Building Partnerships for Data Stewardship

The California National Hydrography Dataset Program

CalGIS Conference
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Joel Osuna: CGS: *Project Manager*

Drew Decker: USGS: *National Map Liaison*
We’ll be talking about...

- Introduction to NHD and State Stewardship Program
- How the NHD is Used
  - Maintenance and Upkeep
    - NHD for California
  - California has an NHD Steward!
NHD Introduction
Attributes provide basic intelligence
Flow Direction – a key piece of intelligence
History of the National Hydrography Dataset

- 1988 - USGS completes national coverage of 100k (Medium Resolution) DLGs
- 1992 - Environmental Protection Agency (EPA) completes national RF3 coverage,
- 1997 - USGS / EPA cooperative effort to combine elements of DLG and RF3,
- 2001 - National coverage of 100k (Medium Resolution) NHD completed,
- 2002 - USGS, USFS, and others begin work to produce 24k (High Resolution) NHD,
- 2003 - Feature Operational Database (FOD) is retired and Geodatabase comes online,
- 2006 – First NHD Stewardship Agreement signed,
- 2007 - National coverage of 24K (High Resolution) NHD completed,
- 2015 – 24K NHDPlus effort begins. Value Added Attribute Table being populated.
History of the NHD

The following datasets were used to create particular characteristics in the NHD:

- **USGS DLGs**: a. Standardized Feature Classification, b. Spatial Accuracy at 100K scale
- **EPA RF3s**: a. Flow Direction (based on from/to node), b. Upstream/Downstream Navigation, c. Reach Codes (unique identification), d. Nationally Consistent Hydrography Network
- **USGS GNIS**: a. Names and ID Unique Numbers for Named Features

Important to remember the NHD is in 1:100,000-scale at this point!
How the 1:24,000-Scale NHD was Created

What is a Digital Line Graph (DLG)?

- DLGs are vector files containing point, line, and polygon data (such as springs, buildings, roads, streams, lakes, contours, boundaries, woodland areas) digitized from USGS 1:100,000-scale and 1:24,000-scale topographic maps.

- DLGs offer a full range of attribute codes, are highly accurate, are topologically structured, which makes them ideal for use in geographic information systems (GIS).
How the 1:24,000-Scale NHD was Created

Conflation of 1:100,000-scale NHD to 1:24,000-scale NHD:

- Transferred selected RF3 attributes from 1:100,000-scale features to 1:24,000-scale geometry
- Input data was “Best Available” High Resolution data:
  - USGS 24K DLGs
  - USFS Cartographic Feature Files (CFFs)
  - Local data (if available)
- This process provided 1:24,000-scale spatial feature accuracy with good feature attribution from the 1:100,000-scale input data
NHD Design Goals

- Retain DLG accuracy and cartographic qualities
- Retain Reach File applications orientation with enhancements to address use in GIS
- Feature-based vector data with permanent feature identifiers
- Position for shared long term maintenance and enhancement responsibilities
NHD Stewardship

State of California

California NHD Principal Steward
Name: Jane Schuler-Kammer
E-mail: jschuler@water.ca.gov
Phone: 916-445-4464
Organization: California - Department of Water Resources

California WBD Principal Steward
Name: Bruce Melven
E-mail: BruceMelven@usgs.gov
Phone: 303-792-5081
Organization: NRCs National and State Offices

USGS Regions I Point of Contact (CA)
Name: Kristiana G. Elle
E-mail: kellenad@usgs.gov

Legend
Regions
Stewardship State Regions

- Region I
- Region II
- Region III
- Region IV
- Region V

Click on a state to see the area's POC, Principal Steward, Geospatial Liaison, and MOU.
Stewardship of the NHD

What is Stewardship of the NHD?

- The NHD is a ‘living’ database, ever changing and requiring constant maintenance.
- Quality revisions will always be needed to keep the NHD current and useful.
- Organizations closest to the Hydrography are most aware of ground truth.
- Such Organizations have the unique opportunity to serve as Stewards.
- USGS will assist in anyway possible to achieve goals of NHD Maintenance program.
Stewardship of the NHD

What is Stewardship (Cont)?

