

APPENDIX H¹

HISTORICAL BACKGROUND ON DEVELOPMENT OF SHARED GROUNDWATER RESOURCES IN THE BINATIONAL SOUTHERN MESILLA BASIN REGION— A HYDROGEOLOGICAL PERSPECTIVE

John W. Hawley, Ph.D., Visiting Sr. Hydrogeologist
NM Water Resources Research Institute, NM State University
Emeritus Sr. Environmental Geologist, NM Bureau of Geology & Mineral Resources,
NM Institute of Mining & Technology hgeomatters@gmail.com
and
Baird H. Swanson, Swanson Geoscience LLC, Albuquerque, NM

¹APPENDIX H in Hawley, J.W., Swanson, B.H., Walker, J.S., and Glaze, S.H., 2025, Hydrogeologic Framework of the Mesilla Basin Region of New Mexico, Texas, and Chihuahua (Mexico)—Advances in Conceptual and Digital Model Development: NM Water Resources Research Institute, NMSU, Technical Completion Report No. 363*

*See also: Hawley, J.W., and Swanson, B.H., 2022. Conservation of shared groundwater resources in the binational Mesilla Basin-El Paso Del Norte Region – A Hydrogeological Perspective, in Granados-Olivas, Alfredo, coordinador, Los Recursos Hidrológicos en Cuencas Transfronterizas entre México y los Estados Unidos: El Paso del Norte y la Gobernanza Binacional de Agua [Hydrological Resources in Transboundary Basins between Mexico and the United States: El Paso del Norte and the Binational Water Governance]: Universidad Autónoma de Ciudad Juárez y Universidad Autónoma de Chihuahua, p. 202-323. ISBN 978-607-536.

H1. INTRODUCTION	1
H1.1. Historical Background	5
H1.2. Overviews of the Geologic and Physiographic Settings.....	5
H1.2.1. The Rio Grande Rift Tectonic Province and Santa Fe Group Rift-Basin Fill	5
H1.2.2. Major Physiographic Features of the Mesilla Basin Region.....	8
H1.2.2a. Basin and Range Physiographic Province—Mexican Highland Section	8
H1.2.2b. Background on the Chihuahuan Desert Ecoregion	12
H1.3. Fluvial-Deltaic Features of the Endorheic Ancestral Rio Grande	13
H1.4. Pluvial-Lake Palomas	18
H1.5. Major Geomorphic Features of the Contemporary Chihuahuan Desert Landscape	19
H1.5.1. El Barreal	20
H1.5.2. Los Médanos de Samalayuca.....	21
H1.6. Overview of the Regional Hydrogeological Setting.....	22
H1.6.1. Groundwater Basins Defined in a Hydrogeologic Context	22
H1.6.2. Basin-Scale Hydrogeologic-Subdivisions Defined in an RG-Rift Tectonic Context ...	24
H1.7. Hydrogeological Subdivisions and GW-Management Units in the Southern MBR	29
H1.8. Background on Hydrogeologic-Framework Controls on GW Flow and Chemistry in the Southern Mesilla Basin Region	33

H1.8.1. Lithofacies Assemblages	34
H1.8.2. Hydrostratigraphic Units.....	38
H1.9. Background on Buried-Bedrock Stratigraphy, Structure, and Topography	43
H1.10. Inferences on Deep-Seated Geologic Relationships.....	47
H2. HISTORICAL BACKGROUND ON INSTITUTIONAL ALTERNATIVES FOR GROUNDWATER MANAGEMENT IN THE NEW MEXICO—CHIHUAHUA REGION	49
H2.1. Institutional Alternatives for Mexico-US Groundwater Management	49
H2.1.1. Prescient Observations by Robert D. Hayton (1978).....	49
H2.1.2. International Groundwater Management: The Case for the Mexico-United States Frontier; Albert E. Utton and Clifford K. Atkinson (1979).....	50
H2.2. In Memoriam—Albert E. (Al) Utton-The Aztec Eagle.....	51
H2.2.1. “The Al Utton Essence”.....	51
H2.2.1a. Michelle Minnis, Preface to “Al Utton-Aztec Eagle—International Waters, Research, Diplomacy, and Friendship (2015)”	51
H2.2.1b. Ambassador Alberto Székely, Albert E. Utton Memorial Lecture (2003).....	52
H2.2.1c. Stephen Mumme on “Professor Utton’s vision and purpose”	52
H2.3. Management of “Precious Water Resources” and the “White Map Problem”	54
H2.4. Octavio E. Chávez on “Mining” of the Shared Aquifers in the Paso del Norte Area	54
H2.4.1. A Global Perspective on Groundwater Mining in “Dry Areas”	55
H2.4.2. An Early Legal Perspective on Groundwater Mining in New Mexico.....	55
H2.5. The Tragedy of the Commons (<i>from</i> Deming, 2002, Introduction to Hydrogeology)	56
H2.5.1. Observations by Robert Glennon (2002) on “Exploitation of a Common-Pool [GW] Resource” in a Sonoran Desert Region	56
H2.5.2. “Associated Press Report raises alarms over Arizona’s water supply”	56
H2.6. Groundwater-Resource Conservation in the Context of Climate-Change Realities.....	57
H2.6.1. “Climate Change on Future Water-Resource Availability in the American West” (Gutzler 2005, p. 277)	57
H2.6.2. Climate change and aridification of North America (Overpeck and Udall 2020)	57
H2.6.3. Climate Change and Upper Rio Grande Watershed Hydrology (Creel 2010).....	58
H2.7. Climate Wild Cards and Water-Resource Sustainability in the US-Mexico Border Region	58
H2.8. Some Realities of Hydrogeologic-Framework Controls on Groundwater-Resource Sustainability in a Chihuahuan-Desert Region.....	59
H2.9. Global Perspectives on Management of Transboundary Aquifers and GW Flow Systems	59

