Assessment of Lands Served
Burley Irrigation District
December, 2008

Introduction

As part of the Surface Coalition Water Call, The Geospatial Technology Section of the Idaho Department of Water Resources (IDWR) assessed the land served by the Burley Irrigation district (BID) for the year 2006. The assessment was done used a geographic information system to process a combination of remote sensing data, water-rights data, and other data in the IDWR data library. The assessment produced a map showing irrigated and non irrigated land irrigated by surface water or ground water, and two tables that summarized the acres irrigated in each category for ground water and for surface water. The map and the tables were delivered to BID with a request to have BID personnel review the map, annotate any areas of disagreement BID had with the map, and return the annotated map to IDWR. The BID annotations would then be evaluated by IDWR personnel and those annotations that IDWR felt were valid would be incorporated into the final irrigated/non-irrigated classification of BID that IDWR will use.

Data

IDWR personnel used remote sensing data, water-rights data, and other departmental data in assessing and mapping the irrigated lands in BID. All the data used in the analysis are available on the Internet at http://www.idwr.idaho.gov/Calls/Surface_Water_Coalition_Call/.

Remote Sensing Data

IDWR used two sources of remote sensing data for the BID analysis, digital aerial photographs, and satellite images. The digital aerial photographs are from the USDA, Farm Services Administration's National Agricultural Imagery Program (NAIP). In the NAIP program, individual digital photos are taken and mosaicked into larger tiles that are delivered to the state. IDWR has both years of NAIP images for Idaho, 2004 and 2006. Both years are true-color. The 2004 images have a pixel size of 1 square meter, and the 2006 images have a pixel size of 4 square meters. The NAIP images were acquired on several dates during the respective summers. All of BID is covered by both years.

The satellite data are from the Landsat 5 and Landsat 7. Landsat has both true color and color infrared data, and has a pixel size of 900 square meters, which is 0.22 acres. The Landsat image dates are listed in tables 1 and 2 of Appendix 1. Refer to Appendix 1 for a detailed description oh how the remote sensing data were used to classify BID lands.

Water Rights Data

IDWR personnel queried the IDWR water-rights file for all active, private, irrigation water-rights within BID. The resulting shape file was composited with the irrigated/non-irrigated shape file. All irrigated land without a private irrigation water-right was assumed to be surface-water irrigated. All land with a private, ground-water, irrigation water-right was assumed to be ground-water irrigated, an assumption that IDWR recognized would not be always correct. IDWR requested BID's participation in evaluating the irrigated/non-irrigated, ground-water/surface-water classification in order to assure that IDWR correctly identified all land to which BID delivers water.

Other Data

IDWR personnel used other geographic data as well. These data are listed in Table 1.

File Name	Description
quad100	Boundaries of the USGS 1:100,000-scale quadrangles
irrigation companies	Boundaries of canal companies and irrigation districts
gcdb_tr	Township boundaries from the BLM's GCDB
counties	County boundaries
clu_irr	Field polygons from the Farm Service Administration's Common Land Unit database.

Table 1. Other geographic data used in mapping irrigated land in the Burley Irrigation District.

Preliminary Results

The preliminary results of the classification are summarized in Tables 2 and 3. Those tables and the accompanying map were sent to BID for their review.

BID returned to IDWR a shapefile containing polygons whose classification BID felt was wrong. BID included a comment field that held a briefly explanation. Figure 1 shows a general overview of BID with the polygons annotated by BID personnel in red. BID's edits took two forms. The first form was land that IDWR classified as not irrigated or "semi-irrigated." "Semi-Irrigated" was used for CLU polygons that define residential areas that are less that fully-irrigated. IDWR accepted all except two of BID's irrigated/non-irrigated edits. Those two rejected areas are shown in Figures 2 and 3. The second form was for land that IDWR classified as groundwater, but that BID identified as land to which they delivered water. IDWR accepted all of BID's ground-water/surface-water edits. The total acreage included in BID's edits is summarized in Table 4.

