Water Reuse in Idaho

Winter 2014-15

This is the second edition of the Idaho Department of Environmental Quality (DEQ) Water Reuse quarterly newsletter. We hope you will find it useful and we welcome your input and comments for future editions. Contact your regional office if you have any questions.

An electronic version of this newsletter is available under "DEQ Resources" at: *www.deq.idaho.gov/permitting/water-quality-permitting/wastewater-reuse.aspx*.

The e-version provides access to the hot links included in the newsletter.

Water Reuse News

IWR – Irrigation Water Requirement

The IWR is one of the most important factors in managing crops. Irrigation at the crop-specific IWR is vital to maintaining a healthy crop and maximizing the yield potential.

Reuse permits for slow rate land application (crop production) require facilities to apply recycled water and supplemental irrigation water in amounts that meet the crop need based on local climate and the amount of water a crop needs as it grows from a seedling to full maturity and harvest.

The attached document, *Reuse Permits: Irrigation Water Requirement*, provides recommendations on how a facility can determine site- and crop-specific IWRs and how DEQ determines compliance with this important permit limit.

Indirect and Direct Potable Reuse

The link below has several videos on this topic: http://nwri-usa.org/directpotable.htm.

The first is by Jeffery Mosher, National Water Research Institute Executive Director, and the second is by George Tchobanoglous of the University of California Davis, a well-known author in the water reuse field.

Throughout the United States, communities are already reusing recycled water. "De facto" indirect potable reuse occurs when a community draws water from a river or stream that includes recycled water discharged from upstream communities.

De facto reuse is particularly pronounced in dry periods, when natural water supplies are reduced and recycled water makes up a larger proportion of the water flow.

For example, in Idaho, the wastewater treatment plant (WWTP) discharge rate to the Snake River from three major urban areas (Idaho Falls, Pocatello, and Twin Falls) averages approximately 25 million gallons per day or 38.7 cubic feet per second (cfs).

The Snake River during low flow conditions (winter) at American Falls and Twin Falls is often in the 300 to 500 cfs range. During these low flow conditions, the WWTP discharge from these three urban areas alone is about 10% of the river flow.

FDA Food Safety Modernization Act (FSMA)

Proposed rules under the FSMA are still under development. The sections that may impact water reuse facilities are (1) waste solids management and (2) irrigation water used to grow food crops for direct consumption.

Find detailed information at *www.fda.gov/food/guidanceregulation/fsma/default*.

In addition, there are several articles on the use of compost and manure on this website that may be of interest.

Growing Alfalfa at Your Reuse Site and Nitrogen Considerations

There are several advantages of growing alfalfa:

- It can consume large amounts of water and nutrients.
- It has a long growing season, which allows a longer season to apply recycled water.
- It has a deep rooting structure, which allows a "deeper" soil treatment zone.
- It is a perennial crop that doesn't have to be planted each year.

However, there are some factors to consider when growing alfalfa.

Alfalfa is a legume crop, which means it can use nitrogen from the air to meet some or all of its nutrient requirements in a process called fixation. Learn more at *http://aces.nmsu.edu/pubs/_a/A129/*.

Nitrogen provided in recycled water is preferentially used by legumes, but some amount of fixation will still occur. Any nitrogen created by fixation will reduce the amount the alfalfa will use from the recycled water.

In addition, if alfalfa does utilize nitrogen from fixation, the alfalfa roots will form nodules that contain large amounts of ammonia nitrogen. If the alfalfa is removed from the crop rotation and tilled in, these nodules can supply a significant amount of nitrogen for the next year's crop.

Photo of alfalfa nodules from *http://www.bti.umn.edu/nasnfc/program.php*

These factors should be evaluated in cropping plans as they may reduce the amount of nitrogen required from your recycled water.

Soils Information

One of the key factors in determining site suitability for land application of recycled water is the types of soil present in the reuse fields.

Soils information for locations in Idaho can be found on the USDA Natural Resources Conservation Service website at *http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx*.

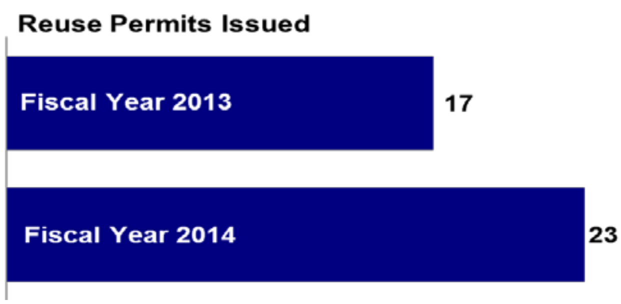
Click on the help tab and instructions are provided on how to access soil data for your area.

What's New at DEQ

- New staff working in Water Reuse
  – Tami Golightly, Administrative Assistant, Wastewater Program Office
  – Wendy Waudby, P.E., Staff Engineer, Boise Regional Office

- Guidance for reuse at forest sites has been developed.
- Permit application forms were updated in 2014. The forms include checklists for plan of operation and technical report content.
- Facilities with exemplary compliance history may qualify for extended permit terms. The Recycled Water Rules were revised in 2011 to allow up to **10-year permit terms**.
- The *Wastewater Land Application Operators Study and Reference Manual* for reuse systems was updated in 2014. It is located at: *www.deq.idaho.gov/media/1117548/ww-land-application-operators-study-reference-manual.pdf*

Idaho Reuse Highlights



- In 2013, 7.7 billion gallons of recycled water containing over 4 million pounds of nitrogen and 1 million pounds of phosphorus were reused.
- DEQ staff completed 61 inspections and 100 annual report reviews in 2014.

