BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
OF THE STATE OF WYOMING

IN THE MATTER OF THE APPEAL OF CLABAUGH RANCH, INC. FROM WYPDES PERMIT NO. WY0049697	))))	Docket No. 08-3802

DOCUMENTS SUBMITTED IN OPPOSITION TO LANCE OIL AND GAS COMPANY'S MOTION FOR SUMMARY JUDGMENT

In addition to the documents submitted by Clabaugh Ranch, Inc. in support of its motion for summary judgment, Clabaugh Ranch, Inc. submits the following documents in opposition to Lance's motion for summary judgment:

1. Deposition Exhibit 4
2. Deposition Exhibit 5
3. Deposition Exhibit 6
4. Deposition Exhibit 8
5. Deposition Exhibit 10
6. Deposition Exhibit 11
7. Deposition Exhibit 16
8. Deposition Exhibit 24
9. Deposition Exhibit 25
10. Deposition Exhibit 28
11. Deposition Exhibit 29
12. Deposition Exhibit 32
13. Deposition Exhibit 34

14. Deposition Exhibit 44

15. Unsigned Affidavit of Jason Thomas

16. Munn Deposition excerpts

17. William P. Maycock's Motion for Expedited Hearing in Docket No. 06-3818

Dated this 29th day of July, 2009.

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Certificate of Service

I certify that on the 29th day of July, 2009, I served a true and correct copy of the foregoing by depositing the same in the U.S. Mail, postage prepaid and addressed to:

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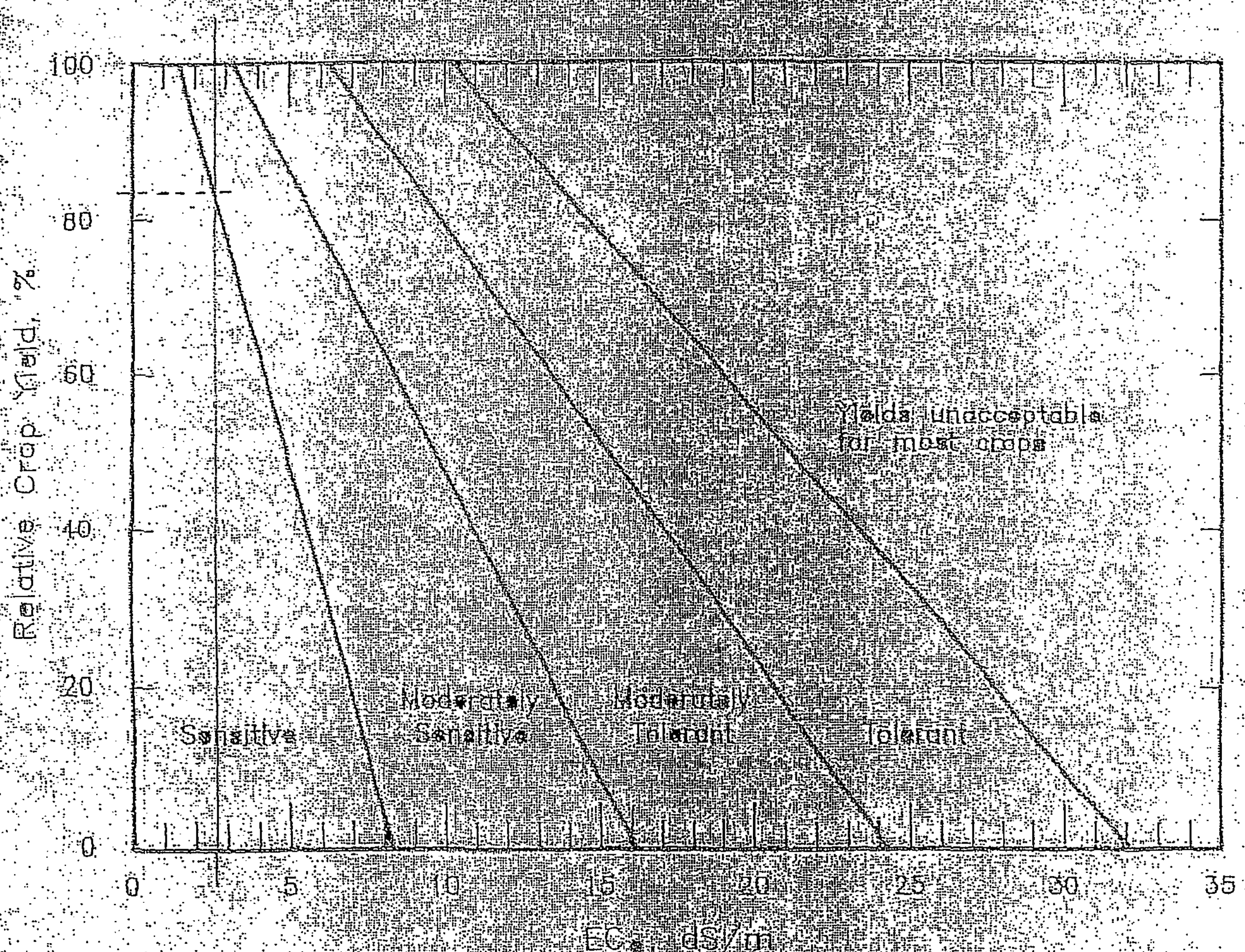