	n Di str ict	ir Di st #2	tio n Di st	n Di str ict	n Di str ict	an al C o.	an al C o.	tio n Di str ict	o m pa ny	n Di str ict	o m pa ny
A&B Irrigation District	23,965				442	242					
American Falls Reservoir Dist. #2		20,932				1,139					
Burley Irrigation Dist.			9,067		1			11,573			
Milner Irrigation Dist.				225			279	1			
Minidoka Irrigation Dist.	442		1		4,811						
North Side Canal Co.	242	1,139				76,748				78	
Twin Falls Canal Co.				279			15,910	5,143			1,352
Total	24,649	22,071	9,068	504	5,254	78,129	16,189				

Table 2. Ground water irrigated acres and overlapping acres by irrigation district in the surface Water Coalition Call. Non-overlapping acres are shown in the gray boxes

	n Di str ict	ir Di st. #2	n Di str ict	n Di str ict	n Di str ict	an al C o.	an al C o.	tio n Di str ict	ni ng C o.	n Di str ict	o m pa ny
A&B Irrigation District	76,904				2,941	2,633					
American Falls Reservoir Dist. #2		78,557				4,138					
Burley Irrigation Dist.			39,413		56			705			
Milner Irrigation Dist.				7,741			4,784	97			
Minidoka Irrigation Dist.	2,941		56		60,194						
North Side Canal Co.	2,633	4,138				135,727			4	153	
Twin Falls Canal Co.				4,784			162,958	798			1,914
Total	82,478	82,695	39,469	12,525	63,191	142,498	167,742				

Table 3. Surface water irrigated acres and overlapping acres by irrigation district in the surface Water Coalition Call. Non-overlapping acres are shown in the gray boxes

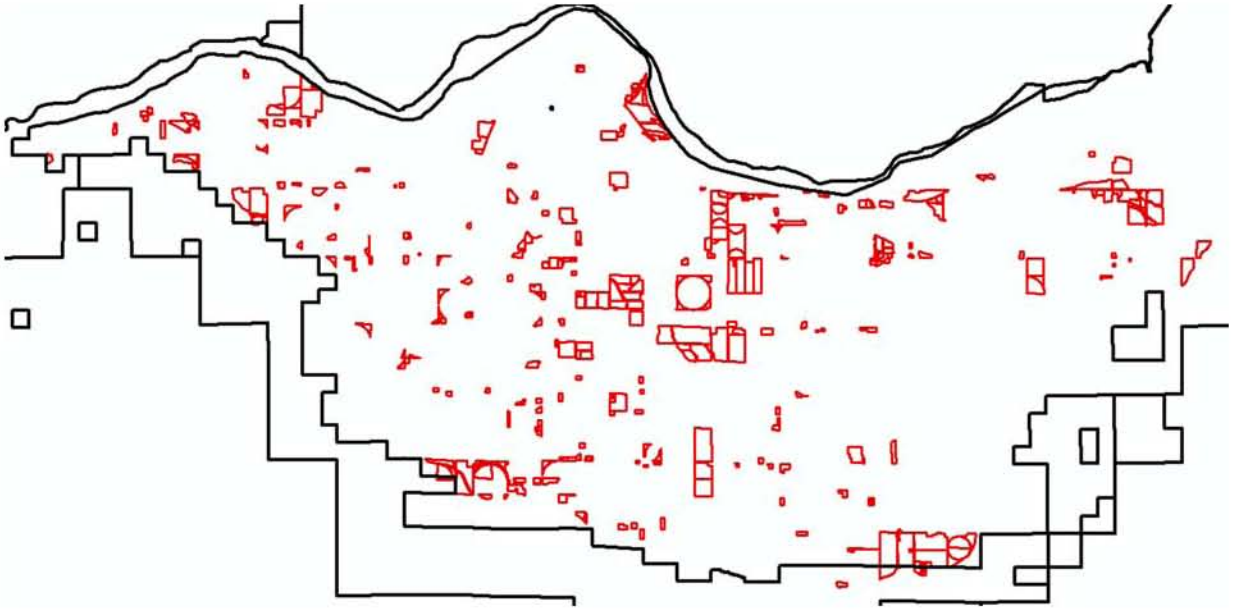

Figure 1. The polygons annotated by Burley Irrigation District personnel in red.

