9/30/2010

PILOT PROJECT: Creating Points of Diversion Events Will Improve Insight into Water Delivery and Water Use

COOPERATIVE AGREEMENT NO. G09AC00273

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1. Introduction

Water, a scarce resource in Idaho and through the Western U.S., is important to many competing water users including the agricultural, urban, recreational, and fisheries sectors. Being able to view all diversions, including irrigation, fish propagation and gage diversions, addressed to the same route (waterway) and in the correct sequence, will provide an unprecedented opportunity to compare and model competing water uses. This ability will considerably improve the Idaho Department of Water Resources' insight into water delivery and water use.

Idaho Department of Water Resources (IDWR) has a database containing information about IDWR Water Right Point of Diversions (POD's). Some water rights are nominally located based on the Public Land Survey (PLS). In general, the water rights spatial location represents the legal location and in some cases is geographically removed from the corresponding stream. The geographic representation of diversions in the IDWR Water Rights database cannot be easily adjusted due to legal restrictions. Idaho has tens of thousands of surface water diversions within the state. Representing Points of Diversion (POD) as events tied to the National Hydrography Database (NHD) that can be adjusted to a better location along the stream, rather than as points is the best way to represent relationships among various diversions. Adding these diversions as events would allow IDWR to store, query, and analyze this information along the hydrographic network without altering the legal location.

Water managers rely on accurate hydrographic data for planning, modeling and other tasks. Many local managers have diverse information about their organization that need to be tied to their hydrological system in order to facilitate planning and system management. The National Hydrography Database (NHD) is a nationwide dataset containing hydrologic features such as streams, canals, lakes, ponds and swamps. The NHD is currently the Idaho state framework database for hydrography, and is used by the major federal land managers as well. The NHD is also a geometric network and an excellent platform for data exchange of water information. Currently, in Idaho, the NHD is available at a medium resolution (1:100,000) and high resolution (1:24,000).

Given the large amount of work this State has done adjudicating water rights in the past 20 years, a dataset of water rights tied to hydrography will benefit water accounting, and water use modeling of Idaho's waterways. IDWR will use the Payette subbasin, 17050122, in this pilot project.

2. IDWR Point of Diversion Survey

During September 2009, a variety of IDWR personnel involved in creating, maintaining and using POD information were interviewed to assess their views on what constitutes a POD, how PODs should be collected and stored, how useful the POD information is for them, and how this representation of POD's can be improved. Twelve participants within IDWR were initially interviewed and asked to fill out a questionnaire consisting of 10 questions. Diagrams were also included within the survey to gather each participant's interpretation of where the point of diversion should be located in three different scenarios. After each participant had completed the survey, interviews lasting approximately 1-2 hours were then conducted with each person to discuss their answers and gather additional information from them regarding PODs. The results of those interviews can be found in Appendix A.

2.1 What is a point of diversion?

The right to divert and appropriate the unappropriated waters of any natural stream to beneficial use is a right granted to all Idahoans as per Section 3 of Article 15 of the Idaho Constitution. The Idaho Code states, "All the waters of the state, when flowing in their natural channels, including the waters of all natural springs and lakes within the boundaries of the state are declared to be the property of the state, whose duty it shall be to supervise their appropriation and allotment to those diverting the same there from for any beneficial purpose (..)" §I.C. 42-101. Based on these descriptions, a point of diversion (POD) is often defined as "the location water is diverted from its natural source" by many IDWR business processes and for this project.

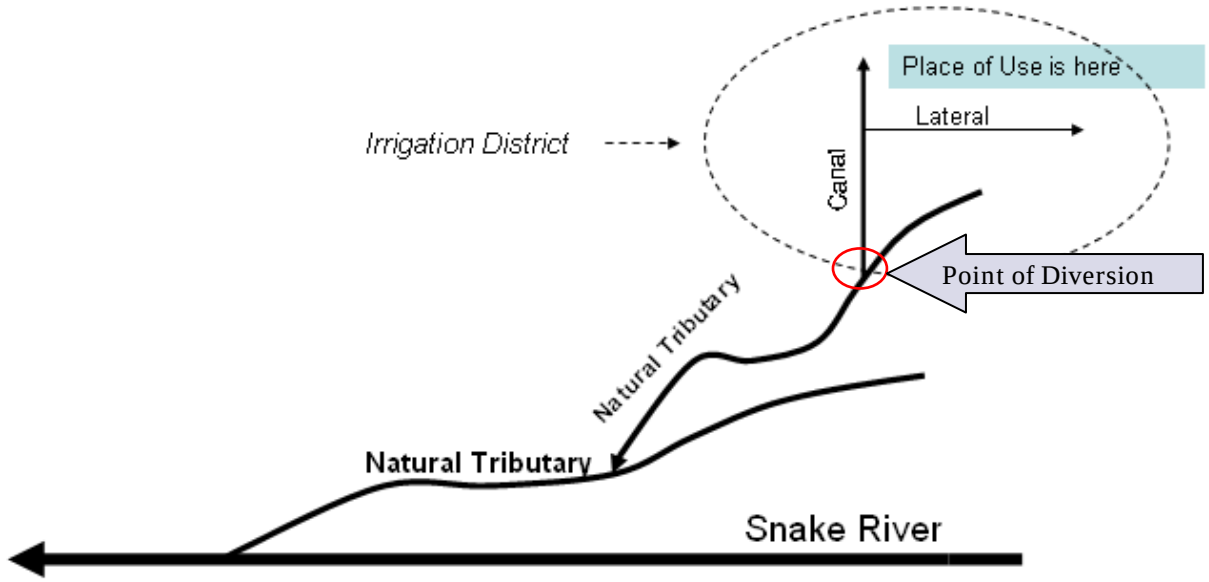


Figure 2.1 – Example of a point of diversion

2.2 Identify sources of PODs in IDWR databases

POD data is used and maintained by several different business processes at IDWR and sometimes in separate databases. A component of the IDWR Point of Diversion Survey was to identify those databases and which business processes used them. A summary of the results is shown in Table 2.1. Footnotes are listed for each department that had additional information regarding the uses of these databases (Table 2.2).

Table 2.1. Database use per discipline.

Feature Dataset / Department	Water modeling [1]	Planning [2]	Adjudication	Water Accounting [3]	Flood Plain [4]	Adjudication /Water Rights [5]	Water Rights [6]	Regulation and Water Measuring [7]	Legal	Systems Programmer	Wells [8]
SpatialData *-Unique ID & spatial locations for features of interest to IDWR business processes.*		X	X			X	X	X			
WMIS (Water Measurement Information System) *- Annual volume data for primarily groundwater wells, incl. some springs*	X	X				X	X	X	X	X	
*Water Rights – Application		X				X	X	X	X	X	
*Water Rights – Permit		X				X	X	X	X	X	
*Water Rights		X	X			X	X	X	X	X	
*Water Rights - Transfers		X				X	X	X	X	X	
*Adjudication Claims		X	X			X	X	X	X	X	
*Adjudication Recommendations		X	X			X	X	X	X	X	
*Adjudication Transfers		X				X	X	X	X	X	
Well Construction	X	X				X		X	X	X	
Wells managed by the USGS	X	X									
Wells data managed by S. Baker	X							X			
Ground Water Monitoring Wells	X	X				X					
Geothermal Wells	X	X				X					
Wells in Public Water Supply Data	X	X				X					
Wells maintained by other agencies	X					X					
Underground Injection Control Wells						X			X		X
Gages maintained by the USGS	X	X		X				X			
Dam Safety Database		X			X	X					

Table 2.2: Footnotes for Table 2.1

* *IDWR Water Rights Databases:*

Shapefiles for Water Rights (WR) were originally developed from GCDB QQ for Place of Use (POU) or GCDB QQ/QQQ centroids for Points of Diversion (POD). If better information is available, irrigation POU and PODs are screen-digitized from Aerial Photos or GPS locations. WR can be in one or more of five process or stages; Application of new WR or transfer, Permit (water use is allowed to develop), License (IDWR has approved final configuration and amounts), Claim (WR has been claimed in an adjudication), Recommendation (what IDWR recommends to the court. A recommendation, when approved by the court, supercedes it's License.

1 *Water Modeling:*

Water Modeling uses other information, such as gages maintained by Idaho Power. In addition, IDWR measures sites and maintains in-house data regarding these sites, but this data is not part of an agency-wide database. It is, however shared among a smaller number of IDWR employees.

2 *Planning*:

The Planning group uses information maintained in the "SpatialData" dataset secondary to project-specific data. For example, PODs in the area of interest are GPS'd and stored into a local database. This data is not currently part of an agency-wide database. Planning also uses other information, such as gages, maintained by Idaho Power and IDWR. The IDWR gage data is not a part of an agency-wide database, but is shared among a smaller number of IDWR employees.

3 *Water Accounting*:

The representative for Water Accounting was a programmer who builds water accounting models. The models are used for billing and allocating water throughout a basin. .

Water Accounting also uses information regarding gages maintained by the Bureau of Reclamation or by individual irrigation entities.

4 *Floodplain*:

Floodplain mapping and modeling does not currently use any of the IDWR listed databases. They do use data that they collect themselves and data they receive from FEMA, Bureau of Reclamation and Corps of Engineers. They also use gage data from the Northwest River Forecast Center (http://www.nwrfc.noaa.gov/).

5 *Adjudication/Water Rights*:

Adjudication/Water Rights uses Groundwater Monitoring, Geothermal Wells, Idaho Department of Agriculture, and Public Well Supply data maintained by the Idaho Department of Environmental Quality. They also use data from the Bureau of Reclamation, the Bureau of Land Management, the Idaho Department of Parks and Recreation, and the IDWR Underground Injection Control Wells Database for the wells that have been issued permits.

