Prepared in cooperation with the Bureau of Land Management

Development of an Interactive Shoreline Management Tool for the Lower Wood River Valley, Oregon, Phase I: Stage–Volume and Stage–Area Relations

By Tana L. Haluska and Daniel T. Snyder

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Cover: The Wood River Valley, with the Wood River Wetland and Agency Lake in the foreground. (Photograph by Trisha Roninger, U.S. Fish & Wildlife Service)

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Conversion Factors and Datums

SI to Inch/Pound

Multiply	By	To obtain
centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter (m)
acre	0.4047	hectare (ha)
acre	4,047	square meter (m^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD88). For the purpose of this publication, the term sea level is used to represent the 0-foot elevation as referenced to NAVD88. The conversion between NAVD88 and the commonly used National Geodetic Vertical Datum of 1929 (NGVD29) varies spatially; for conversions the reader is referred to either the National Geodetic Survey website for VERTCON at http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html or the U.S. Army Corps of Engineers website for Corpscon at http://crunch.tec.army.mil/software/corpscon/corpscon.html.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD83). The conversion between NAD83 and the commonly used North American Datum of 1927 (NAD27) varies spatially; for conversions, the reader is referred to either the National Geodetic Survey website for NADCON at http://www.ngs.noaa.gov/TOOLS/Nadcon/Nadcon.html or the U.S. Army Corps of Engineers website for Corpscon at http://crunch.tec.army.mil/software/corpscon/corpscon.html.

Elevation, as used in this report, refers to distance above the vertical datum.
Vertical coordinate information for historical data collected and stored as NGVD29 have been converted to NAVD88 for this publication. Horizontal coordinate information for historical data collected and stored as NAD27 have been converted to NAD83 for this publication.

A local vertical datum, called the Upper Klamath Lake Vertical Datum (UKLVD), established by the Bureau of Reclamation, is often used for reporting elevation, especially with regard to the stage of Upper Klamath Lake. The conversions from UKLVD to the national datums NAVD88 and NGVD29 vary spatially and are presently not well defined for much of the Wood River Valley. For the purpose of this publication the conversion used is: UKLVD – 1.78 = NGVD29 (all values are in feet). (Source: William Wood, Bureau of Reclamation, written commun., 2007).

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Abstract

This report presents the parcel and inundation area geographic information system (GIS) layers for various surface-water stages. It also presents data tables containing the water stage, inundation area, and water volume relations developed from analysis of detailed land surface elevation derived from Light Detection and Ranging (LiDAR) data recently collected for the Wood River Valley at the northern margin of Agency Lake in Klamath County, Oregon.

Former shoreline wetlands that have been cut off from Upper Klamath and Agency Lakes by dikes might in the future be reconnected to Upper Klamath and Agency Lake by breaching the dikes. Issues of interest associated with restoring wetlands in this way include the area that will be inundated, the volume of water that may be stored, the change in wetland habitat, and the variation in these characteristics as surface-water stage is changed. Products from this analysis can assist water managers in assessing the effect of breaching dikes and changing surface-water stage. The study area is in the approximate former northern margins of Upper Klamath and Agency Lakes in the Wood River Valley.

Introduction

Background

Water-resource managers responsible for managing lake levels and lands adjacent to Upper Klamath and Agency Lakes in southern Oregon must balance multiple competing water needs, including downstream water users, instream flow requirements, and lake-margin habitats and conditions (including those required for fish species listed under the Endangered Species Act). Assessing the benefits of restoring wetland areas around Upper Klamath and Agency Lakes can be difficult due to the limitations and accessibility of existing data. Quantification of the benefits could be improved by assembling information on relationships between surface-water levels, water storage, area of inundation, and local habitat conditions, and by developing a tool to facilitate analysis of the data. Wildlife managers have been interested in identifying areas of potential wetlands along present and former shorelines within currently diked and drained lands adjacent to both lakes. Recently acquired Light Detection and Ranging (LiDAR) elevation data create a unique opportunity to develop an interactive shoreline management tool within a geographic information system (GIS) that could assist natural-resource managers in making more informed decisions about breaching dikes, changing surface-water stage, and designating potential habitat.