- Distributed Maintenance:
  a. Typically on a State-by-State basis
  b. Suited to regional needs

- Identifying a Primary Steward:
  a. Each State will typically have one NHD Principal Steward
  b. Acts as single POC between State and USGS
  c. Coordinates all NHD Maintenance activities within their State
Stewardship of the NHD

Partner: Responsibilities and Procedures

The Principal Steward agrees to:

a. Acts as a single POC to USGS for their particular State,
b. Represent the interests of the entire State-wide user community,
c. Coordinate with all others for the maintenance of the NHD for their State,
d. Accept input, adjudicate, and report any decision publicly
The Principal Steward agrees to:

e. Be responsive to all NHD Users in their State,
f. Maintains an awareness of the activities of all others in their State,
g. Provide contact information for management and technical issues,
h. Provide publicly available information on status of data stewardship activities,
i. Provide updates back to USGS in the agreed upon format
USGS: Responsibilities and Procedures

USGS agrees to:

a. Process transactions/updates in timely manner,
b. Provide assistance/guidance to State Stewardship programs,
c. Provide Maintenance tools, documentation, and training,
d. Develop solutions to incorporate State hydrographic data,
e. Communicate Transaction status
Stewardship of the NHD

USGS: Responsibilities and Procedures

USGS agrees to:

f. Provide reach code allocator,
g. Communicate NHD structure, format, or content changes,
h. Provide clear guidance for updates tracking,
i. Provide documentation on update validation,
j. Provide documentation on formats for update transactions,
k. Provide POC for management and technical issues
Stewardship of the NHD

What are the Advantages for Participating in NHD Stewardship?

- Current hydrography data for all users
- Better maps
- Better results from analysis
- Statewide seamless dataset
- Allows for regional studies
- Share data
- Update notification
- Receive National updates
- Events
- Applications
NHD Stewardship Process

Production Database

NHD job checked out

Edits, updates, and QC are carried out

NHD job checked back in
NHD Stewardship and Updating

USGS ➔ Regional POC ➔ State Steward ➔ State Sub-Stewards
Hydrography

National Hydrography Dataset
Watershed Boundary Dataset

The National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD) are used to portray surface water on The National Map. The NHD represents the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and streamgages. The WBD represents drainage basins as enclosed areas in eight different size categories. Both datasets represent the real world at a nominal scale of 1:24,000-scale, which means that one inch of The National Map data equals 2,000 feet on the ground. To maintain mapping clarity not all water features are represented and those that are use a moderate level of detail.

The NHD and WBD are digital vector datasets used by geographic information systems (GIS). These data are designed to be used in general mapping and in the analysis of surface water systems. In order to make a map these data must be used by a GIS to render the data and then print a map or make an image. The NHD is portrayed on the US Topo map product produced by the USGS and the NHD and WBD can be viewed on the Hydrography Viewer or the general mapping oriented The National Map Viewer.

In mapping, the NHD and WBD are used with other data themes such as elevation, boundaries, transportation, and structures to produce general reference maps. The NHD and WBD are often used by scientists using GIS. GIS technologies take advantage of a rich set of attributes imbedded in the data to generate specialized information. These analyses are possible because the NHD contains a flow network that allows for tracing water downstream or upstream. The NHD and WBD use an addressing system based on reach codes and linear referencing to link specific information about the water such as water discharge rates, water quality, and fish population.

The WBD exists in six levels of a nested hierarchy permitting the analysis to determine which drainage basin a particular location is enclosed in. This makes it possible to determine which rivers and lakes could be affected by an event such as a toxic spill. Using basic NHD features like flow network, linked information, and other characteristics, along with one of the six levels of WBD areas, it is possible to study cause and effect relationships, such as how a source of poor water quality upstream might affect a fish population downstream.
usgs-mrs.cr.usgs.gov/usgssteward/
NHD resources and tools

NHD Tools

The following tools are provided to assist in the use of NHD data. Any problems encountered when using these tools should be reported to nhd@usgs.gov.

