Research Technical Completion Report

DEVELOPMENT OF A TRANSIENT GROUND-WATER MODEL FOR THE TWIN FALLS AREA, IDAHO

by

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Introduction

Background

The City of Twin Falls, Idaho, located in south central Idaho along the south side of the Snake River, is rapidly outgrowing its current municipal water supply. The city is experiencing the greatest growth of any city in Idaho, with an estimated annual growth rate of 2.5 percent. Water supply and water quality are of great concern to the city water department and city planners. To plan for future needs, the City of Twin Falls contracted with the Idaho Water Resources Research Institute of the University of Idaho to design and implement a numerical ground-water flow model. The model is intended to represent the current hydrological conditions of the city and to be used as a planning tool to assist in predicting the impact of projected growth and changes in local water use.

The study was done in two phases. Phase 1 was the design, implementation, calibration and verification of a steady state numerical ground-water flow model for the Twin Falls area (Cosgrove, et al, 1997). Phase 2 included conversion of the numerical model to a transient model to be used for growth projections and future planning. This report covers the work done in Phase 2.

Statement of Problem

The City of Twin Falls meets its municipal water demand using a ground-water right at Blue Lakes on the north side of the Snake River canyon and three municipal wells in the vicinity of the city. The Blue Lakes ground-water right provides eighty-five to ninety percent of the current municipal supply. Approximately 26 mgd (40 cfs) is pumped from the Blue Lakes area to the city through a single 30 inch diameter pipe over the Snake River, with a lift of 500 feet on the south side of the Snake River canyon. The three city wells have a pumping capacity of approximately 10.5 mgd (16 cfs). The city stores water in two 5 million gallon storage tanks and a smaller 750,000 gallon storage tank. Peak water use of the City of Twin Falls occurs in the summer and is estimated at a rate of approximately 29 mgd (45 cfs). The current method of meeting the municipal water needs poses several concerns. During periods of peak water use, the city is near capacity for water delivery. The limited storage capacity indicates that demand must be met in real time. The current ground-water right at Blue Lakes allows for 32 mgd (50 cfs); however, the cost of developing the unused portion of the water right is estimated at 1.7 million dollars. Full development of the ground-water right would stress the environmentally sensitive Blue Lakes area. The increase in dairy farming on the north side of the Snake River also introduces water quality concerns for Blue Lakes. The risk of a failure in the pipeline crossing the Snake River also puts the city's water supply at risk.

Partial to total replacement or augmentation of the Blue Lakes water supply with ground water from the south side of the Snake River Canyon poses a number of questions. First, is the aquifer capable of meeting the additional water demand? Second, can the needed high yield wells be developed without injury to other water users? Third, will changing irrigation practices limit development potential because of decreased recharge? These issues form the basis for this research project.

Of primary concern to the city planners are the impacts to the ground-water resource of both further ground-water development and changing land use. Ground-water development in the tract is primarily for domestic and municipal purposes, with minimal ground water based irrigation. Irrigation on the Twin Falls tract is primarily by gravity delivery fed by diversions from the Snake River with only about ten to fifteen percent sprinkler irrigation in current practice. With increasing labor costs associated with surface irrigation (e.g. flood, furrow), more widespread availability of 3-phase power required for sprinkler systems and federal government incentives under the U. S. Department of Agriculture Environmental Quality Incentives Program, conversion to sprinkler irrigation is expected to rise dramatically in the next several years. This will reduce incidental recharge associated with irrigation. Conversion of irrigated agricultural lands to municipal use due to increased population and reduction of irrigated acreage will also impact recharge volumes. Such diminished recharge will subsequently affect existing ground water users and bring into question new well development projects such as that proposed by the City of Twin Falls.

The onset of surface irrigation in 1905 with the building of the Twin Falls canal system raised ground-water levels dramatically, possibly as much 300 feet (Stearns, et al, 1938). Irrigation, coupled with the existence of low permeability loess sediments, caused localized water logging. To alleviate the situation, tunnels were excavated into the underlying basalt in the late 1920s to drain the fields. Water utilization, with the associated water rights, has been derived from the effluent of these tunnels. Some tunnels flow only during the irrigation season. Other tunnels drain the upper portion of the aquifer throughout the year. Some tunnel drainage is captured and re-applied as irrigation water. Other tunnel rights are used by the aquaculture industry, which is highly dependent upon sustained flow levels, water quality, and stable water temperature. The reduction in recharge associated with conversion to sprinkler irrigation plus changes in land use will result in decreased flows from the tunnels. Increased ground-water pumpage also will impact water rights based on the tunnel discharges.

The City of Twin Falls plans to implement a managed recharge program along with development of new municipal wells south of the city to ensure a stable water supply. The recharge would be used to help sustain production at existing city wells and offset possible water level declines resulting from the new municipal wells. The recharge may also help offset the effects of the anticipated conversion from surface to sprinkler irrigation. The City of Twin Falls is sensitive to the need for balance between municipal water requirements, commercial water use and domestic water use. Lower aquifer levels would have an adverse impact on domestic wells, causing costly increases in pumping lifts and well deepening. Lower aquifer levels would also have an adverse effect on spring flows utilized by the aquaculture industry. In addition, local hydropower plants on Rock Creek and Pigeon Cove could be affected by reduced spring flows. This research project is designed to help provide the City of Twin Falls with the technical basis to judge alternative water development and management programs.

Purpose and Objectives

The purpose of this study is to provide the City of Twin Falls with a better understanding of the local geohydrology via a ground-water model which can be used as a predictive tool for municipal water planning. The objective of the ground-water model is to enable the city to run predictive simulations modeling various well development scenarios, population growth projections and potential recharge programs. The ground-water model will enable estimation of impacts of water level changes and reduced spring flows in specific regions within the study area, to address hydrological concerns of the water user community.

Another objective of the study is to provide the city with a comprehensive baseline of water levels throughout the greater Twin Falls area. This will enable city planners to track future aquifer changes to determine actual impacts of development. Water quality issues were not within the scope of the current study; however, the work done for this study included identification of potential water supply and quality concerns for future study.

A third objective of this research project was to develop spreadsheets which could be used by the City of Twin Falls water department personnel to calculate recharge for model scenarios. The spreadsheets facilitate the setting up and running of water use and management model scenarios by providing the user with a logical presentation of scenario variables which are then incorporated into the model recharge calculations.

A detailed description of the study area, the conceptual ground-water model, the water budgets and the steady state numerical ground-water model are provided in Cosgrove, et al (1997). The reader is referred to that report for complete background on this project. This report documents the design and calibration of the transient numerical ground-water model and sample scenarios which were run using the transient model.

Study Area Description

Study Boundaries

The study area is bounded on the north by the Snake River, on the west and southwest by Salmon Falls Creek, on the south by the Cassia Mountains (locally called the South Hills) and on the east by the Murtaugh Lake area (Figure 1). The deeply incised canyons of the Snake River and Salmon Falls Creek provide natural hydrological boundaries, making them obvious choices for model boundaries. The Cassia Mountains, an uplifted sedimentary body, provide a boundary between developed and undeveloped land as well as a good hydrogeological boundary. The only significant underflow from that region is in the narrow alluvial valleys of streams draining the mountains (Rock Creek and Dry Creek). The Murtaugh area provides a good eastern boundary, with the Oakley Fan area east of Murtaugh being hydrologically distinct from the Twin Falls area. A geological fault to the southeast of the Murtaugh area (Young and Newton, 1989) provides a hydrological boundary with water levels east of the fault being several hundred feet lower than levels west of the fault.

Hydrological Setting

Surface Water

The Snake River occurs in a deep canyon (up to 500 feet deep in the Twin Falls area) cut in the Snake River Plain basalts. The Snake River is gaining in the reach between Milner Dam and Salmon Falls Creek, bordering the study area. Snake River reach gains from springs were analyzed by Kjelstrom (1995) and Thomas (1969). Although most previous work attributes the gains to springs from the north side,

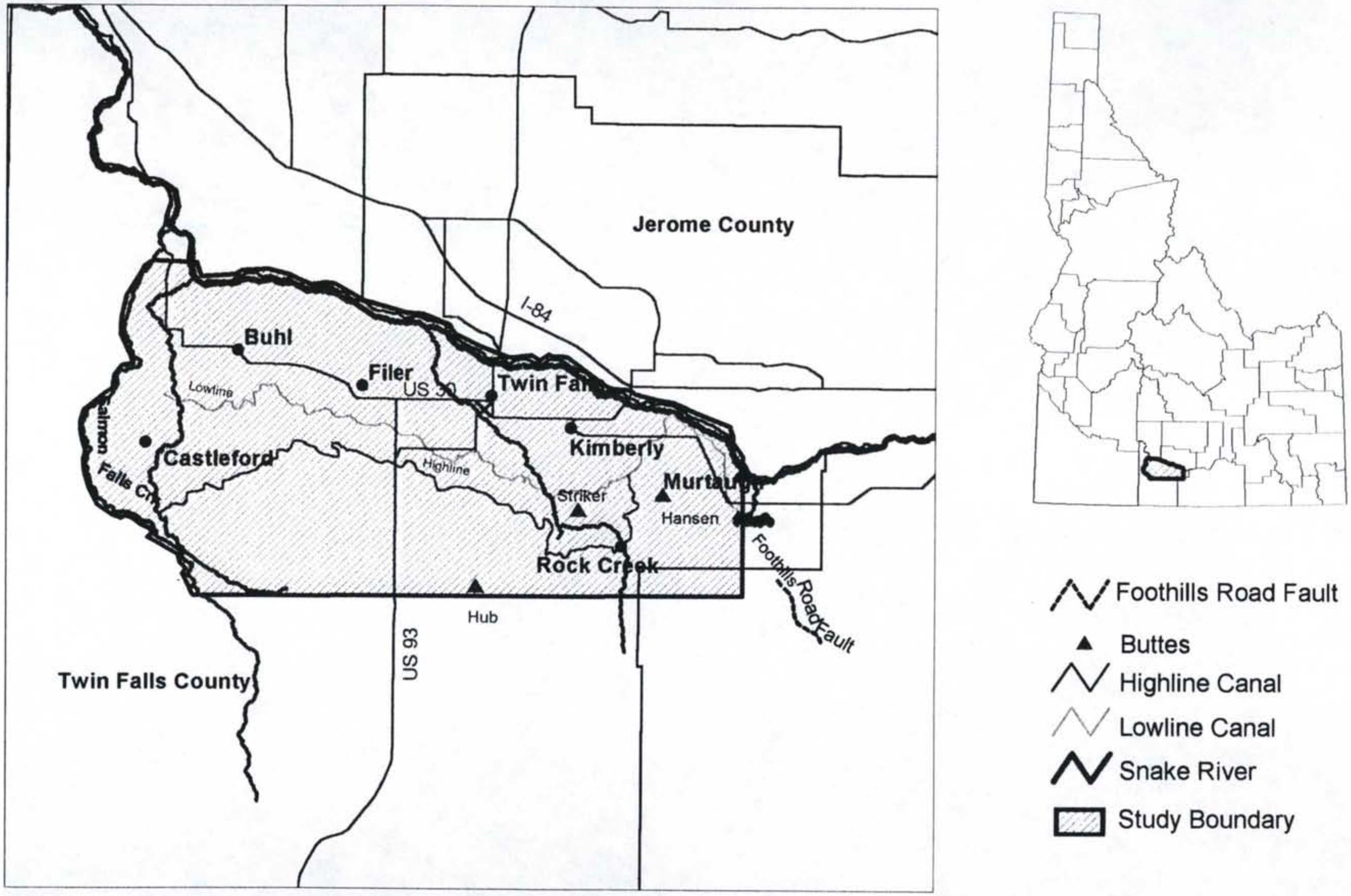

Figure 1. Twin Falls Study Area.

Kjelstrom (1995) estimates that ten percent of Snake River gains are from the south side. Salmon Falls Creek, which originates in Nevada, borders the study area on the southwest and the west. Salmon Falls Creek is dammed south of the study area; streamflow into the study area originates as seepage from the dam. Salmon Falls Creek is gaining along the entire border of the study area from springs emanating primarily from the east side (study area). Salmon Falls Creek flows northward in an increasingly deep canyon, reaching approximately 500 feet in depth as Salmon Falls Creek approaches its confluence with the Snake River. Crosthwaite (1969b) estimates that ninety percent of the gain in Salmon Falls Creek is from the east side (the Twin Falls tract), with only ten percent gain from the west side due to less irrigation in that area.

Rock Creek originates in the Cassia Mountains to the south of the study area and flows north/northeast through the study area. In the south part of the study area, Rock Creek is above the water table. In the more northern part of the study area, Rock Creek is incised in an increasingly deep canyon below the water table and gains water from springs and man-made tunnels.

Dry Creek is an intermittent stream which originates in the Cassia Mountains in the southeast corner of the study area and flows north into Murtaugh Lake and then from Murtaugh Lake into the Snake River. Deep Creek, Mud Creek and Cedar Draw originate within the study area and drain water from the study area. All three are incised in deeper canyons as they approach their respective confluence with the Snake River and all three are spring and drain fed.

Murtaugh Lake, a man-made lake developed as part of the Southside Irrigation Project, is located on the east border of the study area. Murtaugh Lake is completely filled only during the irrigation season and remains partially filled year-round. Murtaugh Lake seeps approximately 14,000 AF into the aquifer annually (Young and Newton, 1989). Murtaugh Lake is hydraulically connected to the regional ground-water system, with seepage from Murtaugh Lake increasing as pumping west and south of Murtaugh Lake increases.

The study area is predominantly irrigated by the Twin Falls Canal Company (TFCC), the largest irrigation company in the state. The TFCC diverts an average of 1.1

million AF/y from the Snake River. The irrigation water is delivered to the area by gravity feed via the High Line and Low Line canals. Approximately 202,000 acres are serviced by the TFCC, with an estimated irrigation application rate of 4.5 feet/acre. It is estimated that in current practice, eighty-five to ninety percent of irrigation in the Twin Falls tract is surface irrigated (primarily furrow irrigation) with sprinkler irrigation making up the balance (per personal communication with V. Alberdi). Surface irrigation provides an important source of recharge to the area aquifer; less recharge occurs from sprinkler-irrigated fields. Crop evapotranspiration is a significant source of water loss in the tract. Irrigation ditches and sub-surface drains conduct irrigation returns to surface streams leaving the tract.

The Salmon River Canal Company (SRCC) services a region south of the study area and extending north into the study area. Approximately sixty-five percent of the acreage served by the SRCC lies within the study area. However, SRCC diversions fluctuate greatly from year to year based upon water supply. There is also some limited surface irrigation within the study area from Rock Creek. In addition, in the southeastern part of the study area, there is limited irrigation by ground water.

Ground Water

The regional aquifer underlying the Twin Falls tract is predominantly in the Quaternary and Tertiary basalts. The dominant sources of recharge to the Twin Falls aquifer are underflow, precipitation in the winter, and irrigation in the summer. The aquifer is fed by relatively minor underflow from the Murtaugh area and from Rock Creek and Dry Creek in the southeast. The Twin Falls aquifer is also fed by underflow from the Salmon Falls area in the southwest. Dominant mechanisms of discharge from the aquifer are springs and man-made drains discharging to the surface streams. Flow in the Twin Falls aquifer is generally south to north with an average gradient of 60 feet/mile (Figure 2).