Table 2.2 Continued
6 *Water Rights*: Water Rights maintains a spreadsheet with temporary appropriations, for example, annual renewals. Those appropriations are only meant to be valid for a limited time, for example an appropriation for dust abatement during exploratory drilling. Information about pumps and dams can be found in the description associated with a water right but not directly in the Water Right Database. 7 *Regulation and Water Measuring*: Additional gage information used by Regulation and Water Measuring include Eastern Snake Plain Aquifer (ESPA) monitoring stations and those maintained by Idaho Power and IDWR. There are plans to include the ESPA monitoring stations in the "SpatialData" dataset in the future. Regulation and Water Measuring sections within IDWR receive annual reports from Idaho Power Company (IPCO) and other utilities in Idaho showing power consumption records for irrigation wells. Based on this data how much water that has been pumped for individual wells can be estimated and Power Consumption Coefficients (PCC's) are developed. 8 *Wells*: The Groundwater Monitoring and Geothermal Wells databases are in the process of being linked to the Well Construction database. The goal is to coordinate and link information between separate well databases and link them through identifiers within the Well construction database and the "SpatialData" dataset. Underground Injection Wells (UIC) information is not currently part of an agency-wide database.

At the conclusion of the survey, it was determined that the POD information in the IDWR Water Right Database would be used for this project.

For more specific information regarding individual databases and applications within IDWR, refer to Appendix A.

2.3 Using PODs in the IDWR Water Right database

POD information for a water right is collected when IDWR receives an application for a water right or for a transfer of an existing water right. Historically, the locations of those diversions were identified by the quarter-quarter (QQ) in which they are located. A QQ has a surface area of 40 acres, and is one sixteenth of a section within the PLS system. When only QQ data is available, a POD is placed in the center of the QQ, which may or may not coincide with a stream or other natural source described in the water right. (Figure 2.2)

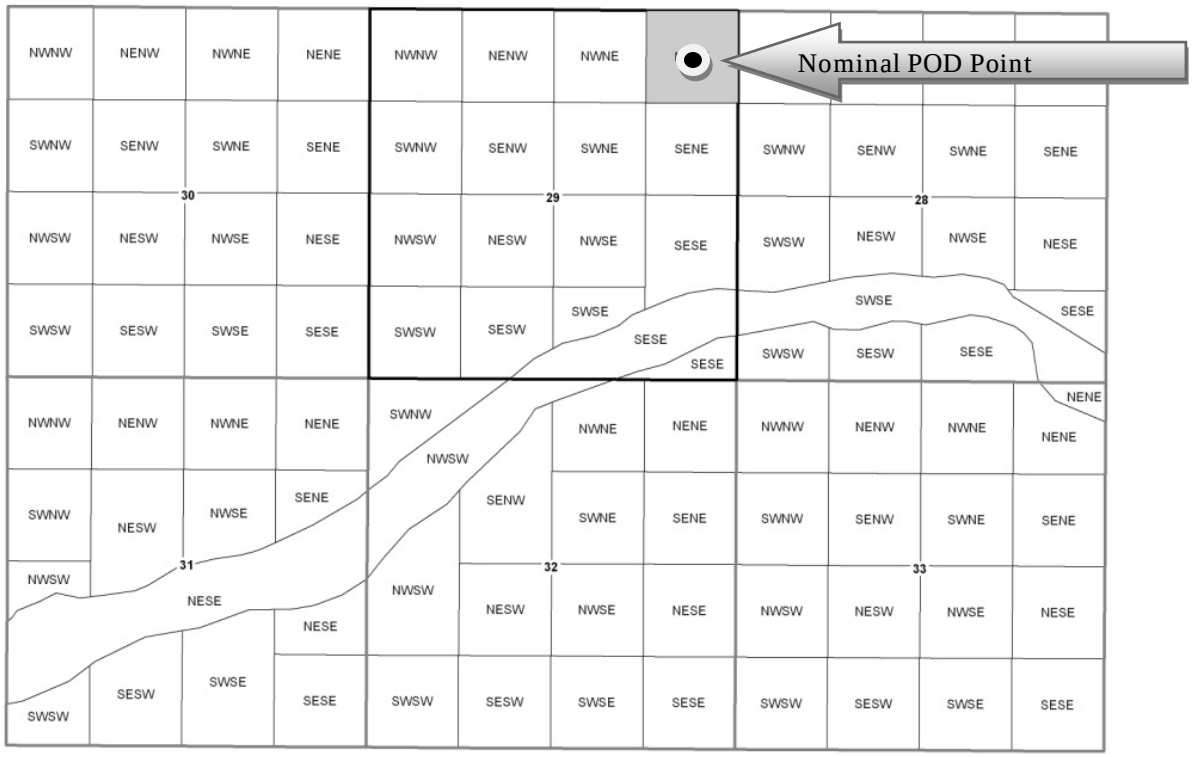


Figure 2.2 – Quarter quarters are one sixteenth of a section in the PLS system, nominal POD's are placed in the center of each QQ..

During the last 10 years, more work has been done to collect GPS locations for PODs, but the legal description of the right can only be changed as a result of either a modification of the water right or an administrative procedure changing the elements of the water right. Using GPS data has allowed IDWR personnel to improve spatial accuracy for some of its points of diversion. However, since points of diversion are legally tied to a given QQ, it is sometimes not possible – without the proper legal procedure – to move a POD to the GPS's location. Over time and depending on resources the locations that were based on QQ locations or digitized will be replaced by GPS locations. Locations of diversions are collected through the various "work flow" processes in place at IDWR and are put into the IDWR Water Right Database.

3. Updating NHDFlowlines in the Payette Subbasin (17050122)

The Payette Subbasin, 17050122, was selected for this pilot project. The proximity of this subbasin to the IDWR State office made it more efficient to perform field validations or to contact local agencies. In addition, the Emmett and Letha Irrigation Districts both agreed to review their service areas on paper maps (provided by IDWR) and submit revisions in an effort to add new canals or update existing canals for inclusion into the NHD. Also, this subbasin has been recently adjudicated and IDWR has done extensive work on water accounting in this subbasin. Revising the NHD linework to reflect the actual irrigation systems in this area was an important prerequisite in order to accurately place the events.

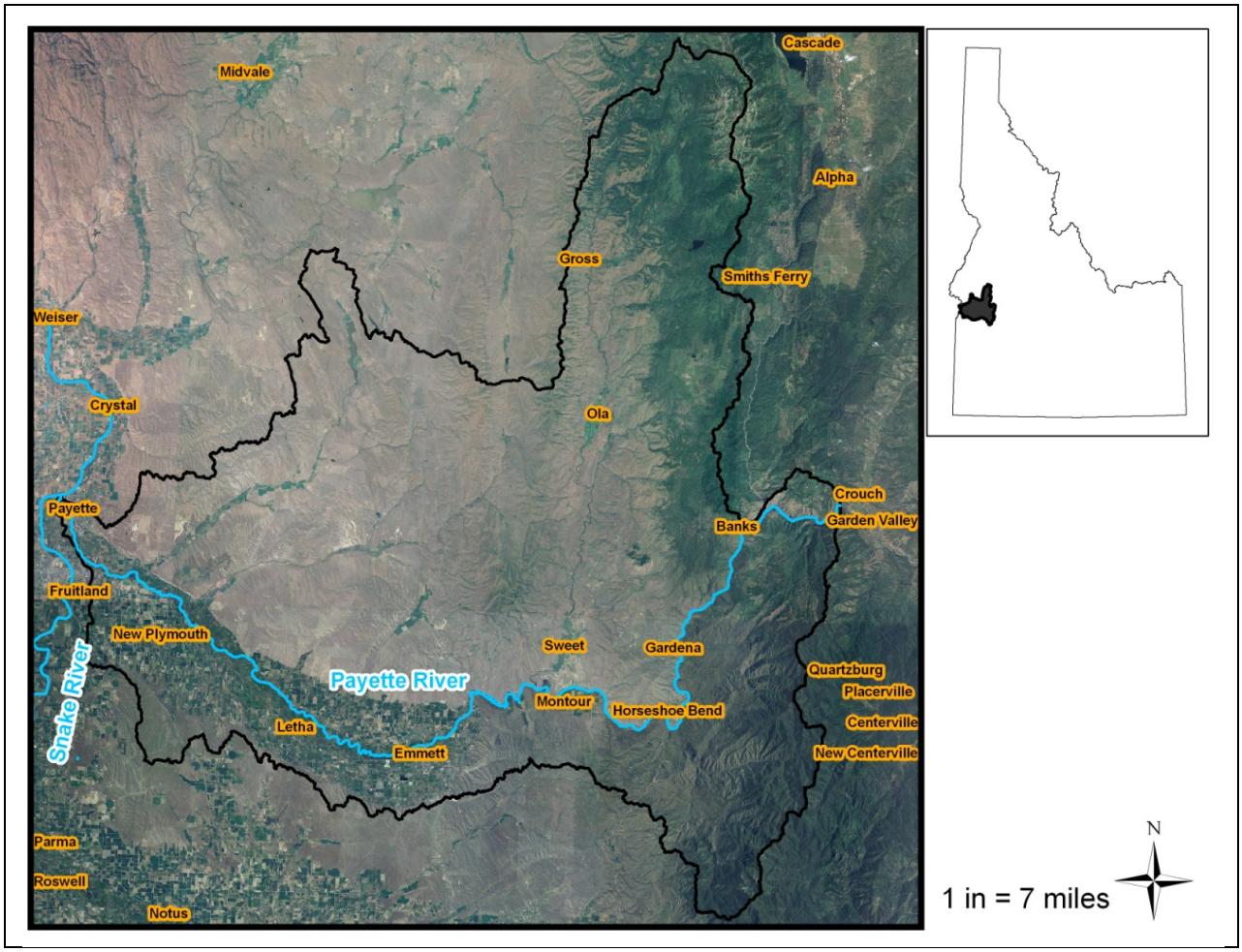


Figure 3.1. The Payette sub-basin is located in Western Idaho.

3.1 Collecting data to update the NHD

Collecting data to update the NHD was done in multiple steps:

1) Using aerial imagery from the National Agriculture Imagery Program (NAIP), existing NHD and information from the IDWR Water Rights Database, a new hydrography layer with the best available data was created.
2) The newly created hydrography was distributed to local agencies and stakeholders. IDWR employees attended a local water meeting in Payette, Idaho and presented maps and asked for input to verify those maps, and update where necessary. Stakeholder input was collected in two different ways:
    a. By handwritten notes on IDWR generated paper maps

b. With the use of ArcGIS. IDWR has developed specialized editing tools, and those are available to districts interested updating their system digitally. More information on these tools and their uses can be found at http://www.idwr.idaho.gov/GeographicInfo/NHD/Projects/collecting_edits.htm

The NHD was updated with the best available data collected in the previous two steps. There were approximately 1190 NHDFlowlines out of 8400 that were either new or revised in the Payette subbasin; the majority of those were contained within the Emmett or Letha Irrigation Districts.

