

January 13, 2006

Idaho Department of Water Resources
Western Region Office
2735 Airport Way
Boise, Idaho 83705

Attn: Jan Shurte

RECEIVED

JAN 17 2006

WATER RESOURCES
WESTERN REGION

RECEIVED

JAN 19 2006

DEPARTMENT OF
WATER RESOURCES

RE: Evidence of Priority & Irrigation Requirement Analysis for SRBA claims 3-4003 & 63-4262

Dear Jan,

On behalf of our client, Mann Farms, enclosed are Evidence of Priority and an Irrigation Requirement Analysis for the above two referenced claims. Evidence of Priority consists of a statement provided by Kent's mother, Mary H. Mann. Mrs. Mann remembers irrigation beginning in either fall of 1961 or spring of 1962. Power line easements were granted to Idaho Power Company on April 7, 1961; Idaho Power constructed facilities to energize pumps used for diverting water under these claims.

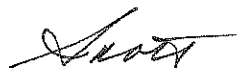
The Irrigation Requirement Analysis provides a basis for these claims exceeding the standard diversion rate of 0.02 cfs per acre. Table 1 presents a summary of the claimed acres, claimed diversion rate, and diversion rate supported by the Field Irrigation Requirement (FIR) analysis.

Claim	Claimed Number of Acres	Claimed Diversion Rate (cfs)	FIR Results (cfs)
3-4003	54	2.6	2.46
63-4262	36	1.2	1.28
Total	90	3.8	3.74

Table 1. Summary of Irrigation Requirement Analysis.

I am not sure to whom these claims are assigned. Could you please forward on this information to the appropriate reviewer?

Sincerely,



Scott N. King, P.E.
Senior Project Engineer

cc: Mann Farms
File: 220.0010

IRRIGATION REQUIREMENT ANALYSIS

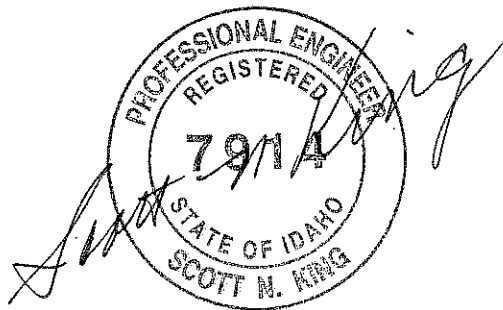
3-4003 & 63-4262

Prepared for

**Kent Mann
31801 Mann Ln
Parma, ID**

Prepared by:

**Scott N. King, P.E.
SPF Water Engineering, LLC
600 East River Park Lane
Boise, ID 83706**



December 12, 2005



SPF

Water Engineering, LLC
water resource consultants

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1. BACKGROUND

This report presents a Field Irrigation Requirement (FIR) analysis for a farm bordering the Snake River located about five miles northwest of Parma, ID, and identified by two Snake River Basin Adjudication (SRBA) water right claims. Claim 3-4003 identifies diversion of 2.6 cfs from the Snake River for irrigation of 54 acres in Sections 13 and 24 of T6N R6W. Claim 63-4262 lists 1.2 cfs of waste water tributary to the Snake River for irrigation of 36 acres in T6N R6W Sec 24.

Kent Mann, owner and long time operator of this farm, provided information necessary to complete this analysis such as irrigation methods, crop patterns, etc. His father, Charles Mann, purchased the first portion of the place in or around 1960, and Kent therefore has a long-time association with the farm.

2. WATER RIGHTS

Mann Farms is current owner of two claims totaling 3.8 cfs for irrigation of 90 acres in Canyon County:

3-4003

Priority: 4/1/1961

Source: Snake River

Use: Irrigation of 54 acres

Rate: 2.6 cfs

Point of Diversion: 6N 6W 24, NWNW

63-4262

Priority: 4/1/1961

Source: waste water tributary to Snake River

Use: Irrigation of 36 acres

Rate: 1.2 cfs

Point of Diversion: 6N 6W 24, NWSE

Figure 1 presents the claimed places of use and points of diversion for these rights. Snake River water supplies the northern 54 acres of the farm, and waste water from a drain ditch is used for the southern 36 acres. This figure also identifies field acreage, field boundaries, and furrow direction. Fields 1 and 8 are further split based on soil types. Adjudication Claim Reports for these claims are included in Appendix A.