In 2006, the U.S. Geological Survey (USGS), in cooperation with the Bureau of Land Management (BLM), began a study to analyze the LiDAR elevation data and to create an interactive tool to evaluate various shoreline management scenarios. The first step in developing a shoreline management tool is to develop the method and data tables to support the interactive tool. This study addresses this first step, which involves analysis in a GIS to estimate inundation areas and volume of water stored in the restored wetland with varying surface-water stage. This information will be used to develop data tables, maps, and graphs depicting the estimated volumetric storage of water and the location of inundated areas for various water stages within land parcels in the lower Wood River Valley.

Purpose and Scope

The purpose of this report is to present the results from Phase 1 of the study, consisting of GIS data that can be used for estimating stage, volume, and area relationships and locations of inundated areas at various surface-water stages for parcels within the LiDAR coverage of the Wood River Valley. This tool may also be helpful in evaluating water budgets for the hydrologic units.

Acknowledgements

We wish to thank Andy Hamilton of the BLM in Klamath Falls, Oregon, and Wedge Watkins formerly with BLM and currently with the U.S. Fish & Wildlife Service (USFWS), for their guidance and ideas on the concept of the Shoreline Management Tool. The LiDAR data were collected by Watershed Sciences, Inc., and funded through a grant to the Klamath Basin Rangeland Trust from the USFWS.

Explanation of Data

LiDAR

LiDAR data are latitude, longitude, and elevation points typically collected from aircraft using specialized equipment at a very high resolution and accuracy. LiDAR data for the Wood River Valley were collected by Watershed Sciences, Inc., on September 26–27, 2004, with an absolute vertical accuracy reported to be within 13.35 centimeters (cm) for 95 percent of the elevation data (Watershed Sciences, 2005). The mean relative vertical accuracy of the LiDAR was found to be 6.5 cm (Michael Boeder, Watershed Sciences, Inc., oral commun., 2007). The elevation estimates in the data tables are limited to the accuracy of the LiDAR data and the National Geodetic Survey's VERTCON (North American Vertical Datum Conversion Utility) software (*http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html*, accessed October 24, 2007), considered to be accurate within 2 cm, which was used for NGVD 29 elevation estimates.

Parcel Coverage

The lower Wood River Valley within the LiDAR extent was divided into 34 parcels (fig. 1) on the basis of land ownership and the ability of an area to be managed as an independent hydraulic unit. Hydraulic independence was evaluated on the basis of the presence of dikes, roads, or other features that could inhibit the passage of water from one parcel to an adjacent parcel at various surface-water stages. A parcel GIS layer was developed for the study area and is provided in an exported ArcInfo coverage format. The polygon attribute table contains a field named PARC_NUMBER with a unique value for each parcel that can be used to identify the associated tables.