Regional Office Reuse Permit Coordinators

- Coeur d'Alene: Matt Plaisted, P.E., 666-4622
- Lewiston: Nicolas Hiebert, P.E., 799-4886
- Boise: Valerie Greear, P.E., 373-0459
- Twin Falls: Jerimiah "JJ" Fenton, E.I., 736-2190
- Pocatello: Scott MacDonald, E.I., 239-5018
- Idaho Falls: Tom Rackow, P.E., 528-2650

State Office Contacts

- Chas Ariss, P.E., Wastewater Engineering Manager, Water Quality Division, 373-0561
- Paul Wakagawa, P.E., Water Reuse Permit Coordinator, 373-0514
- Tami Golightly, Administrative Assistant, 373-0409

Water Reuse Permits in Idaho

Permit search tool: *www.deq.idaho.gov/permitting/issued-permits.aspx?records=10&type=Wastewater+Reuse&sort=effectiveDescending*

Information on municipal wastewater collection and treatment system classification can be found at: *www.deq.idaho.gov/water-quality/wastewater/pwws-classification-licensure/system-classifications*

Training Calendar

Environmental conferences, trainings, and workshops hosted by DEQ can be found at: *www.deq.idaho.gov/assistance-resources/conferences-trainings*

***Funding Agency Training for Water and Wastewater Projects*:** This training will be offered in March and April 2015. *www.deq.idaho.gov/assistance-resources/conferences-trainings/funding-agency-training*

2015 Water Reuse Conference

Reserve the date! The conference will be held May 27–28: *www.deq.idaho.gov/assistance-resources/conferences-trainings/2015-water-reuse-conference*

Reuse Permits: Irrigation Water Requirement

What is the IWR?

The irrigation water requirement (IWR) is any combination of recycled water and supplemental irrigation water applied in the quantity, or depth, required to produce the desired crop yield and quality. The IWR is growing-season specific and takes into account the irrigation efficiency of your system. These values are typically based on long-term averaged weather and are dependent on your local climate and the crop you are growing.

Adjustments to the IWR values may be necessary based on actual weather conditions during a given year. Unusually hot and dry weather conditions may require applying more than the IWR values to maintain crop health. Conversely, abnormally wet and cooler conditions would require use less than the IWR values.

The IWR values are useful for irrigation scheduling. For example, the IWR values can be used for planning the amount of recycled water and supplemental irrigation water that will be applied on a monthly basis throughout the growing season. They are not meant to be exact limits as discussed below.

How does DEQ use IWR in reuse permits?

Reuse permits for slow rate land application have limits on the amount of recycled water and supplemental irrigation that can be applied for the crop being grown, taking the local weather conditions into account.

The specific wording for the growing season hydraulic permit limit is to apply water *"substantially at the irrigation water requirement"* for the crop being grown. This gives you the flexibility to adjust irrigation rates to meet crop requirements based on actual weather conditions. It is not an exact limit and DEQ expects there will be variation from these values. The important point is that when variations do occur, they are made to maintain a healthy crop and are based on the weather conditions that occur at your site.

How is the IWR determined?

The IWR values can be calculated in different ways using local meteorological data and crop water use data. As discussed above, IWR values are "targets" based on historical weather conditions. DEQ recommends using long-term averaged weather data in calculating the IWR.

The following website has been developed by the University of Idaho and is public domain for use in planning water requirements for agriculture throughout Idaho: http://data.kimberly.uidaho.edu/ETIdaho/. There are 126 weather stations throughout Idaho that provide the required data to calculate the IWR. DEQ recommends using this resource to calculate your IWR values. Alternative methods and the resulting IWR values must be reviewed and approved by DEQ.

The following example outlines the procedure for calculating the IWR for growing alfalfa in Buhl, Idaho, using this website.

1. From the above website, choose Buhl – NWS from the drop-down list and click on "Submit Query" (see Slide 1).

2. A new page will load that shows information for the Buhl – NWS weather station (Slide 2). On this page, choose Alfalfa - frequent cuttings in the selection box.

3. A new page will load that shows information for growing "Alfalfa – frequent cuttings" in Buhl (Slide 3). Statistics on six types of water consumption parameters are provided for this station and land cover (crop type):

   a) Actual evapotranspiration
   b) Potential evapotranspiration
   c) Basal evapotranspiration
   d) Precipitation deficit (i.e., net irrigation water requirement)
   e) Effective precipitation (within the root zone) used for supporting transpiration and evaporation
   f) Effective precipitation (within the root zone) used only for transpiration

   To calculate IWR, click on precipitation deficit (P_{def}). P_{def} is the net amount of irrigation water (recycled water + supplemental irrigation water) required to grow this crop, taking into account the amount of precipitation that is received. The data are displayed in table form (Slide 4).

   Notes:

   - The values shown are the net amount of irrigation water required on a monthly basis. Depending on the type of irrigation equipment used, only a percentage of the water applied will be available to the crop. For example, a low pressure center pivot may be 85% efficient while a stationary big gun sprinkler may only be 60% efficient. The net amount of irrigation water is divided by the irrigation efficiency to determine the gross amount of water that is required. This is the target amount of recycled water plus supplemental irrigation water to apply for each month of the growing season.
   - For calculating the IWR, use the mean monthly values. The values shown are in millimeters/day and need to be converted to inches/month (see step 4 below).
   - The typical growing season for most reuse permits is March through October, although it may be shorter in cooler areas that receive more precipitation. IWR values will be calculated for each of these months and the sum of the values for the growing season will be the annual hydraulic loading limit.
   - The graphical presentation illustrates how the net irrigation water requirement varies throughout the growing season (Slide 5).