4. Referencing Water Right PODs to the NHD

Points of diversion (POD) shapes in the IDWR database represent where water is diverted from live flow, either surface water or ground water (i.e., springs, stream, or a well), to be put to beneficial use under a water right. A water right must have at least one, and may have many, PODs. For each water right, any or all PODs can serve any of all uses specified in the water right.

The Hydro Event Management (HEM) tools were developed by the Pacific Northwest Hydrography Framework group (http://hydro.reo.gov/index.thml) with support from the United States Geological Survey (USGS) and the United States Environmental Protection Agency (USEPA). These tools are specifically designed to create and manage event data that is tied to the NHD.

This pilot project used the IDWR Water Rights Database in the Payette subbasin (described in section 4.1) to create point events along NHDFlowlines utilizing the HEM Tools (ver 2.2). By placing events along the NHD geometric network, water managers can share information about their system infrastructure without adjusting local data. In addition, local managers can take advantage of the functionality of a geometric network including tracing and routing.

4.1 POD Source

Shapes for Water Right PODs were initially developed from the Geographic Coordinate Data Base (GCDB) as quarter-quarter (QQ) or quarter-quarter-quarter (QQQ) centroids based on the POD legal description. As better location information becomes available, including digitized points and GPS data, updates to the POD shapes are completed and entered into the database. The “DataSource” field within the IDWR Water Right attribute table contains information about how the POD location was determined. There are four main types of locations for POD’s; 1) digitized, either by placing a point on a paper or digital map, 2) GPS - and downloaded into a GIS system, 3) Quarter-section centroid derivatives, either Q, QQ, or QQQ, or 4) unknown (see Figure 4.1).

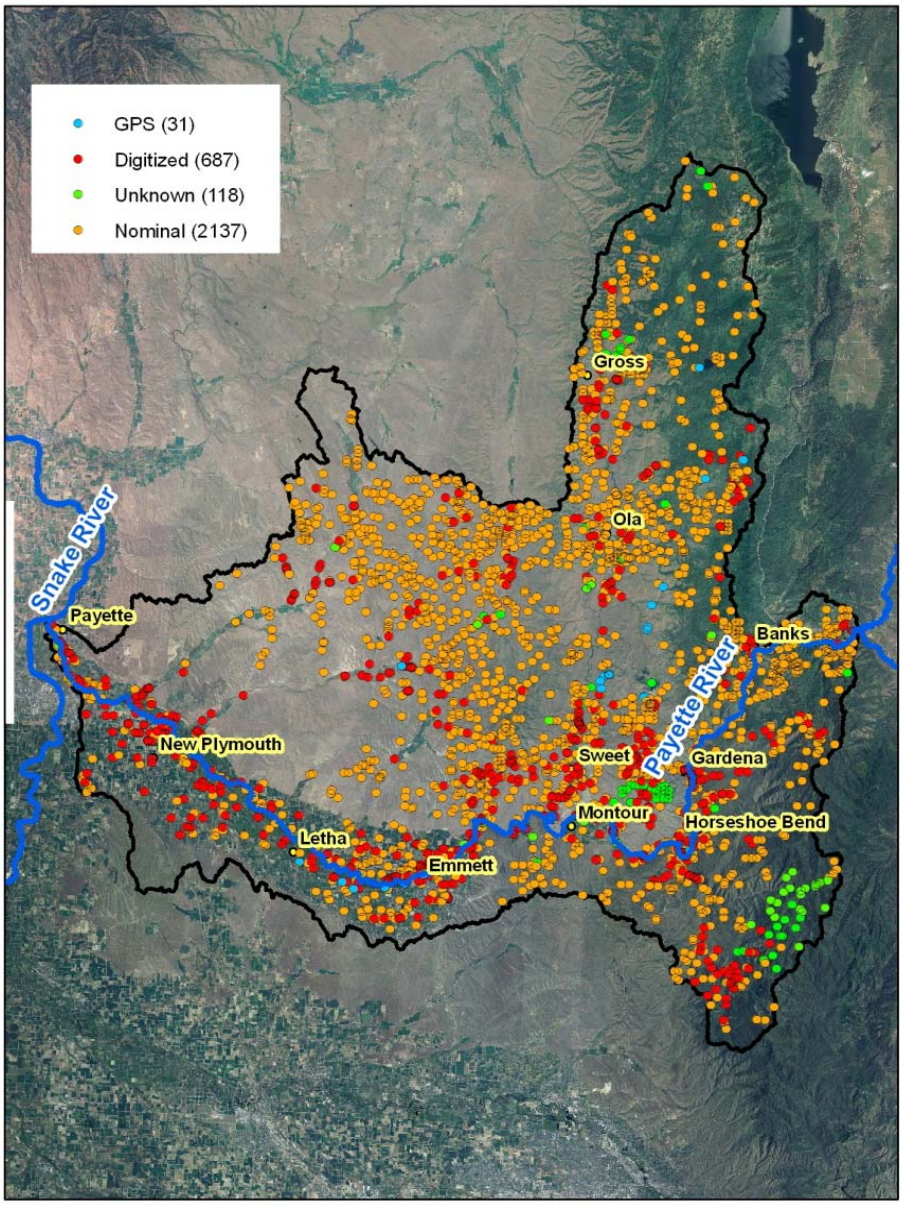
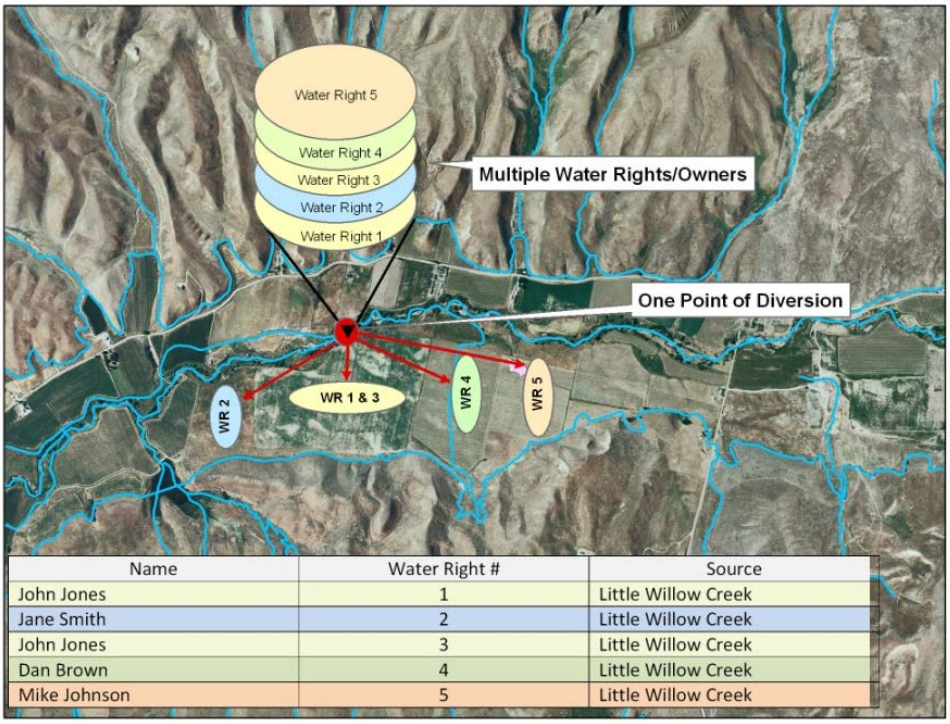


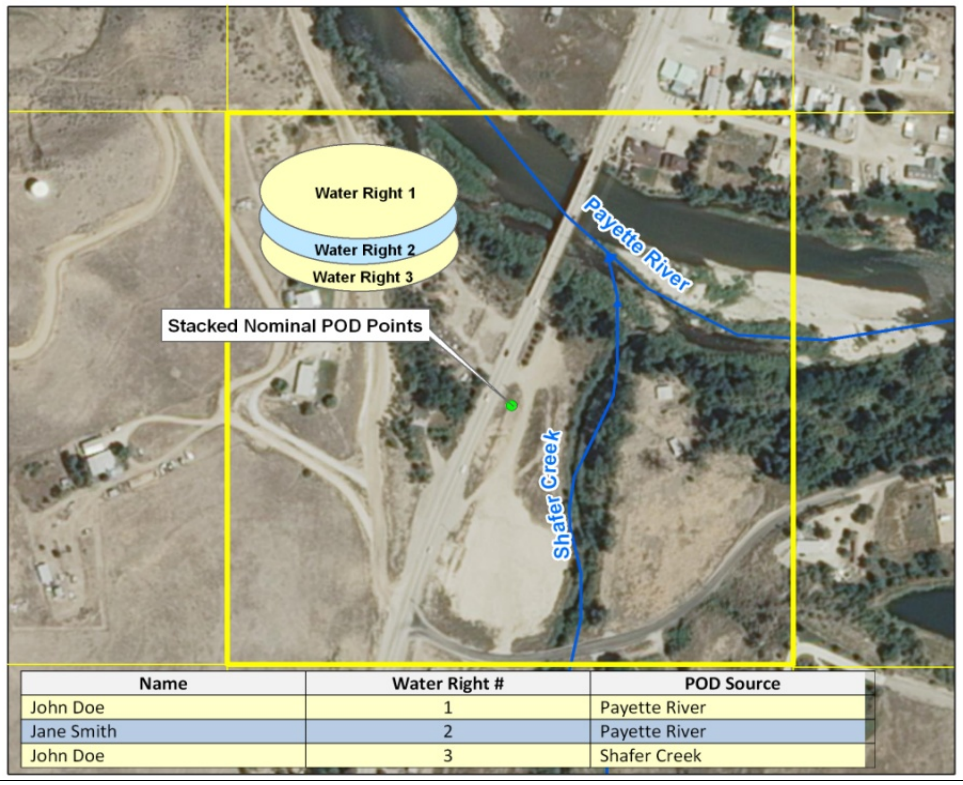
Figure 4.1 – POD's in the Payette Subbasinby collection method.

It is common to have multiple POD "stacked" points for one spatial location, because there may be multiple water rights/property owners diverting water out of one single POD structure. In addition, if the POD is a centroid derivative (nominal), a spatial location can have multiple diversion sources; i.e., Payette River and Shafer Creek (figure 4.2b).