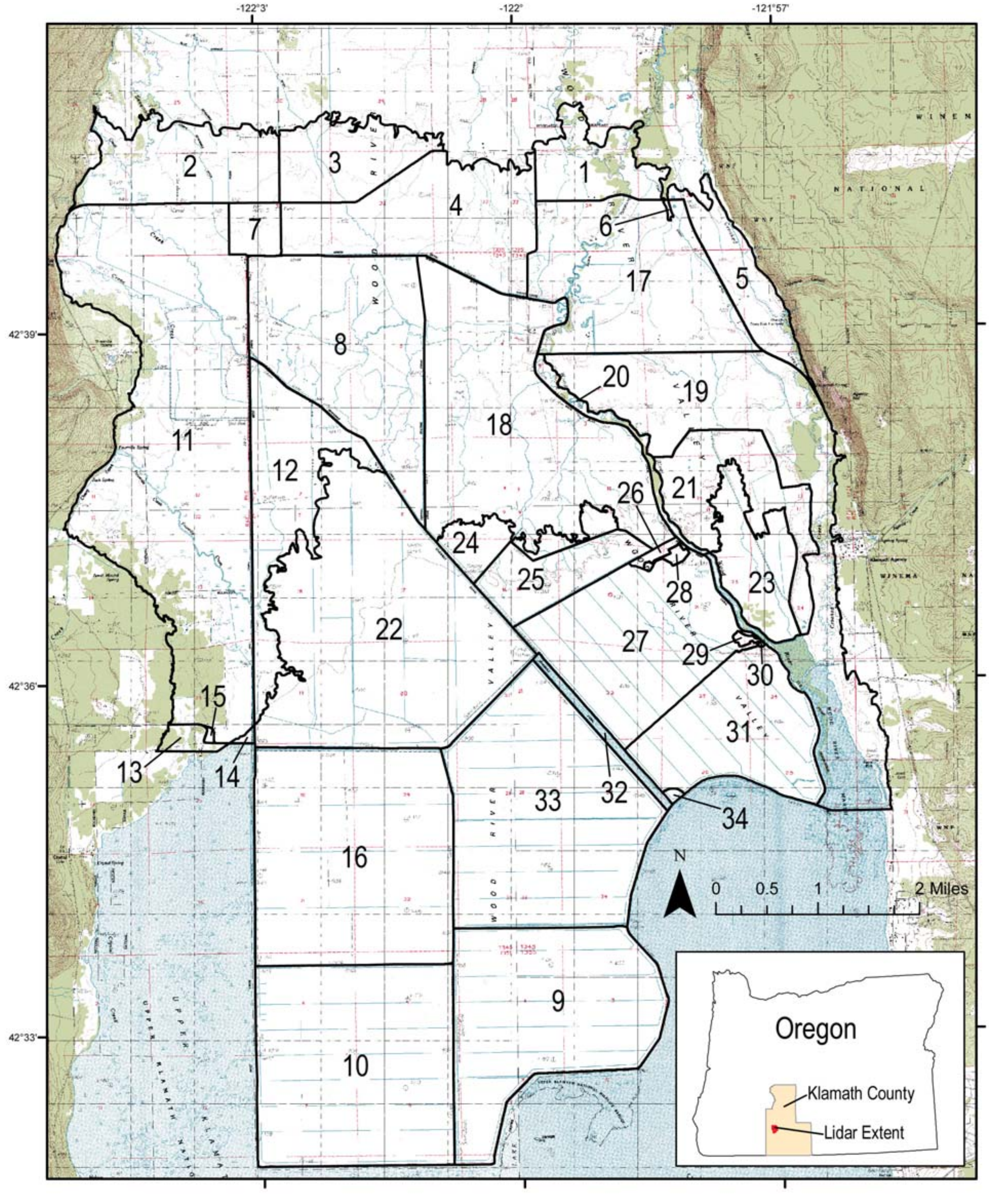

Figure 1. Location of study area and outline of parcel coverage, Wood River Valley, Oregon.

Inundation Coverages

GIS data layers in the format of ArcInfo coverages were developed to show the area of land that is inundated by water with a change in surface-water stage for every tenth of a foot. ArcInfo was used to determine the shoreline for each increment of surface-water stage. As individual parcels are either filled or drained, the actual areas of inundation and change in storage might depend on the inflow and outflow locations. During the filling of a parcel, isolated internal topographically low areas might not become inundated until water in adjacent low areas overtops the intervening land surface. During the draining of a parcel, water in isolated internal topographically low areas might not be emptied. To determine the actual inundation during filling or draining would require information on the location of the inflows and outflows and the use of a flow routing model, which was beyond the scope of this study. In addition, depending upon soil permeability, ground-water flow may tend to equalize surface water levels within a parcel. For the purposes of this report it was assumed that all areas would be inundated below the specified surface-water stage and dry above the specified stage. A map depicting an example of these inundation coverages for parcels 9, 10, 16, and 33 is presented in figure 2. Examples of the naming convention for the inundation coverages for stages 4,138.80 feet (ft) and 4,138.90 ft are listed below for parcel number 33. There is no decimal point in the name of the coverages.

