11.3 Aldasoro Ranch HOC irrigation and water use study

DATE: SEPTEMBER 22, 1995

PURPOSE: ALDASORO RANCH IRRIGATION WATER USE STUDY

FROM MATT MITCHELL:

The purpose of this study is to determine the amount of irrigation water which should be allotted for each single family lot within the Aldasoro Ranch. The amount of irrigation water will directly relate to the Aldasoro Ranch Water Use Calculations (Exhibit WU-l) and precipitation rates for Telluride, Colorado (Exhibit WU-2).

The irrigation system has been broken into three categories;
1.) Turf grass with 4" (pop ups)
2.) Trees (drip irrigation)
3.) Perennial beds (12" pop ups or emitter)

Using the Aldasoro Ranch Water Use Calculations (Exhibit WU-l) the water tank was sized for 20,660 gal. /day for irrigation.
20,660 gallons/day divided by 160 lots = 129.125 gallons/day/lot
-or-129.125 x 30 days = 3,873.75 gallons/month/lot

Therefore the water tank was designed for each single family lot to use 3,873.75 gallons per month for irrigation. Now, we can break down the individual categories to come up with a combination of these which will comply with our use calculations month for irrigation.

CATEGORY ONE - Turf Sod (4" pop ups)

What we are trying to determine is the water use rate for turf grass in Telluride. Water use rate is defined as the total amount of water lost by transpiration and evaporation from soil and plant surfaces. The water use rate of most turf grass is 0.1-0.3 inches per day or 0.7-2.1 inches per week. It has been determined by studies that turf grass in the Telluride area requires approximately 1.5 inches per week per square foot. Knowing this, we can use the average precipitation rates from Exhibit WU-2 to determine the amount of water we receive naturally and how much water per square foot we need to supplement with irrigation.

PLEASE FIND THE REST OF THE WATER USE STUDY AND WATER USE CALCULATIONS AT THE OFFICE AT
307 SOCIETY DRIVE, UNIT C
TELLURIDE, COLORADO 81435

THANKYOU

WATER REQUIREMENTS FOR TURF GRASS IN TELLURIDE

MONTH	Average inches of Precipitation	Inches a month needed	Inches needed to irrigate SQ. Ft./Mo	@500 Sq. Ft Gal/MO	750 Sq. FT Gal/MO	1,000 Sq. FT Gal/MO	1500 Sq. FT Gal/MO
		1.5X4=6					
MAY	1.81	6 INCHES	4.19	2095	3142.5	4190	6285
JUNE	1.23	6 INCHES	4.77	2385	3577.5	4770	7155
JULY	2.48	6 INCHES	3.52	1760	2640	3520	5280
AUGUST							
SEPT.	2.93	6 INCHES	3.07	1535	2302.5	3070	4605
OCT.	1.96	6 INCHES	4.04	2020	3030	4040	6060
AVERAGE 5%			4.13	2065	3097.5	4130	6195

NOTE: These are +/- numbers due to different evaporation pattern rates, growth rates, turf grass species or cultivation soil conditions, and intensity of culture

Due to evaporation and transpiration of the turf grass in the hottest months (July and August) it will require more water. With this in mind I have taken the average amount of irrigation water needed and added 5% for evaporation and transpiration. This has given us a good summer average allowing more water during the hotter months. (Monthly temperatures can be seen on Exhibit B.)This allows homeowners to set their irrigation system once for the summer and not have to reprogram every month.

CATEGORY TWO- Trees and Shrubs (drip irrigation)

Trees and shrubs outside irrigated (turf grass) areas will need irrigated with a drip irrigation system. The amount of water needed for trees and shrubs is determined with the gallons/plant/day formula (Exhibit WU-3) found in the Rain Bird Drip Irrigation Design Manual. These numbers were confirmed with different nurseries and landscapers in the area. The numbers seem to work very well for most trees and shrubs. Aspens trees, due to their root structure, need more water for the first two growing seasons. (* See note below)

SPRUCE TREES- 6 TO 12 FEET	ROOT BALL BEING 3'X3'
	FACTORS:
.783 GALLONS/DAY	PLANT AREA = (3^2 X 7854)X7.0686
	CLIMATE FACTOR = .20
23.49 GALLONS/MONTH	DRIP EFFICIENCY = .90