Fig. 13.3 Divisions for Classifying Crop Tolerance to Salinity

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Table 1. Salt tolerance of herbaceous crops — Fiber, grain and special crops.

Crop	*Threshold Salinity (A)*	*Slope (B)*	*Rating**
Barley	8.0	5.0	T
Bean	1.0	19.0	S
Broad bean	1.6	9.6	MS
Corn	1.7	12.0	MS
Cotton	7.7	5.2	T
Cowpea	4.9	12.0	MT
Flax	1.7	12.0	MS
Guar	8.8	17.0	T
Kenaf			MT
Millet, foxtail			MS
Oats			MT
Peanut	3.2	29.0	MS
Rice, paddy	3.0**	12.0	S
Rye	11.4	10.8	T
Safflower			MT
Sesame			S
Sorghum	6.8	16.0	MT
Soybean	5.0	20.0	MT
Sugar beet	7.0	5.9	T
Sugarcane	1.7	5.9	MS
Sunflower			MS
Tricale	6.1	2.5	T
Wheat	6.0	7.1	MT
Wheat (semi-dwarf)	8.6	3.0	T
Wheat, durum	5.9	3.8	T

Table 2. Salt tolerance of herbaceous crops — Grasses and forage crops.

Crop	*Threshold Salinity (A)*	*Slope (B)*	
Alfalfa	2.0	7.3	MS
Alkali grass, nuttall			T
Alkali sacaton			MT
Barley (forage)	6.0	7.1	MT
Bentgrass			MS
Bermuda grass	6.9	6.4	T
Bluestem, Angleton			MS
Brome, mountain			MT
Brome, smooth			MS
Buffelgrass			MS
Burnet			MS
Canary grass, reed			MT
Clover alsike	1.5	12.0	MS
Clover, Berseem	1.5	5.7	MS
Clover, Hubam			MT
Clover, ladino	1.5	12.0	MS
Clover, red	1.5	12.0	MS
Clover, strawberry	1.5	12.0	MS
Clover, sweet			MT
Clover, white Dutch			MS
Corn, forage	1.8	7.4	MS
Cowpea (forage)	2.5	11.0	MS

**S = sensitive; MS = moderately sensitive; MT = moderately tolerant, T = tolerant*
***Currently being re-examined*

Table 2. Salt tolerance of herbaceous crops — Grasses and forage crops (continued)

Crop	*Threshold Salinity (A)*	*Slope (B)*	*Rating**
Dallis grass			MS
Fescue, tall	3.9	5.3	MT
Fescue, meadow			MT
Foxtail, meadow	1.5	9.6	MS
Grama, blue			MS
Harding grass	4.6	7.6	MT
Kallar grass			T
Love grass	2.0	8.4	MS
Milkvetch, cicer			MS
Oat grass, tall			MS
Oats (forage)			MS
Orchard grass	1.5	6.2	MS
Panic grass, blue			MT
Rape			MT
Rescue grass			MT
Rhodes grass			MT
Rye (forage)			MS
Ryegrass, Italian			MT
Ryegrass, perennial	5.6	7.6	MT
Salt grass, desert			T
Sesbania	2.3	7.0	MS
Sirato			MS
Sphaerophysa	2.2	7.0	MS
Sundan grass	2.8	4.3	MT
Timothy			MS
Trefoil, big	2.3	19.0	MS
Trefoil, narrowleaf bird's foot	5.0	10.0	MT
Trefoil, broadleaf bird's foot			MT
Vetch, common	3.0	11.0	MS
Wheat (forage)	4.5	2.6	MT
Wheat, durum (forage)	2.1	2.5	MT
Wheat grass, standard crested	3.5	4.0	MT
Wheat grass, fairway crested	7.5	6.9	T
Wheat grass, intermediate			MT
Wheat grass, slender			MT
Wheat grass, tall	7.5	4.2	T
Wheat grass, western			MT
Wild rye, Altai			T
Wild rye, beardless	2.7	6.0	MT
Wild rye, Canadian			MT
Wild rye, Russian			T