Ground-water levels fluctuate in an annual cycle, responding to recharge from surface irrigation, with typical water level lows in March and highs in October. Figure 3

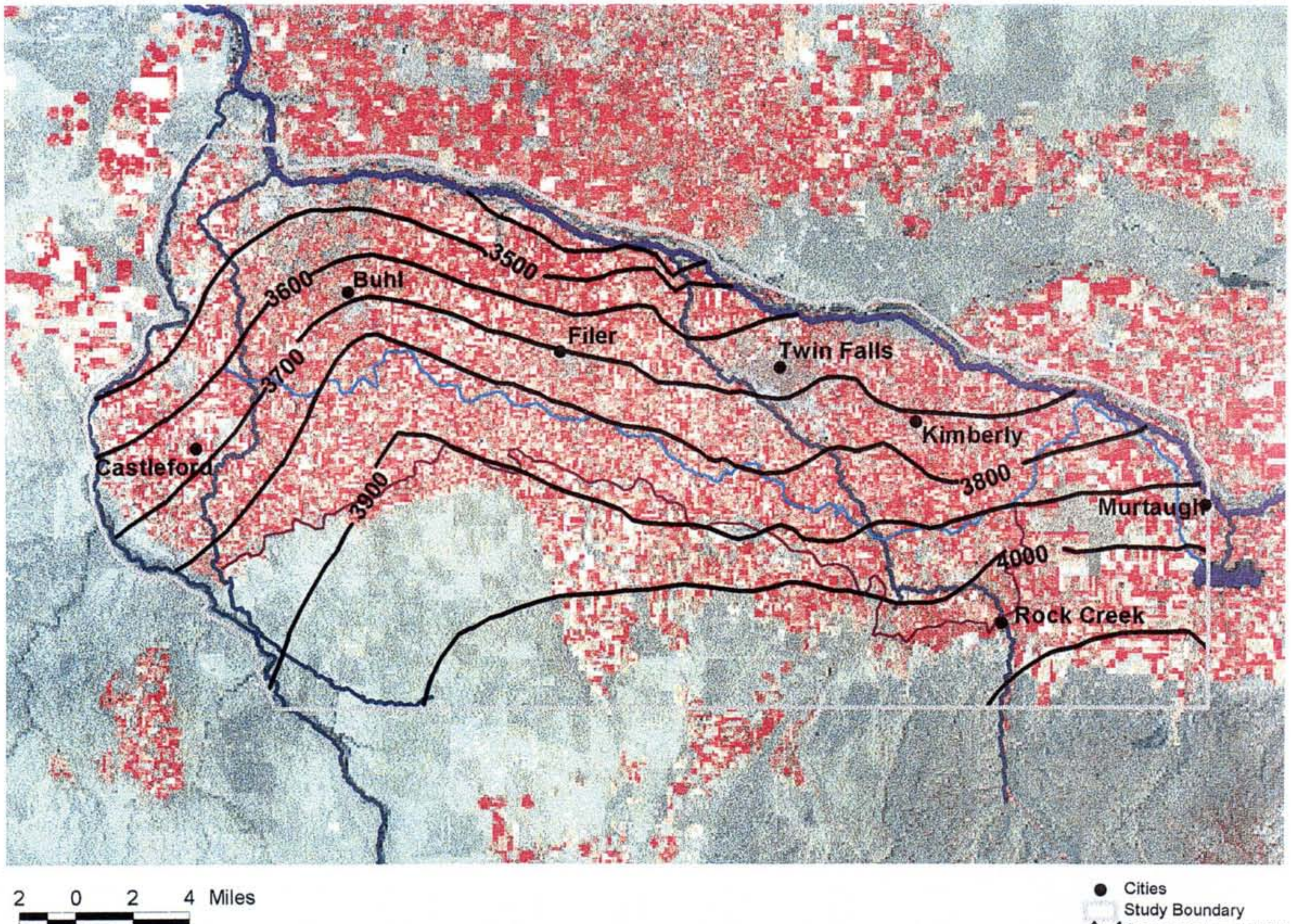

Figure 2. Average Water Level Contours,

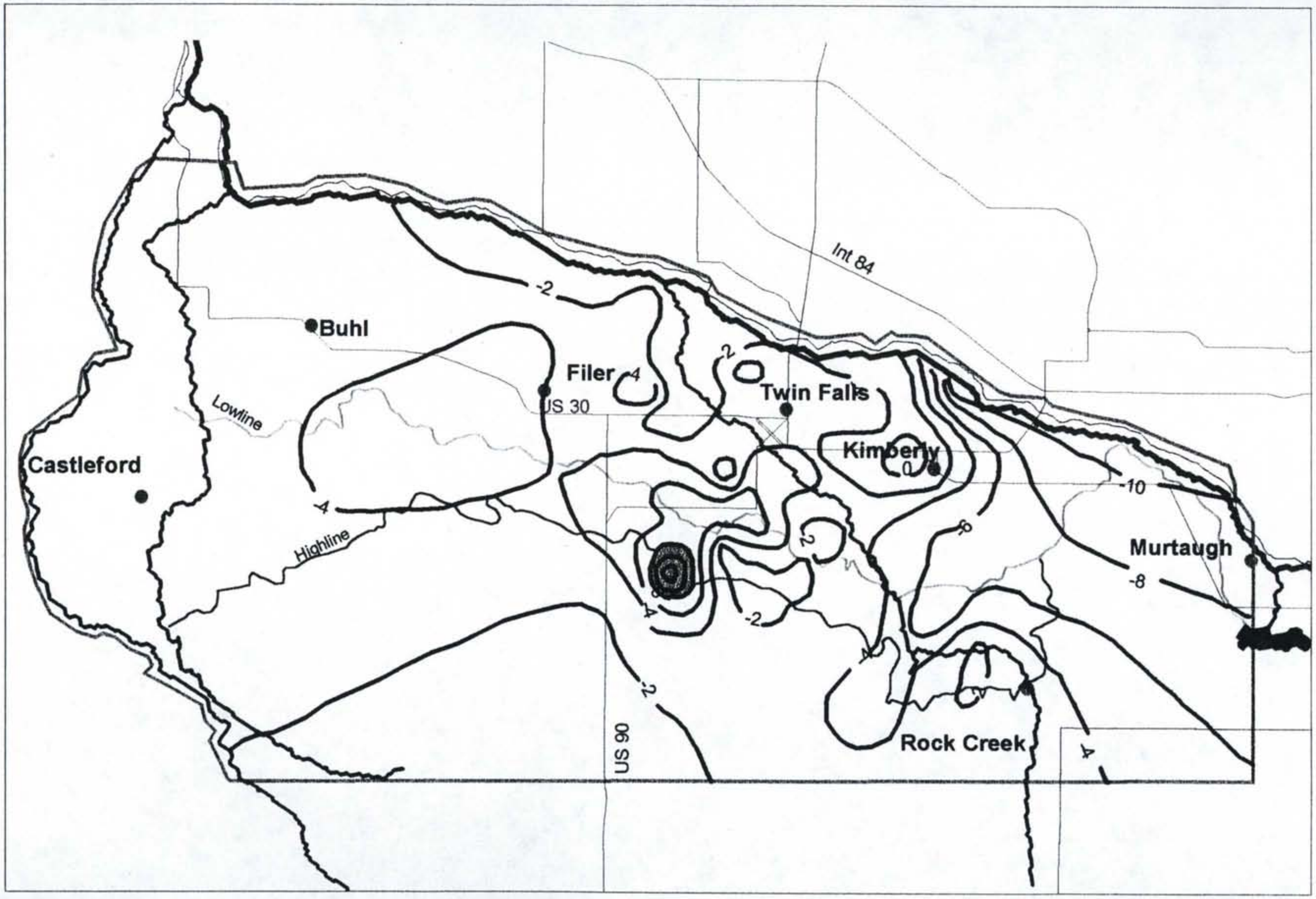

Figure 3. Change in Measured Water Levels Between December and March.

Contour Interval 2 feet
Fall in Water Level
Study Area
Snake River

shows contours for the drop in water table between the average of December 1995 and 1996 water levels and March 1996 water levels. Figure 4 shows contours for the rise in water table between the average of December 1995 and 1996 water levels and July 1996 water levels. Figure 5 shows contours for the rise in water table between the average of December 1995 and 1996 water levels and October 1996 water levels. The water level change contours were generated using measurements taken during 1995-1996, in a network of 118 wells discussed in Cosgrove, et al (1997). Figures 3 through 5 indicate a smaller seasonal swing in water levels than was originally anticipated.

Water Budget

Water budgets were developed for surface and ground water within the study area and for ground water alone. These water budgets are discussed in detail in Cosgrove, et al (1997). An overview of these water budgets is provided in this report.

Overall Water Budget

Inflows to the study area and outflows from the study area were developed using a 20-year average based on the years 1973 to 1993, where possible. This period was chosen to reflect existing conditions due to the limited changes occurring during this 20-year period. Table 1 shows the overall water budget for the study area and the sources of the data.

Inflows

Sources of inflow to the study area are precipitation, irrigation, underflow, surface-water inflow and municipal importation. Irrigation diversions from the TFCC constitute the single greatest source of inflow to the study area. Average diversions for the TFCC for the 1973 to 1993 period were used in the water budget. The SRCC provided annual diversions for the years 1992 to 1996. The diversions were scaled based

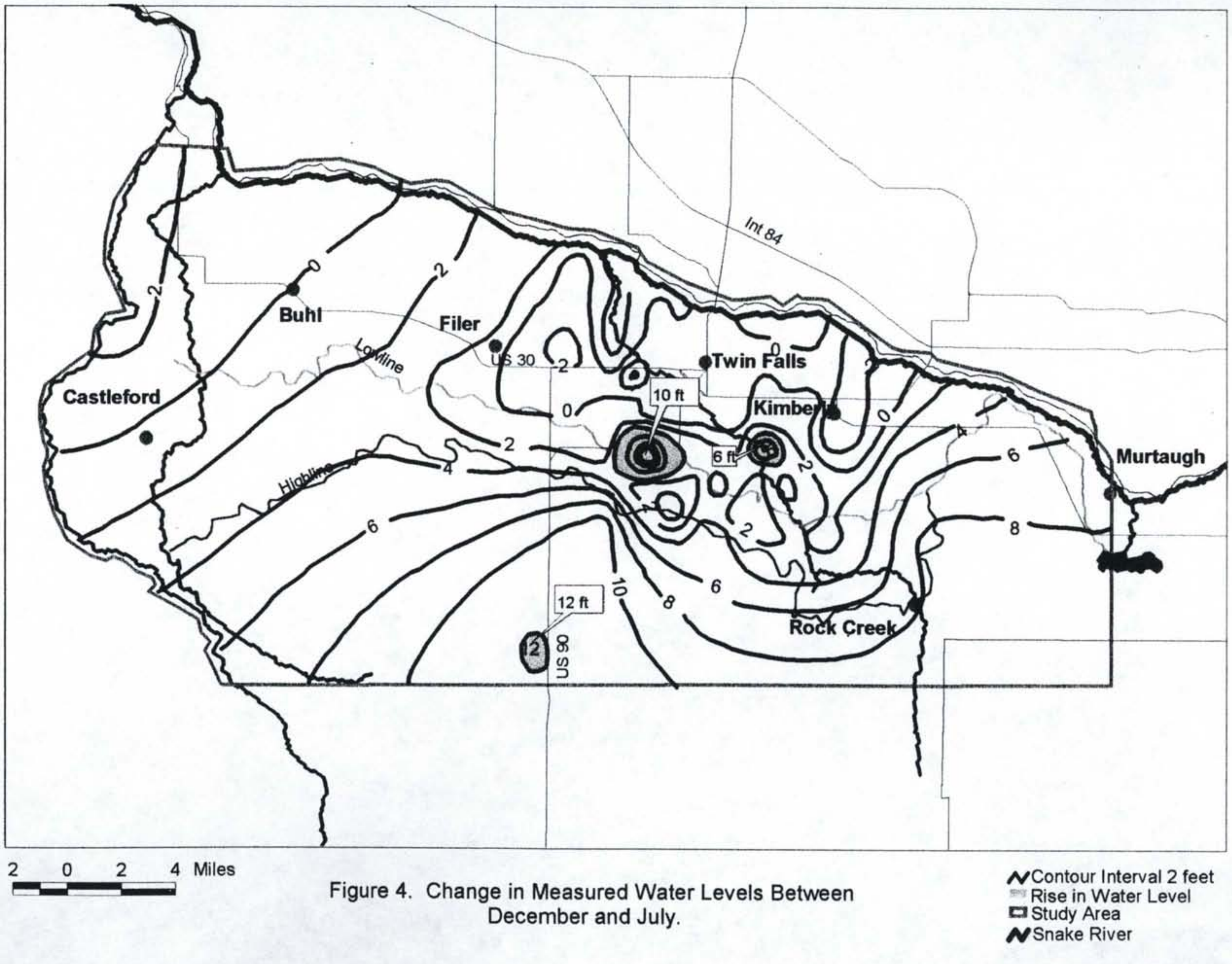

Figure 4. Change in Measured Water Levels Between December and July.

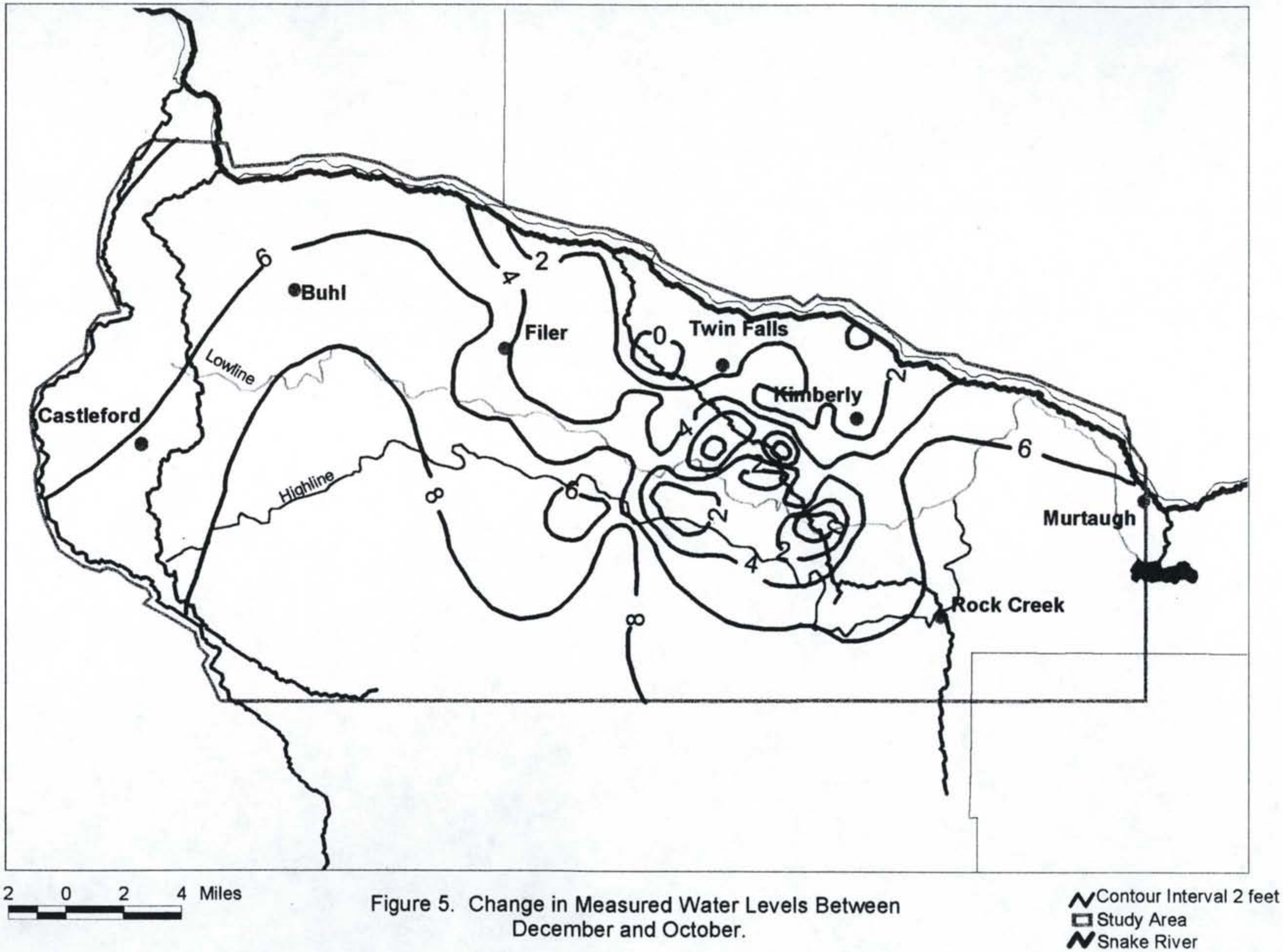

Figure 5. Change in Measured Water Levels Between December and October.

Table 1. Water Budget for Study Area (from Cosgrove, et al, 1997)

		Rate AF/y	Comment
Inflow			
	Municipal water imported from Blue Lakes	9,000.	Average of 1987-present. From city records.
	Precipitation	307,000.	10.3 in/yr spread across active model cells.
	Creek Inflows		
	Dry Creek Inflow	2,800.	From 1994 records.
	Rock Creek Inflow	25,000.	From 1944-1974 records.
	Ephemeral Stream Inflow	10,200.	From Crosthwaite, 1969a.
	Salmon Falls Creek Inflow	5,800.	Estimated.
	Underflow		
	Rock Cr./Dry Cr. Underflow	21,000.	From Crosthwaite, 1969a.
	Salmon Falls Underflow	115,000.	From Crosthwaite, 1969b.
	Murtaugh Area Underflow.	15,000.	Estimated.
	Irrigation		
	Twin Falls Canal Divers.	1,090,000.	Average from 1973-1993.
	Salmon Falls Irrigation	31,000.	Data from Salmon River Canal Co.
Total In		**1,626,000.**	
Outflow			
	Creek Outflows		
	Salmon Falls Creek	103,500.	90% of 115K gain
	Deep Creek	46,000.	From USGS records.
	Mud Creek	62,000.	From USGS records.
	Cedar Draw	69,000.	From USGS records.
	Rock Creek	139,000.	From USGS records.
	Pumpage to West of Study Area		
	Salm. Falls Cr. Consumpt.	44,100.	90% of 49,000 AF Consumption
	Irrigation Returns to Snake River		
	Measured Drains	70,000.	Brockway and Robison (1992), Pigeon Cove Corrected.
	Estimated Drains	38,000.	
	Sewage Treat. Outflow	7,000.	Data provided by City of Twin Falls.
	ET	741,000.	Allen and Brockway method applied to model cells.
Measured Outflow		**1,320,000.**	
Un-meas. surface and sub-surface outflow		**306,000.**	Difference of Total In and Measured Out.

on the percentage of acres irrigated by the SRCC that falls in the study area. Precipitation was derived from 1945 to 1994 daily records from the Twin Falls, Idaho WSO. Precipitation was assumed to be uniform throughout the study area. Water imported to the study area from Blue Lakes by the City of Twin Falls was calculated using flow records from the city for 1987 to 1996.

Surface-water inflows were derived from the U. S. Geological Survey Water Resources Data, where available. The gage at Rock Creek Townsite was discontinued in 1974, so Rock Creek inflows were based on gage records from the Rock Creek Townsite for 1944 to 1974. Dry Creek inflows were gaged only in 1994. Mud Creek, Deep Creek and Cedar Draw inflows were estimated by Crosthwaite (1969a) and are listed as 'ephemeral streams'.

Underflow to the study area from Murtaugh was estimated based on calculated gradients and estimated hydraulic conductivities. Murtaugh Lake seepage estimates were taken from Young and Newton (1989). Underflow from the Rock Creek and Dry Creek drainages was estimated by Crosthwaite (1969a). Underflow from the Salmon Falls area was estimated by Crosthwaite (1969b).