P33413880
P33413890

The polygon attribute table of the inundation coverages contains a field named CF-CODE which can be used to identify the inundation polygons. Those polygons assigned with a CF-CODE value of 2 are inundation polygons. Figure 2 illustrates surface water stage of 4,138.80 ft NAVD 88. All but east-west linear traces of dikes are inundated in parcels 9, 10, and 33. Because parcel 16 is at a higher elevation, only a portion of this area is inundated.

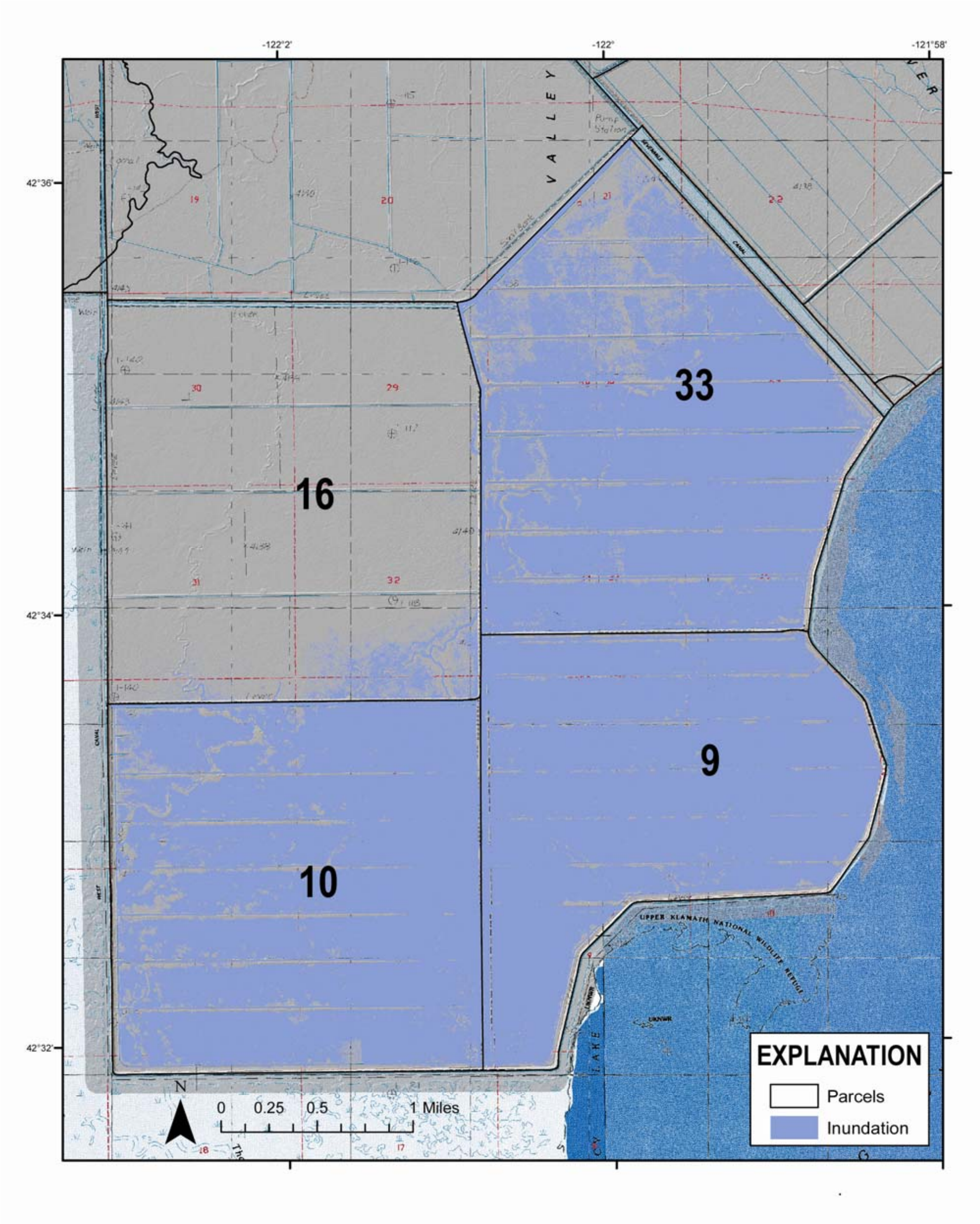

Figure 2. Water inundation for parcels 9, 10, 16, and 33 at surface water stage 4,138.80 feet NAVD 88, Wood River Valley, Oregon.