**S = sensitive; MS = moderately sensitive; MT = moderately tolerant; T = tolerant*

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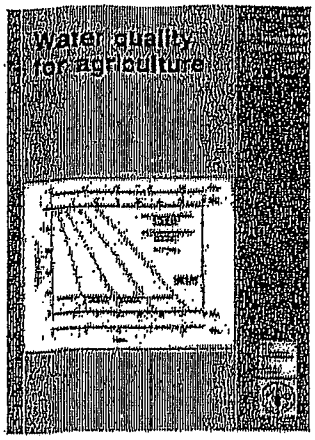

Water quality for agriculture

CONTENTS

Water quality for agriculture

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6 Semi-dwarf, short cultivars may be less tolerant.

7 Tolerance given is an average of several varieties; Suwannee and Coastal Bermuda grass are about 20 percent more tolerant, while Common and Greenfield Bermuda grass are about 20percent less tolerant.

8 Broadleaf Birdsfoot Trefoil seems less tolerant than Narrowleaf Birdsfoot Trefoil.

9 Tolerance given is an average for Boer, Wilman, Sand and Weeping Lovegrass; Lehman Lovegrass seems about 50 percent more tolerant.

10 These data are applicable when rootstocks are used that do not accumulate Na^+ and Cl^- rapidly or when these ions do not predominate in the soil. If either ions do, refer to the toxicity discussion in Section 4.

11 Tolerance evaluation is based on tree growth and not on yield.

Table 5 RELATIVE SALT TOLERANCE OF AGRICULTURAL CROPS[1], [2]

TOLERANT[3]	
Fibre, Seed and Sugar Crops	
Barley	*Hordeum vulgare*
Cotton	*Gossypium hirsutum*
Jojoba	*Simmondsia chinensis*
Sugarbeet	*Beta vulgaris*
Grasses and Forage Crops	
Alkali grass, Nuttall	*Puccinellia airoides*
Alkali sacaton	*Sporobolus airoides*
Bermuda grass	*Cynodon dactylon*
Kallar grass	*Diplachne fusca*
Saltgrass, desert	*Distichlis stricta*
Wheatgrass, fairway crested	*Agropyron cristatum*
Wheatgrass, tall	*Agropyron elongatum*
Wildrye, Altai	*Elymus angustus*
Wildrye, Russian	*Elymus junceus*
Vegetable Crops	
Asparagus	*Asparagus officinalis*
Fruit and Nut Crops	
Date palm	*Phoenix dactylifera*
MODERATELY TOLERANT[3]	
Fibre, Seed and Sugar Crops	
Cowpea	*Vigna unguiculata*
Oats	*Avena sativa*
Rye	*Secale cereale*
Safflower	*Carthamus tinctorius*
Sorghum	*Sorghum bicolor*
Soybean	*Glycine max*
Triticale	*X Triticosecale*
Wheat	*Triticum aestivum*