Outflows

Evapotranspiration (ET), creek outflows, surface drains to the Snake River, subsurface drains and springs, water exportation and sewage treatment effluent comprise the outflows from the study area. Measurements or reasonable estimates are available on all of these elements except spring and drain outflows to the Snake River. This represents approximately twenty percent of the total water discharging from the study area.

Evapotranspiration is the single largest source of water leaving the study area, estimated at 741,000 AF/y or approximately 46% of the water entering the study area. Crop distributions for Twin Falls County, obtained from the Twin Falls Agricultural Stabilization and Conservation Service (ASCS) office for the years 1989 to 1995, were the basis for estimating ET for irrigated areas. ET was based on a weighted average ET reflecting the crop distribution for the study area. The average crop ET was calculated using growing season ET data from Allen and Brockway (1983) and non-growing season

ET data from Wright (1993). The Brockway and Allen growing season ET data were derived for the Kimberly, Idaho area using the FAO-modified Blaney-Criddle method. The Wright non-growing season numbers were developed using lysimeters at the U. S. Department of Agriculture Research Station at Kimberly, Idaho. For range land, ET is assumed to be equal to precipitation, with all precipitation evaporating and no additional water drawn from the aquifer. For any model cell with a mix of land uses, the appropriate ET was applied proportionately for each specific land use.

Outflows for Rock Creek, Deep Creek, Mud Creek and Cedar Draw were obtained from the U. S. Geological Survey Water Resources Data for the available years. Outflow from the study area to Salmon Falls Creek was estimated as ninety percent of the total outflow of Salmon Falls Creek by Ralston and Young (1971). Total Salmon Falls Creek outflow includes water discharged to the Snake River and water pumped out of the creek for irrigation to the west. The volume of irrigation water pumped from Salmon Falls Creek was estimated based on IDWR water rights records. It was assumed that ninety percent of the pumped water also originates in the study area.

Drains to the Snake River were measured as part of the Mid-Snake Water Quality Study and are published in Brockway and Robison (1992). Approximately sixty percent of the drains to the Snake River were measured as part of that study (personal communication with C. Brockway and C. Robison); flows for the unmeasured drains to the Snake River were estimated based upon the measured drains.

Ground-Water Budget

A ground-water budget was developed reflecting all water flowing into and out of the regional aquifer. Table 2 shows the overall ground-water budget.

Ground-Water Inflows

The primary sources of inflow to the regional aquifer are underflow from the areas surrounding the study area, canal seepage and deep percolation of precipitation and

Table 2. Ground-Water Budget (from Cosgrove, et al, 1997).

		AF/y
Inflow		
	Areally Distributed Recharge	
	Precipitation	307,000.
	Irrigation Diversions-Canal Seepage	982,000.
	ET**	-741,000.
	Surface Returns	-168,000.
	Total Areally Distributed Recharge	**380,000.**
	Canal Seepage	**109,000.**
	Underflow	
	Rock Creek/Dry Creek Underflow	21,000.
	Salmon Falls Underflow	115,000.
	Murtaugh Area Underflow	15,000.
	Total Underflow	**151,000.**
Total In		**640,000.**
Outflow		
	Spring/Drain Flows to Surface Streams	
	SF Creek	102,000.
	Rock Creek	96,000.
	Cedar Draw	55,000.
	Mud Creek	59,000.
	Deep Creek	42,000.
	Snake (measured)	26,000.
	Total Measured Spring/Drain Flows	**380,000.**
	Estimated Springs to Snake River	**260,000.**
	Diff. Between Total In and Measured Out	

**Note: Ground-water pumping withdrawals are accounted for in the evapotranspiration term.

irrigation water applied in excess of crop demands. The underflow estimates for the ground-water budget are the same as for the overall water budget. Canal seepage was estimated as ten percent of the average TFCC diversion (based on personal communication with V. Alberdi). For the ground-water model, canal seepage was assumed to be only from the High Line and the Low Line canals of the TFCC and not from any of the laterals; however, seepage from laterals is included in irrigation recharge.

No direct measure of deep percolation from precipitation and applied irrigation water is available. Recharge from precipitation and applied irrigation water was estimated by taking the total volume of diverted water plus precipitation and subtracting water lost to consumptive use (ET) and irrigation return flows. Rock Creek probably is a losing stream in the southern part of the study; however, Rock Creek seepage was assumed to be negligible since most of the surface inflow for Rock Creek is diverted and applied for irrigation. All other surface streams bounding the study area are assumed to be gaining streams.

Ground-Water Outflows

Ground-water outflows from the study area consist of drains and springs to surface streams and the Snake River. Gains to Rock Creek, Mud Creek, Deep Creek, Cedar Draw and Salmon Falls Creek are from a combination of surface irrigation returns plus springs and drains. Monthly gains to each surface stream were used to determine stream gain due to springs and drains versus stream gain due to irrigation returns. In non-irrigation months, the assumption was made that all of the gain was due to spring and drain flow and that this flow would be relatively constant throughout the year.
For irrigation months, the average spring and drain flow was subtracted from the total gain to determine the portion of the gain attributable to surface irrigation returns.
Measured drains to the Snake River which have year-round flow were handled similarly.
Unmeasured spring flows to the Snake River were calculated by subtracting the measured outflows from measured inflows to the ground water. Approximately forty percent of the water leaving the aquifer in the study area is unmeasured springs to the Snake River. This assumes that there has been no net change in ground-water storage during the past few

decades. The unmeasured spring flows to the Snake River represent a large, ill-defined component of the ground-water budget. Kjelstrom (1995) reports a total gain to the Snake River in 1980 between the gages at Milner and Hagerman of 3,740,000 AF. This includes portions of the Snake River to the east and west of the Twin Falls area. Kjelstrom also estimates that approximately 90% of the gain is attributable to springs and surface water from the north side and 10% from the south side. An estimate of unmeasured springs to the Snake River of 260,000 AF is reasonable considering the total gain of the Snake River through this area and Kjelstrom's estimate of the source of the gain.

For ground-water irrigation, the assumption was made that any water pumped from the ground in excess of crop consumption seeps back into the aquifer. Therefore, no additional consumptive use beyond ET was considered as leaving the aquifer due to ground-water pumping.

Model Description

Introduction

This section describes the modeling process which was undertaken to convert the Twin Falls steady state ground-water model to a transient model. The study area was modeled using a 2-dimensional transient finite difference model. In a steady state model, recharge and discharge conditions are held constant and the model is run until the modeled basin is in equilibrium. In a transient model, recharge and discharge conditions are varied with time, representing time-variant hydrologic conditions.

The finite difference modeling was done using the U. S. Geological Survey MODFLOW program (version 2.6). MODFLOW's strongly implicit solver (SIP) package was used for the numerical solution. The MODFLOW Drain package was used to model head-dependent spring discharge to surface streams and rivers. All other recharge/discharge terms (non-head dependent) were summed using a spreadsheet for each model cell and were applied using the MODFLOW Well package. EXCEL spreadsheets and macros were used in the generation of recharge and discharge (WEL term) for each model cell for each transient stress period.

Transient Model Description

The conceptual model for the Twin Falls transient model is the same as the conceptual model for the Twin Falls steady state model. The reader is referred to Cosgrove, et al, (1997) for details of the conceptual model. The transient model was calibrated using 24 15.2-day time steps, representing one annual cycle from December 15, 1995 to December 14, 1996.

Model Grid

The model grid is 49 rows by 53 columns. The grid was established using cells of variable dimension, with .25 mile by .25 mile cells in the central region of the model covering 48 square miles in and around the City of Twin Falls, with increasing cell size away from the center, expanding to 1 mile by 2 mile cells at the boundaries. Figure 6 shows the model grid overlaying the study area. The model origin, the southwest corner of model cell 49,1, is in the southwest corner of Township 12 south, Range 13 east, section 9, with Universal Transverse Mercator coordinates of 4,694,750 meters north , 669,100 meters east and latitude and longitude of 114°56'45" west, 42°23'20"north. The variable grid spacing was chosen to give the highest resolution and modeling detail in the central part of the model, which was of highest interest to the City of Twin Falls.

Starting Heads

Starting heads for the transient model were generated from a 30-year simulation of 1996 conditions using 15.2-day stress periods. The ending heads of the 30-year run were then used as starting heads for the transient model. This was done to allow the model to reach dynamic equilibrium and end a run in December. The ending December heads were then used as starting heads for the annual December to December transient runs.

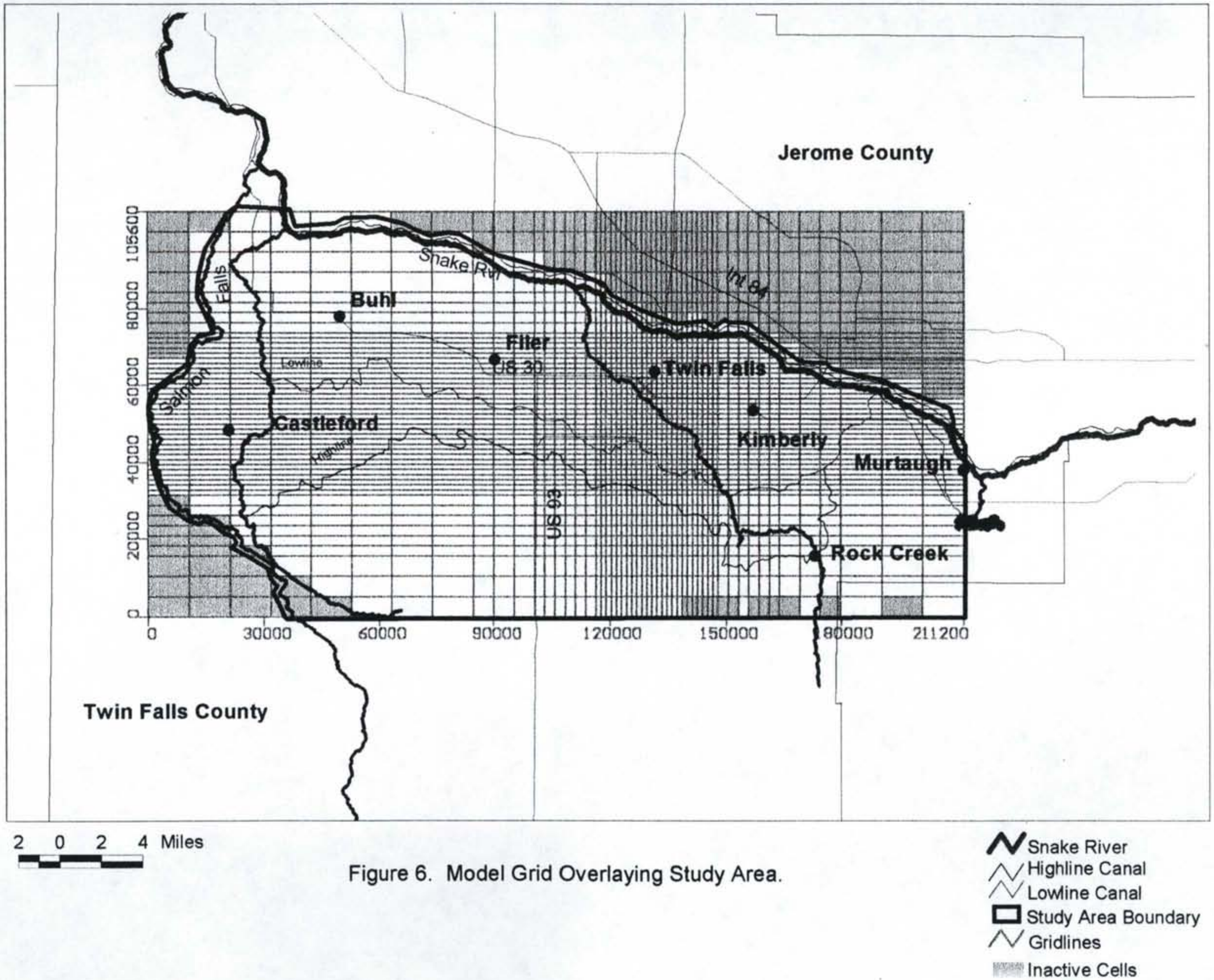

Figure 6. Model Grid Overlaying Study Area.

Model Boundaries

The model boundaries for the transient model are the same as those for the steady state model. The reader is referred to Cosgrove, et al (1997) for a detailed description of model boundaries and boundary assumptions.

Time Distribution of Recharge

Recharge for the one-year transient model was distributed over time using Microsoft EXCEL (version 5.0c) spreadsheets. For each component of recharge, a percentage was calculated for each model stress period representing the proportion which would occur in that stress period. Macros were written using EXCEL's Visual Basic for Applications (VBA) language to process the data for each stress period and generate the transient MODFLOW well file. The spreadsheets are explained in more detail in the appendix. The following paragraphs describe how the different components of recharge were distributed over time. Table 3 shows the percentage of each component of recharge applied in each model stress period. In addition to the recharge components which are distributed over time, the user has the option to change land use, irrigation source, and well pumpage in each model stress period, which would also affect the recharge calculation.

Precipitation--Average daily precipitation data was aggregated into 24 15.2-day groups, representing the length of each stress period in the transient model. A percentage of the annual average precipitation was calculated for each stress period, representing the percentage of annual precipitation expected to fall in that 15.2-day time period. Precipitation was assumed to be 100% effective with no surface run-off.

	Stress Period Start Date											
	12/22	1/6	1/21	2/6	2/21	3/8	3/23	4/8	4/23	5/8	5/23	6/8
TFCC Sprinkler App %	0.00	0.00	0.00	0.00	0.00	0.02	0.21	1.08	8.52	8.81	12.88	13.12
TFCC Irrigation App %	0.00	0.00	0.00	0.00	0.00	0.02	0.21	1.08	8.52	8.81	12.88	13.12
SRCC Irrigation App %	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.81	7.44	7.80	12.96	13.06
Precip per Period %	5.73	5.25	3.23	5.78	5.17	5.66	3.75	5.12	5.50	4.63	5.95	1.97
Average ET per Period %	1.08	1.08	1.54	1.54	2.37	2.37	3.03	3.03	6.30	6.30	9.06	9.06
Grass ET per Period %	0.58	0.58	0.91	0.91	2.12	2.12	3.65	3.65	6.93	6.93	8.06	8.06

	Stress Period Start Date											
	6/23	7/8	7/23	8/7	8/23	9/7	9/22	10/7	10/23	11/7	11/22	12/7
TFCC Sprinkler App %	15.54	15.28	10.70	10.58	1.65	1.59	0.00	0.00	0.00	0.00	0.00	0.00
TFCC Irrigation App %	15.54	15.28	10.70	10.58	1.65	1.59	0.00	0.00	0.00	0.00	0.00	0.00
SRCC Irrigation App %	14.01	13.91	12.05	11.93	3.06	2.94	0.00	0.00	0.00	0.00	0.00	0.00
Precip per Period %	1.29	1.72	1.20	2.87	3.25	2.81	3.69	3.87	4.74	7.08	4.82	4.89
Average ET per Period %	11.74	11.74	6.70	6.70	3.82	3.82	2.43	2.43	1.24	1.24	0.69	0.69
Grass ET per Period %	9.01	9.01	7.58	7.58	5.60	5.60	3.71	3.71	1.26	1.26	0.58	0.58

Table 3. Time Distribution of Recharge Components for One-Year Model.

Evapotranspiration—Monthly ET rates for the average crop distribution and for grass were calculated as previously described. The monthly ET rates were then apportioned to the 24 stress periods to determine the percentage of ET expected to occur in each stress period.

TFCC Gravity Irrigation, TFCC Sprinkler Irrigation, and TFCC Canal Seepage—Average monthly TFCC diversions were apportioned to each stress period to obtain the percentage of irrigation water to be applied during that 15.2-day period. The user enters annual application rates for TFCC gravity irrigation and TFCC sprinkler irrigation. These application rates are then applied to each stress period based on the apportioned percentages. Annual canal seepage is assumed to be 10% of the annual average TFCC diversion. The total annual canal seepage is then apportioned to each stress period using the same percentages as used for applied irrigation water.

SRCC Gravity Irrigation—Average monthly SRCC diversions for 1992 through 1996 were calculated based upon data received from the Salmon River Canal Company. These monthly averages were then used to apportion SRCC gravity irrigation to each of the 24 model stress periods.

Underflow—Underflow was modeled as constant over time. Average annual underflow was divided into 24 equal parts, which were then applied during each stress period.

Well Pumpage—The user has the option of setting constant well pumpage in any model cell for the entire duration of the simulation or to change well pumpage between stress periods. A separate spreadsheet allows the user to specify how much pumpage will be represented in each model cell in each stress period. The recharge macro then incorporates the specified pumpage for each stress period into the net recharge for the appropriate model cell. This enables the user to represent seasonal pumping.

Validation of Transient Model Input

The transient model input initially was validated by comparison with the steady state model input. Recharge was summed for the 24 transient stress periods. The summed transient recharge was compared to the annualized steady state input to ensure that each individual component of recharge was the same in both the transient and the steady state models. The transient recharge components were graphed for the 24 stress periods. Figure 7 shows the components of recharge for each stress period.

Comparison of transient recharge with steady state recharge revealed an error in the steady state recharge in model cells irrigated by groundwater. The groundwater-irrigated cells had too much irrigation water applied to them, causing an error in the steady state model calibration. The error affected recharge in approximately 30 model cells in the southeast corner of the model which have groundwater pumping. The steady state recharge was corrected and a localized model re-calibration was done. In the course of the re-calibration, several of the zones of uniform hydraulic conductivity were split into smaller zones and re-numbered. Figure 8 shows zones of uniform hydraulic conductivity resulting from the steady state model re-calibration. Table 4 shows the corrected values for the hydraulic conductivities for each zone.

