Appendix 3

GIS Approach, Method & Documentation

The R2C2 conceptual study alignments selected only for purposes of developing order of magnitude future project costs as well as for railroad operations modeling lay through several Eastern Plains counties. Initial data gathering proved difficult; the majority of the counties through the corridors had no centralized GIS data repository and thus requests would need to be made directly from each entity. Parcel based ownership data was not available in GIS for the majority of the study area. For the purposes of defining the alignments, several data sources were used to define the cultural, environmental, and topographic constraint features through the alternative corridors.

All datasets were projected to Universal Transverse Mercator (UTM), Zone 13, NAD83 coordinates, the coordinate system used for all GIS data layers utilized in the study. ESRI's ArcGIS v9.2 was used for all spatial data generation. Each dataset was converted to AutoCAD DWG format for the purposes of alignment planning in ArcV2CAD v4.0, a software utility allowing simple conversion of ESRI Shapefile format data to be converted to AutoCAD DWG format. The following list provides descriptions of these sources:

- **Terrain** – Topographic information for the corridor was assembled from USGS 10-meter resolution digital elevation models (DEMs) extracted from the National Elevation Dataset (NED). The DEMs were downloaded in ArcGrid format from USGS Seamless Data Distribution System at http://seamless.usgs.gov . Upon extraction, the source data is provided in Geographic decimal degree coordinates. The data was projected to UTM coordinates and the vertical units were calculated to feet units from source metric units. Contours were generated at 20-foot interval through the study corridors using ESRI's 3D Analyst extension to ArcGIS v9.2. Additional documentation on this data can be found at http://gisdata.usgs.net/ned .

- **Water Wells** – Water well data was obtained from the Colorado Division of Water Resources in Excel Spreadsheet format. Each well entry contained UTM coordinates of well locations; each well and corresponding database entry was generated spatially in ArcGIS. A use code field was used to determine the specific uses for wells through the corridors. A use type was generated in the database to allow quick identification of uses specific to each well. Multiple uses were determined for many wells based upon the use type codes in the database. Additional information on this dataset can be found at http://water.state.co.us/pubs/gis.asp#1 .

- **Oil & Gas Wells & Associated Facilities** - The Colorado Oil and Gas Conservation Commission (COGCC) through the Colorado Department of Natural Resources provides well locations for over 75,000 oil & gas well locations within the State of Colorado. The well point data represent permitted locations, most of which have been drilled and completed, or drilled and abandoned. Codes exist in the database and were used to define existing producing wells versus dry & abandoned wells, etc. More information regarding this dataset can be found at http://oil-gas.state.co.us .

- **Streams & Water Bodies** – Hydrographic features were obtained from the USGS National Hydrography Dataset (NHD). The National Hydrography Dataset is a comprehensive set of digital spatial data that contains information about surface water features such as lakes, ponds, streams, rivers, springs and wells. Within the NHD, surface water features are combined to form "reaches," which provide the framework for linking water-related data to the NHD surface water drainage network. NHD data is provided at four resolutions: Local, High, Medium, and Low. The high resolution data was utilized and downloaded from ftp://nhdftp.usgs.gov/SubRegions . The data is provided based upon Hydrologic Unit Component (HUC) level 4 watersheds.

- **Electric Transmission & Fuel Pipelines** – transmission line and pipeline information was extracted from USGS Digital Line Graph (DLG) datasets for Colorado. A Digital Line Graph (DLG) is digital vector data representing cartographic information. DLGs contain a wide variety of information depicting geographic features. DLGs are derived from hypsographic data (contour lines) using USGS 7.5-minute, 15-minute, 2-arc-second (30- by 60-minute), and 1:2 million-scale topographic quadrangle maps. The spatial accuracy of the transmission line data was coarse (1:100,000 scale) and was out of data in some cases. Aerial photography and field visits were used to verify and/or correct above ground features where available. Additional DLG information is available at http://rockyweb.cr.usgs.gov/nmpstds/dlgstds.html .

- **Physical & Cultural Feature Names** – The U.S. Board on Geographic Names is a Federal body created in 1890 and established in its present form by Public Law in 1947 to maintain uniform geographic name usage throughout the Federal Government. The USGS Geographic Names Information System (GNIS) is the Federal standard for geographic nomenclature. The GNIS contains information about physical and cultural geographic features of all types in the United States. The database holds the federally recognized name of each feature and defines the feature location by state, county, USGS topographic map, and geographic coordinates. Other attributes include names or spellings other than the official name, feature designations, feature classification, historical and descriptive information, and for some categories the geometric boundaries. The data utilized was downloaded as point features and included names of towns, historic features, etc. More information on the GNIS can be found at http://geonames.usgs.gov/domestic/index.html .

- **Railroads** – Current rail network and existing grade crossing data was obtained from the Bureau for Transportation Statistics (BTS). The rail network is a comprehensive database of the nation's railway system at the 1:100,000 scale. The data set covers all 50 States plus the District of Columbia. FRA Grade Crossings are a spatial file that originates from the National Highway-Rail Crossing Inventory Program. The program is structured to provide information to Federal, State, and local governments as well as the railroad industry for the improvements of safety at highway-rail crossing. More information for the railroad data utilized can be found at http://www.bts.gov/programs/geographic_information_services .

- **2005 1-Meter Resolution Aerial Photography** – The National Aerial Imagery Program (NAIP) acquires digital ortho imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to enable availability of ortho imagery within one year of acquisition. NAIP provides two main products: 1 meter ground sample distance (GSD) ortho imagery rectified to a horizontal accuracy of within +/- 3 meters of reference

digital ortho quarter quads (DOQQ's) from the National Digital Ortho Program (NDOP); and, 2 meter GSD ortho imagery rectified to within +/- 10 meters of reference DOQQs. For the purposes of R2C2, aerial photography was obtained at 1-meter resolution as MrSID format images for the counties encountered through the corridor. More information on NAIP imagery can be found at http://www.apfo.usda.gov/NAIP.html .

- **Public Lands Survey System (PLSS) Townships, Ranges, Sections, & QQ Section**s – Township, range, section, and QQ section data were obtained from the BLM's Geographic Coordinate Data Base (GCDB). The locations of PLSS corners, as represented in geographic coordinate pairs, were derived from a variety of source documents, which include U.S. General Land Office and Bureau of Land Management (BLM) survey plats/notes, as well as survey data obtained from other U.S. Government agencies, private sector survey firms, and local governments. Property parcel boundaries for Fort Morgan and Adams counties were defined by referencing on-line internet map servers against PLSS data through the corridors. Jurisdictional boundaries were also extracted from data provided by the BLM, allowing the definition of ownership for state and federal agency lands.

- **Roads & Highways** – Road information was utilized from ESRI StreetMap USA data bundled with ArcGIS 9.2. This data provided street centerlines for all knows streets through the study area. This includes all interstates, state highways, arterials, collectors, local, and private streets. Additional information regarding ESRI's StreetMap data products can be found at http://www.esri.com/data/streetmap/index.html .

Rail/Highway Crossing Types

Below are the crossing types along with pictures demonstrating each crossing scenario.

Grade Separation

Railroad Over Roadway

Railroad Under Roadway

At-Grade Crossings

At-Grade with Active Warning Devices

At-Grade with Crossbucks

At-Grade – Private Crossing

Livestock Crossings

Bridge (Size Varies)

Box Culvert (5 ft. x 7 ft. or 6 ft. x 8 ft.)

Circular Pipe (12-14 ft. diameter)