k DRG) maps as the background. Only those points shown on the quadrangle maps were digitized.
PROCESS_DATE: 20070321
PROCESS_CONTACT:
CONTACT_INFORMATION:
CONTACT_PERSON_PRIMARY:
CONTACT_ORGANIZATION: Washington State Department of Ecology
CONTACT_POSITION: Spatial Database Administrator
CONTACT_ADDRESS:
ADDRESS_TYPE: mailing address
ADDRESS: P.O. Box 47600
CITY: Olympia
STATE_OR_PROVINCE: Washington
POSTAL_CODE: 98504-7600
COUNTRY: United States of America
CONTACT_VOICE_TELEPHONE: (360) 407-6121
CONTACT_FACSIMILE_TELEPHONE: (360) 407-6493
CONTACT_ELECTRONIC_MAIL_ADDRESS: gis@ecy.wa.gov
PROCESS_STEP:
PROCESS_DESCRIPTION: Metadata imported.
SOURCE_USED_CITATION_ABBREVIATION:
C:\Documents and Settings\rkim461\My Documents\metadata\sde.SDE.xml
PROCESS_DATE: 20110607
PROCESS_TIME: 17294200

SPATIAL_DATA_ORGANIZATION_INFORMATION:
DIRECT_SPATIAL_REFERENCE_METHOD: Vector
POINT_AND_VECTOR_OBJECT_INFORMATION:
SDTS_TERMS_DESCRIPTION:
SDTS_POINT_AND_VECTOR_OBJECT_TYPE: Entity point
POINT_AND_VECTOR_OBJECT_COUNT: 5985

SPATIAL_REFERENCE_INFORMATION:
HORIZONTAL_COORDINATE_SYSTEM_DEFINITION:
PLANAR:
MAP_PROJECTION:
MAP_PROJECTION_NAME: Lambert Conformal Conic
LAMBERT_CONFORMAL_CONIC:
STANDARD_PARALLEL: 45.833333
STANDARD_PARALLEL: 47.333333
LONGITUDE_OF_CENTRAL_MERIDIAN: -120.500000

LATITUDE_OF_PROJECTION_ORIGIN: 45.333333
FALSE_EASTING: 1640416.666667
FALSE_NORTHING: 0.000000
PLANAR_COORDINATE_INFORMATION:
PLANAR_COORDINATE_ENCODING_METHOD: coordinate pair
COORDINATE_REPRESENTATION:
ABSCISSA_RESOLUTION: 0.000328
ORDINATE_RESOLUTION: 0.000328
PLANAR_DISTANCE_UNITS: survey feet
GEODETIC_MODEL:
HORIZONTAL_DATUM_NAME: D_North_American_1983_HARN
ELLIPSOID_NAME: Geodetic Reference System 80
SEMI-MAJOR_AXIS: 6378137.000000
DENOMINATOR_OF_FLATTENING_RATIO: 298.257222
VERTICAL_COORDINATE_SYSTEM_DEFINITION:
ALTITUDE_SYSTEM_DEFINITION:
ALTITUDE_RESOLUTION: 1.000000
ALTITUDE_ENCODING_METHOD:
Explicit elevation coordinate included with horizontal coordinates

ENTITY_AND_ATTRIBUTE_INFORMATION:
DETAILED_DESCRIPTION:
ENTITY_TYPE:
ENTITY_TYPE_LABEL: USGS_River_Miles
ENTITY_TYPE_DEFINITION: Point attribute table
ATTRIBUTE:
ATTRIBUTE_LABEL: STATE_CD
ATTRIBUTE_DEFINITION: State postal code
ATTRIBUTE_DOMAIN_VALUES:
ENUMERATED_DOMAIN:
ENUMERATED_DOMAIN_VALUE: ID
ENUMERATED_DOMAIN_VALUE_DEFINITION: Idaho
ENUMERATED_DOMAIN:
ENUMERATED_DOMAIN_VALUE: MT
ENUMERATED_DOMAIN_VALUE_DEFINITION: Montana
ENUMERATED_DOMAIN:
ENUMERATED_DOMAIN_VALUE: OR
ENUMERATED_DOMAIN_VALUE_DEFINITION: Oregon
ENUMERATED_DOMAIN:
ENUMERATED_DOMAIN_VALUE: WA
ENUMERATED_DOMAIN_VALUE_DEFINITION: Washington
ATTRIBUTE:
ATTRIBUTE_LABEL: OBJECTID
ATTRIBUTE_DEFINITION: Internal feature number.
ATTRIBUTE_DEFINITION_SOURCE: ESRI
ATTRIBUTE_DOMAIN_VALUES:
UNREPRESENTABLE_DOMAIN:

Sequential unique whole numbers that are automatically generated.

ATTRIBUTE:

ATTRIBUTE_LABEL: Shape

ATTRIBUTE_DEFINITION: Feature geometry.

ATTRIBUTE_DEFINITION_SOURCE: ESRI

ATTRIBUTE_DOMAIN_VALUES:

UNREPRESENTABLE_DOMAIN: Coordinates defining the features.

ATTRIBUTE:

ATTRIBUTE_LABEL: LLID_NR

ATTRIBUTE_DEFINITION: Longitude latitude identification number

ATTRIBUTE:

ATTRIBUTE_LABEL: COUNTY_NM

ATTRIBUTE_DEFINITION: Name of the county the point is in

ATTRIBUTE:

ATTRIBUTE_LABEL: RIVER_NM

ATTRIBUTE_DEFINITION: Name of the river, creek, or stream

ATTRIBUTE:

ATTRIBUTE_LABEL: QUAD_NM

ATTRIBUTE_DEFINITION: USGS 7½ minute quadrangle name

ATTRIBUTE_DEFINITION_SOURCE: USGS

ATTRIBUTE:

ATTRIBUTE_LABEL: MILE_NR

ATTRIBUTE_DEFINITION: River mile number

ATTRIBUTE_DEFINITION_SOURCE: USGS

ATTRIBUTE_DOMAIN_VALUES:

RANGE_DOMAIN:

RANGE_DOMAIN_MINIMUM: 0

RANGE_DOMAIN_MAXIMUM: 745

DISTRIBUTION_INFORMATION:

DISTRIBUTOR:

CONTACT_INFORMATION:

CONTACT_PERSON_PRIMARY:

CONTACT_ORGANIZATION: Washington State Department of Ecology

CONTACT_POSITION: Spatial Database Administrator

CONTACT_VOICE_TELEPHONE: (360) 407-6121

CONTACT_FACSIMILE_TELEPHONE: (360) 407-6493

CONTACT_ELECTRONIC_MAIL_ADDRESS: gis@ecy.wa.gov

HOURS_OF_SERVICE: 8:00 - 1700 Pacific

CONTACT_INSTRUCTIONS: Electronic mail, telephone, or fax

RESOURCE_DESCRIPTION: ArcGIS data layer

DISTRIBUTION_LIABILITY:

The Washington State Department of Ecology provides these geographic data "AS IS" WITHOUT A WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR USE, AND/OR NON-INFRINGEMENT.

STANDARD_ORDER_PROCESS:

DIGITAL_FORM:
DIGITAL_TRANSFER_INFORMATION:
FORMAT_NAME: SHP
FORMAT_SPECIFICATION: Shapefile
FILE_DECOMPRESSION_TECHNIQUE: zip
TRANSFER_SIZE: 0.142