H2.9.1. International Borders, Ground Water Flow, and Hydroschizophrenia (Jarvis et al. 2005)	59
H2.9.2. “Knowledge Capsules” on a Transboundary Aquifer (Alfonso Rivera, 2021a).....	60
H2.9.2a. Transboundary Aquifer -vs- Transboundary Groundwater	60
H2.9.2b. Transboundary Zoning: to Zone or Not to Zone	60
H2.9.2c. Sustainable Groundwater Development in a Transboundary Aquifer Context....	60
H3. HISTORICAL BACKGROUND ON TRANSBOUNDARY WATER-RESOURCE ISSUES—	
1535 to 1963	61
H3.1. History Meets Pre-History (1535-1583).....	61
H3.1.1. “Who knew what and when did they know it?” (Hartmann and Flint, 2003).....	61
H3.1.2. Tracing the 1535 to 1536 Route of the Núñez Cabeza de Vaca Party.....	61
H3.2. Conquest Number One: The Spanish Empire—1583 to 1821.....	62
H3.2.1. The Antonio de Espejo Expedition into New Mexico—January 1583.....	62
H3.2.2. First “Divine Mandate” for Territorial and Ideological Conquest (4/30/1598).....	63
H3.2.3. Events Leading Up to the Dedication of the First El Paso del Norte “Cathedral” in 1668 (Sonnichsen 1968, p. 23-24).....	64
H3.2.4. “Beginning of the Real Settlement of the El Paso Valley” by “Refugees” from the August 10, 1680 “Pueblo Revolt” (Sonnichsen 1968, p. 33-34).....	65
H3.2.5. Excerpt <i>from</i> “Water Wars During Our Territorial Years” <i>in</i> “100 Years of Water Wars in New Mexico—1912-2012” (John W. Hernandez, 2012d, p. 19-20)	66
H3.2.6. El Paso del Rio del Norte in 1817, <i>from</i> the Report of Father Juan Rafael Rascón to Bishop Juan Francisco de Castañiza (Dennis Dailey, ed. and trans., 2021, p. 4-7)	66
H3.3. The Mexican Republic—1821 to 1846.....	68
H3.3.1. ¡Viva La Independencia!—David J. Weber (1982, p. 4-5).....	68
H3.3.2. September 9-15, 1839—Josiah Gregg (1844, p. 272-273)	68
H3.3.3. Early Era of Anglo-American “Manifest Destiny”—1836 to 1846.....	69
H3.4. Conquest Number Two, and the US-Mexico Boundary Survey (1846-1856).....	69
H3.4.1. First Binational “Collaboration”: The 1850 to 1856 Boundary Survey.....	70
H3.4.2. “The A.B. Gray Report; Survey of a Route on the 32 nd Parallel for the Texas Western Railroad, 1854”	72
H3.4.3. “La Gran Linea” Revisited, and the 2019 Border Wall.....	76
H3.5. Impacts of Early 20 th Century Railway Development.....	78