Wheat, Durum	*Triticum turgidum*
Grasses and Forage Crops	
Barley (forage)	*Hordeum vulgare*
Brome, mountain	*Bromus marginatus*
Canary grass, reed	*Phalaris arundinacea*
Clover, Hubam	*Melilotus alba*
Clover, sweet	*Melilotus*
Fescue, meadow	*Festuca pratensis*
Fescue, tall	*Festuca elatior*
Harding grass	*Phalaris tuberosa*
Panic grass, blue	*Panicum antidotale*
Rape	*Brassica napus*
Rescue grass	*Bromus unioloides*
Rhodes grass	*Chloris gayana*
Ryegrass, Italian	*Lolium italicum multiflorum*
Ryegrass, perennial	*Lolium perenne*
Sudan grass	*Sorghum sudanense*
Trefoil, narrowleaf	*Lotus corniculatus*
birdsfoot	*tenuifolium*
Trefoil, broadleaf	*Lotus corniculatus*
birdsfoot	*arvenis*
Wheat (forage)	*Triticum aestivum*
Wheatgrass,	*Agropyron sibiricum*
standard crested	
Wheatgrass, intermediate	*Agropyron intermedium*
Wheatgrass, slender	*Agropyron trachycaulum*
Wheatgrass, western	*Agropyron smithii*
Wildrye, beardless	*Elymus triticoides*
Wildrye, Canadian	*Elymus canadeneis*
Vegetable Crops	
Artichoke	*Helianthus tuberosus*
Beet, red	*Beta vulgaris*
Squash, zucchini	*Cucurbita pepo melopepo*
Fruit and Nut Crops	
Fig	*Ficus carica*
Jujube	*Ziziphus jujuba*
Olive	*Olea europaea*
Papaya	*Carica papaya*
Pineapple	*Ananas comosus*
Pomegranate	*Punica granatum*
MODERATELY SENSITIVE[3]	
Fibre, Seed and Sugar Crops	
Broadbean	*Vicia faba*

Castorbean	*Ricinus communis*
Maize	*Zea mays*
Flax	*Linum usitatissimum*
Millet, foxtail	*Setaria italica*
Groundnut/Peanut	*Arachis hypogaea*
Rice, paddy	*Oryza sativa*
Sugarcane	*Saccharum officinarum*
Sunflower	*Helianthus annuus*
<u>Grasses and Forage Crops</u>	
Alfalfa	*Medicago sativa*
Bentgrass	*Agrostis stolonifera palustris*
Bluestem, Angleton	*Dichanthium aristatum*
Brome, smooth	*Bromus inermis*
Buffelgrass	*Cenchrus ciliaris*
Burnet	*Poterium sanguisorba*
Clover, alsike	*Trifolium hydridum*
Clover, Berseem	*Trifolium alexandrinum*
Clover, ladino	*Trifolium repens*
Clover, red	*Trifolium pratense*
Clover, strawberry	*Trifolium fragiferum*
Clover, white Dutch	*Trifolium repens*
Corn (forage) (maize)	*Zea mays*
Cowpea (forage)	*Vigna unguiculata*
Dallis grass	*Paspalum dilatatum*
Foxtail, meadow	*Alopecurus pratensis*
Grama, blue	*Bouteloua gracilis*
Lovegrass	*Eragrostis sp.*
Milkvetch, Cicer	*Astragalus cicer*
Oatgrass, tall	*Arrhenatherum Danthonia,*
Oats (forage)	*Avena sativa*
Orchard grass	*Dactylis glomerata*
Rye (forage)	*Secale cereale*
Sesbania	*Sesbania exaltata*
Siratro	*Macroptilium atropurpureum*
Sphaerophysa	*Sphaerophysa salsula*
Timothy	*Phleum pratense*
Trefoil, big	*Lotus uliginosus*
Vetch, common	*Vicia angustifolia*
<u>Vegetable Crops</u>	
Broccoli	*Brassica oleracea botrytis*
Brussels sprouts	*B. oleracea gemmifera*
Cabbage	*B. oleracea capitata*
Cauliflower	*B. oleracea botrytis*