ASPEN TREES AFTER FIRST TWO GROWING SEASONS	
	FACTORS
	MATURE TRESS= .80
	PLANT AREA = 22 X .7854
10.44/MONTH	CLIMATE FACTOR = .20

**NOTE:* For the first two months growing season, these Aspens will need about 24 gallons a month.

FIVE GALLON SHRUBS	
.623X.7854X1X.2	FACTORS
	SHRUB = 1.0
	PLANT AREA = (1^2X.7854)=.7854
.109/DAY	CLIMATE FACTOR = .20
3.27 GALLONS/MONTH	DRIP EFFICIENCY = .90

Using prices of trees from Deep Creek Landscaping listed below, I have calculated examples of gallons/month usage for different combinations.

SPRUCE TREES:

6-8 FOOT TREES	$34.00/FOOT
10-12 FOOT TREES	$45.00/FOOT

ASPEN TREES

1.5 INCH TREES	$150.00/TREE
2 INCH TREES	$200.00/TREE

WATER USAGE-PER TREES-PER DOLLAR

DESCRIPTION	$5000.00	NUMBER OF TREES	WATER/ MONTH
All 10-12 Ft. Spruce	111.10 Ft	11	258.39
All 1.5 foot Aspen		33	775.17
All 8 Ft Spruce	147.Ft	18	431.80
All 2 inch Aspen		25	587.25
¼ - 10 Ft Spruce	27.78 Ft.	3	70
¼ - - 8 Ft Spruce	36.76 Ft.	4	93.96
1/4 -1.5 In Aspen		8	195.75
¼ - 2 In Aspen		6	146.81
TOTAL		21	506.25

DESCRIPTION	$10,000.00	NUMBER OF TREES	WATER/MONTH
All 10-12 Ft Spruce	222.2 Ft.	22	516.78
All 1.5 Ft Aspen		66	1550.34
All 8 Ft Spruce	294 Ft.	37	863.6
All 2In. Aspen		50	1,174.5
1/4 -10 Ft. Spruce	55.56 Ft.	5	117.45
¼ -8 Ft. Spruce	73.52 Ft.	9	215.87
¼ 1.5 In Aspen		17	391.5
¼ In. Aspen		13	293.63
TOTAL		44	1,018.45

WATER USAGE-PER TREES-PER DOLLAR
Continued

DESCRIPTION	$20,000.00	NUMBER OF TREES	WATER/ MONTH
All 10-12 Ft Spruce	444.4 Ft.		
All 1.5 Ft Aspen			
All 8 Ft Spruce	588 Ft.		
All 2In. Aspen			
1/4 -10 Ft. Spruce	111.12 Ft.		
¼ -8 Ft. Spruce	147.04 Ft.		
¼ 1.5 In Aspen			
¼ In. Aspen			
TOTAL			

DESCRIPTION	$30,000.00	NUMBER OF TREES	WATER/ MONTH
All 10-12 Ft Spruce	666.6 Ft.	66	1,550.34
All 1.5 Ft Aspen		198	4,651.02
All 8 Ft Spruce	882.4 Ft.	110	2,590.9
All 2In. Aspen		100	3,523.5
1/4 -10 Ft. Spruce	166.68 Ft.	17	399.33
¼ -8 Ft. Spruce	220.56 Ft.	27	647.62
¼ 1.5 In Aspen		50	1,174.5
¼ In. Aspen		38	880.88
TOTAL		132	3,102.33

WATER USAGE-PER TREES-PER DOLLAR

Continued

DESCRIPTION	$50,000.00	NUMBER OF TREES	WATER/ MONTH
All 10-12 Ft Spruce	1,111.1 Ft	111	2,607.30
All 1.5 Ft Aspen		330	7,751.70
All 8 Ft Spruce	1,471 Ft.	184	4,318.00
All 2In. Aspen		250	5,872.50
1/4 -10 Ft. Spruce	277.8 Ft.	28	657.72
¼ -8 Ft. Spruce	367.6 Ft.	46	1,079.37
¼ 1.5 In Aspen		83	1,957.50
¼ In. Aspen		63	1,468.13
TOTAL		220	5,162.72

