Section 2
Watershed Inventory and Methodology

2.1 Watershed Inventory

The watershed inventory consisted of collecting, compiling, and evaluating existing data applicable to the Master Plan development and developing new datasets. A data search was conducted to identify existing information to be used by the project team. The existing digital and hardcopy information collected and compiled during the study is provided below.

Existing Datasets

- An *Assessment of the Hydrology, Fluvial Geomorphology, and Stream Ecology in the Cardwell Branch Watershed, Nebraska*, draft copy, completed by USGS, dated April 19, 2006
- Hydrologic and hydraulic computer models developed by USGS
- Floodprone areas and floodway boundary developed by USGS
- Existing and future roadway network
- Existing and future land use data
- Comprehensive plan tiers and priority areas for future growth
- Existing and future trails
- 2002 color aerial photography
- 1997 topographic maps with 2-foot contours
- Land parcel information

New Datasets

As part of the study evaluation process, numerous new datasets were developed using GIS technology. The new datasets are summarized below.

- **Watershed Planning Map** - Multiple datasets including existing and future trails, parks and open spaces, wetlands, native prairie, riparian areas, land conservation easements, commercial and industrial facilities, publicly owned lands, and known ongoing or proposed developments.

- **Bridge Culverts** - This dataset includes identification number, type, size, length, flow capacity, top of road profile, and invert elevation. The structure information was obtained by USGS during the hydraulic evaluation (Section 2.3.1).

- **Known Problem Areas** - These datasets identify the location of CIPs and other areas of concern that address issues due to bank erosion, incision, and habitable building flooding. The information was obtained by the project team during the CIP analysis.

- **Geomorphology Information** - These datasets summarize field information gathered by the project team during field visits to analyze the geomorphic processes within the stream reaches. Datasets include channel bar type and condition, bed and bank material, type and bed consolidation, channel profile and cross section information, erosion and mass wasting, vegetative bank protection and condition of riparian corridor, outfalls, infrastructure crossings, location of stream reach photographs, HEC-RAS shear values throughout the watershed, location of knickpoints, debris jams, and fluvial process layers depicting meander adjustment, incising, widening, and stable channel.

- **Minimum Flood Corridor** - The approximate stream buffer setback distance was estimated for the stream reaches within the study area using the City's ordinance criteria. The setback distance was based on field observations at select stream locations. The width of the buffer (including both sides of the creek) is the width of the bottom of the stream, plus 6 times the stream's depth, plus 60 feet. During the field work, photographs were taken at multiple locations. A photo reference identification number is provided with this dataset.

- **Fieldwork Photographs** - This dataset includes location of photographs taken throughout the watershed with a reference to the photo identification number.

Electronic Files

The electronic files associated with the study have been organized according to the following folder structure.

- Study Report and Appendix Information
- Minimum Flood Corridor and Field Work Photographs
- GIS Datasets (as described above; can be accessed using ArcGIS)

2.2 Phase 1 Summary Discussion

As discussed in Section 1.1, the watershed planning process was conducted using a two-phased approach. Phase 1, called the Cardwell Branch Watershed Assessment, was completed by USGS. The USGS planning effort was a comprehensive assessment of existing watershed conditions, focused on only those drainage areas that do not drain to Yankee Hill Lake. The comprehensive assessment included data compilation and analysis for several major items of interest: floodplain mapping, assessing the geomorphic and stream stability conditions, and evaluating the ecological conditions of the watershed using a biological assessment of the stream.

In April 2006, USGS published *An Assessment of the Hydrology, Fluvial Geomorphology, and Stream Ecology in the Cardwell Branch Watershed, Nebraska*, which summarizes the Phase 1 planning effort. In addition, the floodplain mapping completed by USGS has been submitted to FEMA for review and comment. The FEMA review process could potentially take several months to more than a year following the final submittal to FEMA and will include a public comment period. The comment period will include a FEMA-hosted public meeting before the maps become officially adopted. In the interim, the City will use the study floodplain maps for the purpose of regulating the floodprone areas until the FEMA approval adoption process is finalized. Figure 2-1 presents an overview map depicting the entire study area divided into three geographic areas. The floodprone areas within each geographic area, called a tile, are shown in more detail on Figures 2-2 through 2-4. The floodprone maps can also be accessed on the website by going to the City of Lincoln's website at lincoln.ne.gov, keyword "watershed," and following the links to the Interactive Floodplain and Floodprone Area maps.