2004 2006

Figure 2. NAIP images of rejected Area #1. Rangeland in T10SR21E S25 NESE that is not irrigated.

2004 2006

Figure 3. NAIP images of rejected area #2. Gravel pit in T11SR21E S20 NENE.

Table 4 lists three classes of land cover, irrigated, non-irrigated, and semi-irrigated. An "Irrigated" designation means that water was applied to the parcel last at some time during 2006 for the purpose of growing a crop, and that all or nearly all the parcel is subject to irrigation. A "Not-Irrigated" designation means that there was no clear evidence that water was applied to the parcel in 2006. A "Semi-Irrigated" designation is more complex. Semi-Irrigated parcels are generally residential parcels that have some irrigation, but the percentage of the parcel being irrigated can by small.

IDWR Classification	Burley Irrigation District Surface Water Irrigated
Irrigated – GW	2756
Not Irrigated – SW	306
Not Irrigated – GW	521
Semi Irrigated – SW	167
Semi – Irrigated GW	17
Total	**3767**

Table 4. Acres by IDWR class identified by BID as surface water irrigated

Final Results

The edits proposed by BID and accepted by IDWR were incorporated into a new irrigated/non-irrigated shapefile. IDWR personnel recomputed the acreages of the classes, and the result is summarized by Table 5.

Class	Surface Water	Ground Water
Irrigated	42,313	6,320
Semi-Irrigated	4,132	582
Total	46,445	6,902

Table 5. Acres agreed to by the Burley Irrigation District and IDWR as irrigated by surface and by ground water.

Appendix 1
2006 Irrigated Land Classification
for the
Eastern Snake Plain Aquifer

Introduction

IDWR is revising its Eastern Snake Plain Aquifer (ESPA) groundwater model. As part of that revision, the Geospatial Technology Section was asked to generate a new digital classification of the irrigated land within the boundary of the ESPA model. Water from irrigated land is a source of significant recharge to the aquifer, and is one of the factors that determine the accuracy of the model's predictions. The new classification would replace the old classification which is circa 1992. The area of the Eastern Snake Plain is illustrated in Figure 1.