4. How to convert the data provided in Slide 4 into IWR values in inches per month.
   a. Highlight the portion of the table including the mean monthly values and copy into an excel spreadsheet.
   b. Convert the millimeters/day values into inches/month for the growing season months. Multiply the millimeters/day values by the number of days in the month and then multiply by 0.03937 to convert millimeters to inches.
   c. For example, the May P_{def} value is 4.79 mm/day. Convert to inches/month:
   = 4.79 millimeters/day × 31 days/month × 0.03937 inches/millimeter
   = 5.85 inches/month (for May)
   d. Convert the P_{def} values to IWR values by dividing by the efficiency of your irrigation system (in this example assume 85% efficiency). For the month of May:
   = 5.85 inches/month ÷ 0.85
   = 6.88 inches/month

e. A screen shot of the excel spreadsheet showing all of the calculations is shown below:

Alfalfa - frequent cuttings													
Precipitation Deficit (Click here for a graph)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Growing Season
Mean	mm/day												mm
Monthly	-0.21	0.05	0.23	2.48	4.79	4.66	5.68	4.9	3.81	1.94	0.17	-0.29	878
Days/mo:			31	30	31	30	31	31	30	31			
	P_{def} in inches/month												inches
Monthly			0.28	2.93	5.85	5.50	6.93	5.98	4.50	2.37			34.34
Assume a low pressure, center pivot with an irrigation efficiency of 85%. Divide the Pdef values by 0.85 to calulate the monthly IWR values													
	IWR in inches/month												inches
Monthly			0.33	3.45	6.88	6.48	8.16	7.04	5.29	2.79			40.40

In this example, the data copied from the website into the excel spreadsheet is highlighted in red. The calculated monthly and annual P_{def} and IWR values are highlighted in green.

The annual growing season value is 40.4 inches. You can plan on applying approximately that amount of recycled + supplemental irrigation water for growing alfalfa in the Buhl area. The monthly IWR values provide target values based on the typical weather conditions for Buhl.

Remember, these IWR values are only valid in the vicinity of the weather station for the crop grown and the efficiency of your irrigation equipment. IWR values will have to be generated for each type of crop you are raising and each type of irrigation delivery system you are using. Typical irrigation efficiency values can be found on page 4-79 of the DEQ Reuse Guidance manual: www.deq.idaho.gov/media/516329-guidance_reuse_0907.pdf. Your irrigation system provider may be able to provide efficiency values for the specific type of equipment you are using.

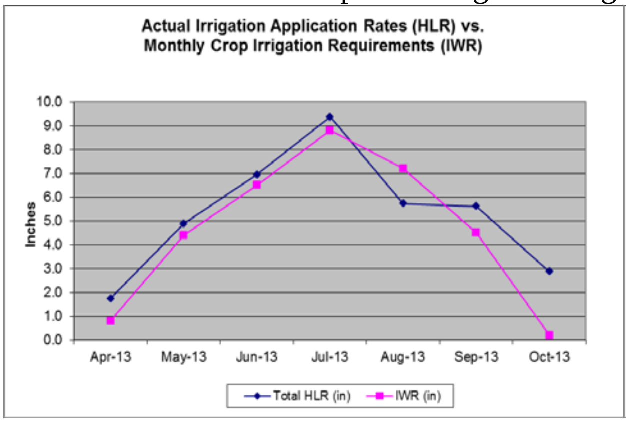
Now that we have IWR values, what should we do with them?

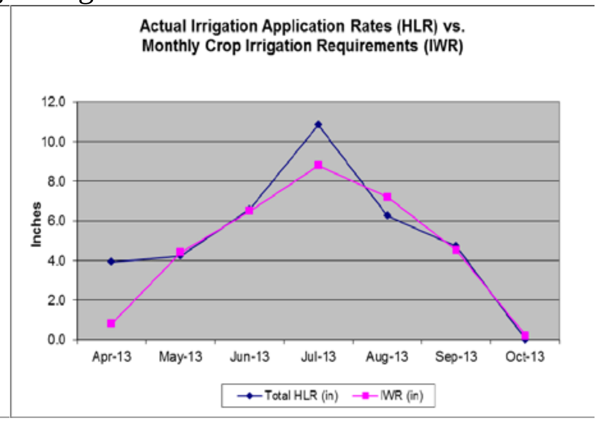
IWR values are a key part of your irrigation management plans. Along with your cropping plan, you can estimate the amount of irrigation water that will be required during the growing season.

With that information, you can decide how to divide up the recycled water you have available between the reuse fields and what volume of supplemental irrigation water, if any, that will be required to meet your crop requirements.

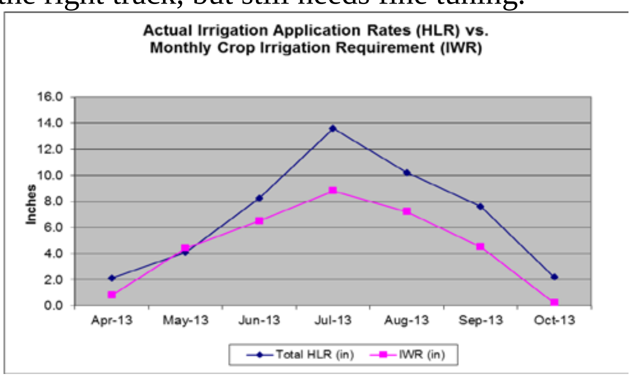
The following graphs show IWR values versus the actual amount of water applied (recycled water + supplemental irrigation water, referred to as the hydraulic loading rate or HLR). The data in these graphs are from actual reuse facilities operating in Idaho.