CATEGORY THREE – PERENNIAL BEDS

It was much more difficult to determine the amount of water needed per square foot of a perennial bed due to the evaporation and transpiration rates. Since perennials grow tall and have greater surface area (stems, leaves, flowers, etc.) evaporation and transpiration is more likely to occur. Therefore, even though during the months of July and August, Telluride receives more precipitation, temperatures are higher, thus evaporation and transpiration rates are proportionately higher. (See Exhibit WU-2) This atmospheric condition requires more water for perennial's during these months. By interviewing landscapers, irrigation specialists an nurseries it has been determined that even with the different precipitation rates per month, perennial beds in the Telluride area basically use a constant amount of water throughout the summer. Through many calculations is has been determined that the constant amount is approximately 0.63 gallons/sq. ft./week or 2.52 gallons/sq. ft./month. The following chart for perennial bed water use is based on this number

	PERENNIAL	BED	WATER	USAGE
Amount of water/Month	250 Sq. Ft Gal./Mo	500 Sq. Ft. Gal/Mo.	750 Sq. Ft. Gal/Mo.	1,000 Sq. Ft. Gal/Mo.
2.52/Sq. Ft.	630 Gal./Mo.	1,260 Gal./Mo.	1,870 Gal./Mo.	2,520 Gal./Mo.

SUMMARY

This date has been gathered from many sources. The only thing that has been constant from all is that there are too many variables to come up with "the answer" and all numbers are "rough estimates", at best; nevertheless these numbers are definitely good enough for what we are using them for. It must be remembered that it will require more water to establish the landscaping. (Four weeks for turf grass and first growing season for perennial beds and trees.) This study has also left out the watering of any revegetation. No matter what we determine, the irrigation water use will be directly affected by irrigation design and the programming of the system. Who decides when the landscaping is established and the water can be backed off? Once again the variables exceed the answers. From this information, we should also be able to come up with a solution.

RECOMMENDATION

Our water system has been designed so that each single family may use 16.713 gallons of water per month. This design is for 12,839 gallons per month for domestic use and 3,873 gallons per month for irrigation use. If a family uses more for irrigation and less for domestic use and the total is less than or equal to the 16,713.00 gallons, no extra charge should be billed. At any time when a family uses more than 16,713 gallons per month, they should be billed at some fee per gallon on top of their monthly water bill (e.g. 10 cents/gallon). We should make homeowners aware of this and let them know it is their responsibility to let their landscaping architect design accordingly. If they would like to, they could use our recommendations, which are listed below, based on the irrigation water use study:

1) Sod not be required
2) Strongly suggest Xeriscaping landscaping to homeowners and landscaping architects
3) Limit sod to 750 sq. feet
4) Reduce tree escrows not to exceed $15,000
5) Allow 7,750 gallons of irrigation water, in addition to the 4,000 gallons per month, for the first 2 months (for irrigating revegitation and extra water for sod and perennials
6) Sample landscape vegetation plan:

500 sq. ft. of sod	**2,065 gal / month**
$10,000.00 tree escrow:	
¼ 10 ft. Spruce	
¼ 8 ft. Spruce	**1,018 gal / month**
¼ 1.5' Aspens	
¼ 2' Aspens	
250 sq. ft. perennial beds	**630 gal / month**
TOTAL	**3,713 gal / month**

CONCLUSION

We should strongly urge homeowners not to exceed the 16,713 gals/month. If they do so they will be charged on a per gallon basis. We need to let them know that irrigation is what will place the greatest demand on the system. Therefore, they need to stress the importance of this to their landscape architect. This irrigation system study will be available to the homeowners and landscape architects so they can estimate the amount of water they are planning to use.

EXIHIBIT WU-1

Date: September 8, 1994
To: Dick dePagter
From: Nancy Hild
RE: Aldasoro Ranch Water Use Calculations

the following parameters were used for the sizing of the Aldasoro water tank and water system. These parameters were based on the San Miguel County Land Use Code in effect at that time and a letter from Wright Water Engineers, Inc. dated February 9, 1990.