Name	Water Right #	Source
John Jones	1	Little Willow Creek
Jane Smith	2	Little Willow Creek
John Jones	3	Little Willow Creek
Dan Brown	4	Little Willow Creek
Mike Johnson	5	Little Willow Creek

Figure 4.2a – Example of "Stacked" GPS'd PODs in the IDWR Active Water Rights feature class



Name	Water Right #	POD Source
John Doe	1	Payette River
Jane Smith	2	Payette River
John Doe	3	Shafer Creek

Figure 4.2b – Example of a "Stacked" nominal POD in the IDWR Active Water Rights feature class

For this study, four POD point feature classes were extracted from the IDWR Water Rights Database. Only active Water Rights were used. The dataset containing named surface hydrography (containing points of diversion where the "Source" field was populated with a named stream attribute) was the only dataset of the 4 that could be verified. Verification of event placement was done by comparing the NHDFlowline named feature attribute (GNIS_Name) and the "SourceFeature_ID" field. The remaining three datasets were kept separate because of the difference of the surface hydrography contained within each – streams, springs, and miscellaneous surfaces consisting of ponds, stockwater, etc. These remaining three datasets did not have unique names within the "Source" field, so a verification using the method of matching GNIS_Name of the NHD_Flowline with SourceFeaure_ID of the the event would not produce usable results.

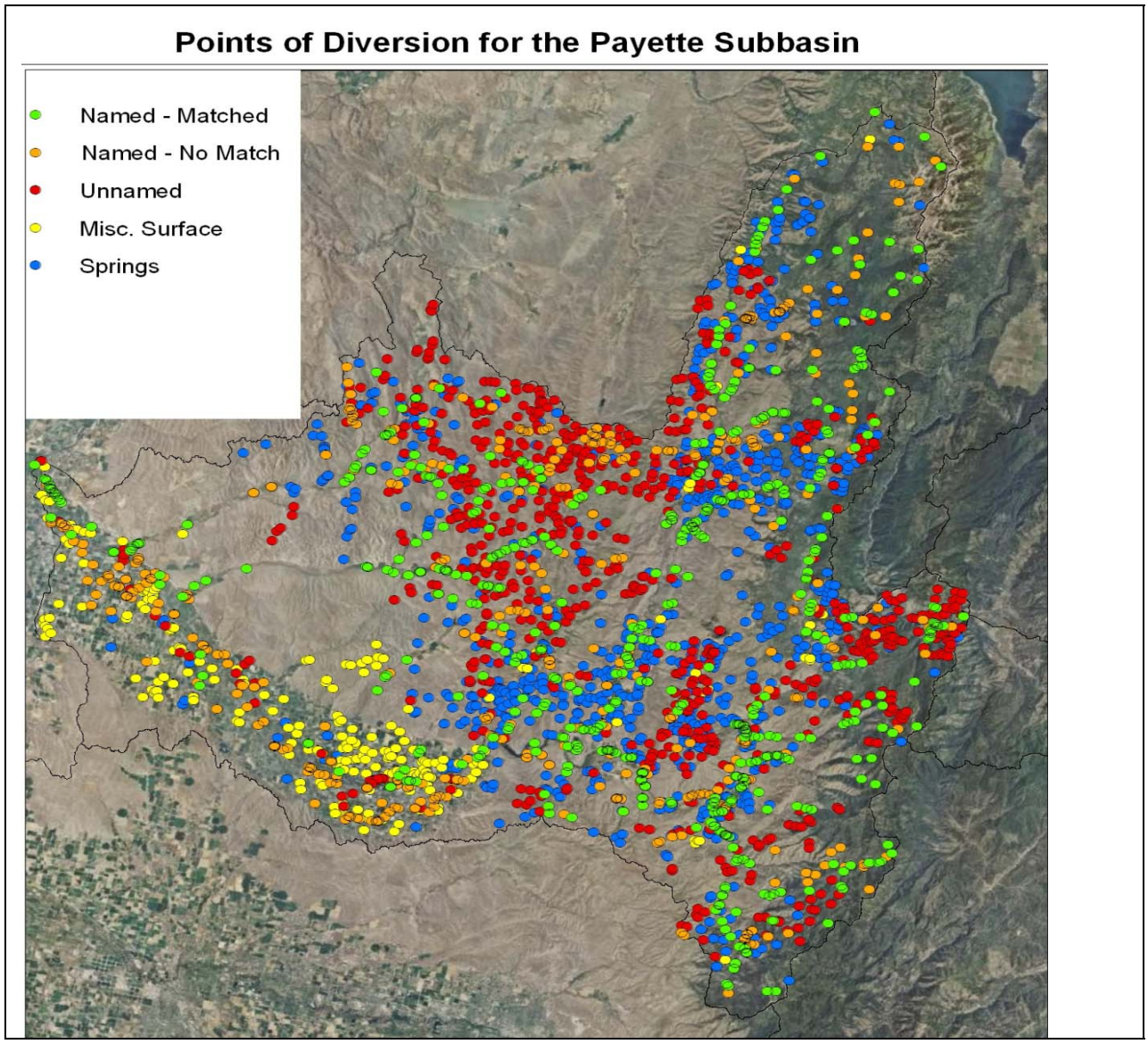


Figure 4.3 – Points of Diversion by Source

Feature Dataset Summary:

Named Surface Hydrography. There were 1561 points in this feature class. All of these POD's were populated with named stream attributes in the "Source" field, which represents where the water is diverted from. There were 559 digitized points and 42 GPS'd points in this feature class. The remaining 960 points were either derived from quarter-section centroids, or unknown.

Unnamed Surface Hydrography. There were 848 points in this feature class. None of these POD's had name attributes populated for the "Source" field, which would represent where the water is being diverted from. There were 154 digitized points in this feature class. The remaining 694 points were either derived from quarter-section centroids, or unknown.

Springs. There were 972 points in this feature class. All of these POD's had name attributes, although 94% of them were simply populated with "Spring" as the name. The remaining 6% had a spring name associated with the "source" field, representing the spring name where the water was diverted from. There were 116 digitized points, and 12 GPS points. The remaining 844 points were either derived from quarter-section centroids, or unknown.

Miscellaneous Surface. There were 292 POD records in this feature class. All of these POD's had name attributes for the "Source" field, although 96% of them were simply populated with either "Pond" or "Wastewater". Of the remaining 4%, 9 records were unknown, and 2 had pond names associated with the "source" field, representing where the water was being diverted from. There were 102 digitized points, and 1 GPS point. The remaining 189 points were either derived from quarter-section centroids or unknown.

In addition to the POD sources listed above, there are also active groundwater points of diversion in the IDWR database. These PODs were not included in this study as creating groundwater POD events along surface hydrography would not be a useful application for this project.

4.2 Tools and Methodology

The process of creating events from points using the HEM Tools (ver 2.2) was summarized in Appendix B – Referencing Water Right PODs in the Payette Subbasin to the NHD using the Hydro Event Management (HEM) Tools. This document outlines the steps needed to set up the HEM Tools, pre-process the IDWR Water Right data, and create the point events that are discussed in this report.

Before POD events could be "snapped" to the NHDFlowline, initial processing was performed to ensure all data used in the analysis was in the same projection. All IDWR data was projected to the Albers projection used by the NHD to avoid any conflicts or errors. A dissolve was performed on the POD's with the same SpatialDataID to avoid multiple point events being placed in the same location (see Figure 4.2a&b for example of stacked data). The dissolve process is done by using a command within ArcInfo that aggregates features based on specified attributes, in this case, the aggregation(or dissolve) was based on the SpatialDataID field contained within the IDWR Water Rights Database. The SpatialDataID is a unique field that identifies each spatial location of a POD within the IDWR water rights database. The POD's of many individual water rights can have the same SpatialDataID if the water is diverted from the same location on a natural source (Figures 4.2a&b). After the dissolve, a separate field was created in the IDWR table called HEMCODE (text, 40), consisting of the unique IDWR "Spatial Data ID" value,

separated by stream name ("Source"), and location information (i.e., GPS, QQ, etc.). After the dissolve, each dataset contained one POD point per spatial location and surface water source. There are many instances where there is more than one POD per location, but they have separate sources of diversion that need to be preserved to illustrate separate diversions at the same spatial location.

		METHOD OF POD LOCATION COLLECTION			
Dataset	Total Records	GPS	Digitized	Nominal (Q, QQ, etc.)	Unknown (Blank)
Active WR Named surface BEFORE DISSOLVE	1561	42	559	914	46
Active WR Named Surface AFTER DISSOLVE	1041	18	367	610	46
Active WR Unnamed Surface BEFORE DISSOLVE	848	--	154	646	48
Active WR Unnamed Surface AFTER DISSOLVE	792	--	126	618	48
Active WR Springs BEFORE DISSOLVE	972	12	116	821	23
Active WR Springs AFTER DISSOLVE	894	12	106	753	23
Active WR Miscellaneous Surface BEFORE DISSOLVE	292	1	102	188	1
Active WR Miscellaneous Surface AFTER DISSOLVE	246	1	88	156	1
Note: "WR" = "Water Right"					
TOTAL – AFTER DISSOLVE	**2973**	**31**	**687**	**2137**	**118**

Table 4.1 – Number of records, per dataset, before and after the dissolve

The HEMCODE field was used from the IDWR feature class to populate the Source_FeatureID field in the point event table (Figure 4.4). The process of creating point events via the HEM Tools is described in Appendix B.