The following are some examples of good irrigation practices. The HLR shown in blue generally matches the IWR values in pink throughout the growing season.

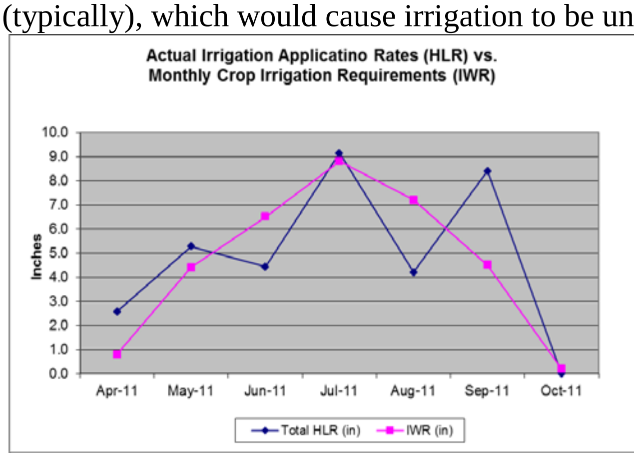




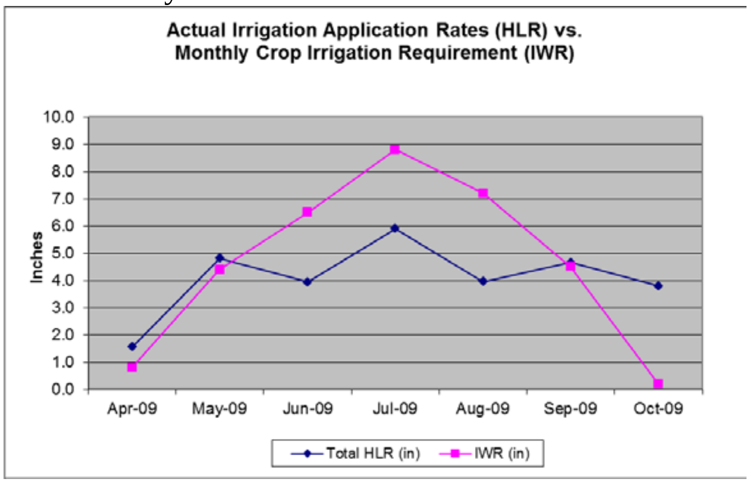
In this example, the HLR generally trends with the IWR values, but too much water was applied in various months. For example, in July, the IWR value was ~9 inches of water and almost 14 inches was applied. Even if it was hotter and drier than normal, that is probably too much water. This system is on the right track, but still needs fine tuning.



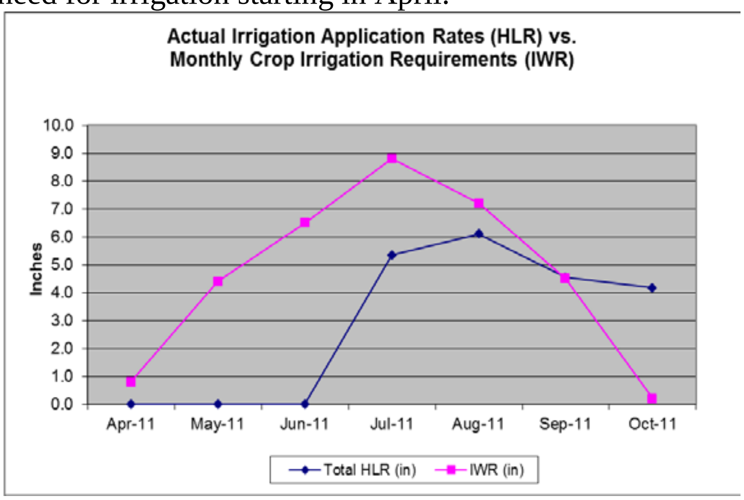
The following example may reflect growing alfalfa. The dips in HLR are when the alfalfa is harvested. The time period to swath, rake and dry, bale, and remove bales from the field takes 7 to 10 days (typically), which would cause irrigation to be under the IWR during those months.



In this example, irrigation rates were not managed properly. Irrigation rates from May to October were fairly constant, in the 4 to 6 inch/month range, instead of tracking with the IWR, which peaked at 9 inches in July.



In this example, irrigation was not started until June, but the IWR for the crop being grown shows a need for irrigation starting in April.



ET_{Idaho} 2012 -- Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho

Please send suggestions for improving this site to robison at kimberly dot uidaho dot edu *Copyright 2012, University of Idaho.*

This ET_{Idaho} web site provides estimates of Evapotranspiration (ET), net irrigation requirement (NIR), and effective precipitation supporting transpiration and evaporation (PEff) estimates for areas in Idaho. These calculations and web site were produced in 2007 and were updated in 2009 and 2012. ET calculation procedures employ a modern reference equation (ASCE standardized Penman-Monteith method) and a modern procedure to calculate crop coefficients that considers the impact of surface wetting by irrigation and precipitation on total evaporation from the soil surface. ET is provided for daily, monthly, and annual timesteps for 125 weather station locations across Idaho. In addition to ET and NIR estimates for agricultural crops grown in Idaho, ET estimates are available for a number of native plant systems (wetlands, rangelands, and riparian areas) and open water surfaces. The ET and NIR estimates are intended for use in design and management of irrigation systems, for water rights management and consumptive water right transfers, and for hydrologic studies. ET estimates are available for all times during the calendar year to provide information for land application design, operation, and management of waste streams from agriculture, food processing and other sources during the nongrowing periods.