Celery	*Apium graveolens*
Corn, sweet	*Zea mays*
Cucumber	*Cucumis sativus*
Eggplant	*Solanum melongena esculentum*
Kale	*Brassica oleracea acephala*
Kohlrabi	*B. oleracea gongylode*
Lettuce	*Latuca sativa*
Muskmelon	*Cucumis melo*
Pepper	*Capsicum annuum*
Potato	*Solanum tuberosum*
Pumpkin	*Cucurbita peop pepo*
Radish	*Raphanus sativus*
Spinach	*Spinacia oleracea*
Squash, scallop	*Cucurbita pepo melopepo*
Sweet potato	*Ipomoea batatas*
Tomato	*Lycopersicon lycopersicum*
Turnip	*Brassica rapa*
Watermelon	*Citrullus lanatus*
Fruit and Nut Crops	
Grape	*Vitis sp.*
SENSITIVE[3]	
Fibre, Seed and Sugar Crops	
Bean	*Phaseolus vulgaris*
Guayule	*Parthenium argentatum*
Sesame	*Sesamum indicum*
Vegetable Crops	
Bean	*Phaseolus vulgaris*
Carrot	*Daucus carota*
Okra	*Abelmoschus esculentus*
Onion	*Allium cepa*
Parsnip	*Pastinaca sativa*
Fruit and Nut Crops	
Almond	*Prunus dulcis*
Apple	*Malus sylvestris*
Apricot	*Prunus armeniaca*
Avocado	*Persea americana*
Blackberry	*Rubus sp.*
Boysenberry	*Rubus ursinus*
Cherimoya	*Annona cherimola*
Cherry, sweet	*Prunus avium*
Cherry, sand	*Prunus besseyi*
Currant	*Ribes sp.*
Gooseberry	*Ribes sp.*

Grapefruit	*Citrus paradisi*
Lemon	*Citrus limon*
Lime	*Citrus aurantiifolia*
Loquat	*Eriobotrya japonica*
Mango	*Mangifera indica*
Orange	*Citrus sinensis*
Passion fruit	*Passiflora edulis*
Peach	*Prunus persica*
Pear	*Pyrus communis*
Persimmon	*Diospyros virginiana*
Plum: Prume	*Prunus domestica*
Pummelo	*Citrus maxima*
Raspberry	*Rubus idaeus*
Rose apple	*Syzygium jambos*
Sapote, white	*Casimiroa edulis*
Strawberry	*Fragaria sp.*
Tangerine	*Citrus reticulata*

[1] Data taken from Maas (1984).

[2] These data serve only as a guide to the relative tolerance among crops. Absolute tolerances vary with climate, soil conditions and cultural practices.

[3] The relative tolerance ratings are defined by the boundaries in Figure 10. Detailed tolerances can be found in Table 4 and Maas (1984).