- **NHD GeoCSS**
  The NHD GeoCSS permanent database tool is to many users the most useful tool in working with NHD data.
  - Contact NHD

- **USGS Reproject Add-In**
  Version 2.2 using ESRI's Forest Service's reprojection format, but adds on tool reprojects NHD levels in both directions.
  - Version

- **Hydrography Editing Add-In**
  The use of the NHD for hydrography editing enables users to keep the database accurate and up-to-date.
  - Imported, the location of the flowline

- **NHD Metadata**
  The source citation operates within the NHD.

NHDFlowline

NHDFlowlines consist of routes that make up a linear surface water drainage network. Flowlines have a reach code and a measure, and are used for the establishment of upstream/downstream relationships. This network allows for powerful analysis and modeling capabilities. Each Feature type is attributed with descriptive information by an F-code.

See a complete list of F-codes for hydrography features.

The arrows on these Flowlines point in the possible direction of flow when flow direction is initialized. Flow direction arrows may be symbolized in the feature properties or by using the Utility Network Analyst.

The attributes associated with NHDFlowlines are as follows:

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Definition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Identifier</td>
<td>Global ID and GUID data types store registry style strings consisting of 38 character encoded in parity</td>
<td></td>
</tr>
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</table>
Editing the NHD to keep up with change

How to maintain constantly changing features in the NHD
Editing the NHD to keep up with change
How to maintain constantly changing features in the NHD
NHD data and feature types

![Add Data window](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDArea</td>
<td>File Geodatabase Feature Clusters</td>
</tr>
<tr>
<td>NHDAreaEventFC</td>
<td>File Geodatabase Feature Clusters</td>
</tr>
<tr>
<td>NHDFlowline</td>
<td>File Geodatabase Feature Clusters</td>
</tr>
<tr>
<td>NHDLine</td>
<td>File Geodatabase Feature Clusters</td>
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<tr>
<td>NHDLineEventFC</td>
<td>File Geodatabase Feature Clusters</td>
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<td>NHDPoint</td>
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<td>NHDPointEventFC</td>
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<tr>
<td>NHDWaterbody</td>
<td>File Geodatabase Feature Clusters</td>
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</tbody>
</table>

Name: NHDFlowline; NHDArea; NHDWaterbody
Show of type: Datasets, Layers and Results
### NHD Feature Class Introduction

<table>
<thead>
<tr>
<th>Feature Class Name</th>
<th>Vector Type</th>
<th>Feature Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDPoint</td>
<td>Point</td>
<td>Springs, Wells, Gates, Water Intakes</td>
</tr>
<tr>
<td>NHDFlowline</td>
<td>Line</td>
<td>Steams, Rivers, Canals, Ditches, Pipelines</td>
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<td>NHDLines</td>
<td>Line</td>
<td>Flumes, Tunnels, Dams, Bridges</td>
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<tr>
<td>NHDWaterbody</td>
<td>Polygon</td>
<td>Lakes, Ponds, Reservoirs, Estuaries, Swamps</td>
</tr>
<tr>
<td>NHDArea</td>
<td>Polygon</td>
<td>Washes, Sea/Ocean, Foreshore, Rapids, 2D Streams</td>
</tr>
</tbody>
</table>

*Image of a map and database structure is also present.*
NHD Waterbodies – lake/pond
Completing the network through waterbodies with artificial paths
NHD – points, lines, and polygons
NHD Flowline features
NHD Flowline feature types