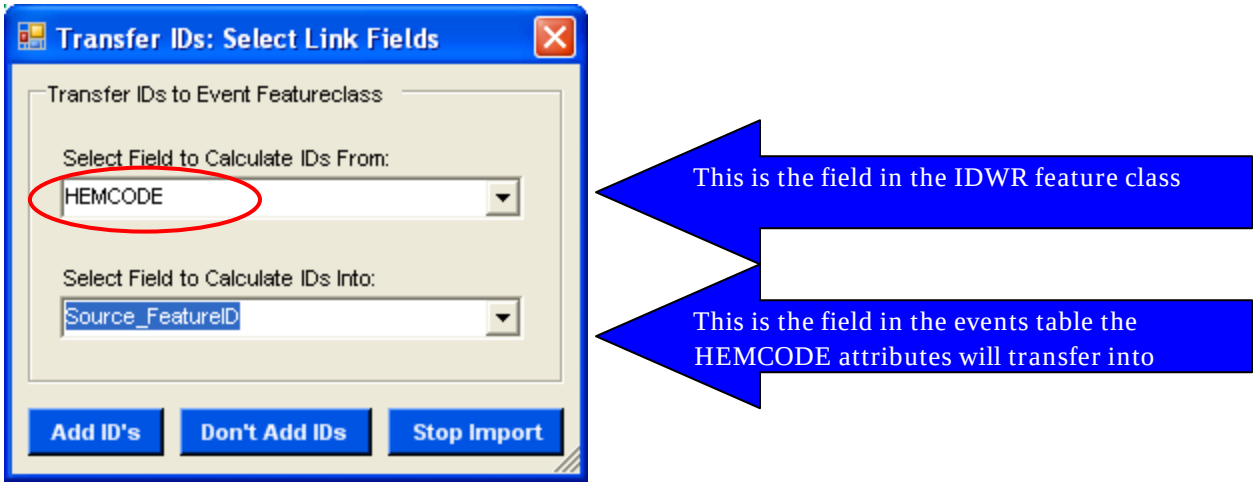


Figure 4.4 – HEMCODE field used to transfer attributes

In a previous review of creating point events using the HEM tools, two ArcMap settings may have affected the results of the analysis; Selection Tolerance and Snapping Tolerance. Both the Selection Tolerance (Tools|Options) and the Snapping Tolerance (Editor|Options|General Tab) can be set in pixels. The value of a pixel is dependent on map scale and can be highly variable. The following issues were identified during the previous review:

1) Changing the Snapping Tolerance has no affect on the number of points that are referenced or the number of candidates selected by the HEM tool. This was found to be true if the Snapping Tolerance was set in either pixels or map units.
2) Selection Tolerance was found to affect the number of points that are referenced and the number of candidates selected by the HEM tool.

Because a starting map scale, hence pixel size, was not specifically set before running the HEM Tools, the pixel size setting is suspected as a cause of inconsistent results. For example, results could vary greatly especially if the person using the tool was changing scale by zooming in to a candidate segment.

A 212-record dataset (Appendix C) bounded by the Emmett and Letha Irrigation districts were compiled as a test subset of the dataset. This subset was used to assess where events were located along the NHD lines and the best methods to use for the entire study area. For the subset, each event record was manually checked to assess whether or not it was correctly located. These checks were performed by comparing feature names within the newly-created point event table with the NHDFlowline feature class table, and comparing the placed event locations with any documentation that was available online via the IDWR Water Rights database. After each location was checked, that point event was assigned an attribute; Y-Correct Location, N-Incorrect Location, or U-Unknown. The methods used and the results of that subset can be found in Appendix C – Test Study: Creating Events for the Emmett and Letha Irrigation Districts.

Following the subset data analysis, point events were created on the NHDFlowline for all four of the IDWR active water right feature classes in the Payette Subbasin, as described in section 4.3.

It was determined that suppressing the candidate form in the HEM Tools (Edit Tools|Options|Route Location Options tab) was the best course of action, to avoid having to hand-pick the best location for over 2900 points of diversion and to avoid issues with the selection tolerance. If this option is not suppressed, a dialog box comes up for each point that is within the specified search tolerance, and the user must interactively choose the best route location for each point event (see Figure 4.5). On all feature classes except for the springs, the option “Use closest candidate first, then top of the downstream” was selected, forcing the event to snap to the closest stream without using the candidate form. Stream names were then compared for the PODs with named features. For the springs, the option “Use top of the downstream first, then use closest candidate” was preferred so that the event points would locate at the top of the nearest stream segment when possible. For all iterations of the data, the “Round Events” option was turned off so that each event would snap to the closest location on the NHDFlowline, rather than snapping to the endpoint of each NHDFlowline. If the “Round Events” option is activated, events within two measures of an endpoint will be rounded to the endpoint, i.e., events 0-2 will be rounded to 0, and 98-100 will be rounded to 100.

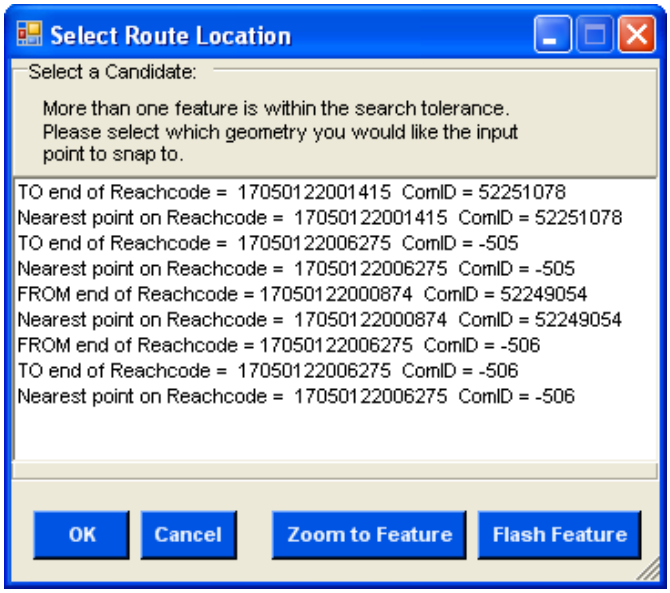


Figure 4.5 – the Hem Tools Candidate Form

5. Results & Discussions

Four separate IDWR Active Water Right geodatabases were created for the entire Payette subbasin study using the HEM Tools (v2.2); Named Surface, Unnamed Surface, Springs and Miscellaneous Surface. Each newly created event point geodatabase corresponds to the IDWR Active Water Right feature class that was originally created for this study. It was decided to keep these geodatabases separate, as each provides individual attributes unique to the Water Right records within IDWR, i.e., streams, springs, and miscellaneous surface (wasteways, ponds) are all different features. In addition, it was advantageous to separate the named features from the unnamed features so that a match could be performed on the named features to verify accuracy. Separating each set of records also avoided having to add an additional field and keep track of the type of water right. Also, processing time was shorter than it would have been if all records had been grouped into one geodatabase. The results of the HEM Tool processing for each of the four geodatabases are summarized below:

Named Surface: There were 1561 points in the original feature class and 1041 points remained after performing the dissolve (including the 212 points from the test study). In this particular feature class, all of the POD's were populated with named stream attributes in the "Source" field, representing where the water is diverted from. After using the "Import Points" feature of the HEM Tools (Edit Tools|Import Points), 1035 point events were created, using the "Suppress the Candidate Form" option in the HEM options dialog box. Six points failed to import. This represents a 99.4% success rate. It is unknown why the 6 points did not import; for further information on this issue, see Appendix D – Hem Tool Error Report.

A separate analysis was performed to assess which named features in the POD_Point_Events table matched the NHDFlowline. The records with stream names that matched were considered correct without further investigation. There were 551 name matches out of 1035 point events, which represent a 53% overall match based on stream name comparisons (Figure 5.1).

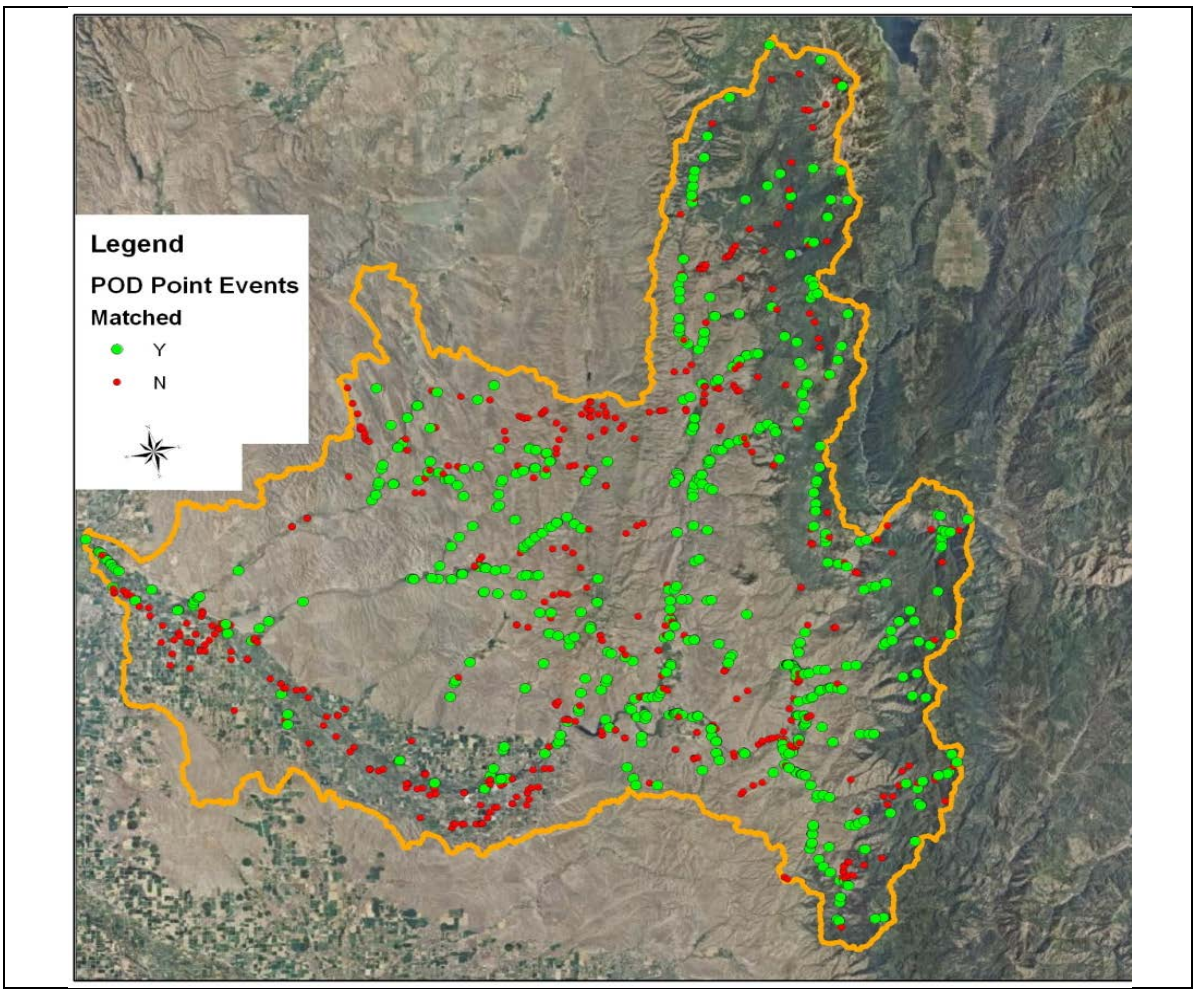


Figure 5.1 – Named Surface POD's – matched (green) vs. unmatched (red)