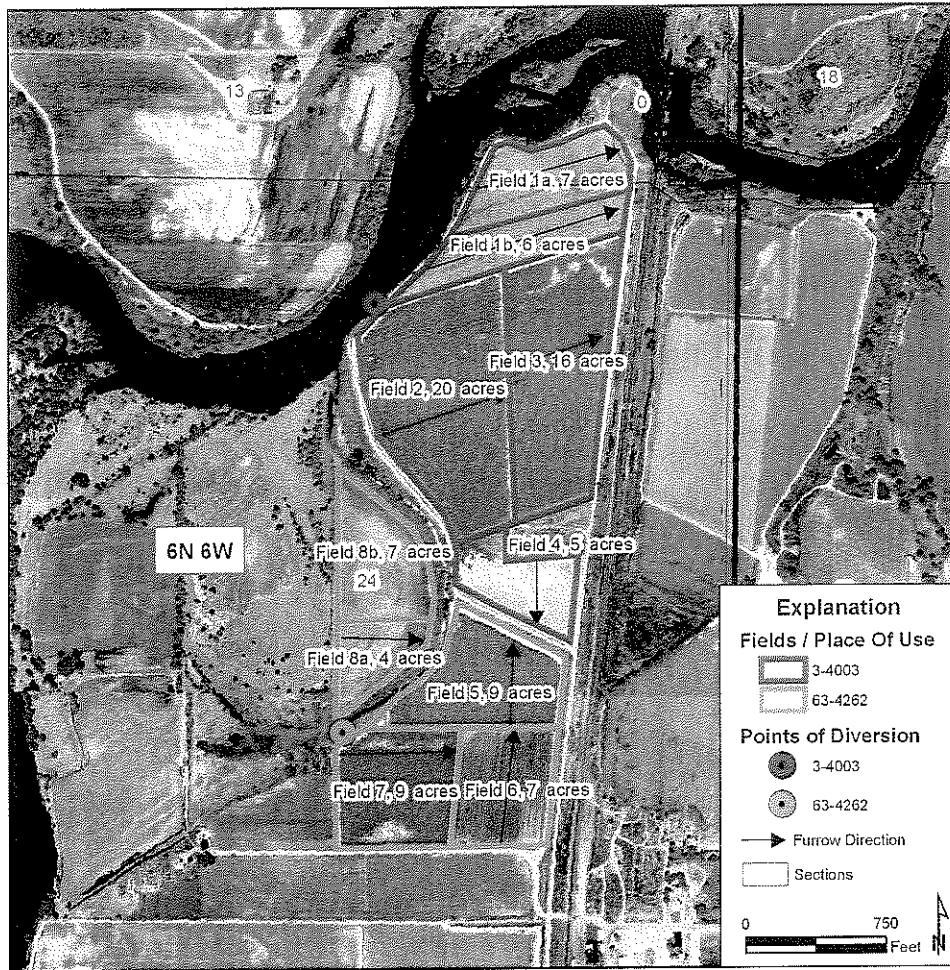


Figure 1. Places of use and points of diversions for water right claims 3-4003 and 63-4262. The base layer is 1994 color infrared imagery.

3. IRRIGATION REQUIREMENT ANALYSIS

3.1. Fields

Field boundaries are based on Kent Mann's identification, IDWR's digital claim-layer place of use shapefile, and 1994 & 2004 aerial imagery. Figure 2 presents field boundaries and furrow direction overlaid on selected soils from the SSURGO soil database. The fields are generally level and irrigated using corrugate and furrow flood methods. Field furrow lengths range from 350 to 1200 feet. Slope was assumed to be 0.005 ft/ft for fields with soils described by the SSURGO soils database to have slopes from 0 to 1 percent, and 0.01 ft/ft is assumed for soils describing slopes from 1 to 3 percent. Based on Dreher and Tuthill, 1999, field irrigation requirements are estimated using the NRCS Furrow program together with soil characteristics, field conditions, and weather station records.