METADATA_REFERENCE_INFORMATION:
METADATA_DATE: 20110607
METADATA_CONTACT:
CONTACT_INFORMATION:
CONTACT_ORGANIZATION_PRIMARY:
CONTACT_ORGANIZATION: Washington State Department of Ecology
CONTACT_POSITION: Spatial Database Administrator
CONTACT_ADDRESS:
ADDRESS_TYPE: mailing address
ADDRESS: PO Box 47600
CITY: Olympia
STATE_OR_PROVINCE: Washington
POSTAL_CODE: 98504-7600
COUNTRY: United State of America
CONTACT_ADDRESS:
ADDRESS_TYPE: physical address
ADDRESS: 300 Desmond Drive
CITY: Olympia
STATE_OR_PROVINCE: Washington
POSTAL_CODE: 98503
COUNTRY: United States of America
CONTACT_VOICE_TELEPHONE: 360-407-6121
CONTACT_FACSIMILE_TELEPHONE: 360-407-6493
CONTACT_ELECTRONIC_MAIL_ADDRESS: gis@ecy.wa.gov
HOURS_OF_SERVICE: 0800 - 1700 Pacific
CONTACT_INSTRUCTIONS: Telephone or electronic mail
METADATA_STANDARD_NAME: FGDC Content Standards for Digital Geospatial Metadata
METADATA_STANDARD_VERSION: FGDC-STD-001-1998
METADATA_TIME_CONVENTION: local time
METADATA_ACCESS_CONSTRAINTS: None
METADATA_USE_CONSTRAINTS: None
METADATA_SECURITY_INFORMATION:
METADATA_SECURITY_CLASSIFICATION: Unclassified
METADATA_EXTENSIONS:
ONLINE_LINKAGE: <<http://www.esri.com/metadata/esriprof80.html>>
PROFILE_NAME: ESRI Metadata Profile

XII. APPENDIX C – NHD FLOWLINE SHAPEFILE METADATA

*Identification Information:**Citation:**Citation Information:*

Originator: U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency, USDA Forest Service, and other Federal, State and local partners (see dataset specific metadata under Data_Set_Credit for details).

Publication Date: See dataset specific metadata.

Publication Time: Unknown

Title:

NHDFlowline

Geospatial Data Presentation Form: vector digital data

Publication Information:

Publication Place: Reston, Virginia

Publisher: U.S. Geological Survey

Online Linkage:

[\\IGSKBTHIWS518\D\Workspace\v107\NHD_04_21_10_v1.07\NHD_File_Template_921_07_04_21_10.gdb](#)

*Description:**Abstract:*

The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on waterbodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee.

Purpose:

The NHD is a national framework for assigning reach addresses to water-related entities, such as industrial discharges, drinking water supplies, fish habitat areas, wild and scenic rivers. Reach addresses establish the locations of these entities relative to one another within the NHD surface water drainage network, much like addresses on streets. Once linked to the NHD by their reach addresses, the upstream/downstream relationships of these water-related entities--and any associated information about them--can be analyzed using software tools

ranging from spreadsheets to geographic information systems (GIS). GIS can also be used to combine NHD-based network analysis with other data layers, such as soils, land use and population, to help understand and display their respective effects upon one another. Furthermore, because the NHD provides a nationally consistent framework for addressing and analysis, water-related information linked to reach addresses by one organization (national, state, local) can be shared with other organizations and easily integrated into many different types of applications to the benefit of all.

Time Period of Content:

Time Period Information:

Single Date/Time:

Calendar Date: REQUIRED: The year (and optionally month, or month and day) for which the data set corresponds to the ground.

Currentness Reference:

See dataset specific metadata.

Status:

Progress: In work

Maintenance and Update Frequency: Irregular

Spatial Domain:

Bounding Coordinates:

West Bounding Coordinate: -200

East Bounding Coordinate: -56.8344239

North Bounding Coordinate: 143.165576

South Bounding Coordinate: 0

Keywords:

Theme:

Theme Keyword Thesaurus: U.S. Department of the Interior, U.S. Geological Survey, 1999, Standards for National Hydrography Dataset (<http://mapping.usgs.gov/standards/>)

Theme Keyword: FWHydrography

Theme Keyword: Hydrography

Theme Keyword: Stream / River

Theme Keyword: Lake / Pond

Theme Keyword: Canal / Ditch

Theme Keyword: Reservoir

Theme Keyword: Spring / Seep

Theme Keyword: Swamp / Marsh

Theme Keyword: Artificial Path

Theme Keyword: Reach Code

Place:

Place Keyword Thesaurus: U.S. Department of Commerce, 1977, Countries, dependencies, areas of special sovereignty, and their principal administrative divisions (Federal Information Processing Standards 10-3): Washington, D.C., National Institute of Standards and Technology.