A 31-year transient simulation composed of 15.2-day stress periods was run to demonstrate that the transient input data, when run to equilibrium, would replicate steady-state model results. The maximum drawdown in the 31st model year was .03 ft, indicating that the basin was near equilibrium and that the transient recharge in the course of a year accurately represents the average annual conditions applied in the steady state model. Additionally, the heads at the end of the 31st year were compared with the ending steady state heads to ensure that the heads had not significantly drifted in the 31-year simulation. Maximum head changes over the 31-year period were 2.5 ft, with most head changes being less than one foot. This change would represent the difference between the mean annual water levels (i.e. steady state ending heads) and the lower water levels in December. A change in water level between the mean and December values of no more than 3 feet is consistent with field measurements.

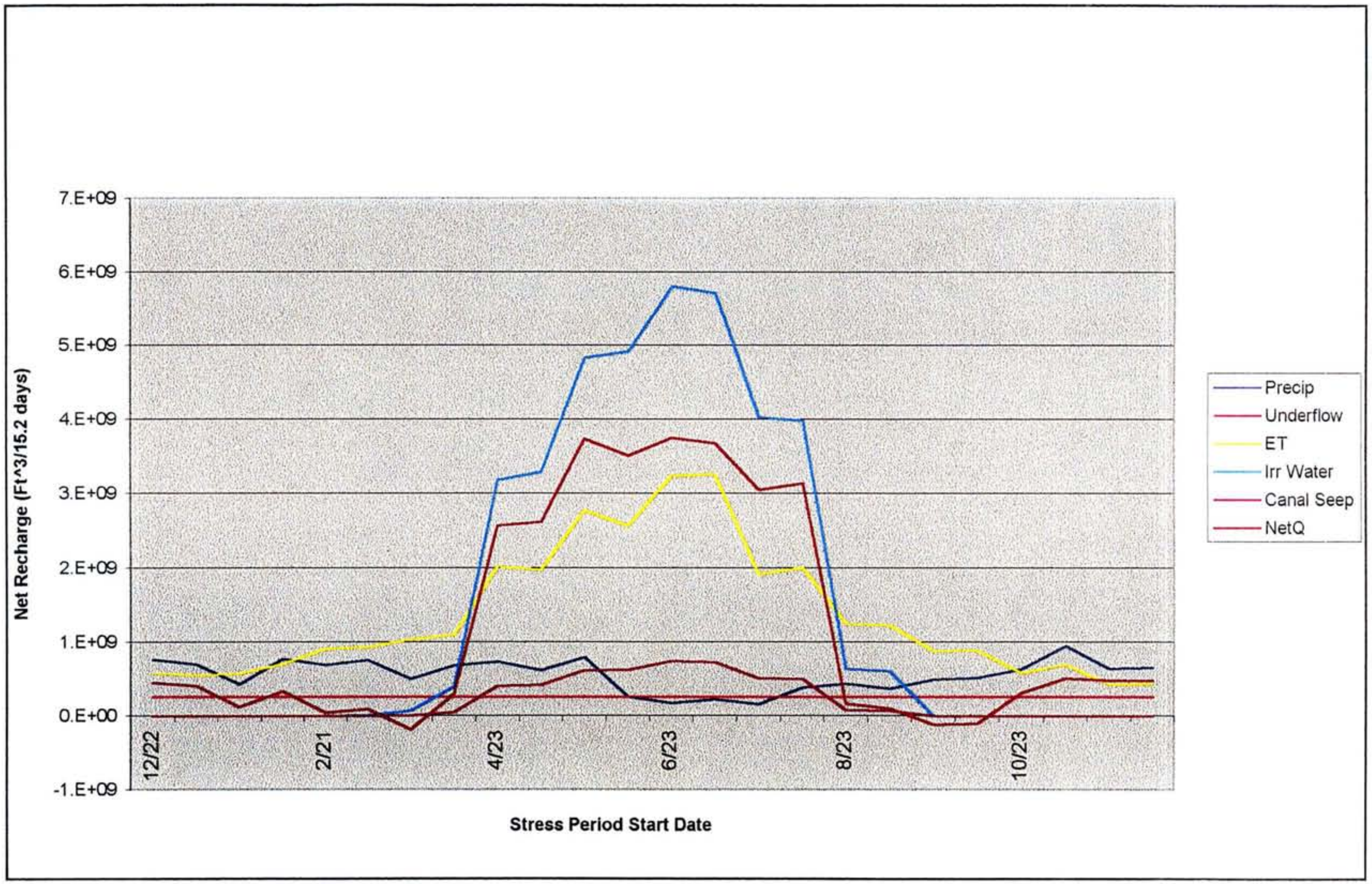

Figure 7. Graph of Recharge vs. Time for One-Year Model.

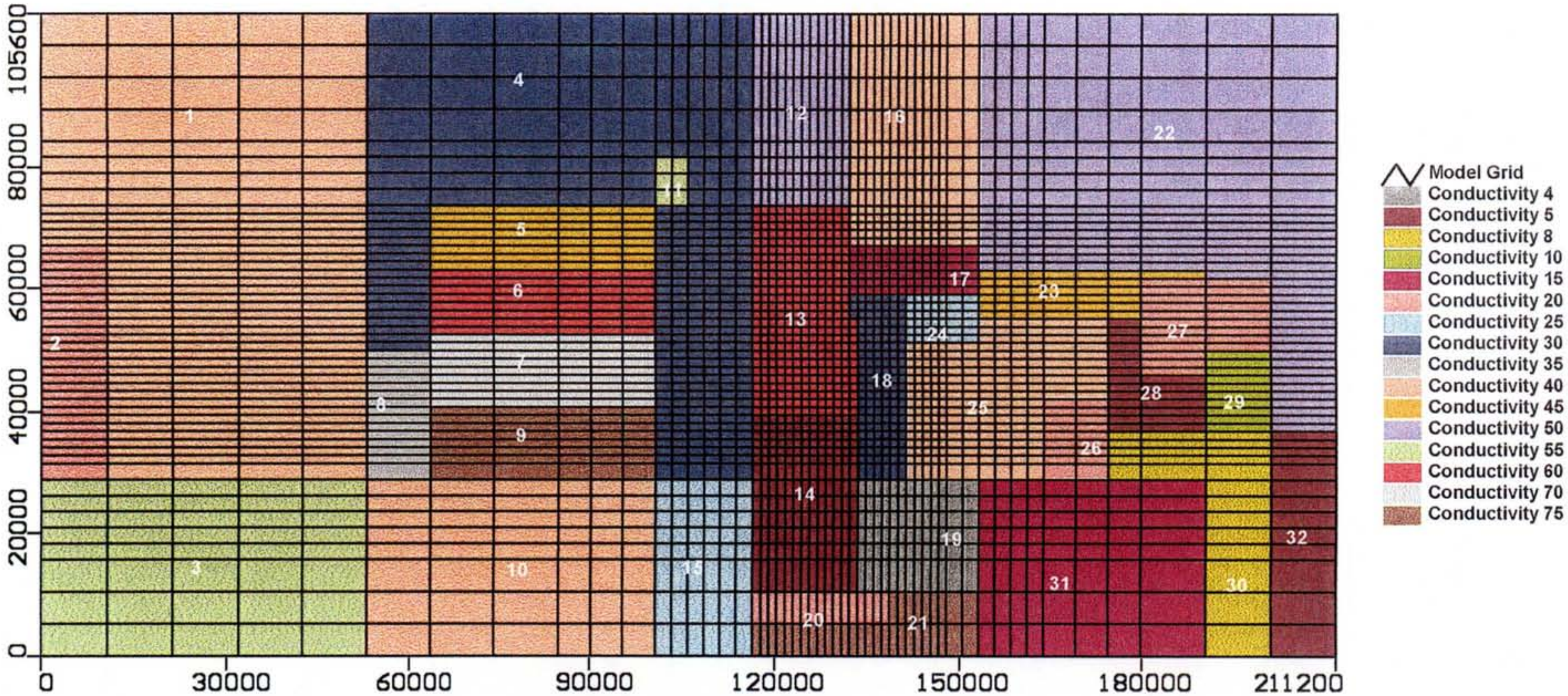

Figure 8. Zones of Uniform Hydraulic Conductivity.

Table 4. Revised Hydraulic Conductivity (ft/d) for Zones of Uniform Conductivity.

Zone	Hydraulic Conductivity (ft/d)
1	40
2	20
3	55
4	30
5	45
6	60
7	70
8	35
9	75
10	40
11	55
12	50
13	60
14	5
15	25
16	40
17	15
18	30
19	4
20	20
21	75
22	50
23	45
24	25
25	40
26	20
27	20
28	5
29	10
30	8
31	15
32	5

Transient Model Calibration

The transient model was run in a trial and error fashion to calibrate cell storativity values. Measured water level differences for December to March, December to July and December to October were compared against model-simulated changes in cells with measured wells. The measured water level differences were interpolated to the grid centroid. Figures 3, 4 and 5 show the contoured measured water level differences for the three measurement periods. The simulated drawdowns were evaluated for stress periods 5, 13 and 19, corresponding to dates of mid March, early July and early October. The root mean square (RMS) and mean absolute error (MAE) were calculated for the difference between the measured and simulated drawdowns. Model cells with simulated water level changes in the opposite direction of the measured water level changes (e.g. a simulated change showing a rise in water level in a cell where the measured change was a drop in water level) were not used in the MAE and RMS calculation. It was accepted that model assumptions concerning the uniform application of irrigation water would make it impossible to replicate anomalous localized conditions.

Hydraulic conductivities and drain conductances were not altered during transient model calibration. Calibration was accomplished by starting with a uniform storativity in each model cell and adjusting the uniform storativity to minimize RMS and MAE. Once the optimal uniform storativity was determined, storativities were adjusted by zone or cell by cell to improve the fit to the measured data.

Final storativities ranged from 0.05 to 0.23, which is a reasonable storativity range for fractured basalts. Figure 9 shows the zones of uniform storativity. Table 5 lists the calibrated storativity for each zone. The overall RMS achieved in the transient calibration was 2.12 ft, with an overall MAE of 1.58 ft. These metrics take into account all cells with water level measurements for all three measurement periods, except those noted above, or

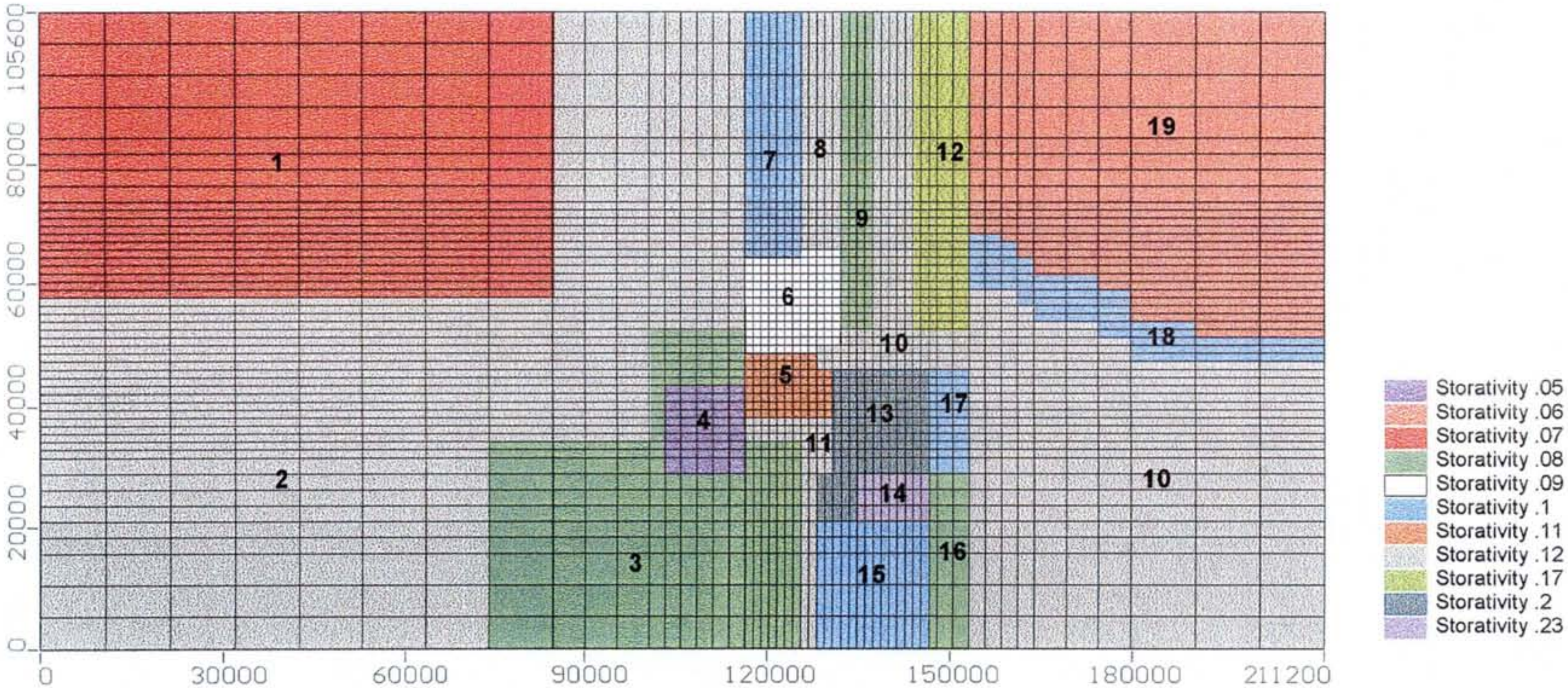

Figure 9. Zones of Uniform Storativity.

Table 5.

Calibrated Storativity Values for Zones of Uniform Storativity.

Zone	Storativity
1	.07
2	.12
3	.08
4	.05
5	.11
6	.09
7	.1
8	.12
9	.08
10	.12
11	.12
12	.17
13	.2
14	.23
15	.1
16	.08
17	.1
18	.1
19	.06

approximately 90 model cells representing approximately 270 measurements. The best fit was for the December to March timeframe, where the RMS was 1.92 and the MAE was 1.34. The December to July time period was the worst fit, with an RMS of 2.27 and an MAE of 1.81. The December to October period had an RMS of 2.19 and an MAE of 1.64. Figure 10 contains a scatter plot of the measured versus simulated differences in water levels for March, July and October. Although considerable point scatter is present, the points are scattered about the line representing equal simulated and measured head change. This may be interpreted as indicating that the model may not represent conditions at any given point with certainty, but on average the changes are properly simulated.

Transient Model Data Sets

Three types of transient model data sets were developed for future use in predictive simulations. The data sets represent models simulating one year (24 15.2-day stress periods), five years (20 90-day stress periods) and ten years (10 365-day stress periods). The EXCEL spreadsheet used to generate the MODFLOW well file for the transient model enables the user to specify which of the three model types is being used. The one-year model was used during model calibration to enable calibration to water level differences measured over a one-year period.

The allocation of recharge components to stress periods for the one-year model was discussed above. Table 6 shows the allocation of recharge values for the 5-year, 90-day stress period model. For the 10-year, 365-day stress period model, each recharge component represented the full average annual recharge.

Results from the 5-year model and the 10-year model were compared with results from the one-year model run for a comparable number of years to validate the input data sets for the 5-year and 10-year models. The results compared favorably, giving reasonable confidence in the model data sets. The 5-year model was used for sample scenarios detailed below. Five years was felt to be too short a time-frame to provide useful results, so the 5-year model was run twice representing two consecutive 5-year periods for a total simulation period of ten years.