Based on the FEMA floodplain mapping process, several homes located along Bobcat Circle were shown to be at risk for flooding. The flooding risk was visually observed by USGS staff during a recent rainstorm that occurred in the Cardwell Woods development area on May 5, 2007, which was estimated to be approximately a 5-year storm. During the rainstorm, stream flow within the south tributary channel was diverted into a side channel through a "notch"

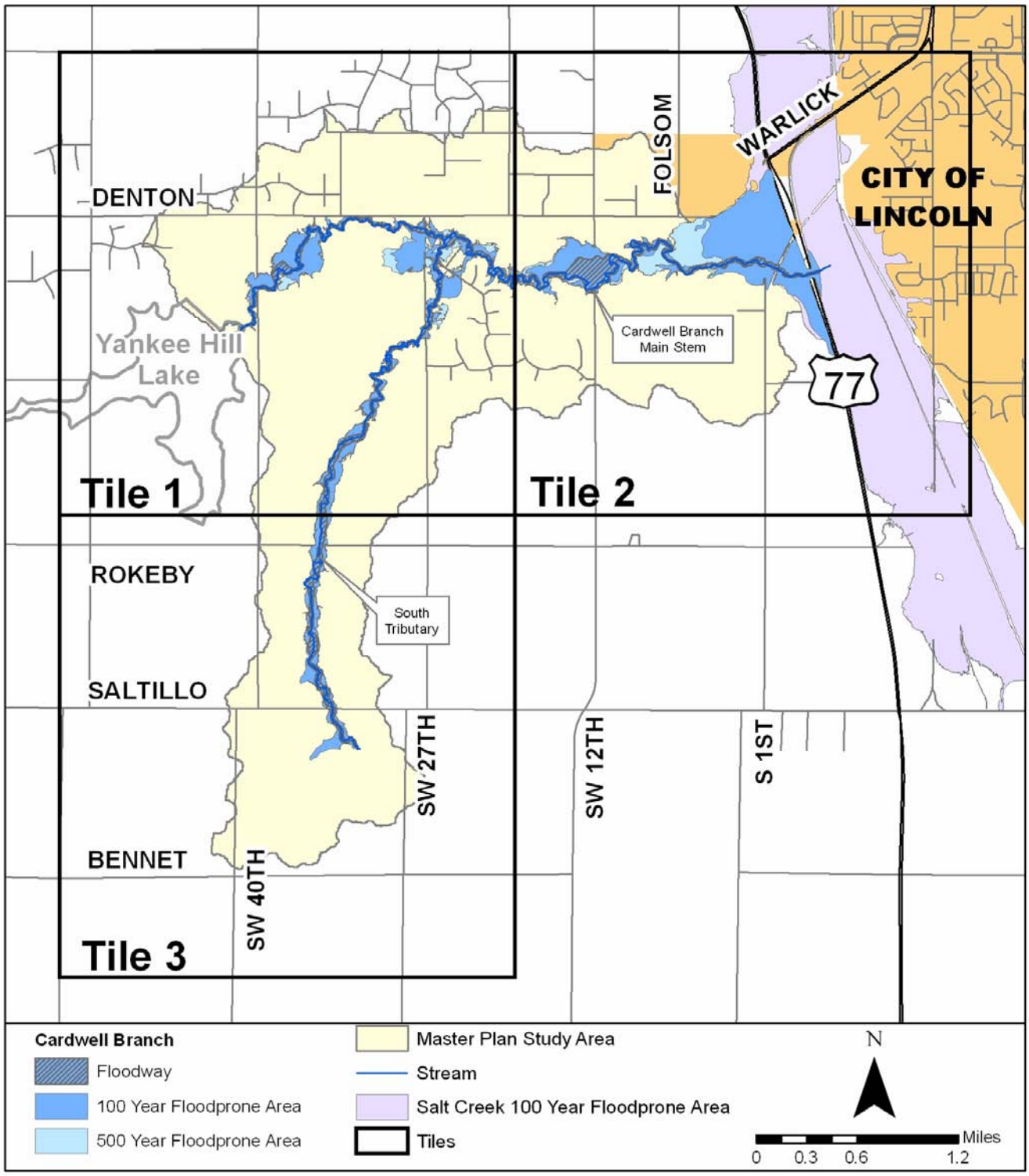

Figure 2-1
Cardwell Branch Floodprone Areas

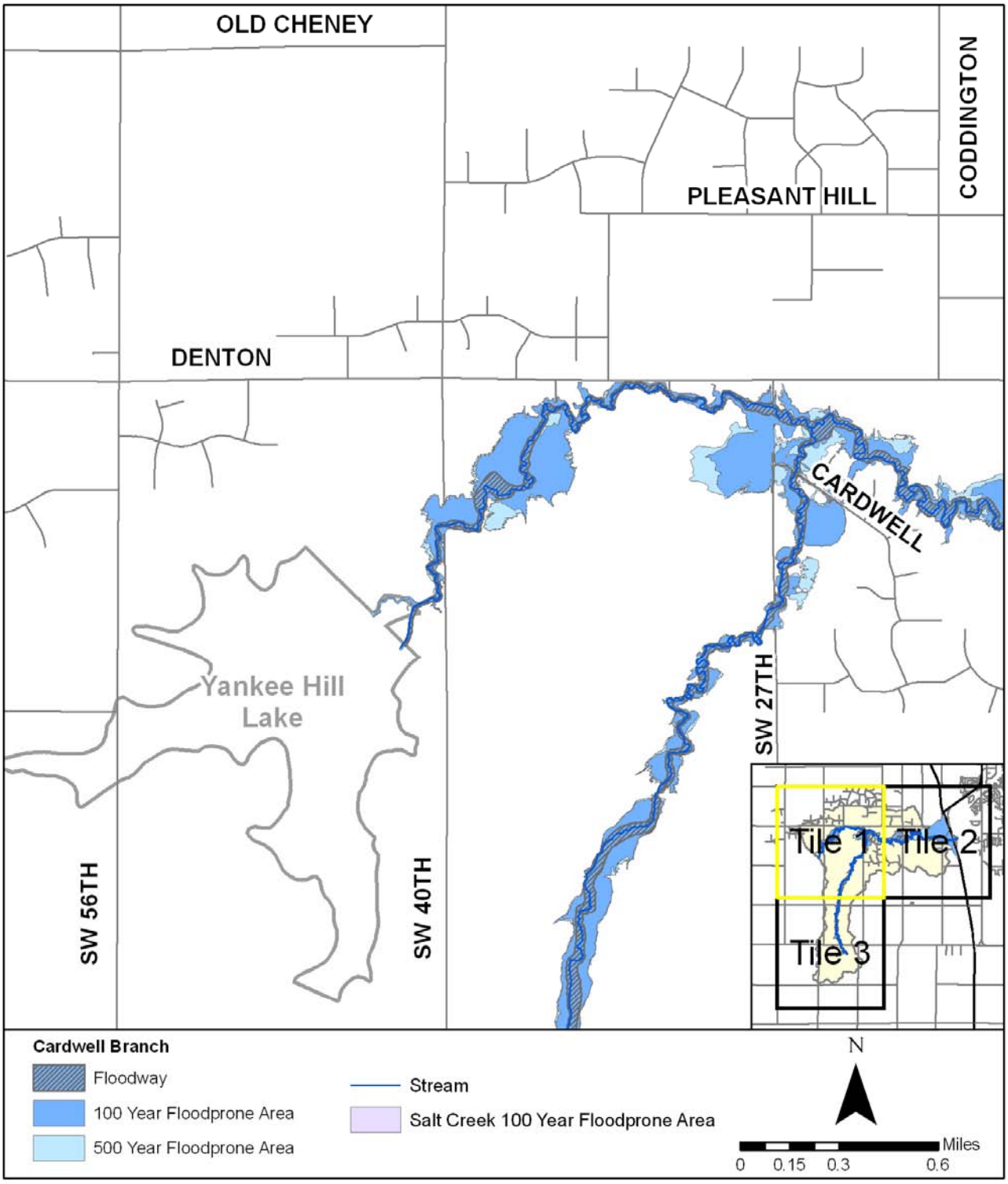

Figure 2-2
Tile 1 Floodprone Area Map

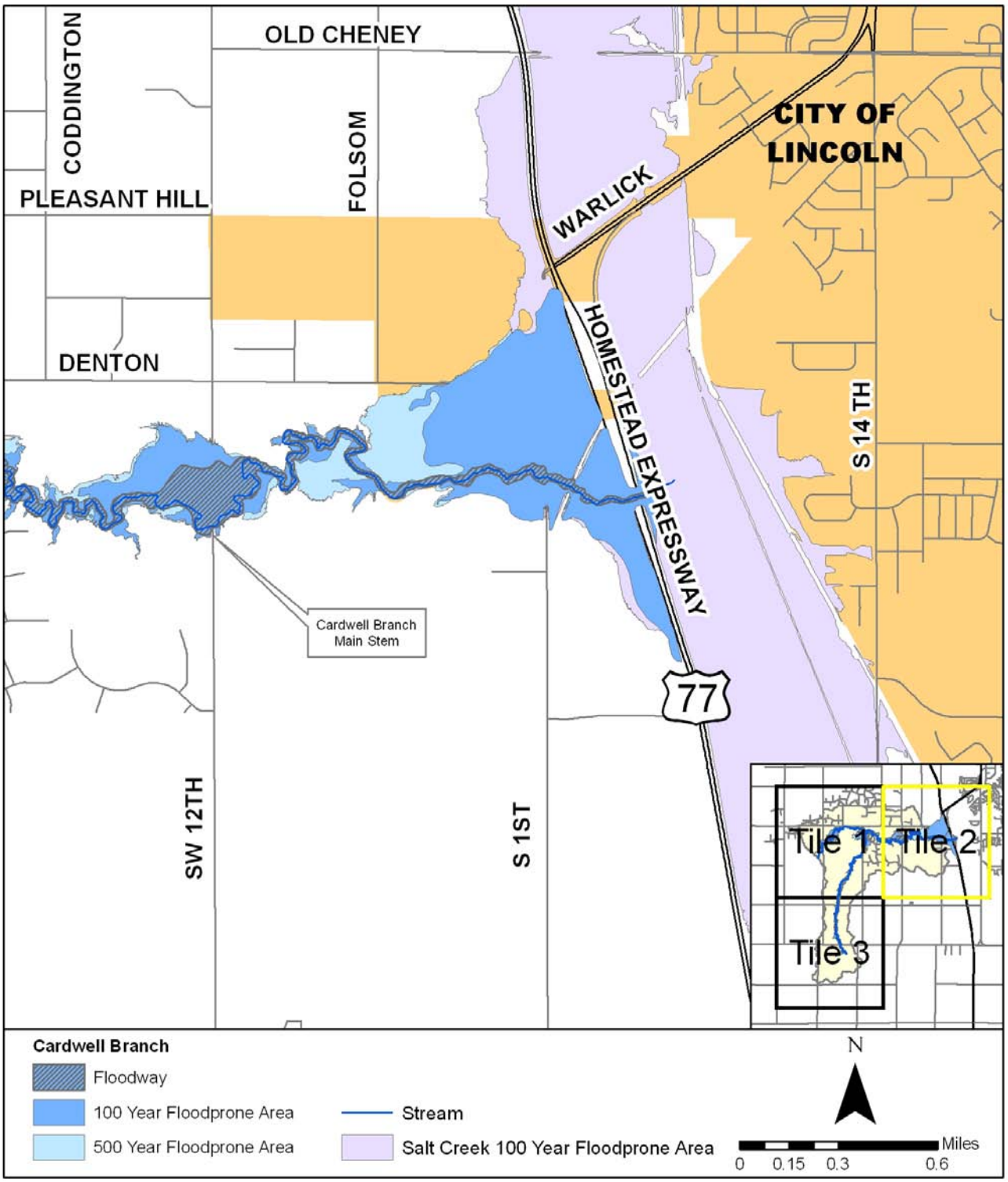

Figure 2-3
Tile 2 Floodprone Area Map

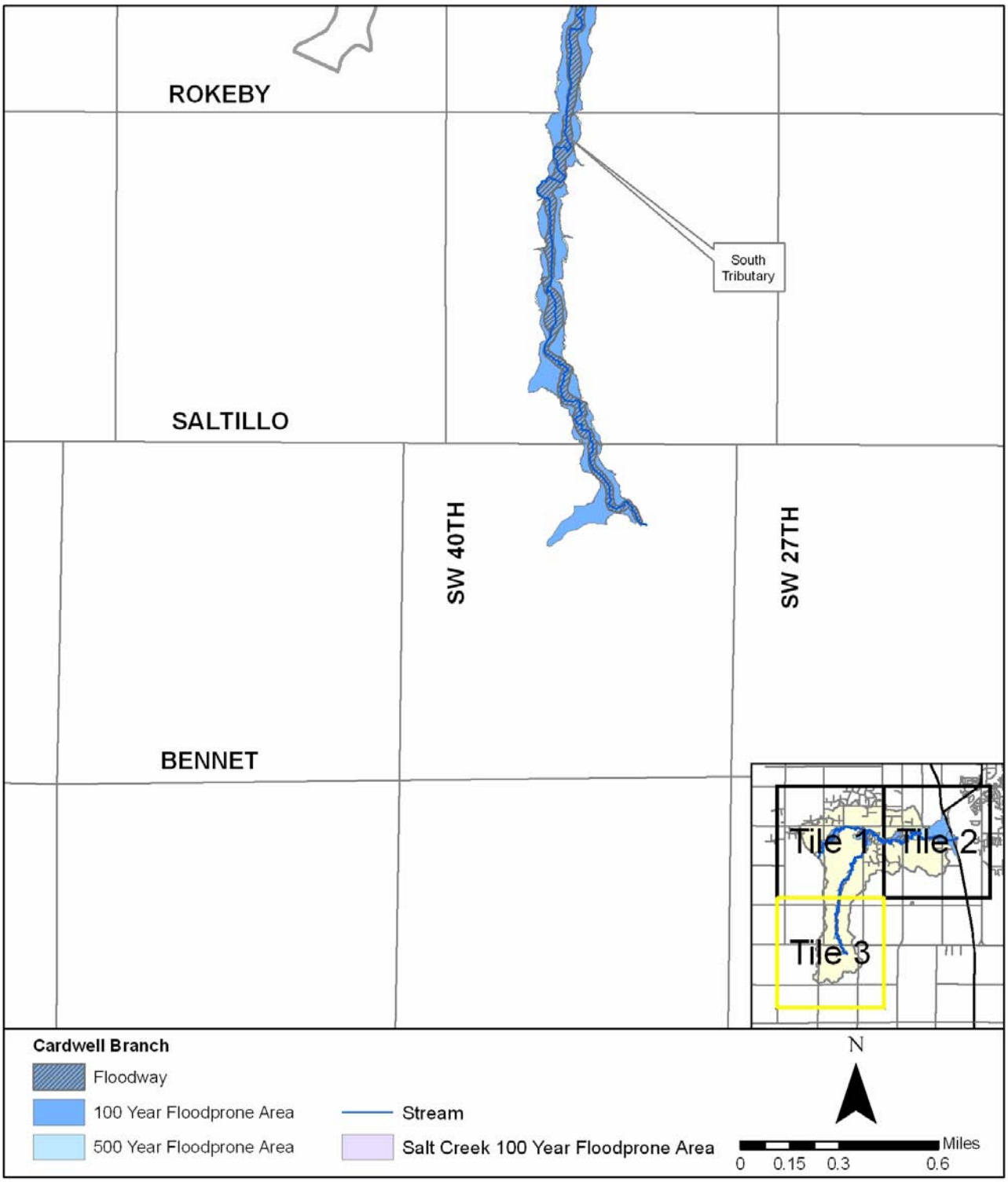

Figure 2-4
Tile 3 Floodprone Area Map