- FCode
- Artificial Path
- Canal Ditch
  - Canal Ditch: Canal Ditch Type = Aqueduct
  - Canal Ditch: Canal Ditch Type = Stormwater
- Coastline
- Connector
- Pipeline
  - Pipeline: Pipeline Type = Aqueduct
  - Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = At or Near
  - Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Elevated
  - Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Underground
  - Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Underwater
  - Pipeline: Pipeline Type = General Case
  - Pipeline: Pipeline Type = General Case; Relationship to Surface = At or Near
  - Pipeline: Pipeline Type = General Case; Relationship to Surface = Elevated
  - Pipeline: Pipeline Type = General Case; Relationship to Surface = Underground
  - Pipeline: Pipeline Type = General Case; Relationship to Surface = Underwater
  - Pipeline: Pipeline Type = Penstock
  - Pipeline: Pipeline Type = Penstock; Relationship to Surface = At or Near
  - Pipeline: Pipeline Type = Penstock; Relationship to Surface = Elevated
  - Pipeline: Pipeline Type = Penstock; Relationship to Surface = Underground
  - Pipeline: Pipeline Type = Penstock; Relationship to Surface = Underwater
  - Pipeline: Pipeline Type = Siphon
- Pipeline: Pipeline Type = Stormwater
  - Pipeline: Pipeline Type = Stormwater; Relationship to Surface = At or Near
  - Pipeline: Pipeline Type = Stormwater; Relationship to Surface = Elevated
  - Pipeline: Pipeline Type = Stormwater; Relationship to Surface = Underground
  - Pipeline: Pipeline Type = Stormwater; Relationship to Surface = Underwater
- Stream/River
  - Stream/River: Hydrographic Category = Ephemeral
  - Stream/River: Hydrographic Category = Intermittent
  - Stream/River: Hydrographic Category = Perennial
- Underground Conduit
  - Underground Conduit: Positional Accuracy = Approximate
  - Underground Conduit: Positional Accuracy = Definite
  - Underground Conduit: Positional Accuracy = Indefinite
Stream classification

Perennial

Intermittent

Ephemeral
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<td>Canal/Ditch Type: stormwater</td>
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<tr>
<td>CONNECTOR</td>
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<td>feature type only: no attributes</td>
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<td>Reservoir Type: treatment-settling pond</td>
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</table>
NHDLIneline - detail
### NHD attribution – NHDFlowline

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<tr>
<th>Field</th>
<th>Value</th>
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### NHD attribution – NHDWaterbody

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
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<tr>
<td>Location</td>
<td>89°20'10.965&quot;W  43°4'45.921&quot;N</td>
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<tr>
<td>Field</td>
<td>Value</td>
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<td>AreaSqKm</td>
<td>13.598</td>
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<tr>
<td>Elevation</td>
<td>&lt;null&gt;</td>
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<tr>
<td>FCode</td>
<td>Lake/Pond: Hydrographic Category = Perennial</td>
</tr>
<tr>
<td>FDate</td>
<td>5/25/2010 2:18:32 PM</td>
</tr>
<tr>
<td>FType</td>
<td>LakePond</td>
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<tr>
<td>GNIS_ID</td>
<td>01569656</td>
</tr>
<tr>
<td>GNIS_Name</td>
<td>Lake Monona</td>
</tr>
<tr>
<td>OBJECTID</td>
<td>8598</td>
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<tr>
<td>Permanent_Identifier</td>
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<tr>
<td>ReachCode</td>
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<td>Resolution</td>
<td>High</td>
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<td>Shape</td>
<td>Polygon Z</td>
</tr>
<tr>
<td>Shape_Area</td>
<td>0.001503</td>
</tr>
<tr>
<td>Shape_Length</td>
<td>0.287323</td>
</tr>
</tbody>
</table>
NHD Utility and Use

Network Analysis and Event Creation:
- Upstream/downstream tracing on the flow network
- Flow analysis
- Linear Referencing: *Creating spatial events by using the NHD. Meant to be maintained by the end user to fit their needs.*
  - Gauging/Monitoring stations
  - Fish spawning extents along a river
  - Hazardous/polluted extent of a stream
  - Portion of a pond that allows for recreational use

NHD Utilities:
- Build Flow
- Build Network
- M-Value Utilities
- Subset by Polygon
NHD Utility and Use

NHD for Water Quality Assessment

CA Basin Plan Mapping Project: Create a more efficient and intuitive system for tracking water quality policies in the State of California by incorporating most components of the CA Basin Plans and other related Water Quality Control Plans into the National Hydrography Dataset (NHD) geodatabase.