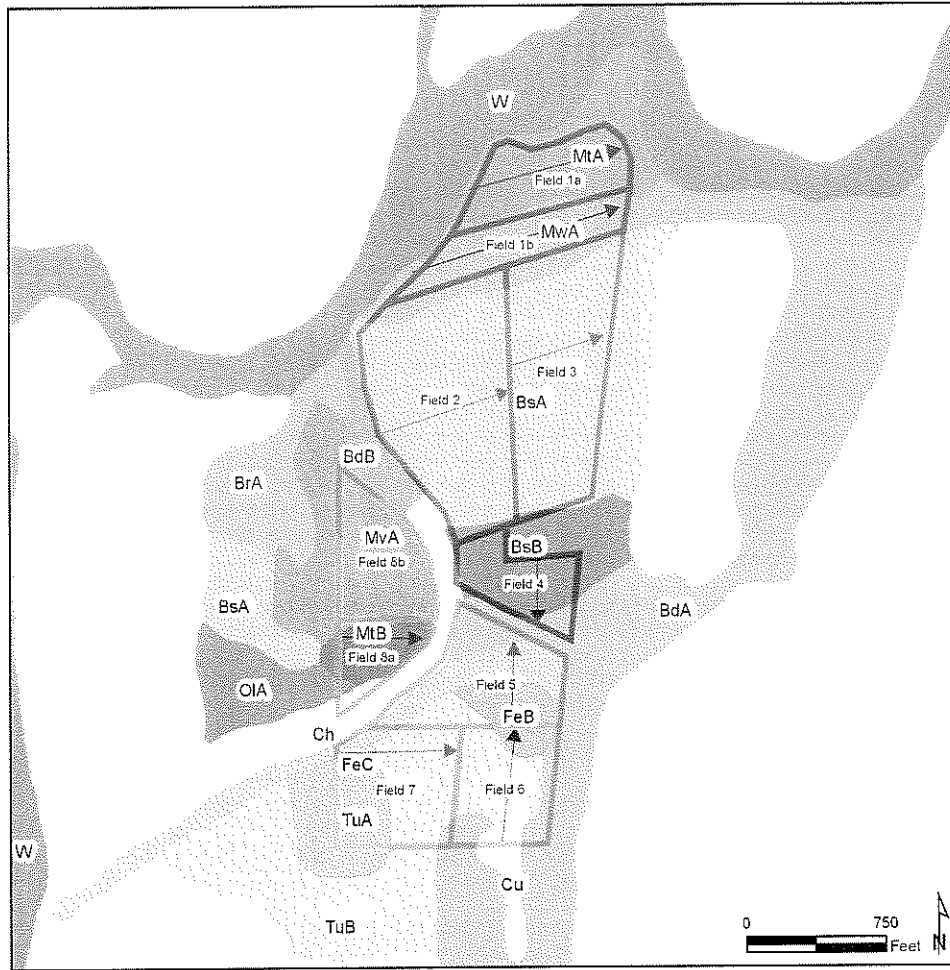


Figure 2. Field boundaries and soils at Mann Farms.

3.2. Soils

Soil information is provided by the Natural Resource Conservation Service digital SSURGO soil database. Table 1 presents the predominant soils found on this farm. Soil analyses, including determination of Management Allowed Deficit (MAD) are included in Appendix B. These soils have furrow intake family values ranging from 0.42 to 0.55, which is in the moderate range. Water infiltrates slowly into low intake family soils, and quickly into high intake family soils (heavy clay = 0.3; sand = 0.8). Most of the soils are deep and have an available water holding capacity (AWC) of at least 0.13 inches of water per inch of soil in the upper layer.

Table 1. Properties of predominant soils.

<i>Field</i>	<i>Soil Properties</i>			
	<i>MUSYM Code</i>	<i>Name</i>	<i>Slope (percent)</i>	<i>Furrow Intake Family</i>
1a	MtA	Moulton Fine Sandy Loam	0 to 1	0.55
1b	MwA	Moulton Loam	0 to 1	0.50
2, 3	BsA	Bram Silt Loam	0 to 1	0.42
4	BsB	Bram Silt Loam	1 to 3	0.42
6, 7	TuB	Turbyfill Fine Sandy Loam	1 to 3	0.50
8a	MtB	Moulton Fine Sandy Loam	1 to 3	0.55
8b	MvA	Moulton Loam	0 to 1	0.50

3.3. Crops

The analyzed crop rotation of onions, beans, potatoes, and grain is based on actual historic cropping patterns per Kent Mann. Other crops and rotations may result in higher or lower irrigation requirements.

3.4. Climate

The Parma Experiment Station climate station is used as the basis for crop evapotranspiration (ET) requirements for this farm. 80th percentile values of monthly ET for this station were obtained from Allen & Brockway, 1983, and are included in Appendix C.

3.5. Irrigation Efficiency

Per IDWR guidelines (Dreher & Tuthill, 1999), the FURROW program written by the NRCS is used to estimate irrigation efficiency. In this analysis, input parameters include:

- Irrigation application depths ranging from 0.56 to 2.19 inches of water, equivalent to MAD found in Soil Characteristics (Appendix B)
- Corrugate irrigation for grain; furrows for potatoes, beans and onions
- Furrow length ranging from 350 to 1200 ft
- Furrow spacing of 2.5 ft for all crops
- Furrow slope of 0.005 for soils described with 0 to 1 percent slope, and 0.01 ft/ft for soils with 1 to 3 percent slope
- Soil intake family as listed in Table 1, and per Soil Characteristics in Appendix B
- Furrow inflow rates range from 3 to 8.5 gpm and application time is 12 hours. The most efficient combination of flow and application time is selected for analysis.

Inflow rate is adjusted for application times of 12, 18, or 24 hours in order to determine the optimum irrigation efficiency. All fields demonstrated peak efficiency with 12-hour sets with longer sets resulting in decreased efficiency. Fields 1 and 8 were split based on soil-type boundaries.

3.6. Field Irrigation Requirement

Field Application Efficiency (FAE) values are the result of Furrow program runs. Table 2 provides Furrow program results for each field based on furrow spacing and length, soil type, crop, irrigation application depth, irrigation method, and the most efficient inflow time / flow rate combination.

Figure 3 presents a spreadsheet used to determine the Field Irrigation Requirement (FIR) for claim 3-4003 based on crop evapotranspiration requirements, net irrigation application (equivalent to MAD values from the soil analysis spreadsheets, Appendix B), and FAE from Furrow runs (Table 2 and Appendix D). Based on the crop rotation presented, the total on-farm irrigation requirement is 2.46 cfs for 54 acres.

