NEH Part 631 Chapter 31, "Groundwater"
Summary of Revisions and General Notes

1. Formatting
   - This draft meets formatting requirements for Handbooks as agreed to by the Directives Management (Management Services Divisions) and the Conservation Engineering Division (CED).
   - Part of the formatting requirements resulted in all the tables, graphs, photos, figures, or other illustrative diagrams to be labeled as Figures.
2. Cover Photo: A cover photo has not yet been chosen. Please submit any suggestions to kari.scannella@usda.gov or susan.grover@usda.gov
3. This new chapter combines several chapters under the April 2012 NEH 210, Part 631 including
   - Chapter 30 – "Groundwater Hydrology and Geology"
   - Chapter 31 – "Groundwater Investigations"
   - Chapter 32 – "Well Design and Spring Development" (groundwater elements)
   - Chapter 33 – "Groundwater Recharge"
   - Part of NEH 651, Agricultural Waste Management Field Handbook, Chapter 7 – "Geologic and Groundwater Considerations and Appendix 10-D" (discussion on permeability)
   - Part of NEH 650 Chapter 12 – "Springs and Wells"
4. 631.3101 General
   - The Introduction includes text from NEH 631 Chap. 31, 631.3100 (Feb. 2010) with added language about why subsurface investigations are conducted, what the data is used for, generally how data is collected and how the document is organized.
   - The Purpose section is largely from NEH 631 Chap. 30, 631.3000 (Jan 2010)
   - The Groundwater Rights section is a compilation of material from:
     - NEH 631 Chap. 30, 631.3000 (Jan 2010)
     - NEH 631 Chap. 33, 631.3300 (Jan 2010)
5. 631.3102 Groundwater Sources
   - New material about USGS, NOAA, BOR, State Oil and Gas Board / Departments of Natural Resources, State Interactive Water Well Maps, and NRCS materials for groundwater.
6. 631.3103 Levels of Groundwater Investigations
   - Some material came directly from NEH 631 Chap. 31, 631.3100 (Feb. 2010)
   - Updated and standardized levels of investigation to match other types of geologic investigation.
7. 631.3107 Appendix A – Groundwater Hydrology
   - Adapted from NEH 631 Chap. 31, 631.3101 (Feb 2010) and combined with NEH 651 (AWMFH) Chap. 7, 651.0703 (Aug. 2010)
   - Most of figures are from NEH 651 (AWMFH) Chap. 7, 651.0703 (Aug. 2010)
   - Much of the material was adapted from NEH 631 Chap. 31, 631.3100 (Feb. 2010)
8. 631.3108 Appendix B – Hydraulic Material Properties
   - Porosity and Specific Yield is adapted from NEH 651 (AWMFH) Chap. 7, 651.0703 (Aug. 2010)
   - Permeability is adapted from NEH 651 (AWMFH) Appendix 10-D (Aug. 2009)
   - Hydraulic Conductivity is adapted from NEH 631 Chap. 30, 631.3000 (Jan 2010)
   - Some concepts, such as Specific Discharge are adapted from NEH 651 (AWMFH) Appendix 10-D (Aug. 2009)

- Other concepts, such as Transmissivity and Storativity (coefficient of storage) are adapted from NEH 631 Chap. 30 (Jan. 2010)