- Regional & Statewide Water Quality Objectives
- Beneficial Uses
- Applicable TMDL’s
- Statewide and regional policies (CTR, NTR, NRWQC, Ocean Plan, and Thermal Plan)
NHD Utility and Use

NHDPlus:

- Value added attributes that tie to the NHD
  - Stream Order
  - Path Length
  - Flow Volume
  - Arbolate Sum

- NHDPlus High Resolution
  - In Progress
  - Beta version produced first for testing/review
  - Sequential refreshes
  - Production First Requires:
    - Repair of NHD flow network issues
    - Correction of NHD severity 1 errors
    - Correction of NHD/WBD errors at the HUC4 level
### NHDPlus High Res:

<table>
<thead>
<tr>
<th>WBD HU2, HU4, or HU6</th>
<th>Hydrologic Region</th>
<th>Additional Information</th>
<th># of HU4s</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>Tennessee</td>
<td>Mississippi 1 of 6</td>
<td>4</td>
</tr>
<tr>
<td>01</td>
<td>Northeast</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Texas</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>14</td>
<td>Upper Colorado</td>
<td>Colorado 1 of 2</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>Lower Colorado</td>
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<tr>
<td>02</td>
<td>Mid-Atlantic</td>
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<tr>
<td>16</td>
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<td>-</td>
<td>6</td>
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<tr>
<td>0903</td>
<td>Canadian Pilot (0903)</td>
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<tr>
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<td>29</td>
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<tr>
<td>07</td>
<td>Upper Mississippi</td>
<td>Mississippi 3 of 6</td>
<td>14</td>
</tr>
<tr>
<td>041504</td>
<td>Canadian Pilot (041504)</td>
<td>Pilot (Lake Champlain)</td>
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</tr>
<tr>
<td>05</td>
<td>Ohio</td>
<td>Mississippi 4 of 5</td>
<td>14</td>
</tr>
<tr>
<td>09</td>
<td>Souris, Red, Rainy</td>
<td>Souris, Red, Rainy (less pilot)</td>
<td>3</td>
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<tr>
<td>1502</td>
<td>Alaska Pilot (1902)</td>
<td>Pilot (MatSu)</td>
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<tr>
<td>11</td>
<td>Arkansas, Red, White</td>
<td>Mississippi 5 of 5</td>
<td>14</td>
</tr>
<tr>
<td>1801</td>
<td>Klamath River Basin</td>
<td>Klamath Dam Removal Project</td>
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</tr>
<tr>
<td>3</td>
<td>South Atlantic</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>17</td>
<td>Pacific Northwest</td>
<td>Pacific Northwest</td>
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</tr>
<tr>
<td>13</td>
<td>Rio Grande</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Great Lakes</td>
<td>Complete Drainage Area (less pilot)</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>Mississippi</td>
<td>Mississippi 6 of 5</td>
<td>9</td>
</tr>
<tr>
<td>18</td>
<td>California</td>
<td>California (less Klamath Priority)</td>
<td>9</td>
</tr>
<tr>
<td>19</td>
<td>Alaska</td>
<td>Alaska (less MatSu Pilot)</td>
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</tr>
<tr>
<td>20</td>
<td>Hawaii</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21 &amp; 22</td>
<td>Virgin Islands &amp; Puerto Rico</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Italicized text indicates partial subregion (HU4).*
Goals:

• Bring the NHD to current conditions.
• Apply uniform standards to the update process.
• Fix quality control errors.
• Document new rules and methods.