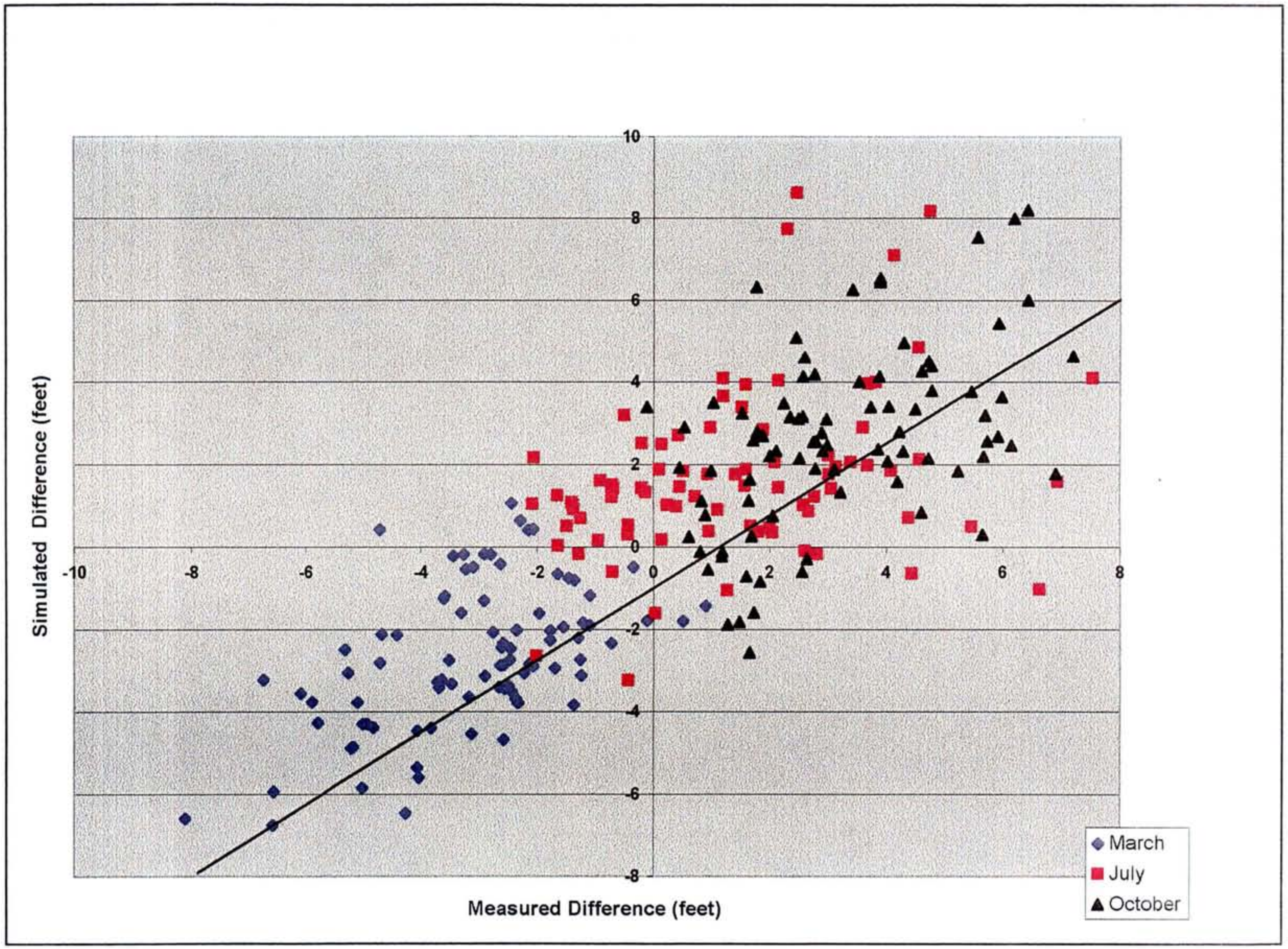

Figure 10. Scatter Plot of Measured vs. Simulated Differences in Water Levels
for March, July and October.

	Year 1	Year 1	Year 1	Year 1	Year 2	Year 2	Year 2	Year 2	Year 3	Year 3	Year 3	Year 3
Stress Period Start Date for Five Year Model	12/22	3/22	6/20	9/18	12/22	3/22	6/20	9/18	12/22	3/22	6/20	9/18
TFCC Sprinkler App %	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0
TFCC Irrigation App %	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0
SRCC Irrigation App %	0.0	42.1	57.9	0.0	0.0	42.1	57.9	0.0	0.0	42.1	57.9	0.0
Precip per Period %	30.8	26.9	13.1	29.1	30.8	26.9	13.1	29.1	30.8	26.9	13.1	29.1
Ave. ET per Period %	10.0	36.8	44.5	8.7	10.0	36.8	44.5	8.7	10.0	36.8	44.5	8.7
Grass ET per Period %	7.2	37.3	44.4	11.1	7.2	37.3	44.4	11.1	7.2	37.3	44.4	11.1

	Year 4	Year 4	Year 4	Year 4	Year 5	Year 5	Year 5	Year 5
Stress Period Start Date for Five Year Model	12/22	3/22	6/20	9/18	12/22	3/22	6/20	9/18
TFCC Sprinkler App %	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0
TFCC Irrigation App %	0.0	44.6	55.4	0.0	0.0	44.6	55.4	0.0
SRCC Irrigation App %	0.0	42.1	57.9	0.0	0.0	42.1	57.9	0.0
Precip per Period %	30.8	26.9	13.1	29.1	30.8	26.9	13.1	29.1
Ave. ET per Period %	10.0	36.8	44.5	8.7	10.0	36.8	44.5	8.7
Grass ET per Period %	7.2	37.3	44.4	11.1	7.2	37.3	44.4	11.1

Table 6. Recharge Allocation for 5-Year Model.

Transient Model Scenarios

Transient model simulations were run for four scenarios. As stated above, the 5-year model was used for the model scenarios. The 5-year model was run twice, with ending heads of the first simulation being used as starting heads for the second five years, enabling simulation of 10 years using quarter-year stress periods. The four scenarios represented 1) current basin conditions, 2) a 30% conversion to sprinkler scenario, 3) current basin conditions with 30 cfs of recharge along the High Line canal and 4) the 30 cfs of recharge superimposed on the 30% sprinkler scenario. For each scenario, the results are presented in terms of changes in water levels. Impacts to spring discharge and surface streams can also be predicted by the model. These scenarios are discussed below.

Current Basin Conditions Scenario

The current basin conditions scenario was run for comparison with the other three scenarios. Because the basin is considered to be in equilibrium, the only changes in water levels for this scenario are seasonal. Water levels will vary seasonally as recharge varies; however, from year to year water levels will remain stable. Figure 11 shows the quarterly water level changes for eight locations around the basin for this simulation. The changes are relative to initial water levels in December (the zero point on the vertical axis).

30% Sprinkler Scenario

This scenario reflects a thirty percent tract-wide conversion to sprinkler irrigation. The scenario was designed to show the impacts of changes in irrigation practice on the Twin Falls tract. With sprinkler irrigation, less water is applied and, therefore, less water infiltrates to the aquifer. Currently, irrigation on the Twin Falls tract is approximately ninety percent surface irrigation and ten percent sprinkler irrigation, with an incidental recharge of approximately 720,000 AF/y. With conversion to thirty percent sprinkler

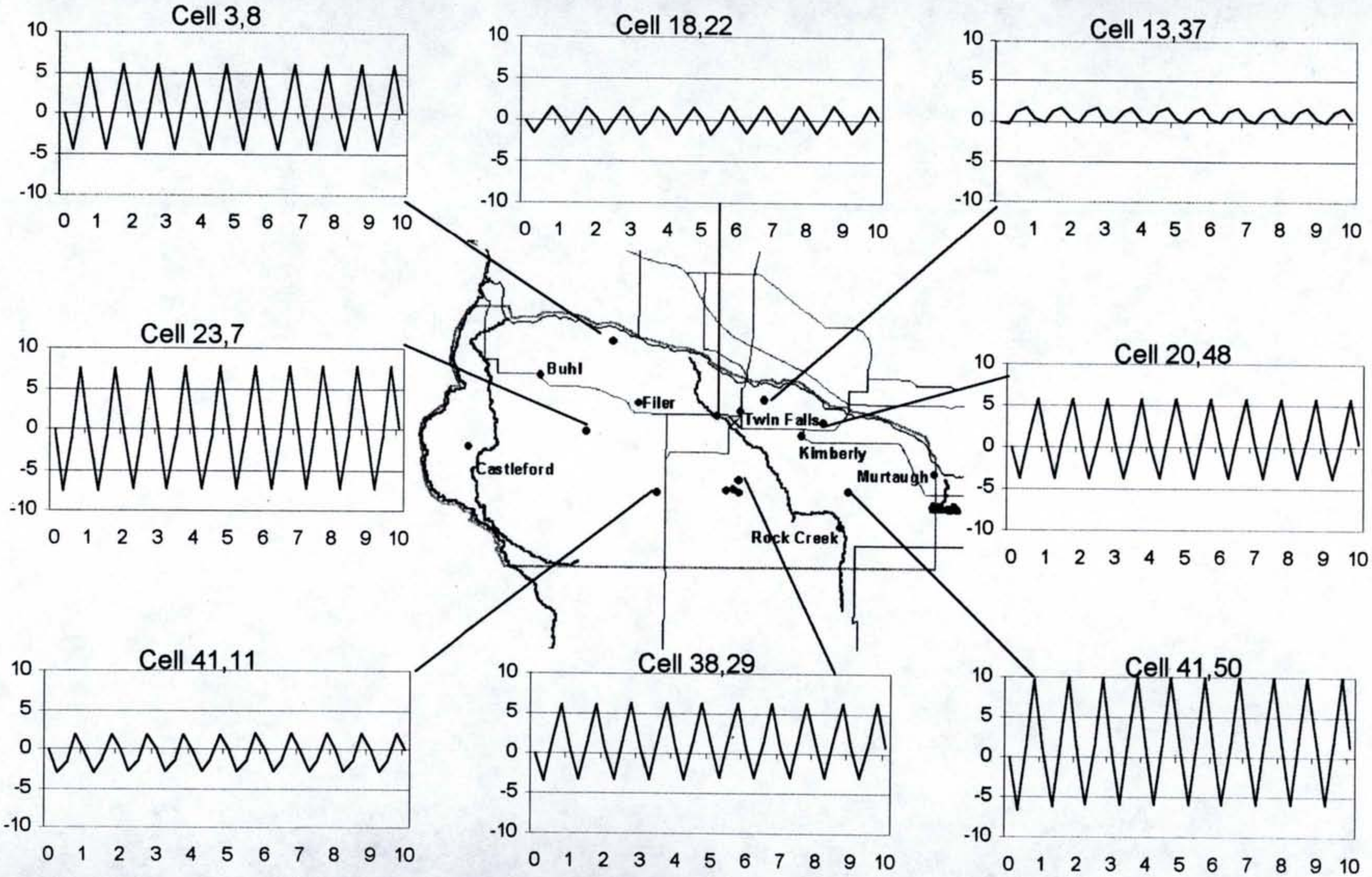

Figure 11. Area Hydrographs (feet) for Baseline Scenario.

irrigation, the incidental recharge would decrease by approximately 110,000 AF/y causing water levels to drop over time.

The scenario which was run reflects a reduction in the overall application rate across the Twin Falls tract, not a conversion to sprinkler irrigation in specific locations (although, that could also be explored as a separate scenario). The application rate for the Twin Falls Canal Company was reduced from 4.6 to 3.7 ft/yr. This is equivalent to a uniform distribution of sprinkler conversion occurring throughout the tract. Figure 12 shows the changes in water levels which would be expected from this conversion to sprinkler irrigation after ten years of operation in eight locations across the basin. Figure 13 shows the contoured changes in water levels basin-wide. Figure 13 was contoured using 4-foot intervals. The highest impact after ten years is an approximately 34 ft drop in water levels in the area from Buhl to Castleford.

30 cfs Recharge Scenario

The 30 cfs Recharge Scenario reflects the effects of locating three 10-cfs injection wells along the High Line Canal. One well is located where Washington Street intersects the High Line Canal. The other two wells are located along the High Line Canal one-half mile east and west of Washington Street. Each well is assumed to inject at a rate of 10 cfs for six months from approximately April 1 to October 1. Figure 14 shows the changes in water levels predicted by the model for this scenario for eight selected locations throughout the basin. Wells nearest the injection wells show the most significant changes in water levels. Figure 15 shows the contoured predicted changes in water levels basin-wide. The injection well locations are shown in red on Figure 15. The contours are spaced at 2-foot intervals, with the highest impact of approximately 6 feet centered in the model cells containing the injection wells. The impact diminishes rapidly with distance from the injection well locations. It should be noted that the numerical model predicts impacts at the center of the model cells. Impacts in the immediate vicinity of the injection wells will be significantly greater.

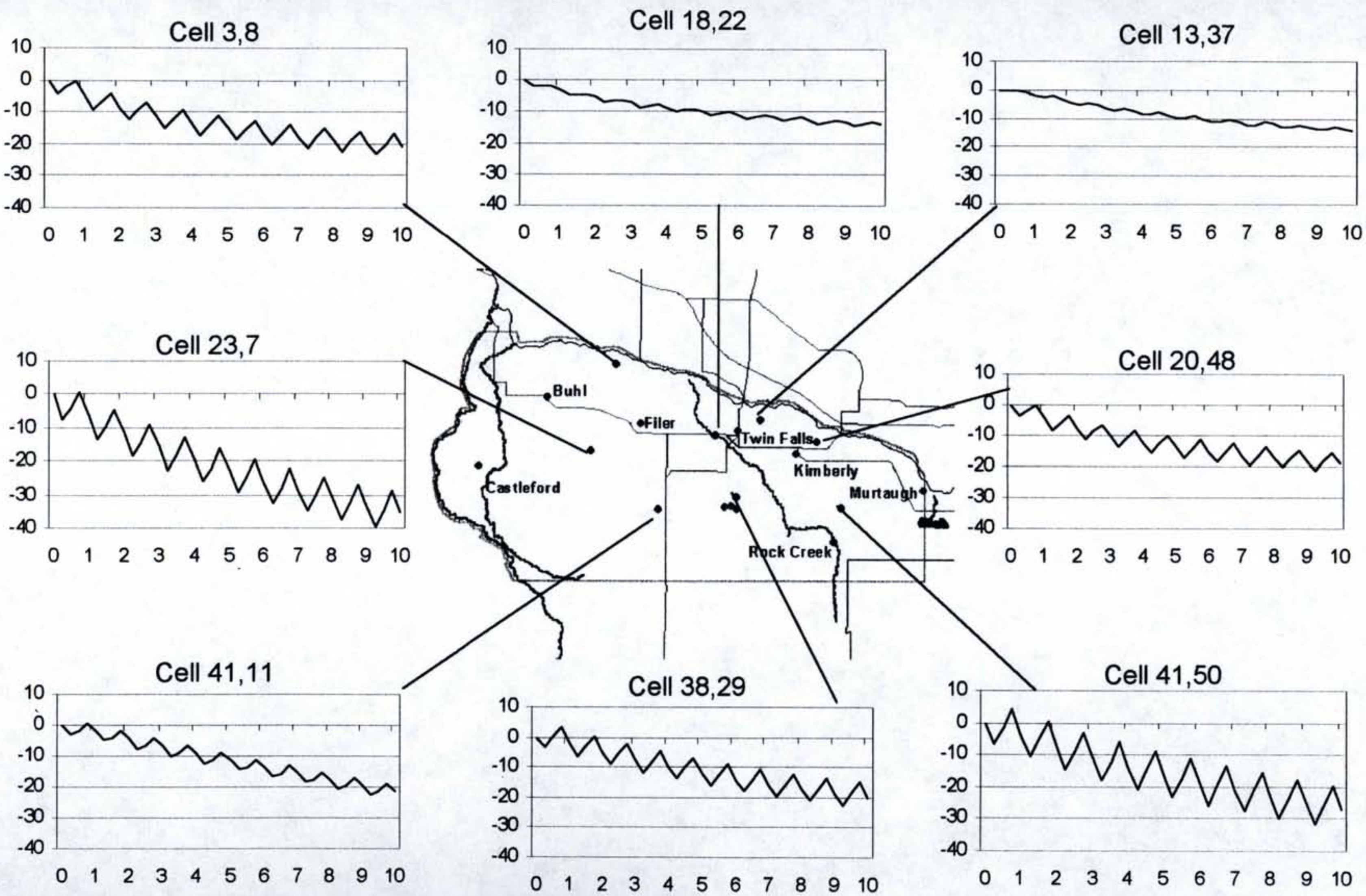

Figure 12. Area Hydrographs (feet) for 30 % Conversion to Sprinkler Scenario.

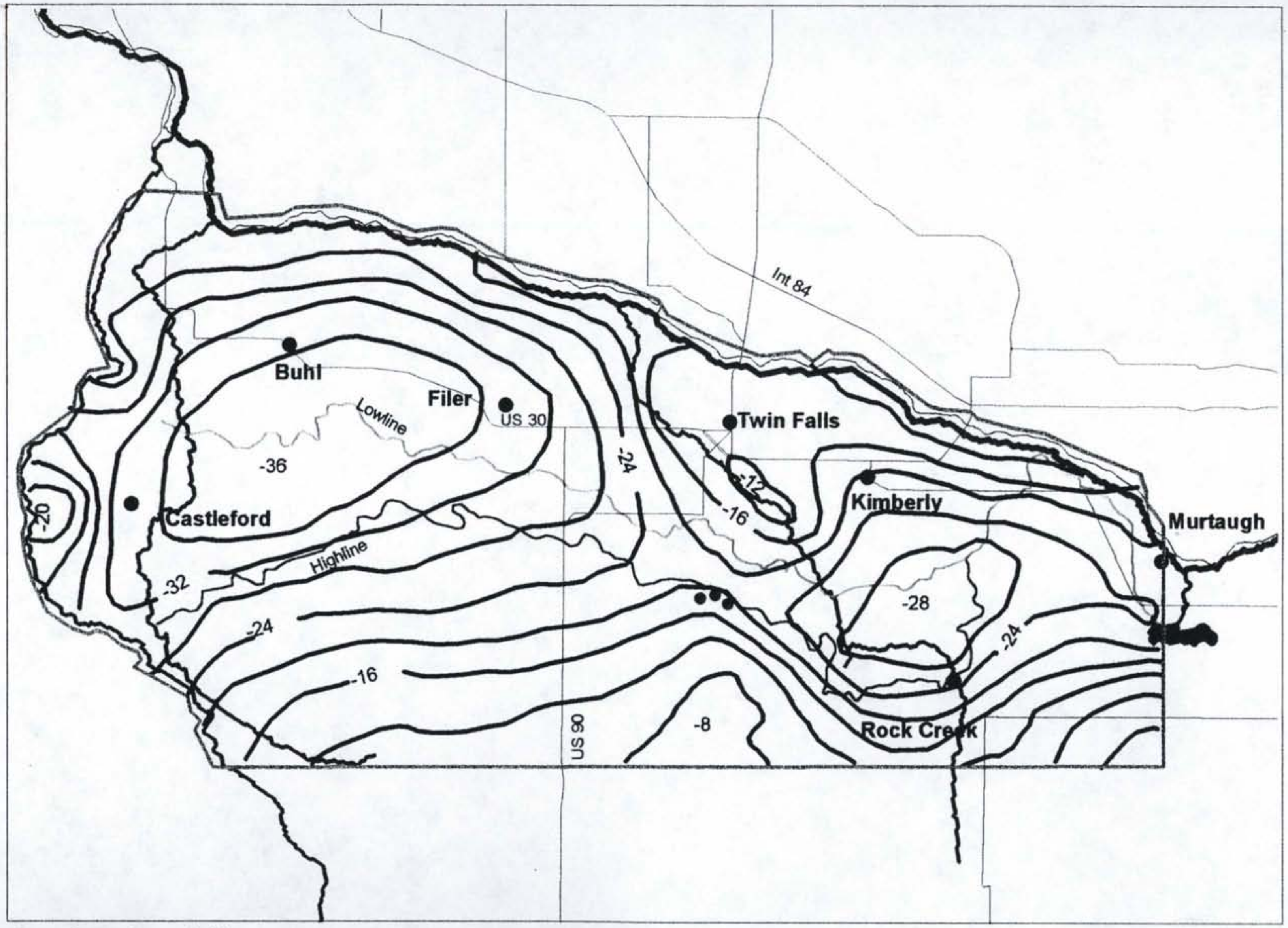

Figure 13. Simulated Change in Water Level (feet) over 10 Year Period for 30% Sprinkler Scenario.