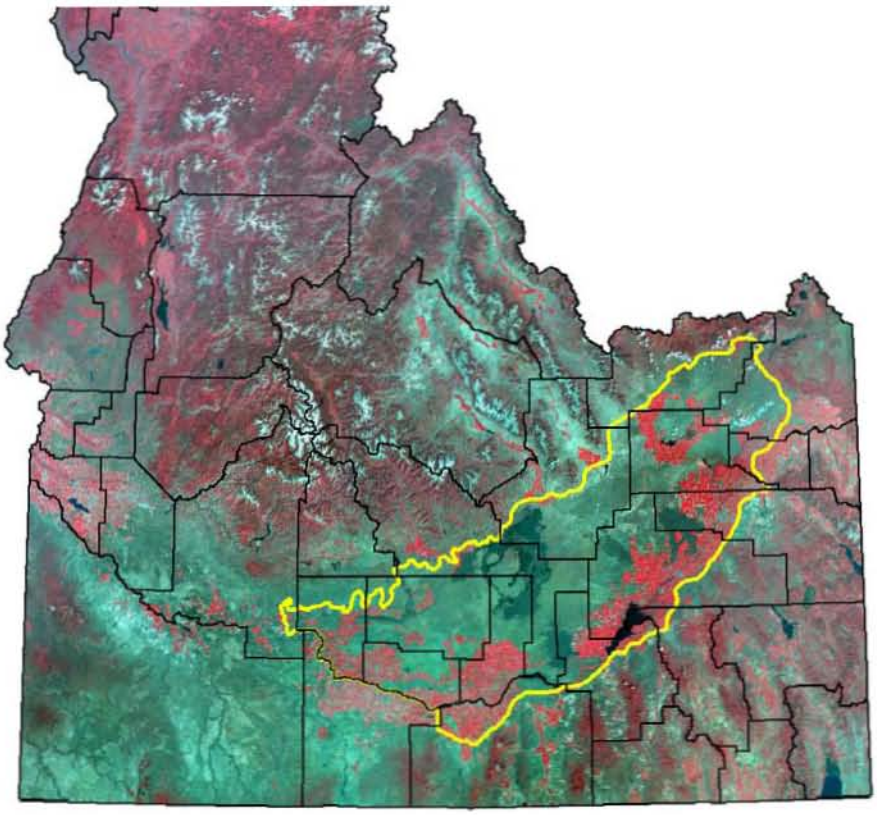

Figure 1. The boundary of the Eastern Snake Plain Aquifer, in yellow.

Several approaches to the classification were considered and for various reasons, rejected. The primary goals of the classification were to delineate agricultural land as accurately 1) as precisely as possible, 2) as accurately as possible, and 3) as recently as possible.

The classification scheme chosen achieves all three goals by using a combination of computer processing and human interpretation operating on both Landsat satellite data and on digital aerial photography acquired through the National Agricultural Inventory Program (NAIP). All image data is from the year 2006.

In conjunction with the image data, IDWR analysts used Common Land Unit (CLU) polygons of individual fields that were digitized from a combination of 2004 and 2006 NAIP imagery by the Farm Services Administration (FSA). Although FSA will allow access to CLU polygons, they deny all requests for access to the associated attribute data, including the land-cover codes. IDWR, therefore, used the unattributed CLU polygons. The CLU polygons were used because they constitute an existing, recent, highly-detailed, vector dataset that IDWR could attribute as irrigated or non-irrigated relatively easily. Figure 2 shows CLU polygons superimposed on NAIP image data.

Figure 2. Common Land Unit (CLU) polygons in black superimposed on National Agricultural Inventory Program (NAIP) image data.

CLU Data

FSA created the CLU polygons as part of its crop compliance responsibilities. While the CLU data are extensive, and have been finished for all the counties on the ESPA, the polygons themselves do not fit perfectly IDWR's needs. An examination of CLU data at the beginning of the project revealed the need for editing the polygons, sometimes in some detail. The project deadline precluded complete editing, but even so, the CLU very nearly fit IDWR's needs.

The Classifier

IDWR used a 3-step classifier to map irrigated land on the ESPA. The first step used Landsat satellite data, the second step used a combination of Landsat and NAIP digital photography, and the 3rd step used NAIP photography and CLU data.

The First Step

The first classification step used Landsat satelltite data exclusively. Landsat is a medium resolution satellite with square pixels that are 30 meters on each side. IDWR used 3 dates of Landsat data: June 20, 2006, July 22, 2006, and August 7, 2006. Those dates were used because they were available at IDWR for processing with the METRIC evapotranspiration model.

As part of the METRIC processing, each scene in transformed to produce a vegetation index, specifically the normalized difference vegetation index (NDVI), which is computed as

$$\frac{\text{band 4} - \text{band 3}}{\text{band 4} + \text{band 3}}$$

The actual computation is more complex, and involves conversion of the raw digital numbers in the image to radiance. This is done as part of the METRIC processing to process a consistent set of data from scene to scene.

The normalized difference is highly correlated with vegetation canopy characteristics, including leaf area index. Plotted through a growing season, the normalized difference nicely tracks the development of vegetation.

IDWR transformed all three dates of Landsat data to NDVI, then clustered and classified the data into 255 spectral classes. The 255 spectral classes were superimposed in the Landsat false color images and interpreted to either “irrigated” or “non-irrigated,” producing a Landsat classification of irrigated and non irrigated pixels as illustrated by Figure 3.

The Second Step

The second step in the classification was to overly CLU polygons on the Landsat classification, as illustrated by Figure 4. A simple decision rule was applied that made a polygon irrigated if at least 75% of the area of the polygon was classified by Landsat as “irrigated”. The result of the decision rule on Figure 4 is illustrated by Figure 5.