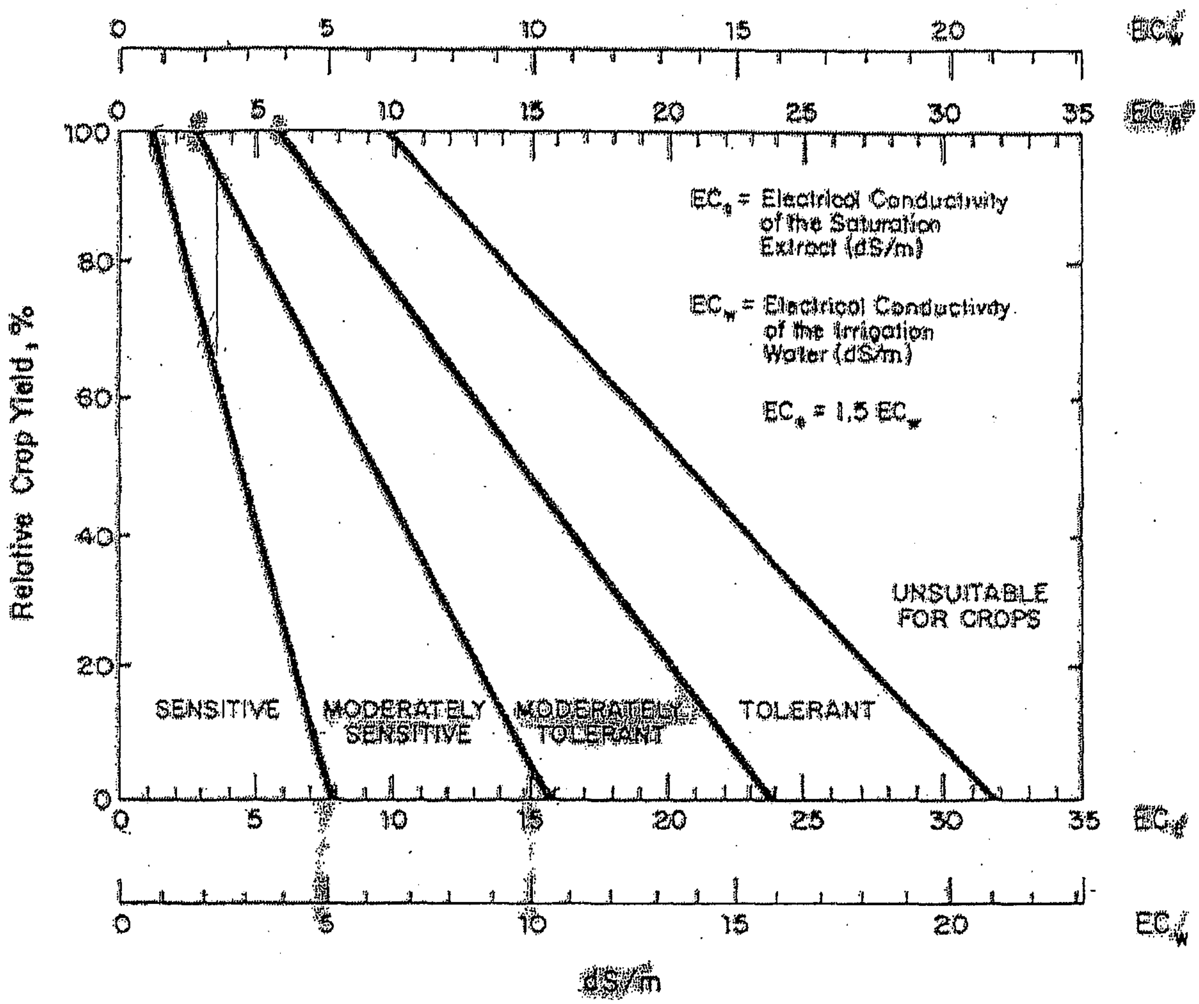


Fig. 10 Divisions for relative salt tolerance ratings of agricultural crops (Maas 1984)

i. Development of tolerance data

Numerical values for tolerance given in Table 4 were adapted from data of Maas and Hoffman (1977) and Maas (1984). These data indicate that plant growth rate decreases linearly as salinity increases above a critical threshold salinity at which growth rate first begins to decrease. This linear decrease in yield is in good agreement with field data throughout the usual range of salinity. Deviations from the linear decrease occur at yields considerably less than 50 percent of potential, at which level yields are commercially unacceptable anyway.

The following equation (Maas and Hoffman 1977) expresses the straight line salinity effect on yield and was used in the preparation of Table 4.

$$Y = 100 - b\,(EC_e - a) \quad (10)$$

where:

	Y	=	relative crop yield (percent)
	EC_e	=	salinity of the soil saturation extract in ds/m
	a	=	salinity threshold value
	b	=	yield loss per unit increase in salinity

The values for (a) and (b) are given by Maas in his original paper but can also be determined from Table 4. The (a) value (the threshold soil salinity) is the ECe value for 100 percent yield potential in Table 4. The (b) value can be determined from Table 4 as follows:

$$b = \frac{100}{EC_e \text{ at 0\% yield} - EC_e \text{ at 100\% yield}} \qquad (11)$$

The ECe values of Table 4 for other than those associated with a 100 percent yield were calculated from the yield equation of Maas and Hoffman (1977) by rearranging equation (10) as follows:

$$EC_e = \frac{100 + ab - Y}{b} \qquad (12)$$

where ECe is the soil salinity associated with a designated percent yield, Y (see Example 4).

In Table 4 values are presented for the potential yields of 100, 90, 75, 50 and 0 percent. Table 4 also lists the applied irrigation water salinity (ECw) equivalent to the soil salinity (ECe) developed by the use of equation (5). This concentration factor from water salinity (ECw) to soil salinity of 1.5 is representative of a 15–20 percent leaching fraction. It was used in the development of the guidelines, and concentration factors for other leaching fractions are given in Table 3. The tolerance limits of Table 4 for water salinity assume that the soil salinity (ECe) results from accumulatin of salts coming from the applied irrigation water. If there is a source of salt other than the irrigation water, for example from a high water table, the concentration relationship between water salinity (ECw) and soil salinity (ECe) is not valid, but the ECe values given in Table 4 are still valid. It is again emphasized that the soil salinity (ECe) that is expected to develop following several years of use of a water assumes that the water is the primary source of soluble salts. If a water table is present, it is an additional salt source not considered in the fixed relationship ECe = 1.5 ECw.