Method of Collection	Total Records	Number Matched	Percent
Digitized	366	214	58%
GPS	18	3	17%
Nominal (Q, QQ, QQQ)	609	309	51%
Unknown (Blank)	42	25	60%
TOTALS	**1035**	**551**	**53%**

Table 5.1 – Method of collection and percentage of matches for each – Named Surface Water Feature class

A number of key factors were identified for GPS points that we flagged as not matching stream names. Surprisingly, in comparing names associated with NHDFlowlines and the names associated with the water right PODs, only 3 of the 18 GPS points snapped to the correct stream. Seven of these points were either injection or re-diversion sites. Injection or re-diversion sites are points when water is diverted out

of one location, injected into another location, and re-diverted into yet another location. These events are separate point of diversion records within the IDWR Water Rights database, but contain the same POD source (usually the original POD). In these cases, the hydrographic names will possibly match the NHDFlowline feature for only one source, the original diversion (see figure 5.2). Further investigation and manual coding would need to take place in order to makes sure these points are placed in the correct location. These points are probably in the correct location, but were flagged because the source name on the POD did not match the hydrography of the closest stream

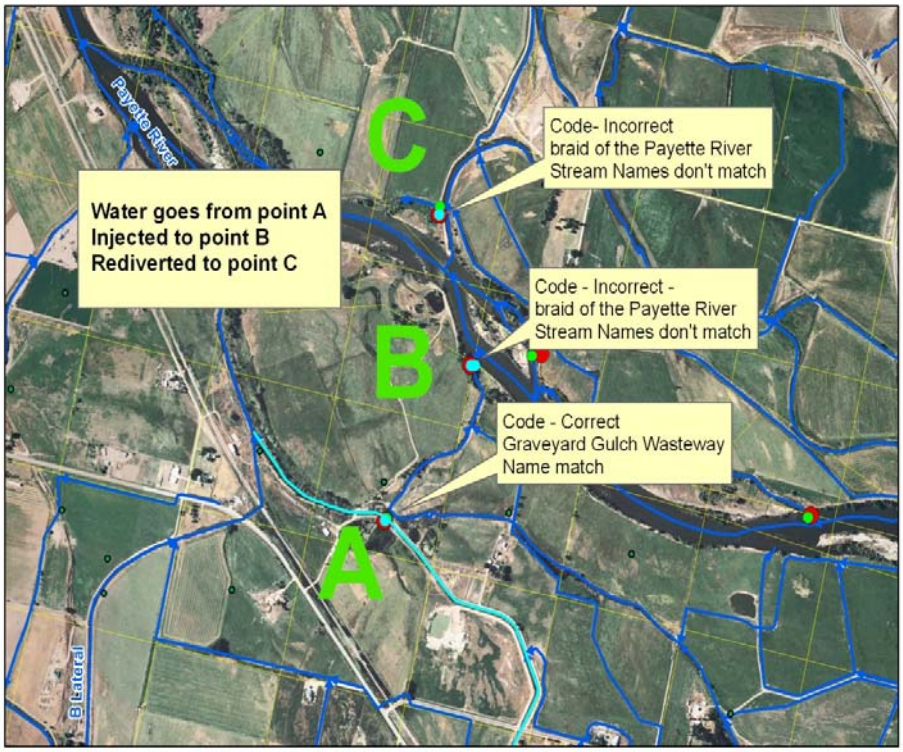


Figure 5.2 – Example of an injection and re-diversion site

There were three GPS points that were flagged as errors due to a braid in the stream. In the example below, the diversion point is located on a major stream braid of the Payette River. The GPS diversion point is located correctly and the diversion source is the Payette River, but the NHDFlowline name is located along the main portion of the Payette River, not the unnamed braid. This causes a non-match between the NHDFlowline and the IDWR Source code stream names (Figure 5.3).

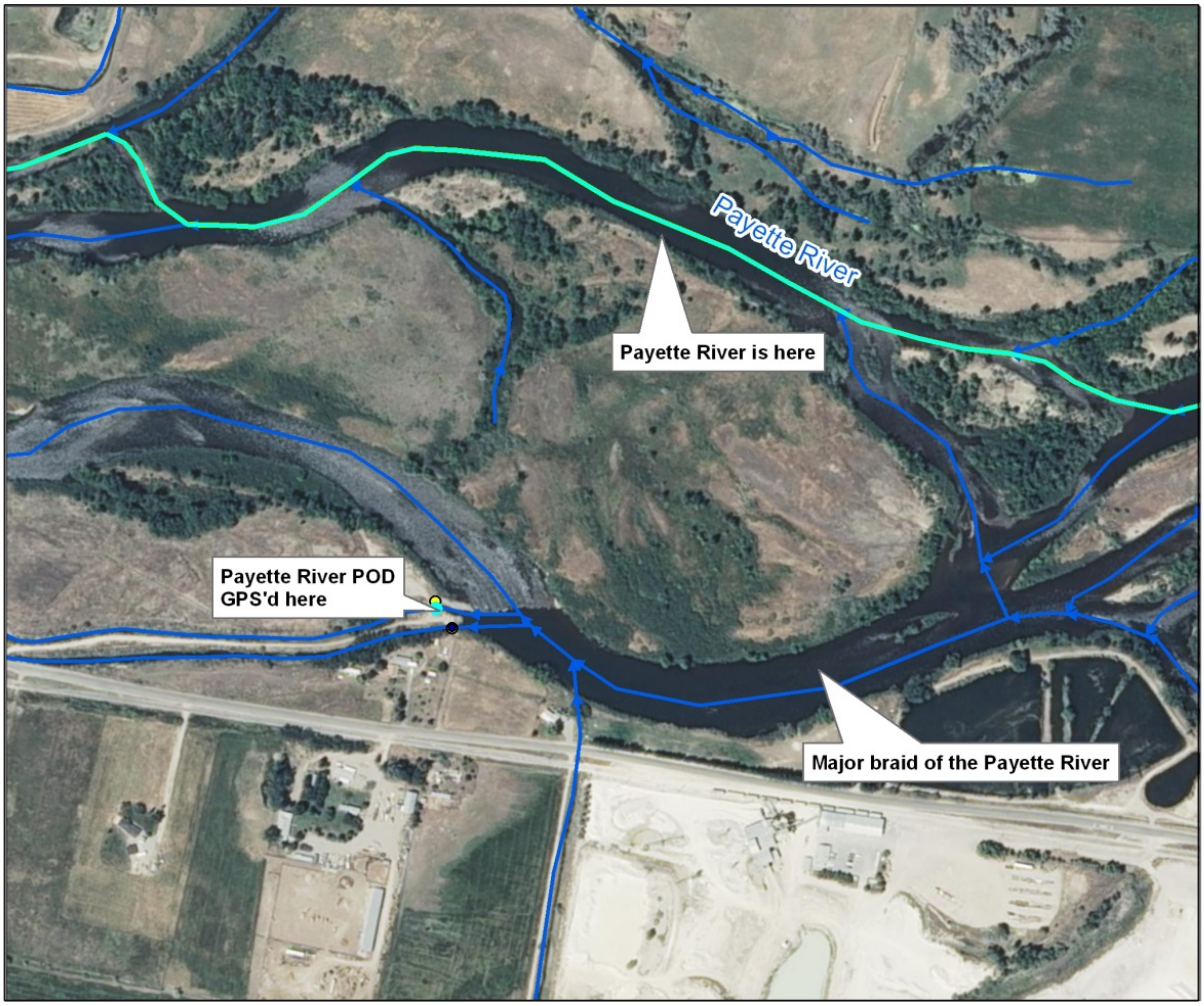


Figure 5.3 – Example of a major stream braid of the Payette River, causing a non-match between the source names

There were also non matches flagged due to the GPS point snapping to the closest NHDFlowline feature, rather than the artificial path. This occurs because the GPS point was not digitized in the center of the river, but at the diversion structure on the bank. This creates an issue because the nearest NHDFlowline feature in these cases is not the artificial path. In the next example (Figure 5.4), the Payette River is the source of diversion, and the point was GPS'd while standing at the bank and diversion structure.