The total on-farm irrigation requirement for claim 63-4262 is 0.035 cfs per acre based on 1.28 cfs for 36 acres identified as irrigated per aerial imagery. Figure 4 presents the FIR spreadsheet for 63-4262.

Table 2. Field characteristics (furrow spacing = 2.5 ft).

Field ID	Size (acres)	Crop	Soil	Irrigation Application (inches)	Slope	Furrow Length (ft)	Inflow Rate (gpm)	Irrigation method	Inflow Time (hours)	Irrigation Efficiency (%)
1a	7	Onions	MtA	0.56	0.005	800	5.5	Furrow	12	17
1b	6	Onions	MwA	0.59	0.005	1200	8.5	Furrow	12	19
2	20	Potatoes	BsA	1.37	0.005	700	4	Furrow	12	52
3	16	Beans	BsA	1.10	0.005	500	3	Furrow	12	40
4	5	Onions	BsB	0.57	0.01	350	3	Furrow	12	14*
5	9	Onions	Mix [†]	0.60				Furrow		20
6	7	Beans	TuB	1.12	0.01	600	3.5	Furrow	12	42
7	9	Potatoes	TuA	1.46	0.005	600	4	Furrow	12	47
8a	4	Grain	MtB	2.19	0.01	450	3.5	Corrugate	12	61
8b	7	Grain	MvA	2.24	0.01	450	3	Corrugate	12	73*

* Irrigation efficiency below 15% and above 70% is limited to 15% and 70%, respectively, for FIR determination based on Dreher and Tuthill, 1999.

[†] Field 5 is a complex mix of 4 soils and varying furrow lengths. The analysis is simplified for this field by selecting slightly above-average conservative values for Irrigation Application (0.60 inches) and Irrigation Efficiency (20%) parameters for onions.

FIELD IRRIGATION REQUIREMENT														
initials:		snk		Claimant = Mann Farms, 3-4003										
date:		12/12/05		Weather Station = Parma Exp Station										
field / crop	acres	irrig. system	eff. (%)	Monthly ET (mm/day)							AVE IR season (mm/yr)	net irrig.		irrig. freq.
				mar	apr	may	jun	jul	aug	sep		oct	app.	
1a/onions	7	fur	17		1.54	3.17	5.24	6.76	5.72	4.14		0.56	1.14	1.8
1b/onions	6	fur	19		1.54	3.17	5.24	6.76	5.72	4.14		0.59	1.14	1.9
4/onions	5	fur	15		1.54	3.17	5.24	6.76	5.72	4.14		0.57	1.14	1.9
2/potato	20	fur	52		1.4	2.39	6.05	7.13	5.32	2.65		1.37	1.13	4.3
3/beans	16	fur	40			1.87	4.17	7.92	3.29	0.56		1.10	1.14	3.1
Summary		54												
Peak Gross Irrigation Application (mm/day) =				27.57										
On-Farm Irrigation Requirement (cfs/acre) =				0.046										
Total On-Farm Irrigation Requirement (cfs) =				2.46										
Irrigation Diversion Volume (ft/yr) =				0.00										
Total Irrigation Diversion Volume (ac-ft/yr) =				0										

Figure 3. Field Irrigation Requirement for claim 3-4003.

FIELD IRRIGATION REQUIREMENT																
initials:		snk		Claimant = Mann Farms, 63-4262												
date:		12/12/05		Weather Station = Parma Exp Station												
field / crop		irrig. eff.		Monthly ET (mm/day)								AVE IR season (mm/yr)	net irrig. app. (in)	ET ratio	irrig. freq. (days)	
				mar	apr	may	jun	jul	aug	sep	oct					
5/onions	9	fur	20		1.54	3.17	5.24	6.76	5.72	4.14		0.60	1.14	2.0		
6/beans	7	fur	42			1.87	4.17	7.92	3.29	0.56		1.12	1.14	3.2		
7/potato	9	fur	47		1.4	2.39	6.05	7.13	5.32	2.65		1.46	1.13	4.6		
8a/grain	4	cor	61	0.67	1.58	5.23	7.86	6.57	1.3			2.19	1.11	6.4		
8b/grain	7	cor	70	0.67	1.58	5.23	7.86	6.57	1.3			2.24	1.11	6.5		
Summary		36														
Peak Gross Irrigation Application (mm/day) =							21.45									
On-Farm Irrigation Requirement (cfs/acre) =							0.035									
Total On-Farm Irrigation Requirement (cfs) =							1.28									
Irrigation Diversion Volume (ft/yr) =							0.00									
Total Irrigation Diversion Volume (ac-ft/yr) =							0									

Figure 4. Field Irrigation Requirement for claim 63-4262.