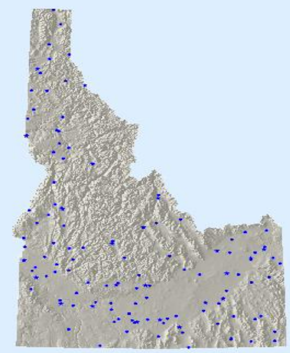
These dynamic web pages allow you to access historical ET data for the State of Idaho at various locations. Currently, the data are based on 109 NWS cooperative weather stations, 16 AgriMet stations and 1 special pseudo station (combination of a NOAA, ARS, and Agrimet site) stations located in predominately agricultural areas through out the state.

Find and explore the summary data for stations and land covers:

Click on this link to locate stations by county or

Please select a station from the following list:

Aberdeen -- AgriMet
Aberdeen Experiment Station -- NWS
Afton -- AgriMet
American Falls 1 SW -- NWS
Anderson Dam -- NWS
Arbon 2 NW -- NWS
Arco -- NWS
Arrowrock Dam -- NWS
Ashton -- NWS
Ashton -- AgriMet
Bayview Model Basin -- NWS
Blackfoot -- NWS
Bliss -- NWS
Boise 7 N -- NWS
Boise WSFO Airport -- NWS
Bonners Ferry -- NWS
Brownlee Dam -- NWS
Bruneau -- NWS
Buhl -- NWS
Burley FAA AP -- NWS



Submit Reset

Techincal Reports and other information:
A pdf copy of the 2007 report submitted to IDWR, *Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho, Research Technical Completion Report* including the 2009 supplement is available for download here. The 2009 supplemental report covers the modifications, changes, and enhancements in computing evapotranspiration and is located at the end of the report pdf.

These estimates for evapotranspiration, precipitation deficit, and effective precipitation superceed the previous versions of ET_{Idaho} web sites 2009 and 2007. For historical purposes those estimates have been archived and are available by special request.

Changes from the 2009 ET_{Idaho} Dataset:
Evapotranspiration and net irrigation water requirement estimates were produced by the University of Idaho in 2009 through December 2008. These estimates were recomputed in 2012 and updated through December 2010. ET is provided for daily, monthly and annual timesteps for 125 weather station locations across Idaho for complete, available periods of record. Thirty year normals have been updated to the end of 2010 (if 2010 was an active year of data collection for the station). To support calculations of ET, the complete National Weather Service Cooperative station database for Idaho stations was re-downloaded from the National Climate Data Center (NCDC) site so that some previous 'holes' in daily time series were filled in for some stations.

Slight changes in the logic of computing precipitation deficit were implemented in the 2012 update. The partitioning of evaporation into that supported by precipitation and by irrigation was modified to better distribute evaporation when both irrigation and a concurrent and/or recent rain event occured.

Minor coding errors discovered in the calculation routines were corrected in 2009. These coding errors included a correction to the statistics program to preclude calculated deep percolation from irrigation from going negative, but to allow effective precipitation to be negative on some days to account for delayed deep percolation of precipitation. In the primary ET calculation code, management of crop startup was modified to consistently calculate the correct estimated date of greenup or planting. Some resetting of variables at the start of a new crop was done and an error in estimating deep percolation from very shallow rooting depths in coarse soils was corrected (this did not occur often).

Additionally, effective precipitation for supporting transpiration and evaporation was partitioned for growing season, non-growing season, and annual time periods. For the annual time series, additional parameters have been included in the output to assist in the quantification of effective precipitation used in evapotranspiration during the growing and non-growing seasons. Also, estimates of non-growing season precipitation stored in the root zone and later used in the growing season are presented.

This work and report were prepared by the University of Idaho Research and Extension Center at Kimberly, Idaho under contract with the Idaho Department of Water Resources. Work was supported by funding from IDWR and the Idaho Agricultural Experiment Station and Idaho Engineering Experiment Station. The authors gratefully acknowledge the long-term evapotranspiration data collection and long-standing advice provided by Dr. James L. Wright, USDA-ARS Kimberly (ret.), the more than two decades of high quality agricultural weather data collection by the U.S. Bureau of Reclamation AgriMet system, and the very long-standing, routine data collection by the hundreds of cooperative weather station volunteers across the state who, for more than one-hundred years, have faithfully observed daily air temperature and precipitation.

The citation for the evapotranspiration data used from this site should be: *Allen, Richard G. and Clarence W. Robison, 2012.* ***Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho: Supplement updating the Time Series through December 2008****, Research Technical Completion Report, Kimberly Research and Extension Center, University of Idaho, Moscow, ID.*

Questions regarding the data should be addressed to Clarence W. Robison or Richard G. Allen, University of Idaho, Kimberly Research and Extension Center, 3793 North 3600 East, Kimberly, ID 83341. Telephone (208)-423-6610

University of Idaho
A LEGACY OF LEADING

ETIdaho web site powered by Debian, Apache, Firebird DBMS, Python, with matplotlib, and kinterbasdb.