Updates to Geometry:

• Realignment
• Densification
• Deletions

Updates to Attributes:

• Seasonality
• Names
• IDs
Updating and Maintaining the NHD

Reference Data: *Provides a guide to decision making in the update process.*

- Most Recent Aerial Photos: NAIP
- Regional and Local Hydro Datasets

NHD Quality Control: *Identifies errors in the NHD before and after editing.*

- Topology
- Database Integrity
- Feature to Feature Relationships
- Flow Checks
- Reachcode Continuity
- Name Continuity
The NHD in many areas of the state is inaccurate.

There is a demand for updated NHD data across multiple agencies, organizations, etc. in California.

In the past, some sub-stewards have made some smaller scale updates to select areas.

Various independent updates to the NHD not associated with the stewardship system have been made.
  - Geometry updates
  - Attribution updates
  - Name additions

Update work within the State has recently initiated, leading to stewardship by CA DWR.

Ongoing and future work on improving the NHD in CA will require major resources.
Main Goal: *Produce a uniform product serving as a common denominator that can be maintained and used across multiple agencies and groups.*

- **Comprehensive Updates**
  - Brining updates to all NHD components
  - Avoiding a piecemealed approach when possible

- **Scale**
  - 1:24,000 to start

- **Mapping and Interpretation Business Rules**
  - Standardizing how features are interpreted and mapped in NHD.
  - Setting limitations.

- **Metadata**
  - Setting metadata standards for the state.
NHD Stewardship in California

- Approximate CA State Area:
  - 163,696 mi²
  - 423,971 km²
- 140 HUC8’s intersect California
- Spans WBD Regions 15, 16, 17, 18
- Contains a large variety of hydro and land cover types:
  - Mountainous
  - Valley
  - Arid
  - Semi-Arid
  - Coastal
  - Agricultural
  - Urbanized
Previous and Current NHD Work

Previous/Current Work

- **NHD Topo Update Pilot: 2014-2015**
  - USGS/CGS
  - 5 Full HUC8’s Updated
  - 2 Partial HUC8’s Updated

- **NHD State Update Project: Ongoing**
  - CA DFW/CGS/GIC
  - ~45 HUC8’s to be Updated
  - DFW-Based Lake and Reservoir Updates for Entire State
  - Provisional Name Integration

- **NHD DLCC Project: Ongoing**
  - USGS/USFWS/DLCC/CGS
  - 1 Full HUC8 in CA/AZ Updated

This equals about 30% of the State.

Note: USFS Lands have not received NHD updates in watersheds currently undergoing NHD updates.
Future Work

- **Legal Delta NHD Update Project:**
  - CA DWR/GIC/CGS
  - NHD updates at a finer scale
  - Specific requirements that go beyond standard scope

- **NHD/WBD State Stewardship:**
  - State Stewardship: DWR
  - In partnership with USGS, CGS, GIC, USFS, CA Tribes, neighboring states, and others.
  - WBD updates to NHD-completed watersheds
  - NHD/WBD updates to additional watersheds
  - Keeping NHDPlus HR timing in perspective

Note: USFS Lands have not received NHD updates in watersheds currently undergoing NHD updates.
California NHD Stewardship

DWR as the State Steward – Year 1

Memorandum of Understanding: USGS and DWR

Coordination and Outreach –

*Participation by Local Hydrology Experts is Welcome!*
• Fund and revive the National Hydrological (sic) Dataset for California to improve high-quality framework geospatial data and the precision and accuracy of mapping and scientific studies.
California NHD Stewardship

DWR as the State Steward – Year 1

Memorandum of Understanding: USGS and DWR

No funding transfer

Describes roles and responsibilities

Formalizes the Steward Program
California NHD Stewardship

The Outlook for NHD in California –

• Updating all Subbasins to 1:24K
• Utilize High Resolution Elevation Data (LiDAR) for NHD including WBD
• NHD Status Map
• Other Priorities

Yes, we’re OPEN

FOR COLLABORATION!
Questions?

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