4. RESULTS AND CONCLUSIONS

The above analysis indicates an average field irrigation requirement of 0.046 cfs per acre for claim 3-4003, and 0.035 cfs per acre for claim 63-4262. Both claims exceed the Idaho standard irrigation rate of 0.02 cfs per acre. The loamy soils present on this farm appear to be fairly well suited for surface irrigation methods. Field application efficiency tends to be high with deep rooting plants such as grains, and low for shallow rooting crops like onions and beans. Based on the current farm configuration and standard 12-hour set times, the claimed flow rates are necessary and justified. Overall system efficiency could be increased on some fields by operating shorter set times for shallow rooting crops.

5. REFERENCES

Allen and Brockway, 1983. Estimating Consumptive Irrigation Requirements for Crops in Idaho. Idaho Water and Energy Resources Research Institute, Moscow

Dreher and Tuthill, 1999. Report Regarding Evaluation of Irrigation Diversion Rates. Idaho Department of Water Resources, January 14, 1999.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database [Online at <http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/>].

Document Info:

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Pages: 11

APPENDIX A
ADJUDICATION CLAIM REPORTS FOR
3-4003 & 63-4262

Close

IDAHO DEPARTMENT OF WATER RESOURCES
Adjudication Claim Report

12/06/2005

WATER RIGHT NO. 3-4003

<u>Owner Type</u>	<u>Name and Address</u>
Current Owner	MANN FARMS 31801 MANN LN PARMA, ID 83660 (208)722-9039
Original Owner	CHARLES C MANN 31801 MANN LN PARMA, ID 83660 (208)722-6343

Priority Date: 04/01/1961
Basis: Statutory Claim
Status: Active

<u>Source</u>	<u>Tributary</u>
SNAKE RIVER	COLUMBIA RIVER

<u>Beneficial Use</u>	<u>From</u>	<u>To</u>	<u>Diversion Rate</u>	<u>Volume</u>
IRRIGATION	03/01	10/31	2.6 CFS	
Total Diversion			2.6 CFS	

Location of Point(s) of Diversion:

SNAKE RIVER|NWNE|Sec. 24|Township 06N|Range 06W|CANYON County

Place(s) of use:

Place of Use Legal Description: IRRIGATION CANYON County

Township	Range	Section	Lot	Tract	Acres	Lot	Tract	Acres	Lot	Tract	Acres	Lot	Tract	Acres
06N	06W	13		SWSE	1		SESE	3						
		24		NENE	16		NWNE	18		SWNE	8		SENE	8

Total Acres: 54

Dates:

Licensed Date:

Claim Received Date:

Decreed Date:

Enlargement Use Priority Date:

Enlargement Statute Priority Date:

Other Information:

State or Federal: S

Owner Name Connector:

Water District Number:

Generic Max Rate per Acre:

Generic Max Volume per Acre:

Civil Case Number:

Old Case Number:

Decree Plaintiff:

Decree Defendant:

Swan Falls Trust or Nontrust:

Swan Falls Dismissed:

DLE Act Number:

Cary Act Number:

Mitigation Plan: False

Close

Close

IDAHO DEPARTMENT OF WATER RESOURCES
Adjudication Claim Report

12/12/2005

WATER RIGHT NO. 63-4262

<u>Owner Type</u>	<u>Name and Address</u>
Current Owner	MANN FARMS 31801 MANN LN PARMA, ID 83660 (208)722-9039
Original Owner	CHARLES C MANN 31801 MANN LN PARMA, ID 83660 (208)722-6343

Priority Date: 04/01/1961
Basis: Statutory Claim
Status: Active

<u>Source</u>	<u>Tributary</u>
WASTE WATER	SNAKE RIVER

<u>Beneficial Use</u>	<u>From</u>	<u>To</u>	<u>Diversion Rate</u>	<u>Volume</u>
IRRIGATION	03/01	10/31	1.2 CFS	
Total Diversion			1.2 CFS	

Location of Point(s) of Diversion:

WASTE WATER|NWSE|Sec. 24|Township 06N|Range 06W|CANYON County

IRRIGATION Use:
Acre Limit: 34

Place(s) of use:

Place of Use Legal Description: IRRIGATION CANYON County

<u>Township</u>	<u>Range</u>	<u>Section</u>	<u>Lot</u>	<u>Tract</u>	<u>Acres</u>	<u>Lot</u>	<u>Tract</u>	<u>Acres</u>	<u>Lot</u>	<u>Tract</u>	<u>Acres</u>	<u>Lot</u>	<u>Tract</u>	<u>Acres</u>
06N	06W	24		SWNE	13		SENE	1						
				NESE	6		NWSE	16						

Total Acres: 36

Conditions of Approval:

1. ||This claim is amended to show actual place of use.