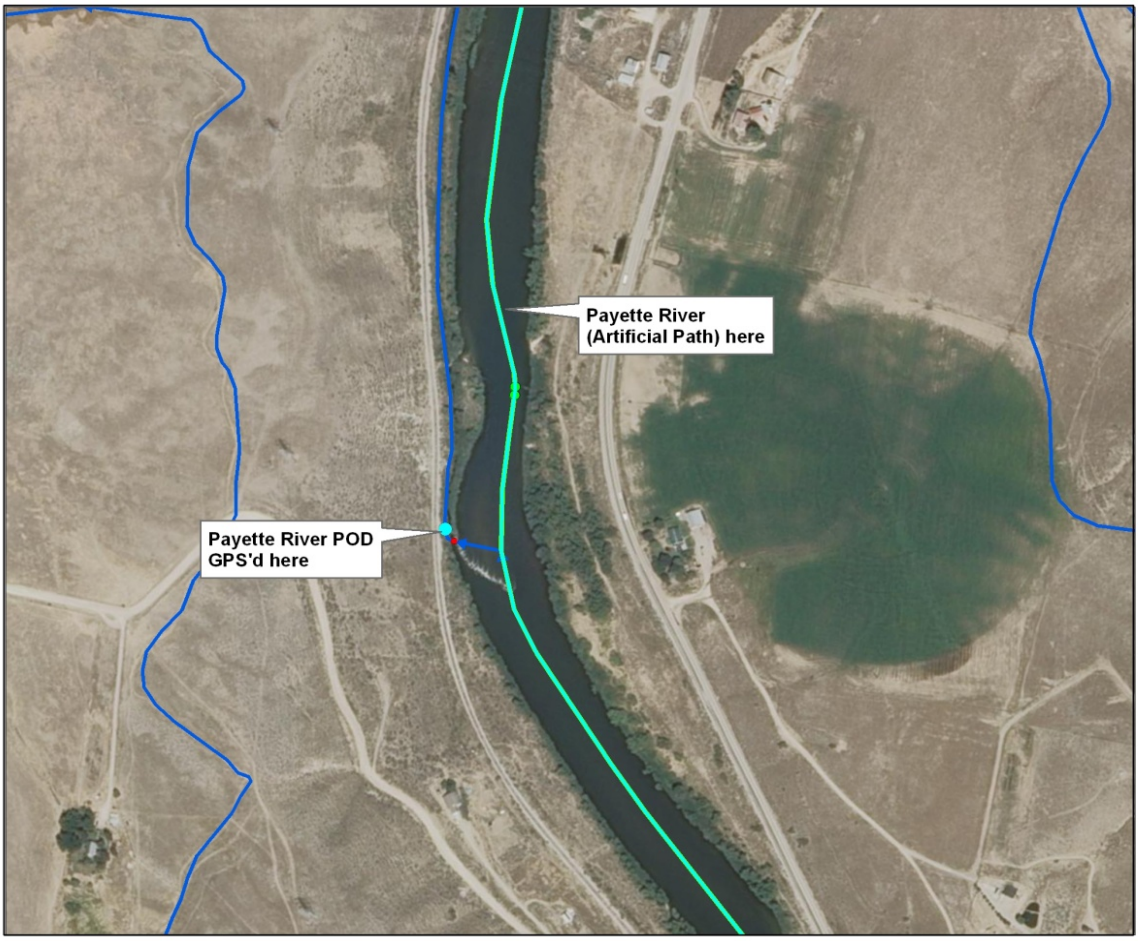


Figure 5.4 – GPS point digitized at the diversion structure; diversion source is the Payette River

Another possible error was identified as slightly differing source names between the POD and NHD. The NHDFlowline (artificial path) through the Sage Hen Reservoir is coded as "Sage Hen Creek", while the IDWR Water Rights database has the POD source listed as "Sage Hen Reservoir". Further work may be needed to correlate these names, either by updating the NHD or correcting the IDWR database, for consistency. This may require checking and perhaps updating the Geographic Names Information System (GNIS). The GNIS may have variants within their names that may be associated with the water rights database but would not be listed as the name on the NHDFlowline. After review, the GPS point was in the correct location, but flagged as an error because of the naming mis-match.

In one instance, there were two diversion structures within 115 meters of each other, with one named stream (Little Creek) and one unnamed stream that appears to flow into Little Creek. If this is the actual diversion point, then additional research will need to take place to determine if the stream names are wrong, and Little Creek should be the unnamed portion of the stream at the GPS'd diversion point. Another possibility exists that the GPS'd point should be at the named portion of the stream, and a field error exists. Further review and coordination with the IDWR water right agents and/or irrigation companies may need to take place to either correct the named portion of the streams, or re-examine the GPS location of this point. See Figure 5.5

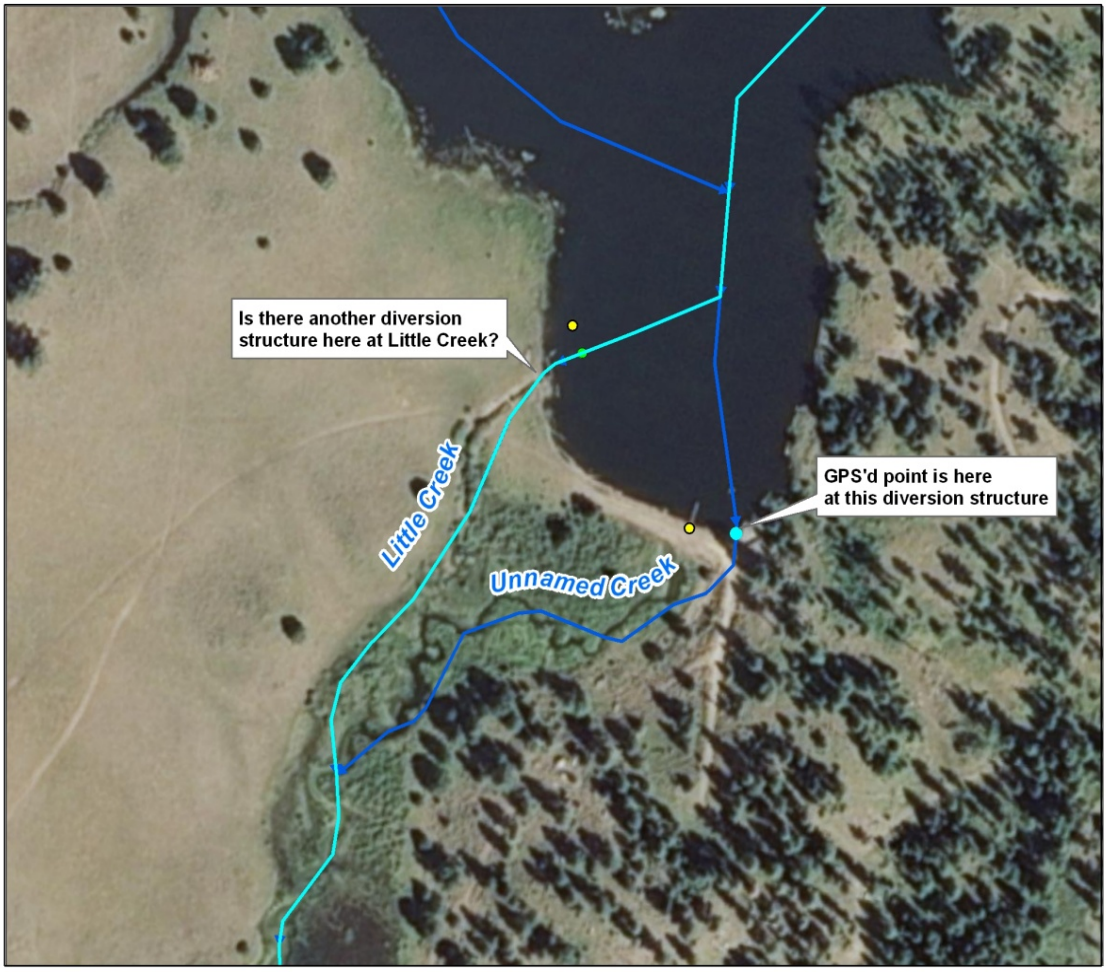


Figure 5.5 – GPS point at unnamed portion of stream. Stream Name change? GPS point location wrong?

A separate analysis was performed to assess whether the 15 unmatched GPS points (*fig 5.1*) could be snapped to the NHDFlowline using the NHD Area feature as a preliminary selection method since these points had accurate GPS locations; and it was anticipated that they would intersect the NHDArea features of the Payette River. By using the "select by location" tool within ArcMap, only three of the 15 unmatched GPS points intersected the NHDArea feature. It was determined that this method of selection would fail because the person collecting the GPS points was often standing on a diversion structure, or on the river bank outside the NHDArea polygon area.

Unnamed Surface: There were 848 points in the original feature class and 792 points remained after performing the dissolve. There were no named surface features in this feature class, thus no cross check with the NHD GNIS named features could be performed. After importing the points via the HEM tools, 790 event points were created, and 2 event points did not import. Again, it is unknown why the 2 points failed to import. This represents a 99.7% success rate for the number of points that would import via the HEM tool for this category.

Springs: There were 972 points in the original feature class and 894 points remained after performing the dissolve. Nearly all (94%) of these points had only "spring" as the named surface feature,

thus no cross check could be performed with the NHD GNIS features. No manual cross check was performed on the remaining 6% of the named features. After importing the points via the HEM tools, all 894 points successfully imported to events, representing 100% import success for this dataset.

Miscellaneous Surface: There were 292 points in the original feature class and 243 points remaining after performing the dissolve. Nearly all (96%) of these features had attribute names of "pond" or "wastewater" in the source field, so no cross check with the NHDFlowline GNIS features was performed on this dataset. After importing the points via the HEM tools, 243 event points were created, and 3 points failed to import. It is unknown why these points did not import. This represents a 98.7% success rate for the number of points that would import in this category.

Un-imported Points: In processing the four categories; named streams, unnamed streams, miscellaneous and streams, there were 11 points combined from all 4 shapefiles that did not import using the HEM tools. A separate process using the ArcGIS Linear Referencing Tools was performed with these points using the ArcMap Locate Features Along Routes Tool and Make Route Event Layer. Using the ArcGIS method and a 100-meter buffer, all 11 remaining points imported successfully and snapped to the NHDFlowline feature. None of the 6 named points snapped to the correct NHDFlowline, because the closest feature was the Black Canyon Irrigation Canal, not the centerline of the Payette River at the Black Canyon Dam (Artificial Path). Four of the 6 points had unknown methods of collection, while one point was digitized, and one point was a QQ. The digitized point was located correctly, at the diversion structure of Black Canyon Canal. Although this was the correct location for the diversion, the names did not match, thus making this appear to be a name mismatch. It is not known why these 11 points imported using the ArcGIS tools failed to successfully import via the HEM Tools. For more information on the specific issues encountered during this process, see Appendix D "HEM Tool Error Report".

The point events created with the ArcGIS Locate Features Along Routes Tool maintain the attributes from the original point dataset and will maintain one field from the geometric network. This is nearly opposite of the HEM tools which maintain all of the attributes from the geometric network needed to populate the NHDPointEventFC but only one attribute from the original point dataset. An advantage of the HEM tool is that it creates a point featureclass. A point feature class must be generated from the tables using Make Route Event Layer tool after using the Locate Features Along Routes Tool. One major disadvantage in using the HEM Tool method is not being able to create a selected set of features to narrow the range of NHDFlowlines available for event snapping. This would be a very helpful addition to the tool, either by allowing the user to specify NHD feature name criteria, or by allowing the user to specify a segment of the NHDFlowline from which to locate the events. Suppressing the Route Location Candidate Form in the HEM Tool Options was the most effective method for this study, as it was too time-consuming to individually select over 2900 points and manually pick locations. Suggestions for improvement were given to the HEM workgroup.