Slide 1

ET*Idaho* 2012 -- Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho

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Buhl

Station Type: NWS	Station Identifier: 101217	County: Twin Falls
Latitude: 42° 36' North	Longitude: 114° 46' West	Elevation: 3760
Start: Jan 1907	Stop: Dec 1963	Years with data: 44
Statistical summaries based on thirty year normal spans 1955 to 2010		
Wind Characterization from Twin Falls AgriMet		
Neighboring stations based on Thiessen polygons for NWS stations -- Jerome -- Hagerman 2 SW -- Castleford 2 N -- Hollister -- Twin Falls WSO --		
Remarks: Record ended in 3/1963. Data from Buhl 2 (101220) 1/1978 to present appended.		
Special Data Summaries		
Alfalfa Reference ET	30 Day Mean Temperature	Gross Precipitation
Land Covers with Evapotranspiration Estimates Managed land covers (crops) are assumed to be irrigated for this station unless otherwise specified.		
Alfalfa - peak (no cutting effects)	Garden Vegetables - general	Mustard
Alfalfa - frequent cuttings	Carrots	Asparagus
Alfalfa - less frequent cuttings	Onions	Bare Soil
Grass Hay	Melons	Mulched soil, including grain stubble
Snap and Dry Beans - fresh	Grapes - wine	Dormant Turf (winter time)
Snap and Dry Beans - seed	Alfalfa - seed	Range Grasses - early short season
Field Corn - moderate season length	Garden Peas - fresh	Range Grasses - long season
Silage Corn - truncated season	Garden Peas - seed	Range Grasses - bromegrass
Sweet Corn - early plant	Potatoes - processing (early harvest)	Sage Brush
Sweet Corn - late plant	Potatoes - cold pack (late harvest)	Wetlands - large stands
Spring Grain - Irrigated	Sugar Beets	Wetlands - narrow stands
Winter Grain - Irrigated	Mint	Cottonwoods
Grass Pasture - high management	Poplar Trees (third year and older)	Willows
Grass Pasture - low management	Sunflower - Irrigated	Open water - shallow systems (ponds, streams)
Grass - Turf (lawns) - Irrigated	Safflower - Irrigated	Open water - deep systems (lakes, reservoirs)
Orchards - Apples and Cherries w/ ground cover	Canola	Open water - small stock ponds
Orchards - Apples and Cherries no ground cover		
ASCII flat file datasets for downloading		
Daily Time Series · Monthly Time Series · Annual Time Series · Statistical Summaries · All datasets		

Generate and download a time series spreadsheet for specific landcover(s) represented at this location.

Series Selection
- ● Annual Series
- ○ Monthly Series
- ○ Daily Series

Landcovers to include

Alfalfa - peak (no cutting effects)
Alfalfa - frequent cuttings
Alfalfa - less frequent cuttings
Grass Hay
Snap and Dry Beans - fresh
Snap and Dry Beans - seed
Field Corn - moderate season length
Silage Corn - truncated season
Sweet Corn - early plant
Sweet Corn - late plant
Spring Grain - Irrigated
Winter Grain - Irrigated
Grass Pasture - high management
Grass Pasture - low management
Grass - Turf (lawns) - Irrigated

NOTE

Use the ctrl and/or shift keys to select multiple landcovers.

Due to limitations on streaming the spreadsheet, only the first two land covers selected will be retrieved for daily series requests when the time frame is greater than five years.

Time Frame (yyyy-mm-dd)

Start: 1907-01-01

Stop: 2010-12-31

Reset   Download XLS file

This work and report were prepared by the University of Idaho Research and Extension Center at Kimberly, Idaho under contract with the Idaho Department of Water Resources. Work was supported by funding from IDWR and the Idaho Agricultural Experiment Station and Idaho Engineering Experiment Station. The authors gratefully acknowledge the long-term evapotranspiration data collection and long-standing advice provided by Dr. James L. Wright, USDA-ARS Kimberly (ret.), the more than two decades of high quality agricultural weather data collection by the U.S. Bureau of Reclamation AgriMet system, and the very long-standing, routine data collection by the hundreds of cooperative weather station volunteers across the state who, for more than one-hundred years, have faithfully observed daily air temperature and precipitation.

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Slide 2

ET_{Idaho} 2012 -- Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho

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Buhl (NWS -- 101217)

for

Alfalfa - frequent cuttings

Statistics on six types of of water consumption parameters were produced for this station and land cover (crop type):

a) actual evapotranspiration;
b) potential evapotranspiration;
c) basal evapotranspiration;
d) precipitation deficit (i.e., net irrigation water requirement);
e) effective precipitation (within the root zone) used for supporting transpiration and evaporation; and
f) effective precipitation (within the root zone) used only for transpiration.

Click the link in the definition below to select a 'topic group' that meets your needs for summary statistics.

The actual daily ET_c (ET_{act}) represents the total estimated flux of ET given any reduction in potential ET caused by soil water shortage or soil surface dryness. ET_{act} was computed as $ET_{act} = K_s * ET_{bas} + K_e ET_r$ where K_s is a stress factor (0 – 1 where 1 means no stress), K_e is the evaporation coefficient and ET_r is the alfalfa reference ET. ET_{bas} is defined below. ET_{act} was often less than potential ET (ET_{pot}) for rainfed crops and occasionally for irrigated crops prior to the growing season when a low-level, basal crop coefficient assigned to the nongrowing season cover could not be sustained by precipitation, and, therefore, the actual ET, in the form of mostly evaporation, could not be sustained at the ET_{pot} level. On occasion, ET_{act} fell below ET_{pot} early in the growing season prior to initiation of irrigation for the same reasons. ET_{act} includes evaporation from the soil surface from both precipitation and any simulated irrigation. ET_{act} is generally the most appropriate ET parameter to use for formulating estimates of consumptive use of irrigation water for hydrologic studies.