For purpose of sizing the water distribution system, a population equivalent of 4 capita per single family dwelling unit and 1.5 capita per accessory-affordable housing unit was used.

Irrigation was based on 3000. Square foot of coverage per dwelling unit at 12" per year applied during the months of May through October.

The club house calculation utilized a 60 person restaurant consuming 35 gallons per day per seat and 300 visitors per day consuming 20 gallon per day per visitor. Irrigation for the club house was based on 6000 square feet of coverage with 12" of water applied during the months of May through October. This information was taken from the Wright Water letter referenced above.

According to the Land Use Code, the system shall be sized hydraulically for a maximum day plus fire demands or peak hour, whichever is greater. Maximum day demand may be assumed as 3.0 times average day demand, and maximum hour demand may assumed to be 6.0 times average day demand. The fire demands used for the site were based on a population of 251-1000 people on the system utilizing 1000 gallons per minute for 4 hour duration.

System Design:

Single family Dwelling Units (75 GPD/Capita) (5.5 Capita per single family and Accessory unit) (166 units)

= 68,475 Gallons per Day

EXHIBIT WU-1 Continued:

Irrigation Demand:

300 SF per individual lot
600 SF at club house
12" irrigation per year total – May –October = 6 months

(166 lots)(3000SF)(12') = 498,000 CF
(1 Clubhouse)(600SF)(12") = 6,000 CF
TOTAL = 504,000 CF

(504,000 CF)(7.48 Gal/CF)/182.5 days per 6 months =20,660 GPD

Clubhouse:

60 seat restaurant@35 GPD/seat÷300 visitors per day @20GPD
= 8,100 GPD

Total Usage:

Single Family	68,475GPD
Irrigation	20,660GPD
Clubhouse	8,100GPD
Demand in Gallons per day	97,235 GPD

Maximum Demands:

Maximum Day Demand plus Fire Demand
291,705 GPD ÷ (100/gal/min) (4HRS) (60min/hr.)
=291,705 Gallons ÷240,000 Gallons
=531,705 Gallon Tank

The tank built at the Aldasoro Ranch was 550,000 gallon tank.

The Aldasoro Ranch is currently analyzing irrigation parameters to be implemented in the design phase of the Landscape Plans for each individual lot.

Should you need further information please don't hesitate to ask.

EXIHIBIT WU-2

Taps Station: Telluride, 8204
Start year – 1901 end year 1988

	TEMPERATURE			2 years in 10 will have			PRECIPITATION	2years in 10 will have	
MONTH	Avg daily max	Avg daily min	Avg	Max temp. > than	Min temp < than	Avg no. of grown degree days	Avg (in)	Less than (in.)	More than (in.)	Avg # of days with 0.10 in. or more
January	37.8	6.1	21.9	55	-22	**5**	1.64	0.69	2.44	5
February	39.7	8.5	24.1	57	-19	0	1.73	0.84	2.50	5
March	43.1	13.8	284	62	-12	3	2.26	1.19	3.20	7
April	51.8	22.4	37.1	69	-0	46	2.25	1.16	3.20	6+0.60
May	61.5	29.7	45.6	76	14	198	1.81	0.90	2.59	5-1.48
June	72.2	35.5	53.8	85	23	419	1.23	0.37	1.99	3-3.15
July	76.7	41.5	59.1	87	30	593	2.48	1.51	3.36	8-3.05
August	74.2	40.6	57.4	86	29	542	2.93	1.49	4.18	8-2.52
September	68.9	34.2	51.5	82	19	349	2.02	0.68	3.11	5-1.84
October	59.2	25.6	42.4	76	6	125	1.96	0.79	3.00	4-0.01
November	48.8	15.	30.9	66	-10	8	1.50	0.75	2.15	4
December	38.4	7.5	23.0	56	-18	0	1.63	0.67	2.44	5
								6.9	18.52	
								-11.33		
Yearly:									ok	
Average	55.9	23.4	39.6							
Extreme	96	-36		88	-26					
Total						2290	23.44	15.75	28.47	**65**

*A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for principal crops in the area (threshold: 40.0 deg. F)

Provided by the Colorado State University Extension Service U.S. Dept. of Agriculture

EXIHIBIT WU-3
SECTION 4

HOW DO I DETERMINE HOW MUCH WATER TO APPLY?