H3.6. First Formal Recognition of a Shared Surface-Water Resource: United States and Mexico, 1907, Convention between the United States and Mexico on Equitable Distribution of the Waters of the Rio Grande (United States and Mexico 1907; <i>cf.</i> Follett 1898, Hundley 1966)	81
H3.7. The 1912 New Mexico State Constitution (Tessa T. Davidson, J.D., 1998, p. 35).....	81
H3.8. Elephant Butte Dam, Reservoir, and the Rio Grande Project	82
H3.8.1. The Rio Grande Project (Clyde Conover 1954, p. 17)	82
H3.8.2. The IBWC Rio Grande Canalization Project (Andrea Glover, 2018, p. 63)	82
H3.9. The 1938 Interstate Rio Grande Compact (Kevin Flannigan 2007, p. 518-519).....	83
H3.10. The 1963 US-Mexico “Chamizal Convention” and Beyond.....	83
H4. REVIEW OF HYDROGEOLOGY-RELATED STUDIES OF TRANSBOUNDARY AQUIFER SYSTEMS SINCE 1890.....	84
H4.1. Hydrogeology-Related Investigations in Northwestern Mexico (1890-1940)	84
H4.1.1. Geology-Based Contributions by Ezequiel Ordóñez (1936 and 1941)	84
H4.1.2. Geography-Based Contributions of Donald Dilworth Brand (1929-1938)	86
H4.2. Geoscientific Investigations in the Northern Chihuahua Borderlands Region (1941-1969).....	86
H4.2.1. Mexico Based Investigations	86
H4.2.2. 1958 West Texas Geological Society (WTGS) Field Trip Guidebook to the Franklin and Hueco Mountains	87
H4.2.3. NM Geological Society 16 th Annual Field Conference—Southwestern New Mexico II (1965).....	89
H4.2.4. Border Stratigraphy Symposium of the American Association for the Advancement of Science-Southwestern and Rocky Mountain Division (El Paso, TX, April 1968)...	92
H4.2.5. New Mexico Geological Society 20 th Annual Field Conference in the New Mexico—Chihuahua Border Region (October 1969)	97
H4.2.5a. Hawley (1969b) Notes on the Geomorphology and Late Cenozoic Geology of Northwestern Chihuahua: NM Geological Society Guidebook 20	98
H4.2.5b. Photointerpretive Mapping from Space Photographs of Quaternary Geomorphic Features and Soil Associations in Northern Chihuahua.....	102
H4.2.5c. Pluvial Lake Palomas and Bolson de los Muertos (Reeves 1969, p. 143-154)....	106
H4.3. International Symposium on Tectonics and Magmatism of the Rio Grande Rift (October 1978).....	108
H4.4. 1983 La Paz and 1994 North American Free Trade Agreement Activities.....	111
H4.4.1. Early La Paz Agreement-Border XXI Program Activity (1994-1997).....	111
H4.4.2. Border XXI Program Hydrogeologic Investigations (1997-2000)	113

H4.5. Related Geohydrological Investigations in Chihuahua (INEGI 1999)	115
H4.5.1. First Formal Use of “Conejos-Médanos” in an “Agua Subterránea (GW)” Context	115
H4.5.2. Analysis and Overview of Aquifer-System Characteristics in Geohydrological Zones...	115
H4.5.3. Early Formal Use of “Conejos-Médanos” in an “Agua Subterránea (GW)” Context...	115
H4.5.4. García Vásquez Translation of INEGI (1999) Chapter (Capítulo) 6-Part 6.2	118
H4.5.4a. Valle Juárez [Rio Grande/Bravo basin].....	118
H4.5.4b. Valle Conejos-Médanos [Intermontane-basin complex].....	119
H4.5.4c. Valle Palomas [Intermontane-basin complex]	119
H4.5.4d. Valle Samalayuca [Intermontane-basin complex].....	120
H4.5.4e. Valle Ascensión [Intermontane-basin complex]	121
H4.6. Pioneering Geophysical Study of “Rift Basin Structure in the Border Region of Northwestern Chihuahua” (Jiménez and Keller 2000).....	122
H5. BINATIONAL HYDROGEOLOGIC-RESEARCH COLLABORATIONS (2000-2009)	125
H5.1. Background.....	125
H5.2. UTEP Dissertation Research Contributions (2000-2006)	126
H5.3. Provisional Assessment of GW-Outflow Contributions Pluvial-Lake Palomas to Southern Mesilla Basin Region’s Transboundary Aquifer Systems	127
H5.4. El Paso del Norte’s Control on Regional GW-Flow and Chemistry	128
H5.5. Basic Hydrogeologic Framework Components of the Southwestern Hueco Bolson Area	131
H6. THE TRANSCONTRIBUTORY AQUIFER ASSESSMENT PROGRAM (TAAP)	134
H6.1. Overview	134
H6.2. Progress in Hydrogeologic-Framework Characterization of the “Acuífero Conejos-Médanos” Region of Northwestern Chihuahua (2010-2015)	137
H6.3. Recent Developments in Transboundary GW-Flow System Characterization.....	140
H6.4. Remaining Problems in Delineation of the Mesilla/Conejos-Médanos Transboundary Aquifer System.....	140
H6.4.1. Mesilla Basin/Conejos-Médanos Aquifer System Conceptual-Model Development – Stage 1	141
H6.4.2. Mesilla Basin/Conejos-Médanos Aquifer System Conceptual-Model Development – Stage 2	143

H7. CHALLENGES FACING, AND OPPORTUNITIES FOR LONG-TERM GW-RESOURCE DEVELOPMENT IN THE MESILLA BASIN-PASO DEL NORTE REGION	148
H7.1. Challenges	148
H7.2. Opportunities	148
H7.3. Remaining Environmental Legacy of 20 th Century Operation of the ASARCO Smelter at El Paso del Norte	149
H8. CITED REFERENCES (with APPENDIX B alphanumeric topical-entry codes-p. 178).....	154