9. 631.3109 Appendix C – Groundwater Movement
   - Darcy's Law, Flow Lines, Equipotential Lines and Flow Nets sections are adapted from NEH 631 Chap. 30, 631.3000 (Jan 2010)
   - Potentiometric Surface – adapted partially from NEH 631 Chap. 30, 631.3000 (Jan 2010) and partially from Fetter, C.W., Jr. 2001. Applied hydrogeology, 4th ed. Merrill Publ. Co. Columbus, OH. 488 pp.
10. 631.3110 Appendix D – Groundwater Recharge
    - Mostly adapted from NEH 631, Chap. 33, 631.3300 (Jan. 2010)
11. 631.3111 Appendix E – Groundwater Geology
    - Adapted from NEH 631 Chap. 30, 631.3002 (Jan 2010) except portions of the rock aquifer sections which were updated, slightly rearranged, and expanded upon.
12. 631.3112 Appendix F – Groundwater Quality
    - Recharge water quality primarily came from NEH 631, Chap. 33, 631.3300 (Jan. 2010) combined with NEH 651 (AWMFH) Chap. 3, 651.0302 (b) (Aug. 2010) and NEH 651 (AWMFH) Chap. 7, 651.0700 (Aug. 2010)
    - Additional information came from:
      - NEH 210 Part 651, Animal Waste Management Field Handbook, (March 2008) Chap. 4.
      - NRCS Environmental Technical Note No. MT-5, "Water Quality Indicator Tools", August 2007. Water Quality Technical Note No (usda.gov)
      - Natural Resources Conservation Service. (1996, March). RCA Issue Brief #9 March 1996. Retrieved from: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/rca/?cid=nrcs143_014216
      - Sharpley, A. (1995, October). Fate and Transport of Nutrients: Phosphorus. Retrieved from NRCS Soil and Water Resources Conservation Act (RCA): https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/rca/?&cid=nrcs143_014203
      - NRCS Water Quality Technical Note No. 2 (Revised), "The Phosphorus Index", June 2013, Spokane, Washington. TECHNICAL NOTES (usda.gov)
      - Pick, Tom. (June 2011). "NRCS Environment Tech Note MT-1, Assessing Water Quality for Human Consumption, Agriculture, and Aquatic Life Uses". United States Department of Agriculture (usda.gov)
13. 631.3113 Appendix G – Groundwater Flow Direction
    - Adapted and modified from NEH 210 Part 651, Animal Waste Management Field Handbook, (Aug. 2010) Appendix A.
14. 631.3114 Appendix H – Groundwater Data Collection
    - Maps, mapping, imagery, equipment, field logs, geologic sections, and well logs material adapted from NEH 631 Chap. 31, 631.3101 (Feb 2010), NEH 631 Chap. 2, 631.0204 (e) (Feb 2010) , NEH 631 Chap. 32, 631.3200 (Jan 2010)
    - Geophysical logs adapted from NEH 631 Chap. 32, 631.3200 (Jan 2010)
    - Tracers and Dyes adapted from NEH 631 Chap. 31, pg. 31-12 (Jan 2010) and the Bureau of Reclamation *Water Measurement Manual (2001)*

- Water Level Measurements and Water Surface Elevations sections are adapted from NEH 631 Chap. 31, 631.3101, (b) (Jan 2010)

15. 631.3115 Appendix I – Groundwater Monitoring
    - Piezometers – NEH 631 Chap. 31, pg. 3-19 and 3-20 (Feb 2010)
    - Monitoring Wells – A variety of sources were used to include:
        - Direct Push Technology - https://www.cascade-env.com/technologies/drilling/direct-push/
        - https://clu-in.org/download/char/540r04005.pdf
        - Well Design and Construction for Monitoring Groundwater at Contaminated Sites (ca.gov)
        - Part 650 Chapter 19 OpenNonWebContent.aspx (usda.gov)
        - Cascade Drilling: https://www.cascade-env.com/technologies/drilling/direct-push/
        - Contreras, Grosser, and Ver Strate, 2008,"The Use of the Fully-grouted Method for Piezometer Installation, " Geotechnical News, pp 30 - 37, Vol 26, June 2008.
        - Mikkelsen, P. E, Grouting in Piezometers - An Experiment at Slope Indicator, 1999
        - Mikkelsen, P. E, Cement-Bentonite Grout Backfill for Borehole Instruments, Geotechnical News, December, 2002.
        - Mikkelsen and Green, 2003,"Piezometers in Fully-Grouted Boreholes." International Symposium on Geomechanics, Oslo, Norway. September 2003.
        - Sterrett, R.J. 2007. Groundwater and Wells. Third edition. Johnson Screens, a Weatherford Company. New Brighton, MN.
        - U.S. Department of the Interior – Bureau of Reclamation. 1987. Embankment Dam Instrumentation Manual. Pressure Measuring Devices, Sections 27, 28, 29, 30, 31, 32, 33, and 34. Pp 17-56.
        - U.S. Department of the Interior – Bureau of Reclamation 1987. Concrete Dam Instrumentation Manual. Pressure Measuring Devices, Sections 2.3, 2.4, 2.5, and 2.6. pp 20-36.
        - U.S. Environmental Protection Agency (USEPA). 1998. Manual of Water Well Construction Practices. pg. 135.
        - U.S. Environmental Protection Agency (USEPA), Office of Water, EPA 540R=-4/-005, August 2005: https://clu-in.org/download/char/540r04005.pdf]

16. 631.3116 Appendix J – Groundwater Aquifer Testing
    - Pressure Testing –
    - Aquifer Testing – Adapted from NEH 631 Chap. 32, pg. 32-37 (Jan 2010) and NEH 631 Chap. 31, pg. 31-25 (Feb 2010) with updated material by Kari Scannella.