Place Keyword: US

Access Constraints: None.

Use Constraints:

None. Acknowledgment of the originating agencies would be appreciated in products derived from these data.

Point of Contact:

Contact Information:

Contact Organization Primary:

Contact Organization: Earth Science Information Center, U.S. Geological Survey

Contact Voice Telephone: 1 888 ASK USGS

Contact Electronic Mail Address: ask@usgs.gov

Hours of Service: 0800-1600 Eastern Time

Contact Instructions:

In addition to the address above there are other ESIC offices throughout the country. A full list of these offices is at URL: http://mapping.usgs.gov/esic/esic_index.html

Data Set Credit:

See dataset specific metadata.

Native Data Set Environment:

Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.3.1.1850

[Back to Top](#)

Data Quality Information:

Attribute Accuracy:

Attribute Accuracy Report:

Statements of attribute accuracy are based on accuracy statements made for U.S. Geological Survey Digital Line Graph (DLG) data, which is estimated to be 98.5 percent. One or more of the following methods were used to test attribute accuracy: manual comparison of the source with hardcopy plots; symbolized display of the DLG on an interactive computer graphic system; selected attributes that could not be visually verified on plots or on screen were interactively queried and verified on screen. In addition, software validated feature types and characteristics against a master set of types and characteristics, checked that combinations of types and characteristics were valid, and that types and characteristics were valid for the delineation of the feature. Feature types, characteristics, and

other attributes conform to the Standards for National Hydrography Dataset (USGS, 1999) as of the date they were loaded into the database. All names were validated against a current extract from the Geographic Names Information System (GNIS). The entry and identifier for the names match those in the GNIS. The association of each name to reaches has been interactively checked, however, operator error could in some cases apply a name to a wrong reach.

This statement is generally true for the most common sources of NHD data.

Other sources and methods may have been used to create or update NHD data. In some cases, additional information may be found in the NHDMetadata table.

Logical Consistency Report:

Points, nodes, lines, and areas conform to topological rules. Lines intersect only at nodes, and all nodes anchor the ends of lines. Lines do not overshoot or undershoot other lines where they are supposed to meet. There are no duplicate lines. Lines bound areas and lines identify the areas to the left and right of the lines. Gaps and overlaps among areas do not exist. All areas close.

Completeness Report:

The completeness of the data reflects the content of the sources, which most often are the published USGS topographic quadrangle and/or the USDA Forest Service Primary Base Series (PBS) map. The USGS topographic quadrangle is usually supplemented by Digital Orthophoto Quadrangles (DOQs). Features found on the ground may have been eliminated or generalized on the source map because of scale and legibility constraints. In general, streams longer than one mile (approximately 1.6 kilometers) were collected. Most streams that flow from a lake were collected regardless of their length. Only definite channels were collected so not all swamp/marsh features have stream/river delineated through them. Lake/ponds having an area greater than 6 acres were collected. Note, however, that these general rules were applied unevenly among maps during compilation. Reaches codes are defined on all features of type stream/river, canal/ditch, artificial path, coastline, and connector. Waterbody reach codes are defined on all lake/pond and most reservoir features. Names were applied from the GNIS database. Detailed capture conditions are provided for every feature type in the Standards for National Hydrography Dataset available online through <http://mapping.usgs.gov/standards/>.

This statement is generally true for the most common sources of NHD data.

Other sources and methods may have been used to create or update NHD data. In some cases, additional information may be found in the NHDMetadata table.