The potential daily ET_c (ET_{pot}) represents the total estimated flux of ET that would occur if there were no moisture stress imposed by soil water shortage in the 'root zone.' ET_{pot} includes evaporation from the soil surface from both precipitation and any simulated irrigation. ET_{pot} was computed as $ET_{pot} = ET_{bas} + K_e * ET_r$.

The basal ET (ET_{bas}) represents the ET that would occur under no water stress and with no surface wetting by precipitation or irrigation. In other words, ET_{bas} represents potential ET for a dry soil surface. ET_{bas} should not be used to estimate irrigation water requirements, and is included to provide an indication of the partitioning of ET_{pot} between 'transpiration,' as represented by ET_{bas} and evaporation of water from the soil surface layer. (K_{cb})

The precipitation deficit (P_{def}) is the difference between the potential ET (ET_{pot}) and the amount of precipitation infiltration and residing in the root zone. In essence, P_{def}, is the amount of additional precipitation needed to fully support ET_{pot}. P_{def} was calculated as $ET_{pot} - P_{rz}$ where P_{rz} is the precipitation infiltrating into and residing in the root zone. P_{def} is synonymous with the ***net irrigation water requirement*** when occurring during the growing season for an irrigated crop. P_{def} represents the amount of additional water that the crop would evaporate or transpire beyond P_{rz} if that water were made available at the right time during the growing season. Because the ET_{pot} estimate only includes soil evaporation for known precipitation and irrigation events, any additions of P_{def} outside of the simulated growing season would tend to increase ET_{pot} and thus P_{def} to some extent, causing a type of positive feedback process. The precipitation deficit is generally the most appropriate "ET" parameter to use for irrigation system design.

The effective precipitation residing with in the root zone used for transpiration and evaporation represents the precipitation that enters the root zone and is used in supplying transpiration from the vegetation and evaporation from the soil at some point in time after the precipitation event.

The effective precipitation residing within the root zone used for transpiration represents the precipitation that enters the root zone and is used in supplying transpiration by the vegetation, only, and not used by surface evaporation at some point in time after the precipitation event.

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ETIdaho web site powered by Debian, Apache, Firebird DBMS, Python, with matplotlib, and kinterbasdb.

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ET*Idaho* 2012 -- Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho

Buhl (NWS -- 101217)

Statistics based on thirty year normal spans 1955 to 2010 years

For a different land cover or crop click on the above link.
You can highlight this table and copy via the clipboard to a Mircosoft Excel or OpenOffice spreadsheet to plot or otherwise work with this data.

Alfalfa - frequent cuttings
Precipitation Deficit (Click here for a graph)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Growing Season[a]	Non Growing Season[b]	Annual
Mean[j]	mm/day												mm		
Monthly[c]	-0.21	0.05	0.23	2.48	4.79	4.66	5.68	4.90	3.81	1.94	0.17	-0.29	878	-15	872
15-Day Moving Average[d]	-0.26	0.02	0.20	2.49	4.98	4.55	5.68	4.88	3.88	1.93	0.10	-0.31			
7-Day Moving Average[e]	-0.25	0.03	0.21	2.48	4.90	4.60	5.64	4.89	3.83	1.95	0.10	-0.32			
3-Day Moving Average[f]	-0.22	0.05	0.22	2.50	4.82	4.65	5.68	4.90	3.82	1.94	0.15	-0.30			
Standard Deviation[k]	mm/day												mm		
Monthly[c]	0.65	0.28	0.65	1.27	1.29	1.15	0.65	0.81	0.85	1.27	0.61	0.71	101	21	103
15-Day Moving Average[d]	0.66	0.46	0.58	1.39	1.38	1.79	1.33	1.26	1.37	1.12	0.85	0.71			
7-Day Moving Average[e]	0.93	0.72	0.80	1.76	1.95	2.31	1.94	1.71	1.73	1.52	1.18	0.97			
3-Day Moving Average[f]	1.27	1.10	1.29	2.27	2.60	2.76	2.24	2.04	2.11	2.05	1.71	1.29			
20% Exceedance[l]	mm/day												mm		
Monthly[c]	0.08	0.27	0.54	3.25	5.51	5.44	6.01	5.31	4.59	2.67	0.66	0.04	963	-2	960
15-Day Moving Average[d]	0.40	0.53	1.00	4.14	7.04	7.70	7.85	6.72	5.56	3.81	1.44	0.30			
7-Day Moving Average[e]	0.79	0.96	1.72	5.98	7.90	8.42	8.51	7.41	6.52	4.65	1.95	0.82			
3-Day Moving Average[f]	1.17	1.64	2.60	6.82	9.12	9.38	9.04	8.14	7.05	5.36	2.48	1.12			
80% Exceedance[m]	mm/day												mm		
Monthly[c]	-0.71	-0.11	-0.09	1.22	3.77	3.76	5.28	4.42	3.03	1.10	-0.30	-0.61	784	-27	783
15-Day Moving Average[d]	-1.25	-0.64	-0.37	0.21	2.78	2.14	3.66	2.84	1.51	0.40	-1.06	-1.20			
7-Day Moving Average[e]	-2.62	-1.39	-1.62	-0.28	0.33	1.10	2.09	1.76	0.30	-0.90	-2.49	-2.82			
3-Day Moving Average[f]	-5.06	-3.32	-4.06	-2.40	-2.94	-1.77	1.32	1.10	-1.09	-4.49	-4.64	-4.80			
Ave Highest P_{def}	mm/day												--		
15-Day Moving Average[g]	0.26	0.37	0.73	3.44	6.24	6.00	7.26	6.13	4.90	2.79	0.80	0.19			
7-Day Moving Average[h]	0.57	0.89	1.31	4.49	7.32	7.40	7.94	6.99	5.81	3.77	1.38	0.51			
3-Day Moving Average[i]	0.85	1.41	2.11	5.61	8.37	8.28	8.62	7.71	6.45	4.46	2.01	0.77			
Ave Lowest P_{def}	mm/day												--		
15-Day Moving Average[g]	-0.67	-0.32	-0.22	1.60	3.53	3.10	4.05	3.48	2.71	1.13	-0.47	-0.74			
7-Day Moving Average[h]	-1.42	-1.00	-0.85	0.60	1.92	1.68	2.43	2.12	1.57	0.05	-1.33	-1.51			
3-Day Moving Average[i]	-2.90	-2.24	-2.47	-1.27	-0.33	-0.03	1.74	1.42	-0.01	-1.88	-3.05	-2.82			
Special normal distribution parameters for monthly, seasonal, and annual intervals															
Skew[n]	-0.50	-2.26	0.34	0.53	-0.15	-0.38	-0.32	-0.26	-0.66	0.02	-0.04	-0.73	0.24	-0.73	-0.13
Kurtosis[o]	1.04	10.03	1.03	2.61	0.68	2.73	0.85	0.91	3.64	0.58	3.16	2.08	2.24	4.64	2.88