Figure 3. The initial Landsat-based classification output from Step 1 of the classifier. Irrigated land is green

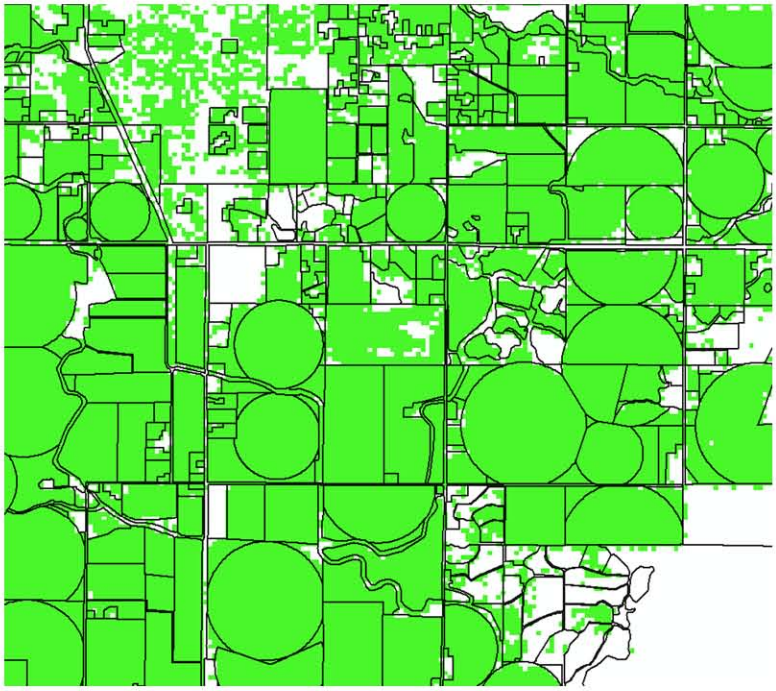

Figure 4. The initial Landsat-based classification output from Step 1 of the classifier with CLU polygons superimposed. Irrigated land is green

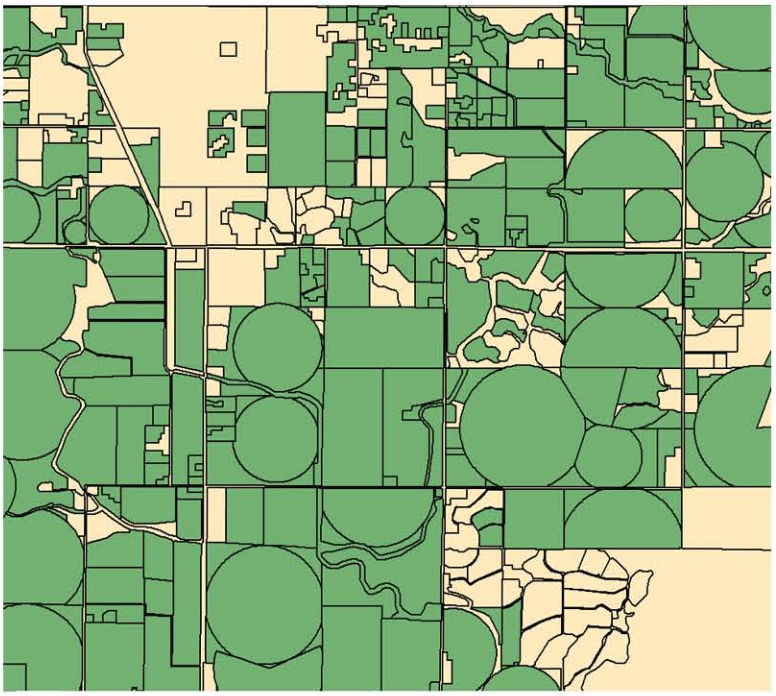

Figure 5. The Landsat-based classification output from Step 2 of the classifier with CLU polygons superimposed and all the CLU polygons classified as irrigated or non-irrigated based on a 75% or greater rule. Irrigated land is green.

The Third Step

The third step was to review the Irrigated-Nonirrigated classification in Figure 4 by superimposing the classified image on top of the 2006 NAIP digital photography. This was done in 2 phases by alternately masking irrigated polygons and then non-irrigated polygons, and then overlaying the masked image sequentially on all available dates of Landsat data, one date at a time, and on the NAIP.