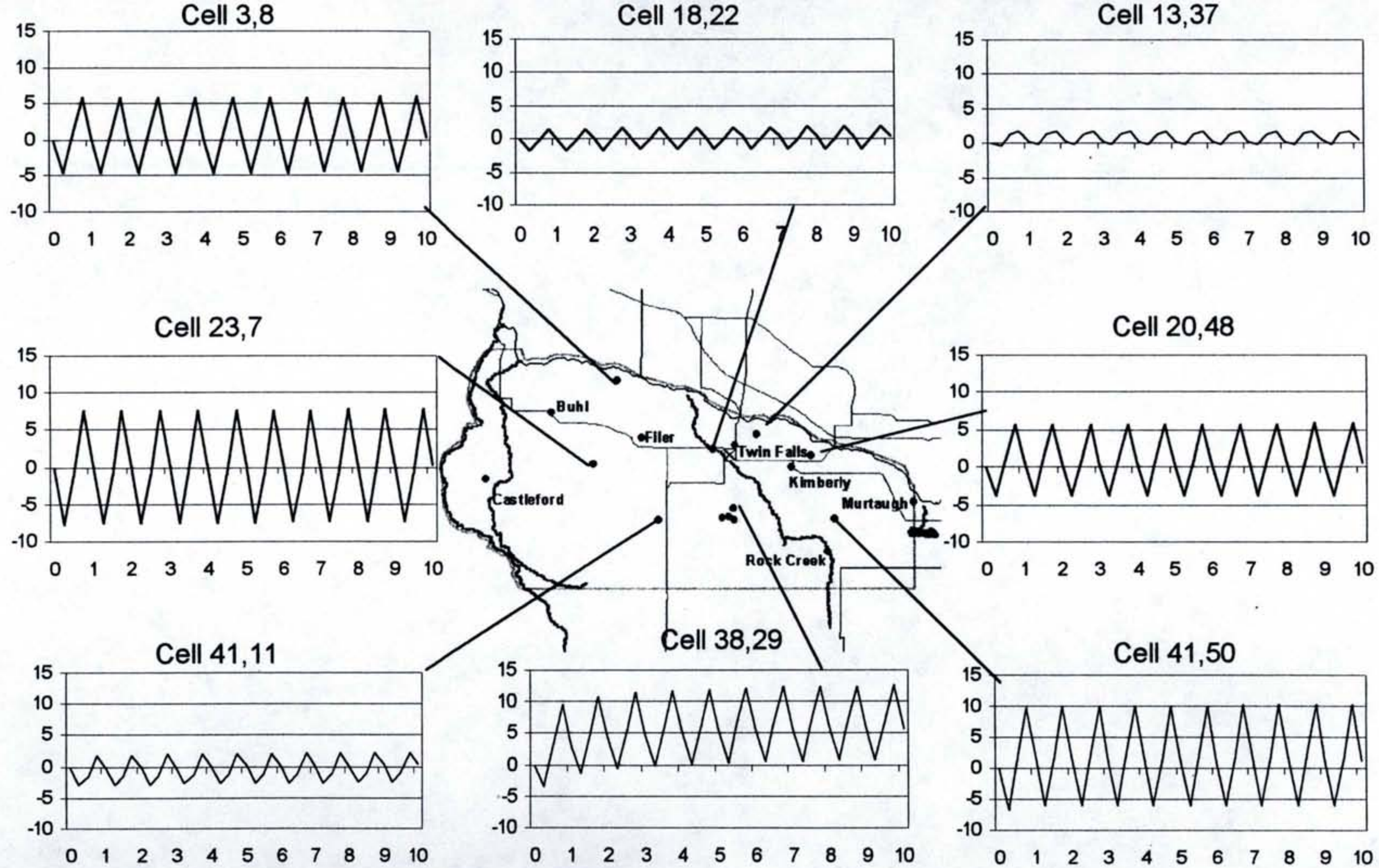

Figure 14. Area Hydrographs (feet) for 30 cfs Recharge Scenario.

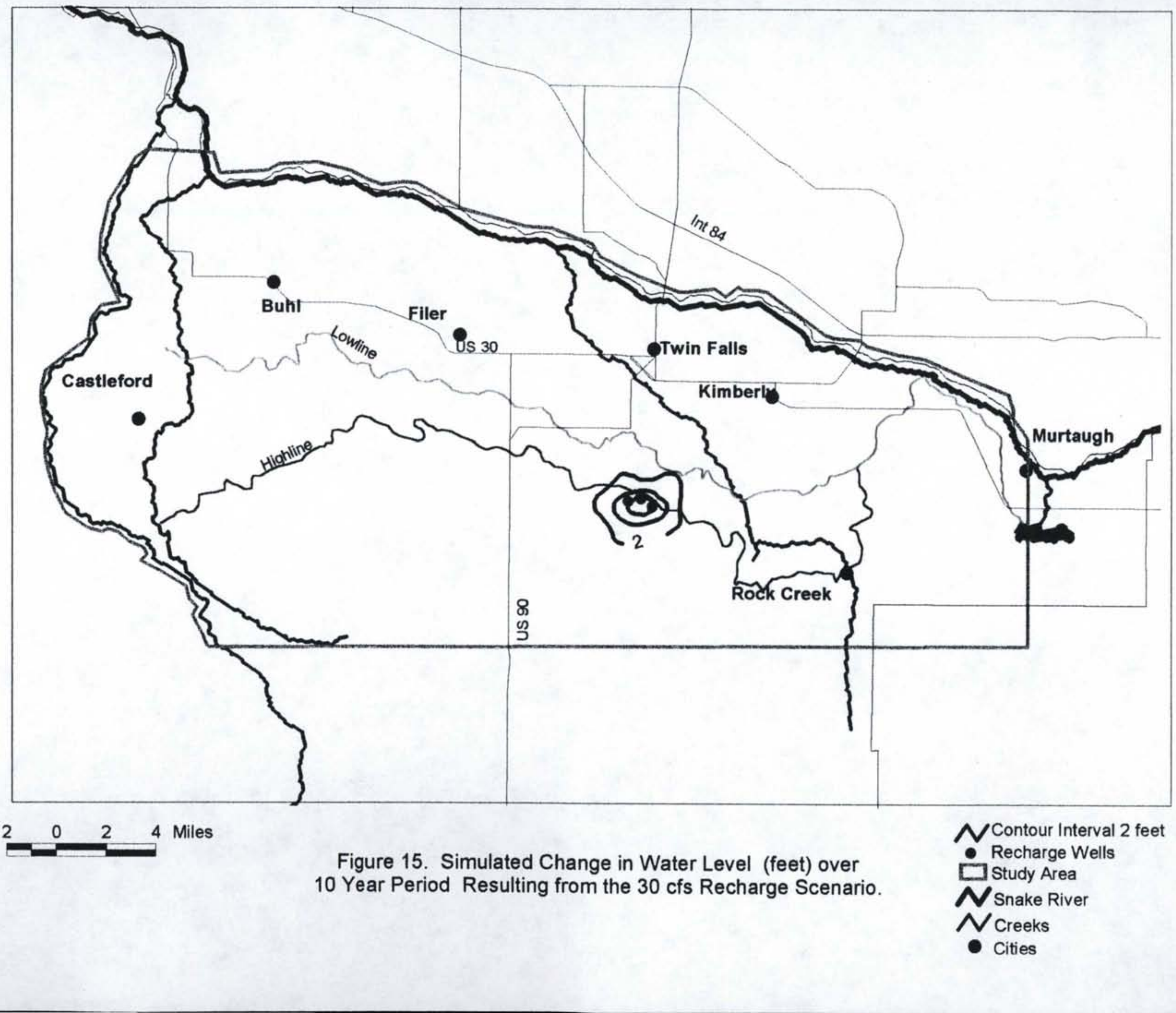

Figure 15. Simulated Change in Water Level (feet) over 10 Year Period Resulting from the 30 cfs Recharge Scenario.

30 cfs Recharge Superimposed on 30% Sprinkler Scenario

This scenario combines the two previous scenarios, superimposing the impact of injecting 30 cfs of recharge on the scenario reflecting a thirty percent conversion to sprinkler irrigation. Figure 16 shows the changes in water levels for the quarterly stress periods for eight locations distributed around the basin. As expected, water levels in wells basin-wide will continue to drop. The wells nearest the injection wells will also continue to experience a drop in water levels, but at a slower rate. Figure 17 shows the contoured changes in water levels basin-wide. As can be seen from Figure 17, although the 30 cfs of recharge does have some positive effect on water levels, it is overshadowed by the negative impact of the tract-wide conversion to sprinkler.

Conclusions

The design and calibration of the transient model provides another step towards understanding the hydrology of the Twin Falls area. The area is in transition with urban growth, increased water demands from both the municipality and from industry, changes in land use and changes in irrigation practices. The transient model can be used to evaluate basin impacts on a seasonal basis and over time. The transient model provides the city with another tool to explore the impacts of changes in local water practices and will assist the city in future planning. It must be noted that all regional ground-water models are approximations of conceptual models that are, themselves, flawed. Consequently, model predictions represent "best estimates" of future system response but should not be interpreted too literally.

The results from the scenarios documented above indicate the need for basin-wide planning in the Twin Falls area. It is clear from the simulations that major basin-wide recharge efforts will be needed to offset changes in local irrigation practices.

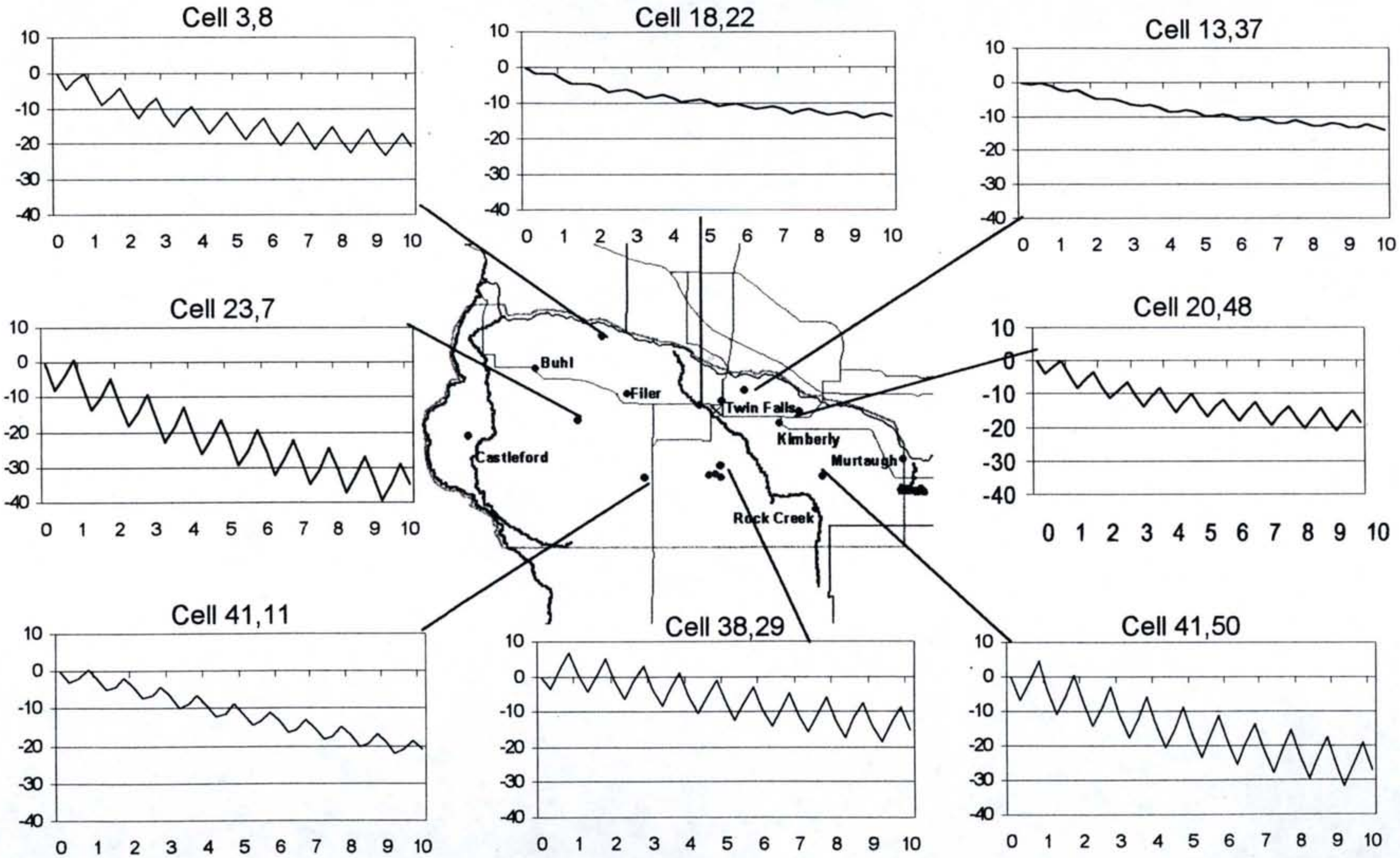

Figure 16. Area Hydrographs (feet) for 30 cfs Recharge Superimposed on 30% Sprinkler Scenario.

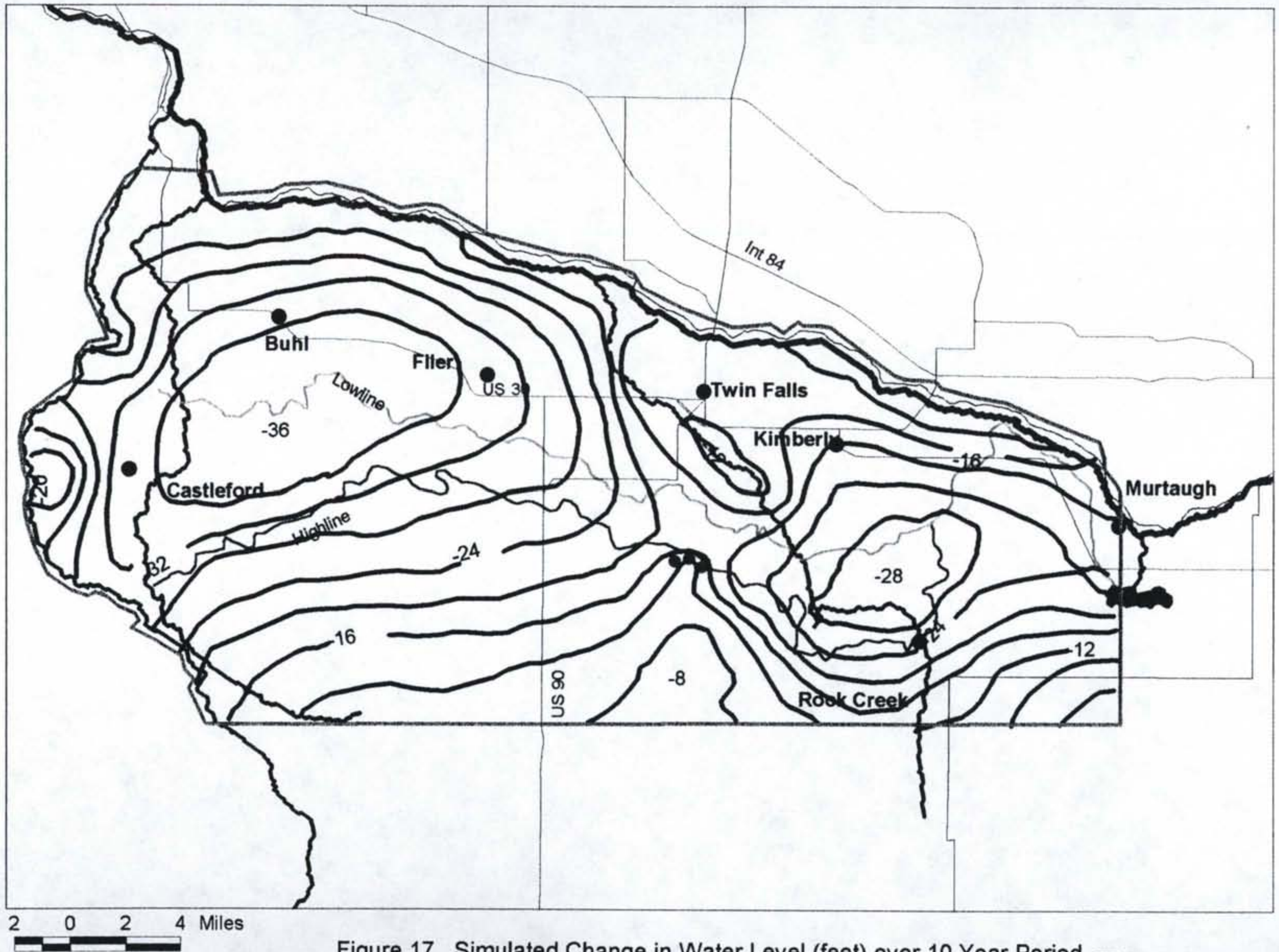

Figure 17. Simulated Change in Water Level (feet) over 10 Year Period for 30 cfs Recharge Superimposed on 30% Sprinkler Scenario.