Dates:

Licensed Date:

Claim Received Date:

Decreed Date:

Enlargement Use Priority Date:

Enlargement Statute Priority Date:

Other Information:

State or Federal: S

Owner Name Connector:

Water District Number:

Generic Max Rate per Acre:

Generic Max Volume per Acre:

Civil Case Number:

Old Case Number:

Decree Plaintiff:

Decree Defendant:

Swan Falls Trust or Nontrust:

Swan Falls Dismissed:

DLE Act Number:

Cary Act Number:

Mitigation Plan: False

[Close](#)

APPENDIX B

SOIL CHARACTERISTICS

Field la 60.9 acres

SOIL CHARACTERISTICS

0-3" = FSL; 3-21" = FSL, SL; 21-60" = GRV-LS, GRV-S

source of soils Data = SSURGO (on-line) and Soil Survey of Canyon Area, Idaho, 1972

[illegible]

Management Allowed Deficit (MAD)

crop	root depth (ft)	stress point	MAD (inches)
alfalfa (hay or seed)	5	0.5	2.55
corn (field or silage)	4	0.5	2.19
grain (winter or spring)	4	0.5	2.19
pasture (or grass hay)	3	0.5	1.83
other (enter below)			
Onions	1	0.35	0.56
Beans	2	0.4	1.18
Potatoes	3	0.35	1.28

Mann Farms
Field 1b 6.3 acres

SOIL CHARACTERISTICS initials: snk date: December 7, 2005

Soil Type = MWA Moulton Loam, Saline, 0 to 1% Slopes
0-3" = L; 3-21" = FSL, SL; 21-60" = GRV-LS, GRV-S
Source of Soils Data = SSURGO (on-line) and Soil Survey of Canyon Area, Idaho, 1972

soil depth (inches)	AWC (in/in)		PH		organic (%)		soil depth (ft)		AWC (inches)		intake family	
	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	flood	furrow
0	3	0.16	0.18	6.6	7.8	1	2	1	1.68	1.5	0.5	
3	21	0.11	0.15					2	3.03			
21	60	0.04	0.08					3	3.75			
								4	4.47		alternate	
								5	5.19		method	
										1.5	0.49	

Management Allowed Deficit (MAD)

crop	root depth (ft)		stress point		MAD (inches)	
	lower	upper	lower	upper	lower	upper
alfalfa (hay or seed)	5	0.5	2.60			
corn (field or silage)	4	0.5	2.24			
grain (winter or spring)	4	0.5	2.24			
pasture (or grass hay)	3	0.5	1.88			
other (enter below)						
Onions	1	0.35	0.59			
Beans	2	0.4	1.21			
Potatoes	3	0.35	1.31			
Beets (same as alfalfa)						

Mann Farms

Field 2, 19.7 acres
Field 3, 15.1 acres

date: December 7, 2005

snk

initials:

SOIL CHARACTERISTICS

Soil Type = BSA Bram Silt Loam, Saline-Alkali, 0 to 1 % Slopes
Source of Soils Data = SSURGO (on-line) and Soil Survey of Canyon Area, Idaho, 1972

soil depth (inches)		AWC (in/in)		PH		organic (%)		soil depth (ft)		AWC (inches)		intake family	
lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	flood	furrow
0	8	0.14	0.17	8.5	9.6	1	2	1	2	1.62	0.3	0.3	0.3
8	52	0.08	0.11					2		2.76			
52	60	0.07	0.1					3		3.90			
60	65	0.1	0.14					4		5.04			
								5		6.10			

alternate
method

1 0.42

Management Allowed Deficit (MAD)

crop	root depth (ft)		stress point (inches)		MAD (inches)	
	lower	upper	lower	upper	lower	upper
alfalfa (hay or seed)	5		0.5		3.05	
corn (field or silage)	4		0.5		2.52	
grain (winter or spring)	4		0.5		2.52	
pasture (or grass hay)	3		0.5		1.95	
other (enter below)						
Onions	1		0.35		0.57	
Beans	2		0.4		1.10	
Potatoes	3		0.35		1.37	

Mann Farms

Field 4, 5.1 acres

SOIL CHARACTERISTICS initials: date: December 7, 2005 snk

Soil Type = BsB Bram Silt Loam, Saline-Alkali, 1 to 3 % Slopes
Source of Soils Data = SSURGO (on-line) and Soil Survey of Canyon Area, Idaho, 1972

soil depth (inches)		AWC (in/in)		PH		organic (%)		soil depth (ft)		AWC (inches)		intake family	
lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	flood	furrow
0	8	0.14	0.17	8.5	9.6	1	2	1	2	1.62	2.76	0.3	0.3
8	52	0.08	0.11					2		2.76	3.90		
52	60	0.07	0.1					3		3.90	5.04		
60	65	0.1	0.14					4		5.04	6.10		
								5		6.10			

alternate
method
1 0.42

Management Allowed Deficit (MAD)

crop	root depth (ft)	stress point (inches)	MAD (inches)
alfalfa (hay or seed)	5	0.5	3.05
corn (field or silage)	4	0.5	2.52
grain (winter or spring)	4	0.5	2.52
pasture (or grass hay)	3	0.5	1.95
other (enter below)			
Onions	1	0.35	0.57
Beans	2	0.4	1.10
Potatoes	3	0.35	1.37