Data Tables

Each of the 34 parcels has associated tables containing volume and area values computed for surface-water stages in increments of 0.01 ft. The stage–area–volume relationship analysis was conducted for both NAVD 88 and NGVD 29 vertical datums. The vertical datums commonly used by resource managers in the Klamath Basin are NGVD 29, NAVD 88, and the Bureau of Reclamation local vertical datum for Klamath Falls, UKLVD (see Conversion Factors and Datums). The NGVD 29 tables contain a field named STAGE_BR that has the Bureau of Reclamation's equivalent surface water stage (using UKLVD) for the NGVD 29 stage value in the field named STAGE_FT. These tables contain the surface-water stage, volume of storage, and area of inundation. The surface water stage is provided in feet, volume of storage is provided in cubic meters as well as acre-feet, and area of inundation is provided in square-meters as well as acres. Examples of the naming convention for the tables are listed below for parcel number 33. The suffixes of 88 and 29 indicate the vertical datum (NAVD 88 and NGVD 29 respectively) used for the surface water stage.

PARC_33-88	vertical datum of NAVD 88
PARC_33-29	vertical datum of NGVD 29

The stage/volume/area tables have the following fields:

STAGE_FT – surface water stage, in feet
VOLMTR3 – volume of storage, in cubic-meters
AREAMTR2 – area of inundation, in square-meters
VOLACRFT – volume of storage, in acre-feet
AREAACRE – area of inundation, in acres

In the NGVD 29 tables, an additional field is provided that stores the UKLVD stage equivalent:

STAGE_BR – surface water stage, in UKLVD feet

An example of a data table for parcel 33 is presented in table 1. As might be expected, the volume and inundated area increase with increasing surface-water stage. The volume and inundated area increase gradually with increases of stage except, however, between 4,138.81 and 4,138.82 ft, where the inundated area increases significantly because much more of the area is at elevation 4,138.82 ft than the elevation just above or below 4,138.82 ft. Water managers can use data tables such as table 1 to estimate the storage gained and water available for release for a given surface-water stage.

Table 1. Example of data table for lake stages 4,138.80 through 4,138.84 feet NAVD 88 in parcel 33, Wood River Valley, Oregon

Field Name:	STAGE_FT	VOLMTR3	AREAMTR2	VOLACRFT	AREAACRE
Definition:	Surface water elevation, in feet NAVD 88	Storage volume, in cubic meters	Inundated area, in square meters	Storage volume, in acre-feet	Inundated area, in acres
	4,138.80	1,405,657.002	7,937,406.000	1,139.566	1,961.333
	4,138.81	1,429,880.201	7,937,514.000	1,159.204	1,961.360
	4,138.82	1,454,612.390	8,156,916.000	1,179.254	2,015.574
	4,138.83	1,479,505.430	8,156,980.000	1,199.435	2,015.590
	4,138.84	1,504,398.691	8,157,063.000	1,219.616	2,015.610

A graph illustrating the stage, volume, and area relationship for parcel 33 is presented in figure 3. The graph illustrates the increase in volume with increasing surface-water stage and the large increase in inundated area between 4,137.00 and 4,139.00 ft. The inundated area increases more rapidly because the land surface is relatively flat. In the example, as the inundated area approaches the area of the parcel, 2,544.6 acres, the rate of increase in inundated area with stage becomes nearly flat. However, although the inundated area is unchanged after the parcel is submerged, the volume continues to increase because the depth of water continues to increase. These examples use the coverages and data for NAVD 88.