There's a gallon per plant per day formula that delights college mathematics majors, challenges determined agricultural specialist and terrorizes those of us that squeaked through high school algebra. However, this formula can be brought to its knees with a few simple tables and pocket calculator.

The formula looks like this:

Gallons
Per Plant =
Per Day

But I prefer

$$\text{Daily Gallons} = \frac{.623 \times \text{ROOT ZONE AREA} \times \text{TYPE OF TREE} \times \text{P.E.T}}{\text{DRIP EFFICENCY FOR CLIMATE}}$$

If you have your field data concerning the job site, the following pieces to this puzzle fall together easily.
The constant of.623 is a conversion factor that reconciles the plant area which is in square feet, the P.E.T. which is in inches per day, with gallons of water which is part of the answer we are after. If you're really interested, here's how that number came up.
One cubic foot of water equals 7.48 gallons (someone measured). If you take a one inch deep off this cube you have one square foot of area and one square inch of water depth and .623 gallons of water

EXHIBIT WU-3
Continued:

For the climate variable in the formula, if you don't have the precise P.E.T rate for your area, table "A" below has the information necessary to help you select a ballpark figure. P.E.T stands for potential evaporation-transpiration. Evapo-transpiration is defined as the loss of water from the soil both by evaporation and transpiration from plants growing thereon. Table "A" shows this potential range in inches per day for various climate types.

TABLE "A" P.E.T

Climate	Inches Daily
Cool Humid	.10-.15
Cool Dry	.15-.20
Warm Humid	.15-.20
Warm Dry	.20-.25
Hot Humid	.20-.30
Hot Dry	.30-.45

"Cool" equals less than 70 degrees F as an average midsummer high.
"Warm" equals between 70 degrees and 90 degrees F as midsummer highs.
"Hot" equals over 90 degrees F.
"Humid" equals over 50% as midsummer relative humidity (Dry is under 50%)

I recommend using the worst case column of numbers for your climate type. When you plug the worst case number into the formula you are automatically adjusting your water requirements answer to accommodate the hottest, driest part of the year.

In appendix B you will also find a list of selected U.S. cities and their average Evapo-transpiration rate per day for midsummer. If one of the listed cities happens to be the location of your project look up the E.T. number and determine which range it is on Table "A". Then use the P.E.T number from the top of this range, the: "worst case" condition, as your P.E.T. number for the formula.

You may have to decide which range of numbers is appropriate to your climate type if your number fits into two ranges with differing "worst case" figures.

For example, the .30 rate for Las Vegas Nevada and its desert climate is really the .30 at the bottom of the "hot dry" scale not the.30 "Hot Humid," the worst case number to use for Las Vegas is .45 inches per day. It is not unusual for Las Vegas to occasionally rate an above average midsummer E.T. of .37 inches per day. As you can see a "worst case" in that climate (.45) still provides a margin of safety.

Remember, if your drip irrigation system is most efficient in midwinter when it's off, adequate in spring and fails miserably during peak moisture use in midsummer, you have designed for the "worst" case conditions.

EXHIBIT WU-3
Continued:

"Plant Area" for the formula is simply a way of accounting for the size of the plant in your calculation. For individual plants and trees that are not in regular spacing pattern use the drip line (outside edges of the plants canopy) in determining the plant area. The illustration below shows how to calculate the square feet.

D
r
i
p

l
i
n
e

D
r
i
p

l
i
n
e

Plant area

_____Diameter_____

Step 1. Measure the diameter of the canopy of the plant from one edge of the drip line across to the opposite edge.
Step 2. Multiply the diameter measurement times itself (diameter squared).
Step 3. Multiply your previous answer by .7854 and you have the plant area number in square feet. It's just calculation the area of a circle. (You can use πR^2 if you like. For example, a 15 foot diameter tree calculation would be: 15'x15'x.7854=176.71 square feet.

For plants in regular, close spacing's patterns like a shrub mass use the area between plants as shown in the next page

EXHIBIT WU-3
Continued:

4'
Plant 4'
Area

(4'x4'=16 square feet of plant area). In a design for a new project that does not have existing plant material, remember to use the estimated mature sizes of the plants for the plant area numbers.