Mann Farms
Field 8b, 6.9 acres

SOIL CHARACTERISTICS initials: snk date: December 8, 2005

Soil Type = MvA Moulton Loam, 0 to 1% slopes
 0-3" = L; 3-21" = FSL, SL; 21-60" = GRV-LS, GRV-S
Source of Soils Data = SSURGO (on-line) and Soil Survey of Canyon Area, Idaho, 1972

soil depth (inches)	AWC (in/in)		PH		organic (%)		soil depth (ft)		AWC (inches)		intake family	
	lower	upper	lower	upper	lower	upper	1 2 3 4 5	flood	1.5	0.5	alternate method	furrow
0	3	0.16	0.18	6.6	7.8	0						
3	21	0.11	0.15									
21	60	0.04	0.08									

1.5 0.49

Management Allowed Deficit (MAD)

crop	root depth (ft)		stress point		MAD (inches)	
	depth	point	depth	point	depth	point
alfalfa (hay or seed)	5	0.5	5	0.5	2.60	
corn (field or silage)	4	0.5	4	0.5	2.24	
grain (winter or spring)	4	0.5	4	0.5	2.24	
pasture (or grass hay)	3	0.5	3	0.5	1.88	
other (enter below)						
Onions	1	0.35	1	0.35	0.59	
Beans	2	0.4	2	0.4	1.21	
Potatoes	3	0.35	3	0.35	1.31	

APPENDIX C

CLIMATE DATA

Est. CU and CIR.		Parma Exp. Station		(Allen & Brockway, 1983)		mm/day and mm/season		ORCHD VEGES ONION HOPS											
MO	NYRS	PREC	ETR	ALFH.	ALFS.	BEANS	F. ORN	SILGE	S. ORN	PEAS	POTAT	SBEET	SGRAN	WGRAN	PAST.	ORCHD	VEGES	ONION	HOPS
AVE	ET	2.23	3.57	3.64	4.67	4.92	5.75	5.75	5.61	1.87	1.97	1.40	1.59	4.53	3.35	2.04	1.54	1.48	
IR	94		3.03	3.09			4.13	4.14	4.00	1.37	1.46	1.94	1.17	4.11	3.35	1.36	1.14	1.01	
AVE	ET		3.33	3.33			4.41	4.41	4.14	1.41	1.51	1.35	1.41	4.00	3.00	1.40	1.16	1.05	
STOD	IR	.29	3.63	3.63			4.09	4.09	3.88	1.35	1.46	1.44	1.41	3.69	2.69	1.40	1.16	1.05	
STOD	IR	.15	3.09	3.09			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81	3.81	3.57	1.25	1.36	1.35	1.35	3.35	2.35	1.09	1.05	0.98	
STOD	IR		3.57	3.57			3.81												

APPENDIX D

FURROW.EXE RESULTS

```

FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 0.6 INCHES
FURROW SLOPE (CS) = 0.005 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 800 FEET
INFLOW RATE (CQ) = 5.5 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 451.5 MINUTES; OR 7.5 HOURS
GROSS APPLICATION (CG) = 3.10 INCHES
NET APPLICATION (CA) = 1.71 INCHES
RUNOFF (CR) = 0.12 INCHES
DEEP PERCOLATION (CDP) = 2.19 INCHES
EFFICIENCY (CE) = 17.61 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 0.55 in
Furrow Slope (C2) = 0.005 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 800 ft
Furrow Intake Family (C5) = 0.55
Inflow Rate (C6) = 5.5 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 1. Field 1a, onions.