IDWR used three dates for the initial Landsat classification because the NDVI transformation had been run on only those dates as part of the METRIC processing. The editing of the classification was done using all available Landsat dates, which are summarized by Tables 1 and 2.

Figure 6 shows masked irrigated polygons on a Landsat image. What is not masked is classified as non-irrigated. Clearly, there are some irrigated fields being classified as non-irrigated. Those misclassifications were corrected by simple editing, and the process was repeated for each date of Landsat data available, and for the NAIP (Figure 7).

Orbital Path 40	
Landsat 5	Landsat 7
May 3	April 25
May 19	August 31
June 20	
July 22	
August 7	
September 8	
September 24	
October 10	

Table 1. Landsat scenes dates for Orbital Path 40

Orbital Path 39	
Landsat 5	Landsat 7
April 26	April 4
May 12	October 11
June 13	
July 15	
August 16	
September 1	
October 3	

Table 2. Landsat scenes dates for Orbital Path 39

Figure 6. Irrigated polygons masked to black and superimposed on Landsat data from May 19, 2006.

The analysis done in Step 3 revealed that many fields that were classified as non-irrigated using the three dates were actually irrigated in the May and/or September-October time-frame. Although these fields were not classified as irrigated by Steps 1 or 2, they were classified as irrigated by Step 3

The entire classification could have been done using just Step 3, but it would have taken longer and been more tedious. The first two steps were designed to classify quickly those fields that the computer could readily identify as irrigated. The third step was designed to use a human interpreter to make subtle decisions that were beyond the meager intelligence of the software, and to correct any classification errors made by the software. Figure 9 shows an example of one kind of those errors. Steps 1 and 2 resulted in small polygons of residential land being classified as irrigated. In Step3, those polygons were changed from irrigated to a third class not used in the first 2 steps: residential.

The residential class was added because there is generally irrigation occurring in residential areas, but that irrigation is not as intense as the irrigation of agricultural land. The residential class captures that less-intense irrigation.

Figure 7. Irrigated polygons masked to black and superimposed on 2006 NAIP image data.

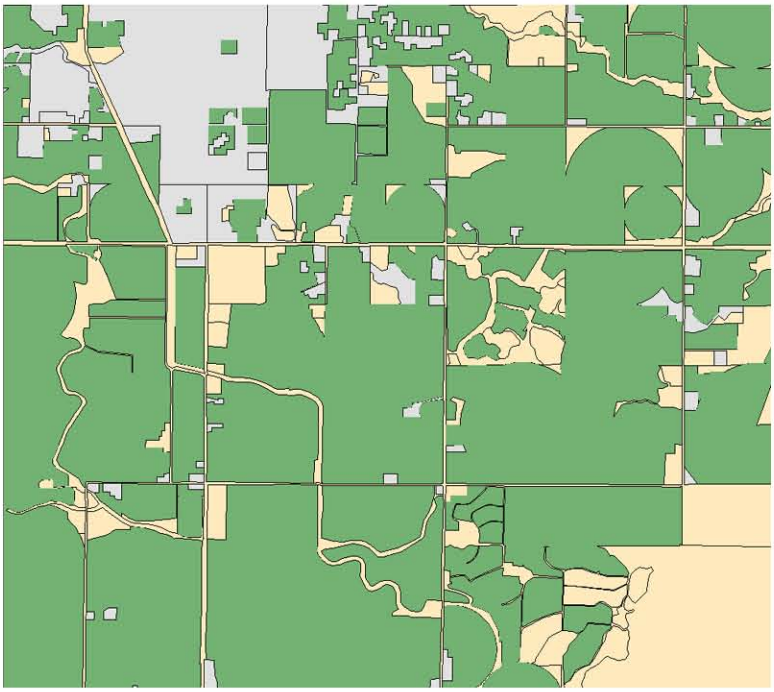

Figure 8. The final, edited classification with irrigated in green, non-irrigated in beige, and residential in gray.

Figure 9 . Non-Irrigated mask on NAIP. Arrows point to some residential land classified as irrigated. Those polygons are changed during editing.