Unlike the closely watched and tended agricultural drip irrigation systems, no one usually adds elements to a landscape system later on to adjust for maturing plants. That's why table "B" below is such a short table of factors, its plant factors is for mature plant material only.

Plant factors for gallons per plant per day formula provide adjustments of water required for different plant types. Instead of the individual agricultural crop factors listed in the RAIN BIRD INTERNATIONAL DRIP IRRIGATION DESIGN MANUAL, table"B" below simply list general factors for "tree", "shrub", and "vine".

TABLE B PLANT FACTOR

For the occasional fruit tree here are a few extra factors:
Apples, Cherries, Walnuts (mature trees) .85
Peaches, Plums, Apricots, Almonds, Pecans &Pears (mature trees) .75
Citrus (mature trees).

EXHIBIT WU-3
Continued:

As you can see from the table and fruit tree factor examples, a landscape or ornamental tree will be close to the .80 general factor. The 1.0 factor for shrubs means that unless we know the plant factor for a particular shrub, we are not factoring back or reducing the expected water requirements from 100% level.

A warning note concerning existing plant material is appropriate here. If you have a plant that is thriving on your project site without any irrigation, even in midsummer, you could possible damage or kill it through irrigation. I've seen it happen on landscape irrigation projects particularly in arid climates. A large native tree area may be surrounded by a new lawn area and sprinkler system. The water to maintain the turf overwaters the tree and so ends the life of a one-hundred year old climatic veteran.

The final variable in the formula for gallons per plant per day is the divisor used for the efficiency of drip irrigation systems. No irrigation system is 100% efficient. A 100% efficient system would be one where every drop of water delivered is used by the plant.

Irrigation efficiency then is defined as the percentage of irrigation water available for consumptive use by the plant material.

If, for example, you had a high-flow rate emitter, on tight clay soil, producing a nine foot diameter puddle on the surface, you couldn't expect a very high efficiency rating.

EXHIBIT WU-4

DRIP IRRIGATION EFFICIENCY :

Climate	Decimal Equivalent

Note: "Moderate" refers to the cool but dry climates.

At about this point in a drip design seminar a question usually comes up similar to this one. "You have used the highest number for P.E.T, the higher factors for plant type, and further bumped up the gallons by efficiency factors. I thought drip irrigation".

The answer to this question is through system control. You design for mature plant material, but that's for a few years down the road. You designed for midsummer water use, but what about other seasons?

The reduced application, for plant immaturity or cooler seasonal water requirements, is an operational or maintenance responsibility. Any reductions from peak water use and availability are accomplished through the controls of the delivery system. Irrigation time is the main means of controlling the amount of water delivered.

The controller (automatic irrigation timer) for the system requires some adjustment to tailor the delivery of water to the requirements. It may be switched off in winter, switched on with adjusted time for spring and adjusted once again for hot dry weather.

Some of today's modern controllers not only time in hours for drip systems, but have water budgeting for reducing or adding time in percentage increments.

From your knowledge of the project site, landscape plan and local climate you are now ready to use the preceding tables to determine the water requirements for your plant materials. Here's an example of the G/P/D formula applied.

Problem: what are the daily water requirements for a 15' diameter tree in a warm, dry climate?

The Factors

Mature Tree = .80

Plant area 15x15x.7854 = 176.71 sq. ft.

Climate factor worst case = .25

Drip efficiency for warm dry area = .85

The Formula

$\frac{.623 \times 176.71 \times .80 \times .25}{.85}$ **= reduced with your calculator to:** = 25.9 or 26 gal per day peak **use.**

EXAMPLE NUMBER TWO:

What are the daily water requirements in a hot region for a plant area in a shrub bed where the plants are spaced three feet on center in a square pattern?

The Factors

Shrub = 10

Plant area 3'x3'=9 square feet

Climate factor worst case = .30

Drip efficiency (humid) = .95

The Formula:

Reduced to: = 1.77 gallons per plant area per day, worst case

In the drip system design process you would figure up the water requirements for all the various types of plants on the project and have that information ready for your next step selecting the number of emitters per area.