Positional Accuracy:

Horizontal Positional Accuracy:

Horizontal Positional Accuracy Report:

Statements of horizontal positional accuracy are based on accuracy statements made for U.S. Geological Survey topographic quadrangle maps. These maps were compiled to meet National Map Accuracy Standards. For horizontal accuracy, this standard is met if at least 90 percent of points tested are within 0.02 inch (at map scale) of the true position. Additional offsets to positions may have been introduced where feature density is high to improve the legibility of map symbols. In addition, the digitizing of maps is estimated to contain a horizontal positional error of less than or equal to 0.003 inch standard error (at map scale) in the two component

directions relative to the source maps. Visual comparison between the map graphic (including digital scans of the graphic) and plots or digital displays of points, lines, and areas, is used as control to assess the positional accuracy of digital data. Digital map elements along the adjoining edges of data sets are aligned if they are within a 0.02 inch tolerance (at map scale). Features with like dimensionality (for example, features that all are delineated with lines), with or without like characteristics, that are within the tolerance are aligned by moving the features equally to a common point. Features outside the tolerance are not moved; instead, a feature of type connector is added to join the features. This statement is generally true for the most common sources of NHD data. Other sources and methods may have been used to create or update NHD data. In some cases, additional information may be found in the NHDMetadata table.

Vertical Positional Accuracy:

Vertical Positional Accuracy Report:

Statements of vertical positional accuracy for elevation of water surfaces are based on accuracy statements made for U.S. Geological Survey topographic quadrangle maps. These maps were compiled to meet National Map Accuracy Standards. For vertical accuracy, this standard is met if at least 90 percent of well-defined points tested are within one-half contour interval of the correct value. Elevations of water surface printed on the published map meet this standard; the contour intervals of the maps vary. These elevations were transcribed into the digital data; the accuracy of this transcription was checked by visual comparison between the data and the map.

This statement is generally true for the most common sources of NHD data. Other sources and methods may have been used to create or update NHD data. In some cases, additional information may be found in the NHDMetadata table.

Lineage:

Process Step:

Process Description:

The processes used to create and maintain high-resolution NHD data can be found in the table called "NHDMetadata". Because NHD data can be downloaded using several user-defined areas, the process descriptions can vary for each download. The NHDMetadata table contains a list of all the process descriptions that apply to a particular download. These process descriptions are linked using the DuuID to the NHDFeatureToMetadata table which contains the com_ids of all the features within the download. In addition, another table, the NHDSourceCitation, can also be linked through the DuuID to determine the sources used to create or update NHD data.

Process Date: Unknown

Process Step:

Process Description:

Dataset copied.

Source Used Citation Abbreviation:

\\F880\oracle_export\GDBExtractServer\Template\NHD_Template_High.mdb

Process Step:

Process Description:

Metadata imported.

Source Used Citation Abbreviation:

D:\Workspace\v107\Metadata\nhdflowline.xml

Process Date: 20100421

Process Time: 16520900

[Back to Top](#)

Spatial Data Organization Information:

Direct Spatial Reference Method: Vector

Point and Vector Object Information:

SDTS Terms Description:

SDTS Point and Vector Object Type: String

Point and Vector Object Count: 0

[Back to Top](#)

Spatial Reference Information:

Horizontal Coordinate System Definition:

Geographic:

Latitude Resolution: 0.000000

Longitude Resolution: 0.000000

Geographic Coordinate Units: Decimal degrees

Geodetic Model:

Horizontal Datum Name: North American Datum of 1983

Ellipsoid Name: Geodetic Reference System 80

Semi-major Axis: 6378137.000000

Denominator of Flattening Ratio: 298.257222

Vertical Coordinate System Definition:

Altitude System Definition:

Altitude Datum Name: National Geodetic Vertical Datum of 1929

Altitude Resolution: 0.000025

Altitude Distance Units: meters

Altitude Encoding Method: Explicit elevation coordinate included with horizontal coordinates

[Back to Top](#)

Entity and Attribute Information:

Detailed Description:

Entity Type:

Entity Type Label: NHDFlowline

Attribute:

Attribute Label: OBJECTID

Attribute Definition:

Internal feature number.