[a] Growing Season: This is usually the time from green up or planting in the spring to a killing frost or harvest in the fall. It is not applicable for entries without a growing season and will be blank.

[b] Nongrowing Season: This is usually the time from a killing frost or harvest in the fall to the of green up in the spring. It is not applicable for entries without a growing season.

[c] Mean of the average daily value for month

[d] Mean of the fourteen 15-day period averages contained in the month

[e] Mean of the twenty three 7-day period averages contained in the month

[f] Mean of the twenty seven 3-day period averages contained in the month

[g] Mean of the highest/lowest 15-day period average in month

[h] Mean of the highest/lowest 7-day period average in month

[i] Mean of the highest/lowest 3-day period average in month

[j] This value represents the *mean value* for the parameter for the month over the 'normal' period of record. Generally, the 'normal' period is the last thirty years with data.

[k] This value represents the *standard deviation* for the parameter for the month over the 'normal' period.

[l] This value represents the *value* for the parameter that has a 20% chance of being exceeded that month durning any particular year. Conversely, there is an 80% chance that the parameter value will be less than the *value* shown.

[m] This value represents the *value* for the parameter that has a 80% chance of being exceeded that month durning any particular year. Conversely, there is an 20% chance that the parameter value will be less than the *value* shown.

[n] This value represents the *skewness (asymmetry) of the distribution of the parameter values* for the month (year) over the 'normal' period. A value near zero indicates that the distribution approximates a normal (Gaussian) and symmetrical distribution. A negative skew indicates that the parameter distribution has relatively few low values compared to high values. A positive skew indicates that the distribution has relatively few high values compared to the number of low values. A skew value near 1 indicates that the underlying distribution approximates a lognormal distribution.

[o] This value represents the *kurtosis* of the parameter value distribution for the month (year) over the 'normal' period. Kurtosis is a measurement of the height to width ratio of the probability distribution, or the *peakedness (slenderness)*. A normal (Gaussian) distribution has a kurtosis of 3. A high kurtosis distribution has a sharper peak and longer tails, while a low kurtosis distribution has a more rounded peak and shorter tails.

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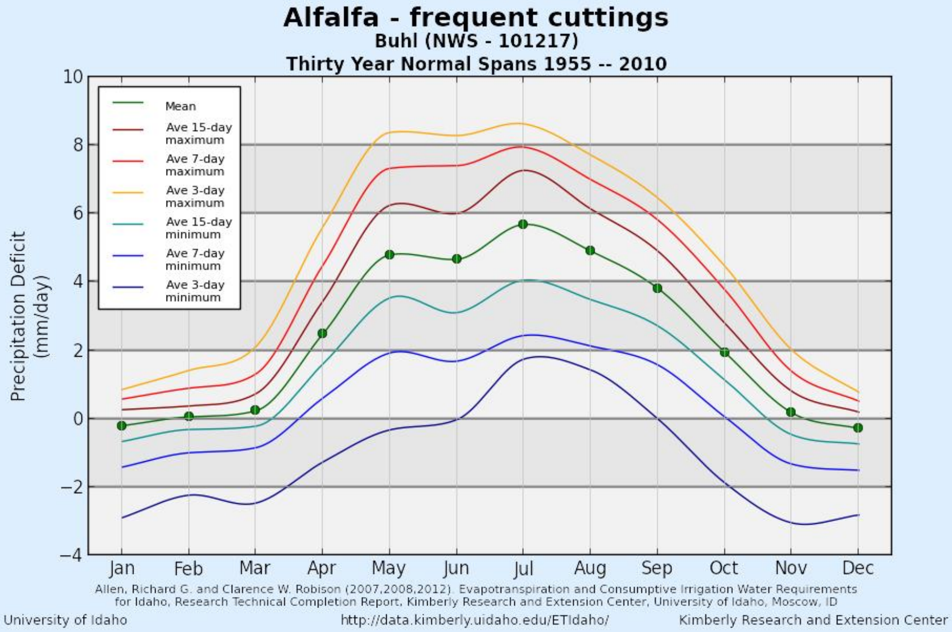

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