The HEM Tools provide a valuable resource for creating and managing spatial event data along the NHD network because they maintain all of the attributes necessary to utilize the geometric network of the NHD data model (v2.0). Using the techniques described in this report, 2959 event points (99.6%) were successfully created in the Payette subbasin via the HEM tools. Eleven points did not import, but were successfully imported using ArcGIS Tools. For an explanation of specific issues and problems during the HEM Tool import process, see appendix D "HEM Tool Error Report". This data has been forwarded in the form of a large format paper map to the Letha Irrigation District for QA/QC of the surface water

features within their district. As a result of that review, it is anticipated that work will continue as updates and further revisions are received.

6. Establishing Procedures and Requirements for Referencing PODs in the Future

As the result of this study, several steps were identified as key components, in order to effectively create and manage point events for additional subbasins within Idaho.

Obtain and Update Linework: Acquiring the most-recent canal and irrigation information from various local agencies and stakeholders was identified as a critical first step before POD events could be correctly located along the NHDFlowline. At the beginning of this study, a large amount of work was done to meet with representatives from local irrigation entities, and provide them with paper and/or digital data, and develop a method for data exchange. After the canal companies checked the areas in their district boundaries, the revised lines and updates were sent to IDWR.

Check out Subbasin from NHD: When this data was received by IDWR, the Payette subbasin was checked out from the USGS by the State NHD Data Steward (Technical Point of Contact), and work began to revise the NHD with the new information supplied by the local agencies.

Revision: Before point events could be created, the NHD dataset had to be updated with the most-recent linework supplied by the irrigation entities. For these edits, the NHD GeoEdit tools were used to complete the revisions. In conjunction with this NHD update, 11 new GNIS named features were identified and successfully submitted to the Geographic Names Information System (GNIS) for inclusion into the national database.

Check in Subbasin to NHD: After the dataset had been revised, it was checked back into the NHD to ensure it met the requirements for inclusion into the national repository.

Download Subbasin: After the subbasin had been QC'd and accepted back into the national repository by NHD, it was downloaded for use with this project. During the editing process, the NHD Data Model was upgraded to version 2.0, and this new edition was obtained in order to use the new version of the HEM Toolset. Both new versions (HEM Tools and NHD data) were needed to utilize the "suppress selection candidate" option that was only available in the new version of the HEM Tools, and only worked with the new NHD 2.0 data model.

Obtain and Prepare the IDWR Water Rights Database within the Payette Subbasin: After consulting with IDWR water right specialists, it was established that one point event (diversion structure) should be referenced by its spatial location (IDWR unique "Spatial ID Number"), the diversion stream name, ("Source"), and the collection method (GPS, digitized, QQ). This was preferred to having multiple event points at the same location ("stacked" points) showing multiple property owners (see figure 4.1) using the same diversion source at the same structure. Using this approach prevented stacked event points for the same location and source, while allowing changes such as property sales, splits or transfers, to not affect the accuracy of the Water Rights Spatial Data as modifications occur in the database. If additional water right information is required, the SpatialDataID number is linked back to the IDWR database for the most

current water right records at each diversion site. For more information on the specifics of this process, see Appendix C - "Test Study - Creating Events for the Emmett and Letha Irrigation Districts".

Point Events were created using the HEM Tools: The HEM Tools were used to create point events for all four feature classes created from the IDWR Water Rights Database. Instructions for completing this task have been documented in the reference manual "HEM Tool Instructions (Appendix B), and described in sections 4 and 5 of this report. Additional information can be found in Appendix C – "Test Study – Creating Events for the Emmett and Letha Irrigation Districts.

QA/QC of the Named Streams: Although the procedure for referencing all points using the HEM tools was consistent for all four datasets, records with named streams could be programmatically verified through matching stream names. Events with stream names that matched the NHDFlowline (GNIS Name) features were considered correct without further investigation. Some assessment was done to assess the events that did not match, specifically GPS'd points, where a higher instance of match was expected than was received. There were several key factors that influenced the accuracy results for the named PODs that were not matched to the named NHDFlowline features, and those elements will be further reviewed and, where possible, procedures will be refined in an attempt to eliminate some of these errors in the future.

QA/QC of the Unnamed Streams and Features: All of the unnamed streams and other features (65%) will require manual investigation to validate whether the snapped location was placed on the correct canal or stream. PODs with historical nominal QQ centroids and unnamed POD sources provide an initial location that is spatially referenced but further refinement is necessary in order to verify that the event corresponds to the correct hydrologic feature. Using this same method for GPS and digitized points, either with or without named streams, provides an excellent opportunity to spatially reference these events using the NHD data model. As better spatial locations and information is entered into the IDWR Water Rights Database, more accurate results will be obtained as a result of using these tools.

During this study, the HEM Tool methods used specifically for this project were documented in Appendix B, "Hem Tool Instructions", and Appendix C, "Test Study: Creating Events for the Emmett and Letha Irrigation Districts". Both of these documents were created to familiarize the user with this pilot study and the steps that were required in order to create point events using the HEM Tools. As Cooperation and coordination efforts with local irrigation entities continue, it is anticipated that additional POD locations (i.e., headgate structures) maintained by the irrigation companies can be obtained and included as point events into the NHD data model. As future updates are received, the initial procedures and requirements that have been identified for this pilot study will be revisited and updated as needed.

6.1 Possibilities for Automating POD Referencing Statewide – Assessment

Establishing a process for automating the existing POD's is also being investigated. As a result of this study, it has been determined that an initial subset of the PODs with named surface diversions would be a good starting point, as well as PODs with known GPS or digitized locations. IDWR staff currently works with a correlation tool application using a 5-meter buffer. This system alerts the water right agent to another point within 5 meters of the current point, and asks if the PODs are, in fact, separate points. It might be possible to modify this tool to create events for GPS'd or digitized points.

Also during the course of this study, it has been determined that it is not practical to define a process to automate the nominally located POD points for two main reasons. First, because these points are located in the center of each QQ section, there is no way to regulate with the current HEM tools which stream or canal the point event would snap to for multiple points. Second, in these cases where a location would need to be manually selected by using the HEM Tools "Selection Candidate Form", it would be an unrealistic use of time to get through the nominally-located POD points statewide. A two-step process using ArcGIS to do an initial selection of these POD points before running the HEM Tools may be a more efficient method, pending additional enhancements with the HEM tools.

The Idaho Department of Water Resources manages a relational database consisting of approximately 180,000 active water right records in Idaho. When a water right is created, transferred, or split, the IDWR water right agent will initiate an update of the POD spatial location when applicable. IDWR water right agents are familiar with GIS applications and use a large amount of spatial data to assist them in locating the correct PODs and water right information. This would be an optimal time to initiate a procedure to create or update event points as they are entered into the system. IDWR is currently assessing methods by which the HEM Tools could be used as a background application as these points are either created or updated, automatically snapping them to the appropriate canal or stream.

7. Time Requirement Assessment

This project was started in October 2009. In order to get the most recent and accurate canal and stream data, a crucial first step was taken to gather information from local irrigation companies and stakeholders. Considerable time was spent providing assistance and coordination efforts so that each stakeholder could supply IDWR with their surface water updates essential to update the NHD. The approximate time for this endeavor was 2-3 months. After these updates were received, the majority of time spent on this project involved using the NHD GeoEdit Tools to complete the actual NHD updates and submit them to USGS. This subbasin had to be re-downloaded and edited a second time to complete some minor GNIS name edits. IDWR also downloaded the subbasin in the new 2.0 version of the data model. This entire editing process took approximately 8 months to complete.

After the final edits had been resubmitted and accepted into the NHD, a copy was downloaded and the HEM Tool analysis began. Creating point events using the HEM Tool applications as described in this report and accompanying attachments, took approximately 6 weeks to complete, including assessing the results of the study. In the future, it is expected that the processing time will be minimized as a course of action has now been identified to optimally accomplish these tasks. In addition, it is hoped that with the release of the new GeoEdit Tools, the editing process will be expedited, thus improving both the time it takes to update NHD data, and the number of subbasins that can be populated with POD event data.

8. Conclusions

There are approximately 180,000 active water rights throughout the state of Idaho that can be categorized into approximately 60,000 separate points of diversion structures. Diversion points that have a GPS entry or have been digitized with good base data are the most favorable candidates for incorporating statewide POD event points into the NHD model. Diversion points with named surface water sources are also excellent candidates for inclusion into the NHD. Based on the pilot study, this would represent

approximately 21,000 diversion points statewide, or 35%. The remaining POD points (approximately 39,000) are nominally located, or have an unknown value for collection method. These points would require a considerable amount of time to verify they snapped to the correct location using the HEM Tool approach described in this study.

An accurate and reliable representation of surface water data within the NHD was a key component to this project. Before POD point events could be located along the NHDFlowline features, those features needed to be accurately represented in the spatial data model. In order to accomplish this task, continued collaboration with local irrigation companies and interested stakeholders was an important factor, and a critical first step in this process. Additional surface water updates have been received from these agencies, and further work will continue to update the NHD in the Payette subbasin as a result of this analysis.

This study provided valuable insight into the distinctive type of information contained within the IDWR Water Rights database, and how that information can be used to improve the NHD. IDWR gained a better understanding of the challenges ahead, and the minimum requirements necessary to implement a statewide system for incorporating POD event data into the NHD. The advantages of having an up-to-date representation of the current canal systems in Idaho that are fully networked in the NHD will greatly improve IDWR's insight into water delivery, and provide an unprecedented opportunity to compare and model water use for various natural resources statewide.

9. Appendix

a. **Appendix A: POD Interview Results**
b. **Appendix B: Referencing Water Right PODs in the Payette Subbasin to the NHD**
c. **Appendix C: Creating Events for the Emmett and Letha Irrigation Districts**
d. **Appendix D: Hem Tool Error Report**

10. Acknowledgements

This document and the work described in it were produced by the Idaho Department of Water Resources and were funded partially by the Unites States Geological Survey (USGS).

We wish to thank the IDWR Staff who provided valuable input on the POD Survey:

Thank you to Sharla Curtis (IDWR), the Letha Irrigation District, the Emmett Irrigation District, and Water District 65 Staff for providing valuable edits to the NHD.

Special thanks to Wilma Robertson for all her hard work, NHD training and assistance, and continued dedication to the success of this project.