Attribute Definition Source:

ESRI

Attribute Domain Values:

Unrepresentable Domain:

Sequential unique whole numbers that are automatically generated.

Attribute:

Attribute Label: Shape

Attribute Definition:

Feature geometry.

Attribute Definition Source:

ESRI

Attribute Domain Values:

Unrepresentable Domain:

Coordinates defining the features.

Attribute:

Attribute Label: ComID

Attribute:

Attribute Label: FDate

Attribute:

Attribute Label: Resolution

Attribute:

Attribute Label: GNIS_ID

Attribute:

Attribute Label: GNIS_Name

Attribute:

Attribute Label: LengthKM

Attribute:

Attribute Label: ReachCode

Attribute:

Attribute Label: FlowDir

Attribute:

Attribute Label: Permanent_Identifier

Attribute:

Attribute Label: WBAreaComID

Attribute:

Attribute Label: FType

Attribute:

Attribute Label: FCode

Attribute:

Attribute Label: Shape_Length

Attribute Definition:

Length of feature in internal units.

Attribute Definition Source:

ESRI

Attribute Domain Values:

Unrepresentable Domain:

Positive real numbers that are automatically generated.

Attribute:

Attribute Label: WBArea_Permanent_Identifier

Detailed Description:

Entity Type:

Entity Type Label: NHDFlowlineToMeta

Overview Description:

Entity and Attribute Overview:

The National Hydrography Dataset is a comprehensive set of digital spatial data that encodes information about naturally occurring and constructed bodies of water, paths through which water flows, and related entities. The information encoded about features includes a feature date, classification by type, other characteristics, a unique common identifier, the feature length or area, and (rarely) elevation of the surface of water pools and a description of the

stage of the elevation. For reaches, encoded information includes a reach code. Names and their identifiers in the Geographic Names Information System, are assigned to most feature types. The direction of flow is encoded for networked features. The data also contains relations that encode metadata, and information that supports the exchange of future updates and improvements to the data. The names and definitions of all feature types, characteristics, and values are in the Standards for National Hydrography Dataset: Reston, Virginia, U.S. Geological Survey, 1999. The document is available online through <http://mapping.usgs.gov/standards/>.

Entity and Attribute Detail Citation:

The names and definitions of all feature types, characteristics, and values are in U.S. Geological Survey, 1999, Standards for National Hydrography Dataset High Resolution: Reston, Virginia, U.S. Geological Survey. The document is available online through <http://mapping.usgs.gov/standards/>. Information about tables and fields in the data are available from the user documentation for the National Hydrography Dataset at <http://nhd.usgs.gov>. The National Map - Hydrography Fact Sheet is also available at: <http://erg.usgs.gov/isb/pubs/factsheets/fs06002.html>.

[Back to Top](#)

Distribution Information:

Resource Description: Downloadable Data

Standard Order Process:

Digital Form:

Digital Transfer Information:

Format Name: ArcGIS Geodatabase

Format Version Number: 8.3

File Decompression Technique: tar and uncompress

[Back to Top](#)

Metadata Reference Information:

Metadata Date: 20100421

Metadata Contact:

Contact Information:

Contact Organization Primary:

Contact Organization: Earth Science Information Center, U.S. Geological Survey

Contact Person: REQUIRED: The person responsible for the metadata information.

Contact Address:

Address Type: mailing address

Address:

507 National Center

City: Reston

State or Province: VA

Postal Code: 20192

Country: USA

Contact Voice Telephone: 1 888 ASK USGS.

Contact Electronic Mail Address: nhd@usgs.gov

Contact Instructions:

In addition to the address above there are other ESIC offices throughout the country. A full list of these offices is at URL: http://mapping.usgs.gov/esic/esic_index.html

Metadata Standard Name: FGDC Content Standards for Digital Geospatial Metadata

Metadata Standard Version: FGDC-STD-001-1998

Metadata Time Convention: local time

Metadata Extensions:

Online Linkage: <http://www.esri.com/metadata/esriprof80.html>

Profile Name: ESRI Metadata Profile