Study Area
Contour Interval 2 feet.
Recharge Wells
Snake River
Creeks
Cities

Appendix A

Recharge Spreadsheet Description

The spreadsheet WTTRAN.XLS is provided for user generation of recharge for different scenarios for the Twin Falls Transient Model. WTTRAN.XLS has user-entered data such as simulation type and irrigation application rate. Additionally, WTTRAN.XLS uses data in three other spreadsheets which are maintained by the user. The other three spreadsheets used by WTTRAN.XLS are LANDUSTR.XLS, IRRPRTR.XLS and WELLS.XLS. These spreadsheets are organized to give the user control over variables such as land use, irrigation source and well pumpage. The WTTRAN.XLS spreadsheet uses an EXCEL macro to calculate ET and applied irrigation water based on the user's input and to generate the transient MODFLOW well file. The worksheets within the WTTRAN.XLS spreadsheet are listed in Table A1 and are discussed below.

Table A1. List of EXCEL Worksheets in Spreadsheet WLTERMSS.XLS.
*Denotes worksheet which is updated by the user.

Worksheet Name	**Worksheet Description**
Wellterm	Summarizes data for each model cell
MacroStartData*	User-input data for running MakeTranWells Macro
StressPerInfo	Stress Period Information Used by MakeTranWells Macro
Constants	Constant Values Used by MakeTranWells Macro
Canal Seepage	Row by column listing of canal seepage
Underflow	Row by column listing of underflow
ACT-INACT	Row by column listing of active cells vs. inactive cells
NetFlux	Row by column listing of net flux in/out of each model cell
Error	Worksheet Containing Error Messages Written by MakeTranWells Macro
InitData	Initialization data required by macros

Each worksheet is discussed separately below. Two distinct worksheet formats were used. The Wellterm Worksheet, the InitData Worksheet and the Constants worksheet have data in tabular format. The balance of the worksheets are in row/column format, with the data laid out spatially according to the model cells. Additionally, LANDUSTR.XLS, IRRPRTR.XLS and WELLS.XLS are laid out in the row/column format. In the row/column format, the rows and columns are laid out the same way the model cells are laid out. A cell in the southwestern portion of the model will appear in the lower left hand corner of the worksheet. This allows the user to visualize where the model cells are located spatially. The fields of each worksheet and allowable input for fields which will be modified by the user are described below.

Wellterm Worksheet

The Wellterm Worksheet is comprised of fields which describe each model cell location, size, land use and flux components. The Wellterm Worksheet is not updated by the user. Updates to other worksheets within this workbook and other workbooks are used by an EXCEL macro to recalculate the fields in the Wellterm Worksheet. Figure A1 shows a sample of the Wellterm Worksheet.

The Wellterm Worksheet contains one row for every cell of the model grid. Table A2 lists the fields which are contained in the Wellterm Worksheet columns. The Wellterm Worksheet is updated by the MakeTranWells Macro for each transient stress period. The Wellterm Worksheet serves as a tabular summary of all relevant information about each model cell. It enables the user to look at the individual components of flux for a particular model cell or group of cells, for the last stress period.

The Wellterm Worksheet enables the user to check the reasonableness of each flux term after data changes are made. Additionally, the user can check data such as irrigation source or land use for the last stress period.

Row	Column	miles Row Heigh	miles Col.Wid	miles Cell Area	Total #Acres	TWP	Range	Sect	ACT/ INACT	Irrigat Profile	Average Daily Underflow	Urban Use	SubUrbanU	AgricUse	RangeUse	Scaled (Ag) Irrig Acres	Activity	Stress Period Precip	Stress Period ET
1	1	1	2	2	1280	9S	13E	4	I		0.00E+00	0.00	0.00	0.72	0.28	926.95	0	0.00E+00	0.000E+00
2	1	1	2	2	1280	9S	13E	9	I		0.00E+00	0.00	0.00	0.32	0.68	412.09	0	0.00E+00	0.000E+00
3	1	1	2	2	1280	9S	13E	16	I		0.00E+00	0.00	0.00	0.00	1.00	0.00	0	0.00E+00	0.000E+00
4	1	1	2	2	1280	9S	13E	21	I		0.00E+00	0.00	0.00	0.00	1.00	0.00	0	0.00E+00	0.000E+00
5	1	0.5	2	1	640	9S	13E	28	I		0.00E+00	0.00	0.00	0.23	0.77	146.54	0	0.00E+00	0.000E+00
6	1	0.5	2	1	640	9S	13E	28	I		0.00E+00	0.00	0.00	0.23	0.77	146.54	0	0.00E+00	0.000E+00
7	1	0.5	2	1	640	9S	13E	33	I		0.00E+00	0.00	0.00	0.00	1.00	0.92	0	0.00E+00	0.000E+00
8	1	0.5	2	1	640	9S	13E	33	I		0.00E+00	0.00	0.00	0.00	1.00	0.92	0	0.00E+00	0.000E+00
9	1	0.25	2	0.5	320	10S	13E	4	I		0.00E+00	0.00	0.00	0.40	0.60	127.28	0	0.00E+00	0.000E+00
10	1	0.25	2	0.5	320	10S	13E	4	I		0.00E+00	0.00	0.00	0.40	0.60	127.28	0	0.00E+00	0.000E+00
11	1	0.25	2	0.5	320	10S	13E	4	I		0.00E+00	0.00	0.00	0.40	0.60	127.28	0	0.00E+00	0.000E+00
12	1	0.25	2	0.5	320	10S	13E	4	I		0.00E+00	0.00	0.00	0.40	0.60	127.28	0	0.00E+00	0.000E+00
13	1	0.25	2	0.5	320	10S	13E	9	I		0.00E+00	0.00	0.00	0.08	0.92	26.69	0	0.00E+00	0.000E+00

Canal Seepage Percent	Irrigation Water Ft^3/d	ft^3/d NetFlux	Stress Period Pumpage	Stress Period Canal Seepage	Stress Period Underflow
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0
0	0.000E+00	0.000E+00	0.00	0.000E+00	0

Figure A1. Wellterm Worksheet.

Table A2. Field Descriptions for Wellterm Worksheet.

Field Name	**Units**	**Description**
Row	Counter	Row number of model cell, fixed value
Column	Counter	Column number of model cell, fixed value
Row Height	Miles	North-south dimension of model cell, fixed value
Column Width	Miles	East-west dimension of model cell, fixed value
Cell Area	Square Miles	Total area of model cell, calc from row ht. and column width
Total Number of Acres	Acres	Number of acres in model cell, calculated from cell area and constant ft^2/acre
Township	Number	Township number, fixed value
Range	Number	Range number, fixed value
Section	Number	Section number within township/range, fixed value
ACT/INACT	A/I	Indicator for whether model cell is Active or Inactive, read from ACT-INACT Worksheet
Irrigation Profile	Alpha Field	Indicates source of irrigation water--TF, SPRK, SR, RC, GW, or NI (described below), read from IRRPRTR.XLS, variable by stress period.
Underflow	ft^3/day	Average daily boundary underflow into model from outside model area, read from Underflow Worksheet
Urban Use	decimal	Decimal indicator of proportion of cell which is urban, read from LANDUSTR.XLS, variable by stress period.
Suburban Use	decimal	Decimal indicator of proportion of cell which is suburban, read from LANDUSTR.XLS, variable by stress period.
Agricultural Use	decimal	Decimal indicator of proportion of cell which is agricultural, read from LANDUSTR.XLS, variable by stress period.
Range Use	decimal	Decimal indicator of proportion of cell which is range, read from LANDUSTR.XLS, variable by stress period.
Irrigated Acres	number	Number of irrigated acres in model cell, calculated by spreadsheet as Agricultural Use * Acres in Cell
Activity	1 or 0	Integer representation of whether model cell is active (1) or inactive (0), based on ACT-INACT indicator
Active Acres	number	Number of active acres in model cell(calculated as Activity * Acres in Cell)
Stress Period Precipitation	ft^3/day	Average daily precipitation for model cell for this stress period, calculated by MakeTranWells macro.
Stress Period ET	ft^3/day	Average daily ET for model cell for this stress period, calculated by MakeTranWells macro.
Canal Seepage %	ft^3/day	Percentage of Canal Seepage apportioned to this model cell, read from CanalSeepage worksheet.
Applied Irrigation Water	ft^3/day	Average daily irrigation water applied in model cell for this stress period, calculated by MakeTranWells macro.
NetFlux	ft^3/day	Calculated by spreadsheet as sum of canal seepage, underflow, precipitation, well pumpage and applied irrigation water minus ET for each stress period.
Stress Period Pumpage	ft^3/day	Well Pumpage for this stress period, read from WELLS.XLS, variable by stress period.
Stress Period Canal Seepage	ft^3/day	Average daily canal seepage for model cell for this stress period, calculated by MakeTranWells macro.
Stress Period Underflow	ft^3/day	Average daily underflow for model cell for this stress period, calculated by MakeTranWells macro.

MacroStartData Worksheet

The MacroStartData Worksheet contains the user-input parameters which will control the recharge calculation. Figure A2 shows the data fields of the MacroStartData Worksheet. The fields are described below:

Model Type (A, B or C). A single alphabetical digit, A, B or C, indicating which type of transient model is being used. A indicates 24 15.2-day stress periods, B indicates 20 90-day stress periods, and C indicates 10 365-day stress periods. This field must be entered as a single, capital A, B or C or the macro will not run properly.

Output File Name. A seven character alphanumeric field which conforms to the DOS file naming conventions, which is the name under which the MODFLOW well file will be saved. The MODFLOW well file is saved with the user input name with a single digit number at the end of the name and with the .WEL extension. For example, if the user input name is TWTR, the MODFLOW well file will be saved as TWTR1.WEL. For long transient simulations, multiple, sequential files will be created (such as TWTR1.WEL, TWTR2.WEL), which the user will then concatenate.

Irrigation Source Change in Simulation. This YES/NO field allows the user to specify whether the source of irrigation in each model cell will be changed during the simulation. If NO is entered, indicating that the irrigation source does not change during the simulation, the irrigation source for each model cell will be read from the worksheet PER1 of IRRPRTR.XLS and used during the entire simulation. If YES is entered, the MakeTranWells macro will read irrigation source for each model cell for each stress period. Unless a simulation is designed to specifically vary irrigation source, the user is advised to not vary irrigation source during the simulation. Varying irrigation source during the simulation will significantly slow the running of the MakeTranWells macro. Data entered in this field must be YES or NO in all capital letters, otherwise the macro will not run properly.

Input data for starting macro							
Model Type (A, B or C)	B		Model Type Must be Capital A, B or C				
A--One Year Model			24 15 day stress periods				
B--Five Year Model			20 91 day stress periods				
C--Ten Year Model			10 365 day stress periods				
model type must be A, B or C							
Output File Name	Quar		Note, output file name may be no longer than				
			7 characters.				
Irrigation Source Change in Simulation?	NO		YES or NO must be all caps				
YES or NO							
Land Use Change in Simulation?	NO						
YES or NO							
Pumping Wells Change in Simulation?	NO						
YES or NO							
TFCC Flood Application Rate feet/year	4.595796						
TFCC Sprinkler Application Rate ft/year	3.1						
SRCC Application Rate ft/year	4.595796						
SRCC Efficiency Rate	0.345928		0.427761	replaced			
Rock Creek Application Rate ft/year	4.595796						

Figure A2. MacroStartData Worksheet.

Land Use Change in Simulation. This YES/NO field enables the user to reflect changes in land use during a transient simulation. If YES is entered in this field, the MakeTranWells macro will read updated land use percentages for Urban Use, Suburban Use, Agricultural Use and Range Use for every stress period of the simulation from the LANDUSTR.XLS worksheet. If NO is entered, the land use data will be read from worksheet PER1 of LANDUSTR.XLS and will remain the same throughout the simulation. Unless a simulation is designed to specifically vary land use, the user is advised to not vary land use during the simulation. Varying land use during the simulation will significantly slow the running of the MakeTranWells macro. Data entered in this field must be YES or NO in all capital letters, otherwise the macro will not run properly.

Pumping Wells Change in Simulation. This YES/NO field enables the user to vary well pumpage during a transient simulation. If YES is entered in this field, the MakeTranWells macro will read updated well pumpage for each model cell for each stress period from the worksheet WELLS.XLS. This enables a user to turn wells on and off during a simulation and to introduce new wells during a transient simulation. If NO is entered in this field, the MakeTranWells macro will read well pumpage for each model cell from the worksheet PER1 of WELLS.XLS and this well pumpage will be held constant during the entire simulation. Unless a simulation is designed to specifically vary well pumpage, the user is advised to not vary well pumpage during the simulation. Varying well pumpage during the simulation will significantly slow the running of the MakeTranWells macro. Data entered in this field must be YES or NO in all capital letters, otherwise the macro will not run properly.

TFCC Flood Application Rate. This is the annual application rate of water used by customers of the TFCC for flood irrigation. It is expressed in feet of water per year.

TFCC Sprinkler Application Rate. This is the annual application rate of water used by customers of the TFCC for sprinkler irrigation. It is expressed in feet of water per year.

SRCC Application Rate. This is the annual application rate of water used by customers of the Salmon River Canal Company. It is expressed in feet of water per year.

SRCC Efficiency Rate. This is a decimal used to describe the percentage of Salmon River Canal Company-irrigated crops within the study area which are, on the average, irrigated. Historical data for the past six years indicate that if an irrigation application rate identical to that used for TFCC irrigation is assumed for the SRCC, in an average year, only forty-three percent of the land within the SRCC tract is irrigated, due to a shortage of water. The input decimal to reflect forty-three percent efficiency is .43.

Rock Creek Application Rate. This is the annual application rate of water used by irrigators with water rights from Rock Creek. It is expressed in feet of water per year.

StressPerInfo Worksheet

The StressPerInfo Worksheet contains data to be used by the MakeTranWells macro when calculating net flux for each model cell for each stress period. Figure A3 contains a sample of the StressPerInfo Worksheet. Information contained in this worksheet includes the percentage of total irrigation water, precipitation and evapotranspiration to be applied in each stress period. This information is repeated for each of the three model types. The user will not modify the StressPerInfo Worksheet.

Constants Worksheet

The constants worksheet contains constants used within the spreadsheet. Many of the constants are used for unit conversions. This worksheet also contains constants used in the calculation of the various flux components, such as average daily precipitation and average evapotranspiration. Figure A4 contains the Constants Worksheet. This worksheet will not be altered by the user.

Canal Seepage Worksheet

The Canal Seepage Worksheet is laid out in the row/column format. Model cells which contain the High Line and Low Line Canals are highlighted and contain the percentage of total seepage to be applied to this model cell. Inactive cells are grayed out. It is not anticipated that the user will modify the canal seepage data, however, if scenarios such as lined canals are to be simulated, the user could modify canal seepage on this worksheet. Figure A5 contains a sample of the Canal Seepage Worksheet. In the

Simulation Type A									
24 15.21 day stress periods									
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
TFCC Sprinkler App %	0	0	0	0	0	0.01654	0.20951	1.084663	8.523459
TFCC Irrigation App %	0	0	0	0	0	0.01654	0.20951	1.084663	8.523459
SRCC Irrigation App %	0	0	0	0	0	0.002499	0.031851	0.81112	7.436613
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
Precip per Period %	5.734993	5.251825	3.232496	5.783572	5.173048	5.657528	3.749803	5.124468	5.503913
Average ET per Period %	1.084994	1.084994	1.543509	1.543509	2.371374	2.371374	3.025377	3.025377	6.298509
Grass ET per Period %	0.577642	0.577642	0.913046	0.913046	2.122833	2.122833	3.647527	3.647527	6.931699
Simulation Type B									
20 91.31 Day Stress Periods									
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
TFCC Sprinkler App %	0.01654	44.63209	55.35137	0	0.01654	44.63209	55.35137	0	0.01654
TFCC Irrigation App %	0.01654	44.63209	55.35137	0	0.01654	44.63209	55.35137	0	0.01654
SRCC Irrigation App %	0.002499	42.09534	57.90216	0	0.002499	42.09534	57.90216	0	0.002499
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
Precip per Period	30.83346	26.93661	13.13088	29.09905	30.83346	26.93661	13.13088	29.09905	30.83346
Average ET per Period	9.999753	36.76256	44.52662	8.711061	9.999753	36.76256	44.52662	8.711061	9.999753
Grass ET per Period	7.227041	37.28583	44.39362	11.09351	7.227041	37.28583	44.39362	11.09351	7.227041
Simulation Type C									
10 365.25 day simulations									
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
TFCC Sprinkler App %	100	100	100	100	100	100	100	100	100
TFCC Irrigation App %	100	100	100	100	100	100	100	100	100
SRCC Irrigation App %	100	100	100	100	100	100	100	100	100
	Per1	Per2	Per3	Per4	Per5	Per6	Per7	Per8	Per9
Precip per Period	100	100	100	100	100	100	100	100	100
Average ET per Period	100	100	100	100	100	100	100	100	100
Grass ET per Period	100	100	100	100	100	100	100	100	100
	36.31768	36.31768	36.31768	36.31768	36.31768	36.31768	36.31768	36.31768	36.31768
	78.26381	78.26381	78.26381	78.26381	78.26381	78.26381	78.26381	78.26381	78.26381
	78.03192	78.03192	78.03192	78.03192	78.03192	78.03192	78.03192	78.03192	78.03192

Figure A3. Stress Period Info Worksheet.