along the streambank. The notch in the channel is located just upstream of Bobcat Circle. Once the flow is diverted through the notch, the floodwater was conveyed within a side channel that is located along the backyards of several buildings along Bobcat Circle. At least one habitable building was flooded as a result of the diverted flow from the south tributary.

2.3 Study Methodology

The study methodology was based on integrating hydrology and hydraulic engineering principles with the ecological and geomorphic characteristics of the natural stream system. A summary of each component is provided below.

2.3.1 Hydrologic and Hydraulic Evaluation

The hydrologic and hydraulic evaluation consisted of conducting a cursory review of the HEC-HMS model (version 2.2.2) and HEC-RAS model (version 3.1.2) developed by USGS. The purpose of the review process was to become familiar with the methodologies used to develop the models, with the goal of using these models to evaluate potential CIPs as discussed in Section 5.

The HEC-HMS and HEC-RAS models were developed using the City of Lincoln's 1997 2-foot contours supplemented with survey information to provide a detailed representation of the channel geometry. The floodprone areas were then delineated using the City of Lincoln's LiDAR data, which was flown between November 2003 and January 2004. In summary, the HEC models were developed according to FEMA standards and provide an excellent tool to evaluate and predict erosive and flooding conditions based on existing and future watershed characteristics.

2.3.2 Geomorphic Evaluation

The geomorphic evaluation consisted of verifying the observations and interpretations made by USGS as part of the Phase 1 planning effort. The purpose of the review process was to become familiar with the methodologies and techniques used to conduct the geomorphic evaluation, with the goal of using the USGS data to evaluate potential stream improvements to address erosive or excess sediment conditions. The verification process included a field investigation to verify key stream data, including:

- Planform type
- Vegetative bank protection
- Streambed material
- Streambank material
- Sediment transport
- Qualitative flow conditions
- Presence of debris jams
- Stream process
- Vegetation canopy
- Presence of erosion and mass wasting

2.3.3 Water Quality Assessment

A water quality assessment was conducted to document and evaluate the natural resources within the study area, with the goal of developing a watershed management strategy that protects and enhances the natural stream system as development continues in the watershed. One of the key objectives was to categorize the relative condition of the various stream reaches and to identify open spaces and potential conservation easements.