```

FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 0.57 INCHES
FURROW SLOPE (CS) = 0.005 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 1200 FEET
INFLOW RATE (CQ) = 8.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 630.4 MINUTES; OR 10.5 HOURS
GROSS APPLICATION (CG) = 3.08 INCHES
NET APPLICATION (CA) = 0.82 INCHES
RUNOFF (CR) = 0.22 INCHES
DEEP PERCOLATION (CDP) = 1.32 INCHES
EFFICIENCY (CE) = 19.15 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 0.57 in
Furrow Slope (C2) = 0.005 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 1200 ft
Furrow Intake Family (C5) = 0.55
Inflow Rate (C6) = 8.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 2. Field 1b, onions.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.42
DESIGN APPLICATION (CA) = 1.17 INCHES
FURROW SLOPE (CS) = 0.005 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 700 FEET
INFLOW RATE (CQ) = 4.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 424.7 MINUTES; OR 7.1 HOURS
GROSS APPLICATION (CG) = 2.44 INCHES
NET APPLICATION (CA) = 1.41 INCHES
RUNOFF (CR) = 0.79 INCHES
DEEP PERCOLATION (CDP) = 0.79 INCHES
EFFICIENCY (CE) = 51.29 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 1.17 in
Furrow Slope (C2) = 0.005 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 700 ft
Furrow Intake Family (C5) = 0.42
Inflow Rate (C6) = 4.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 3. Field 2, potatoes.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.42
DESIGN APPLICATION (CA) = 1.10 INCHES
FURROW SLOPE (CS) = 0.005 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 500 FEET
INFLOW RATE (CQ) = 3.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 265.0 MINUTES; OR 4.4 HOURS
GROSS APPLICATION (CG) = 2.77 INCHES
NET APPLICATION (CA) = 1.82 INCHES
RUNOFF (CR) = 0.42 INCHES
DEEP PERCOLATION (CDP) = 1.25 INCHES
EFFICIENCY (CE) = 39.68 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 1.10 in
Furrow Slope (C2) = 0.005 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 500 ft
Furrow Intake Family (C5) = 0.42
Inflow Rate (C6) = 3.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 4. Field 3, beans.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.42
DESIGN APPLICATION (CA) = 0.57 INCHES
FURROW SLOPE (CS) = 0.010 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 800 FEET
INFLOW RATE (CQ) = 3.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 42.7 MINUTES; OR 0.8 HOURS
GROSS APPLICATION (CG) = 3.26 INCHES
NET APPLICATION (CA) = 2.29 INCHES
RUNOFF (CR) = 1.60 INCHES
DEEP PERCOLATION (CDP) = 1.79 INCHES
EFFICIENCY (CE) = 14.39 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 0.57 in
Furrow Slope (C2) = 0.010 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 800 ft
Furrow Intake Family (C5) = 0.42
Inflow Rate (C6) = 3.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 5. Field 4, onions.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 1.19 INCHES
FURROW SLOPE (CS) = 0.010 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 800 FEET
INFLOW RATE (CQ) = 3.1 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 190.7 MINUTES; OR 3.2 HOURS
GROSS APPLICATION (CG) = 2.49 INCHES
NET APPLICATION (CA) = 2.28 INCHES
RUNOFF (CR) = 0.81 INCHES
DEEP PERCOLATION (CDP) = 1.56 INCHES
EFFICIENCY (CE) = 41.56 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 1.12 in
Furrow Slope (C2) = 0.010 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 800 ft
Furrow Intake Family (C5) = 0.50
Inflow Rate (C6) = 3.5 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 6. Field 6, beans.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 0.895 FEET/FOOT
FURROW SLOPE (CS) = 2.50 FEET
FURROW SPACING (CU) = 500 FEET
FURROW LENGTH (CL) = 1.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 315.2 MINUTES; OR 5.3 HOURS
GROSS APPLICATION (CG) = 3.88 INCHES
NET APPLICATION (CA) = 2.81 INCHES
RUNOFF (CR) = 0.29 INCHES
DEEP PERCOLATION (CDP) = 1.32 INCHES
EFFICIENCY (CE) = 47.48 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 1.96 in
Furrow Slope (C2) = 0.005 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 600 ft
Furrow Intake Family (C5) = 0.50
Inflow Rate (C6) = 4.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

```

Figure 7. Field 7, potatoes.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 2.19 INCHES
FURROW SLOPE (CS) = 0.010 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 450 FEET
INFLOW RATE (CQ) = 3.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 92.2 MINUTES; OR 1.5 HOURS
GROSS APPLICATION (CG) = 3.50 INCHES
NET APPLICATION (CA) = 3.18 INCHES
RUNOFF (CR) = 0.19 INCHES
DEEP PERCOLATION (CDP) = 1.22 INCHES
EFFICIENCY (CE) = 58.95 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 2.19 in
Furrow Slope (C2) = 0.010 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 450 ft
Furrow Intake Family (C5) = 0.55
Inflow Rate (C6) = 3.5 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 8. Field 8a, grain.

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FURROW.EXE
INTAKE FAMILY (IF) = 0.55
DESIGN APPLICATION (CA) = 2.24 INCHES
FURROW SLOPE (CS) = 0.010 FEET/FOOT
FURROW SPACING (CU) = 2.50 FEET
FURROW LENGTH (CL) = 450 FEET
INFLOW RATE (CQ) = 3.0 GPM/FURROW
APPLICATION TIME (CT) = 12 HOURS

ADVANCE TIME (CT) = 109.0 MINUTES; OR 1.8 HOURS
GROSS APPLICATION (CG) = 3.88 INCHES
NET APPLICATION (CA) = 2.80 INCHES
RUNOFF (CR) = 0.81 INCHES
DEEP PERCOLATION (CDP) = 0.81 INCHES
EFFICIENCY (CE) = 72.79 %

TO CHANGE: PRESS (EXISTING)
Design Application (C1) = 2.24 in
Furrow Slope (C2) = 0.010 ft/ft
Furrow Spacing (C3) = 2.50 ft
Furrow Length (C4) = 450 ft
Furrow Intake Family (C5) = 0.50
Inflow Rate (C6) = 3.0 gpm/furrow
Inflow Time (C7) = 12 hours (ANALYSIS MODE)

TO PRINT: DATA/WITH HEADING PRESS (B/?)
NEW DESIGN PRESS (10), NEW ANALYSIS PRESS (11), QUIT PRESS (12)?

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Figure 9. Field 8b, grain.