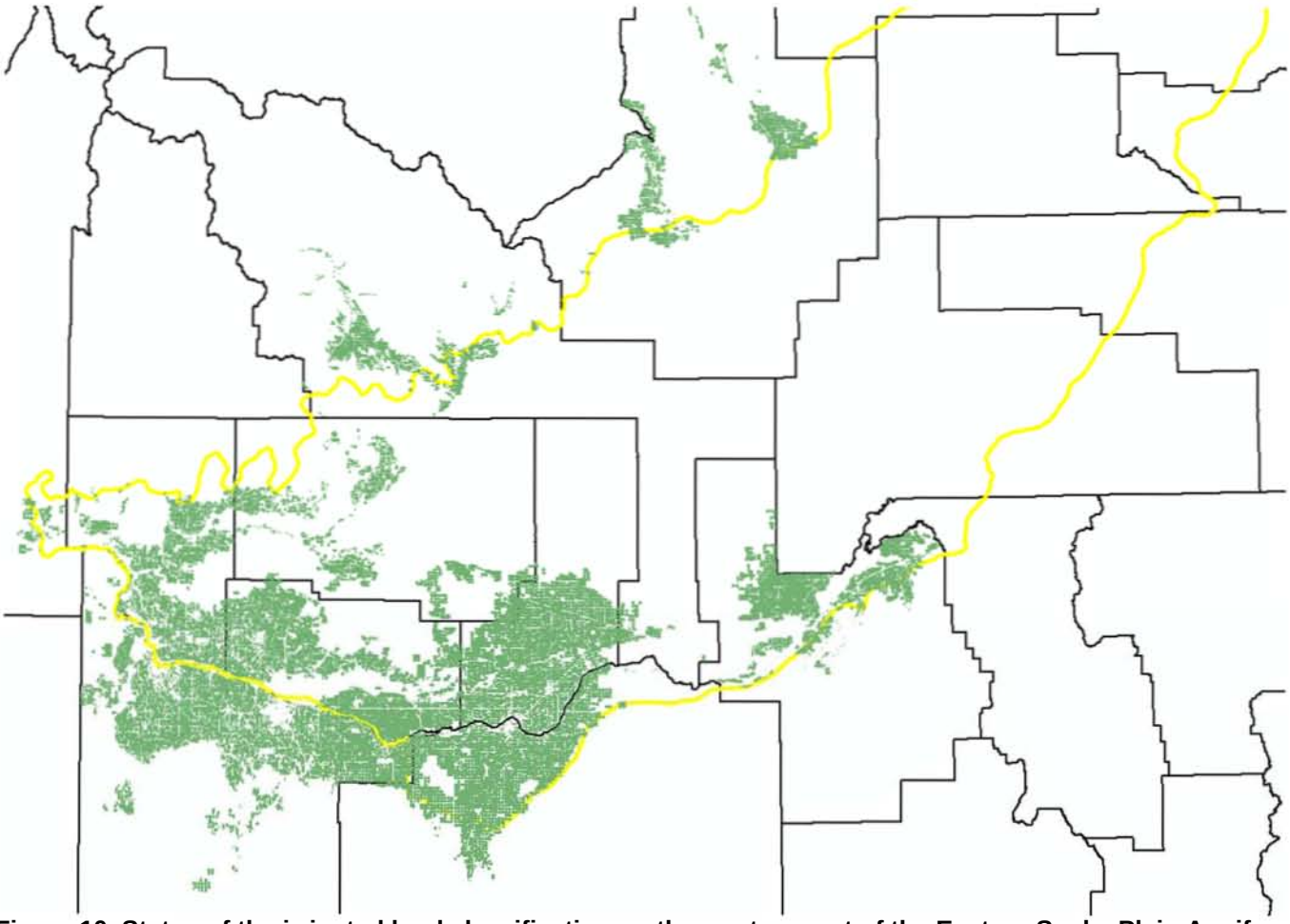

Figure 10. Status of the irrigated land classification on the western part of the Eastern Snake Plain Aquifer, as of November 1, 20080.

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Dec. 12, 2008