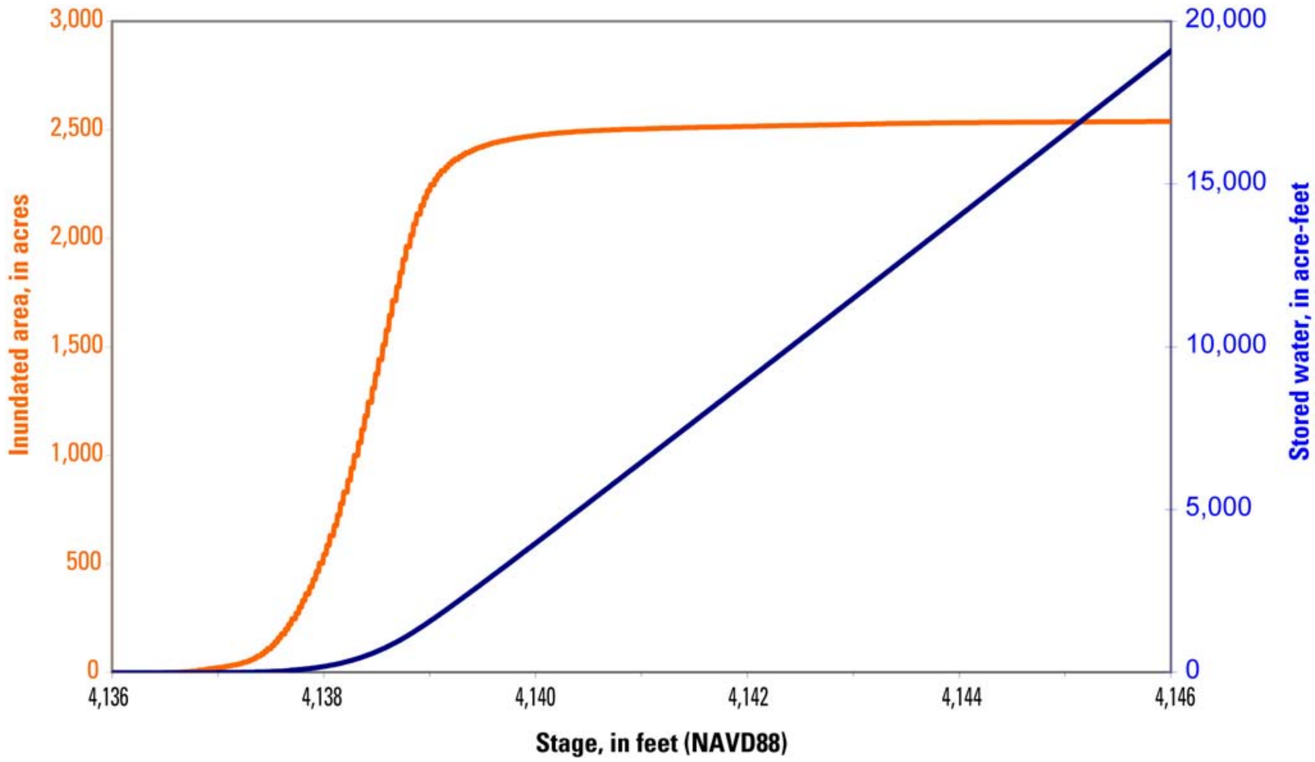

Figure 3. Stage, volume, and area relationship for parcel 33, Wood River Valley, Oregon.

References Cited

Watershed Sciences, Inc., 2005, LiDAR remote sensing data collection—Wood River, Oregon: Corvallis, Oregon, Watershed Sciences, Inc. (Submitted to Klamath Basin Rangeland Trust), April 16, 2005, 29 p.

Appendix

Data for this report, consisting of the parcel coverage and stage, volume, and area tables for each parcel, as well as information on how to obtain inundation coverages on DVD, can be downloaded from *http://pubs.usgs.gov/of/2007/1364/data/data.xls*.