General								
	Acres/Section	640						
	Days/Month	Jan	Feb	Mar	Apr	May	Jun	Jul
		31	28	31	30	31	30	31
	mm/inch	25.4						
	mm/ft	304.8						
	ft^2/acre	43560.00						
	in/ft	12						
	days/year	365.25						
	days/IrrigYear	180						
	ft Per Mile	5280						
Irrigation Percentages								
	UrbanIrrigAcrePercent		0.27					
	SuburbanIrrigAcrePercent		0.73					
ET								
	Ave. ET-ft/yr	2.98		AveETCuFTPerAcre		129808.8		
	GrassETftyr	3.52		GrassETCuFTPerAcr		153393.2		
	Ave ET-ft/d	0.008164						
	Grass ETft/d	0.009648						
	Ave ET by Per	1	2	3	4	5	6	7
	(Array)ft/per	0.032354	0.032354	0.046027	0.046027	0.070713	0.070713	0.090215
	Grass ET by Per	1	2	3	4	5	6	7
	(Array)ft/per	2.03E-02	2.03E-02	3.22E-02	3.22E-02	7.48E-02	7.48E-02	1.28E-01
Precip								
	Ann. Precip (in)	10.27	in.					
	Precip by Period (inches)							
	Period	1	2	3	4	5	6	7
		0.59	0.54	0.33	0.60	0.53	0.58	0.39
	PrecipFtPerYr		8.56E-01	ft/y				
	PrecipFtPerDay		2.34E-03	ft/d				
	Number of Active Cells							
	2251							

Figure A4. Constants Worksheet.

Canal Seepage

Row/Col	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1			0.00	0.00	0.00	0.00															
2		0.00	0.00	0.00	0.00	0.00	0.00	0.00													
3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
4		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
5		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00			0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					0.00	0.00	0.00	0.00	0.00	0.00
26		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00
29		0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
30		0.00	0.00	0.00	0.00					0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00		
31		0.00	0.00	0.00	0.00		0.00				0.00	0.00		0.00	0.00	0.00					0.00
32	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00						0.00	0.00	0.00	0.00			0.00
33	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						

Figure A5. Canal Seepage Worksheet.

reproduction of this worksheet, the highlighted cells containing canals appear similar to the grayed out inactive cells.

Underflow Worksheet

The Underflow Worksheet is laid out in the row/column format with inactive cells grayed out. Boundary cells which have underflow entering from the Salmon River area, the Murtaugh Lake area or from stream drainages from the South Hills have the average daily volume of underflow in the corresponding cell on this worksheet. All other cells are zero. The volume of underflow is expressed in cubic feet/day. It is not anticipated that the user will modify this worksheet. Figure A6 contains a sample of the Underflow Worksheet.

ACT-INACT Worksheet

The ACT-INACT Worksheet indicates which cells are active model cells and which are inactive. It is laid out in a row/column format. "A" indicates an active model cell and "I" indicates an inactive model cell. It is not anticipated that the user will change this worksheet. Figure A7 contains a sample of the ACT-INACT Worksheet.

NetFlux Worksheet

The NetFlux Worksheet is organized in the row/column format and is generated by running the MakeTranWells Macro. The user does not directly modify the NetFlux Worksheet. After updating well pumpage, land use and irrigation source data and re-calculating ET and applied irrigation water, the CalcETandIrrig Macro reads the flux values from the Wellterm field on the Wellterm Worksheet and writes them into the appropriate cell on the NetFlux Worksheet. This worksheet is provided as a means of checking the calculated net fluxes for reasonableness. Figure A8 contains a sample of the NetFlux Worksheet. The net flux values contained in the NetFlux worksheet are for the last calculated stress period.

Underflow

Row/Col	45	46	47	48	49	50	51	52	53
29	0	0	0	0	0	0	0	0	44757
30	0	0	0	0	0	0	0	0	44757
31	0	0	0	0	0	0	0	0	44757
32	0	0	0	0	0	0	0	0	44757
33	0	0	0	0	0	0	0	0	44757
34	0	0	0	0	0	0	0	0	44757
35	0	0	0	0	0	0	0	0	44757
36	0	0	0	0	0	0	0	0	44757
37	0	0	0	0	0	0	0	0	44757
38	0	0	0	0	0	0	0	0	44757
39	0	0	0	0	0	0	0	0	44757
40	0	0	0	0	0	0	0	0	44757
41	0	0	0	0	0	0	0	0	44757
42	0	0	0	0	0	0	0	0	44757
43	0	0	0	0	0	0	0	0	89514
44	0	0	0	0	0	0	0	0	89514
45	0	0	0	0	0	0	0	0	89514
46	0	0	0	0	0	0	0	0	89514
47	0	0	0	0	0	0	0	0	179028
48	0	0	0	0	0	0	0	0	179028
49	[redacted]				1,670,795	[redacted]	835397.3	[redacted]	179028

Figure A6. Underflow Worksheet.

ACT-INACT Indicator		A-Active																			
		I-Inactive																			
Row/Col	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1			A	A	A	A															
2		A	A	A	A	A	A	A													
3		A	A	A	A	A	A	A	A	A	A	A									
4		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
5		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
8		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
9		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
10		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
12		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
13		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Figure A7. ACT-INACT Worksheet.

	Net Flux ft^3/day											
Row/Col	1	2	3	4	5	6	7	8	9	10	11	12
1			-2.8479584E+03	6.6361430E-03	6.6361430E-03	-1.8246124E+01						
2		-1.5582006E+03	-4.8083392E+03	-3.7015489E+02	-1.7839810E+03	-4.0678017E+03	-1.9605112E+03	-5.3813240E+02				
3		6.6361430E-03	-4.1459086E+03	-1.9420950E+03	-9.4154168E+02	-4.7300180E+03	-5.2362248E+03	-3.9761700E+03	-1.2342307E+03	-2.8730387E+02	-1.2089098E+02	1.6590357E-03
4		-3.7094731E+03	-4.4632597E+03	-2.1778719E+03	-1.5345148E+04	-5.6663873E+03	-8.2400978E+03	-4.7431041E+03	-2.9064071E+03	-2.8568614E+03	-2.8279555E+03	-1.0483925E+03
5		-1.0733325E+03	-2.7022188E+03	-1.1852481E+03	-1.9010328E+03	-2.7992508E+03	-2.8224469E+03	-2.7003551E+03	-1.4463216E+03	-1.4250750E+03	-1.4379247E+03	-7.0623635E+02
6		-1.0733325E+03	-2.7022188E+03	-1.1852481E+03	-1.9010328E+03	-2.7992508E+03	-2.8224469E+03	-2.7003551E+03	-1.4463216E+03	-1.4250750E+03	-1.4379247E+03	-7.0623635E+02
7		-5.9077963E+02	-2.6990380E+03	-2.5901599E+03	2.3328227E+04	-2.7474152E+03	-2.8309398E+03	-2.7145695E+03	-1.4168641E+03	-1.4375856E+03	-1.4519715E+03	-7.1485785E+02
8		-5.9077963E+02	-2.6990380E+03	-2.5901599E+03	2.3328227E+04	-2.7474152E+03	-2.8309398E+03	-2.7145695E+03	-1.4168641E+03	-1.4375856E+03	-1.4519715E+03	-7.1485785E+02
9		-8.8194064E+02	-1.3567116E+03	-1.4227882E+03	-1.4000355E+03	-1.4427770E+03	-1.4590971E+03	-1.4767866E+03	-7.0591790E+02	-7.1140843E+02	-7.3930324E+02	-3.6679779E+02
10		-8.8194064E+02	-1.3567116E+03	-1.4227882E+03	-1.4000355E+03	-1.4427770E+03	-1.4590971E+03	-1.4767866E+03	-7.0591790E+02	-7.1140843E+02	-7.3930324E+02	-3.6679779E+02
11		-8.8194064E+02	-1.3567116E+03	-1.4227882E+03	-1.4000355E+03	-1.4427770E+03	-1.4590971E+03	-1.4767866E+03	-7.0591790E+02	-7.1140843E+02	-7.3930324E+02	-3.6679779E+02
12		-8.8194064E+02	-1.3567116E+03	-1.4227882E+03	-1.4000355E+03	-1.4427770E+03	-1.4590971E+03	-1.4767866E+03	-7.0591790E+02	-7.1140843E+02	-7.3930324E+02	-3.6679779E+02
13		-1.0110795E+03	-1.2704462E+03	-1.4148043E+03	-1.4024233E+03	-1.3963048E+03	-1.4070756E+03	-1.4123164E+03	-5.3167716E+02	-3.0962742E+02	-7.0101432E+02	-3.5071655E+02
14	-4.6490715E+01	-1.0110795E+03	-1.2704462E+03	-1.4148043E+03	-1.4024233E+03	-1.3963048E+03	-1.4070756E+03	-1.4123164E+03	-5.3167716E+02	6.4423601E+03	-7.0101432E+02	-3.5071655E+02
15	-4.6490715E+01	-1.0110795E+03	-1.2704462E+03	-1.4148043E+03	-1.4024233E+03	-1.3963048E+03	-1.4070756E+03	-1.4123164E+03	-5.3167716E+02	6.4423601E+03	-7.0101432E+02	-3.5071655E+02
16	-4.6490715E+01	-1.0110795E+03	-1.2704462E+03	-1.4148043E+03	-1.4024233E+03	-1.3963048E+03	-1.4070756E+03	-1.4123164E+03	-5.3167716E+02	6.4423601E+03	-7.0101432E+02	-3.5071655E+02
17	-3.1561326E+02	-7.8655613E+02	-1.3410010E+03	-1.3982580E+03	-1.4136448E+03	-1.4069414E+03	-1.4286918E+03	-1.4282202E+03	-6.5362853E+02	-6.4738676E+02	-7.0761235E+02	-3.4979422E+02
18	-9.1237266E+02	-7.8655613E+02	-1.3410010E+03	-1.3982580E+03	-1.4136448E+03	-1.4069414E+03	-1.4286918E+03	-1.4282202E+03	-6.5362853E+02	-6.4738676E+02	-7.0761235E+02	-3.4979422E+02

Figure A8. NetFlux Worksheet.

Error Worksheet

The Error Worksheet contains error messages written by the MakeTranWells macro. Errors are written predominately if the user has entered data incorrectly on the MacroStartData worksheet.

TransientWellFile Macro Module

The TransientWellFile Macro Module contains the MakeTranWells Macro which is used to generate the MODFLOW well file. The MakeTranWells Macro uses information input by the user via the MacroStartData Worksheet and the IRRPRTR.XLS, WELLS.XLS and LANDUSTR.XLS Workbooks. The MakeTranWells Macro calculates evapotranspiration and applied irrigation water for each model cell and updates the NetFlux Worksheet for each stress period. The MakeTranWells Macro generates a text file in the precise format of the MODFLOW well file, containing the layer, row, column and flux for each active cell for each stress period in the simulation. The file is saved in the name specified by the user on the MacroStartData Worksheet with a 1 appended at the end of the name and with a .WEL extension. As previously explained, for long simulations, multiple, sequentially numbered files will be created which the user will then concatenate.

InitData Worksheet

The InitData Worksheet contains initialization data required by the macros. This worksheet will not be changed by the user unless the format of the Wellterm Worksheet is altered (the user is advised against changes to the Wellterm Worksheet or the InitData Worksheet). The data contained on the InitData Worksheet is predominantly row and column counters which are used by the macros. Figure A9 contains the InitData Worksheet.

Starting Row Number	10	Note, these variables are derived from
Ending Row Number	2606	the worksheet Wellterm and should not
Row Column Number	1	be altered unless the format of the
Column Column Number	2	worksheet is altered. Fields are
Act/Inact Column Number	10	write-protected to protect against
ActInt Column Number	18	inadvertent change.
Acres_In_Cell Column Nur	6	
Urban Column Number	13	
SubUrban Column Numbe	14	
Ag Column Number	15	
Range Column Number	16	
Irrig Source Col Number	11	
Irrig Acres Col Number	17	
ET Column Number	20	
Irrig Column Number	22	
Wellterm Column Number	23	
Ave Seepage Col Num	21	
Ave Underflow Col Num	12	
Stress Seepage Col Num	25	
Stress Underflow col Num	26	
Well Pumpage Col Num	24	
Stress Precip Col Num	19	

Figure A9. InitData Worksheet.

Irrigation Profile Workbook IRRPRTR.XLS

Each worksheet in the Irrigation Profile Workbook is organized in the row/column format, with one worksheet for every stress period in the transient simulation. These worksheets are maintained by the user and can be used to reflect changes in irrigation practices, such as conversion to sprinkler irrigation or taking land out of irrigation. If irrigation source does not change during the simulation, the irrigation source as listed in the stress period 1 (Per1) worksheet is read by the MakeTranWells Macro and used throughout the simulation. Inactive cells are grayed out in each worksheet. The worksheet organization allows for a spatial visualization of the irrigator assignments (that is, irrigator assignments in the western part of the study area appear on the left of the worksheet). Each worksheet contains a code for each model cell indicating the source of irrigation water for the cell. The codes which may be used by the user to reflect sources of irrigation are:

TF	TFCC Irrigation
SPRK	TFCC Sprinkler Irrigation
SR	Salmon River Canal Company Irrigation
RC	Rock Creek Irrigation
GW	Ground-water Irrigation
NI	Not irrigated.

The codes input by the user must be input exactly as shown and are case-sensitive. Any cell containing a code which does not exactly match the codes as shown is assumed to be not irrigated. Figure A10 contains a sample of one worksheet from the Irrigation Profile Workbook.

Note, entries must match these options exactly, including case.		TF	Twin Falls Canal Company Flood Irrigation
		SPRK	Sprinkler Irrigation
		SR	Salmon River Canal Company
		RC	Rock Creek Irrigation
Irrigation Profile by Cell		GW	Groundwater Irrigation
		NI	Not Irrigated

Row/Col	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1			TF	TF	TF	TF												
2		TF	TF	TF	TF	TF	TF	TF										
3		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF						
4		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
5		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
6		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
7		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
8		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
9		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
10		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
11		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
12		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
13		TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
14	SR	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
15	SR	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
16	SR	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
17	SR	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
18	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
19	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
20	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
21	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
22	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
23	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
24	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
25	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
26	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
27	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
28	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
29	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
30	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
31	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
32	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
33	TF	TF	TF	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	TF	TF	TF	TF	TF
34	TF	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	SR	TF	TF	TF	TF
35	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	SR	SR	TF	TF	TF	TF
36	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	SR	SR	TF	TF	TF	TF
37	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR	TF	TF
38	TF	TF	TF	TF	TF	TF	SR	SR	SR	SR	SR	TF	SR	SR	SR	SR	TF	SR
39	SR	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	TF	SR	SR	SR	SR	SR	SR
40	SR	TF	TF	TF	TF	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR
41		TF	TF	TF	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR
42		TF	TF	TF	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR
43			TF	NI	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR
44			TF	NI	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	SR
45			NI	NI	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	NI
46				NI	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	NI
47				NI	NI	NI	NI	NI	SR	SR	SR	SR	SR	SR	SR	SR	SR	NI
48					NI	NI	NI	NI	NI	SR	SR	SR	SR	NI	NI	SR	SR	NI
49						NI	NI	NI	NI	SR	SR	SR	NI	NI	NI	SR	SR	SR

Figure A10. Irrigation Profile Worksheet.

Land Use Workbook LANDUSTR.XLS

Each worksheet in the Land Use Workbook is organized in the row/column format, with one worksheet for every stress period in the transient simulation. Each worksheet contains data indicating Urban, Suburban, Agricultural and Range land use for that stress period. These worksheets are maintained by the user and can be used to reflect changes in land use, such as converting urban areas to agricultural areas. If land use does not change during the simulation, the land use as listed in the stress period 1 (Per1) worksheet is read by the MakeTranWells Macro and used throughout the simulation. Inactive cells are grayed out in each worksheet. The worksheet organization allows for a spatial visualization of the land use assignments (that is, land use assignments in the western part of the study area appear on the left of the worksheet). Each worksheet contains four parts indicating the proportion of each model cell which is Urban, Suburban, Agricultural and Range land. To ensure that exactly 100% of the model cell is allocated for land use, the user enters only Urban, Suburban and Agricultural land use proportions. For example, if Urban Use is .4, Suburban Use is .3 and Agricultural Use is 0, the workbook enters a Range Use of .3. The LANDUSTR.XLS Workbook calculates Range use based upon the values entered for the other three categories.

Well Pumpage Workbook WELLS.XLS

The Well Pumpage Workbook enables the user to enter well pumpage for each stress period for each model cell. The workbook contains one worksheet for each stress period. The worksheets are laid out in the row/column format described above. Well pumpage is expressed in ft^3/d. This enables the user to turn wells on and off during a simulation. If well pumpage does not vary during the simulation, the well pumpage for the first stress period will be read by the MakeTranWells Macro and will be used during the entire simulation.

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