If conditions of use consistently indicate a leaching fraction other than 0.15 to 0.20, the concentration factor (1.5 ECw = ECe), will also be different and the equivalent water salinity (ECw) of Table 4 can be changed and a new table prepared. However, this should only be done if well documented local experience confirms that the 1.5 concentration factor does not apply. The soil salinity values (ECe) presented in Table 4 for crop tolerance are believed to be the best available to date and should not be changed. They are supported by extensive and worldwide field research. Changing the leaching fraction to change the concentration factor is one of the options available for control of salinity. Table 3 presents concentration factors for various leaching fractions. These are useful to predict soil salinity (ECe) that is expected to result from use of water at any given salinity and leaching fraction, as explained in a previous section.

The majority of the yield data used by Maas and Hoffman (1977) to develop their linear equation (Equation 10) were for yields varying between 50 and 100 percent yield potential. Because the linear equation predicts these yields so well, it can be used to predict the approximate theoretical soil salinity (ECe) at which the plant is presumed to be unable to extract water, and growth ceases (yield in this case would be zero). The maximum ECe or the 0 percent yield predicted by this procedure are given in the last column of Table 4. Figure 11 illustrates this projection to the expected salinity for zero yield.

EXAMPLE 4 - DETERMINATION OF YIELD POTENTIAL

For a cotton crop, from Table 4:

a = salinity threshold value (EC_e for 100 percent yield)
a = 7.7 ds/m

From equation (11) and Table 4:

$$b = \frac{100}{EC_e \text{ at } 0\% \text{ yield} - EC_e \text{ at } 100\% \text{ yield}} \qquad (11)$$

where: b = slope of the yield loss line
b = 5.2 percent yield loss per 1 unit increase in soil salinity (EC_e)

Substituting a and b into equation (12) for yield (Y) at 100 percent,

$$EC_e = \frac{100 + ab - Y}{b} = 7.7 \text{ dS/m} \qquad (12)$$

The following shows EC_e corresponding to indicated yield:

Potential Yield (percent)	EC_e (ds/m)
100	7.7
90	9.6
75	13
50	17
0	27

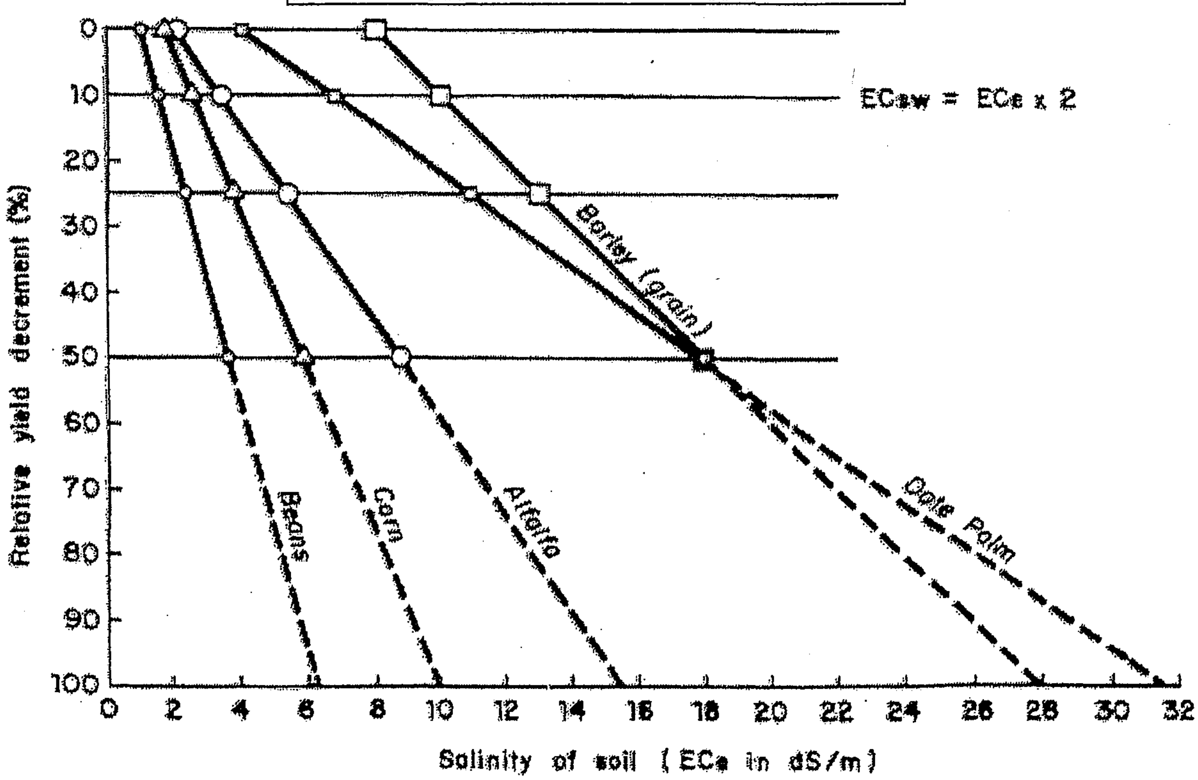


Fig. 11 Method of determining maximum EC_e

If the tolerance data are plotted in graphic form, crops with similar tolerances from groups. Boundaries and relative tolerance ratings can then be assigned to these groups. The schematic diagram in Figure 10 (Maas 1984) corresponds to the relative tolerance ratings given earlier for the crops in Table 5. The divisions, although arbitrary, are useful for general planning and for comparisons among crops. In those instances where sufficient data do not exist, a relative tolerance rating was assigned to the crop, based upon best judgement from field experience and observations (Maas 1984). According to the diagram in Figure 10, crop tolerances have been grouped as follows:

Relative crop salinity tolerance rating	Soil salinity (ECe) at which yield loss begins
Sensitive	< 1.3 ds/m
Moderately sensitive	1.3 – 3.0 ds/m
Moderately tolerant	3.0 – 6.0 ds/m
Tolerant	6.0 – 10.0 ds/m
Unsuitable for most crops (unless reduced yield is acceptable)	> 10.0 ds/m

If there are few crops in an area, it may be desirable to prepare separate guidelines for each specific crop or group of crops rather than use the broad guidelines given in Table 1. Guidelines for an individual crop can be more specific and are better aids to managers and cultivators for evaluating the suitability of the available water supply. An example of such a specific guideline is given in Table 6.

ii. Factors affecting tolerance

Crop production potential using a particular irrigation water can range from 100 percent down to zero but there are often factors other than water quality which affect yield. The tolerance values in Table 4 represent production potential when salinity is the only limiting factor. Such conditions, however, do not always exist. Other conditions may also limit production but the relative yield loss due to salinity will approximate those in Table 4 if salinity is the main limiting factor.

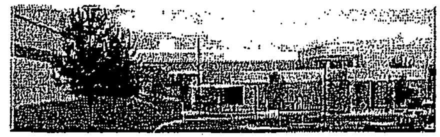
The soil salinity tolerances in Table 4 apply primarily to crops from late seedling stage to maturity. Tolerance during the germination and early seedling stage may be different and is only clearly defined for a few crops. Table 7 presents data for a few crops showing soil salinity that resulted in a 50 percent reduction in either yield or seedling emergence. In general, if the soil salinity in the surface soil (seeding area) is greater than 4 ds/m, it may inhibit or delay germination and early seedling growth. This slowed germination may then delay emergence, allowing soil crusting and disease problems to reduce the crop stand. Rainfall or pre-plant irrigations will often help to maintain low salinity, delay crusting and promote good emergence.

Table 6 GUIDELINES FOR INTERPRETING LABORATORY DATA ON WATER SUITABILITY FOR GRAPES[1]

Potential Irrigation Problem	Units	Degree of Restriction on Use		
		None	Slight to Moderate	Severe[2]
Salinity[3] *(affects water availability to crops)*				
EC_w	ds/m	< 1	1.0 – 2.7	> 2.7
Toxicity *(specific ions which*				

4

USDA ars United States Department Of Agriculture
Agricultural Research Service



Pacific West   Riverside, CA   US Salinity Laboratory

Relative Salt Tolerance of Herbaceous Crops

Maas (1990) (a)

- Grasses and Forage Crops -

Common Name	Botanical Name (b)	Threshold dS/m (c)	Slope % per dS/m	Rating (d)
Vetch, common	Vicia angustifolia	3.0	11.0	MS
Rescuegrass	Bromus unioloides	--	--	MT*
Rhodesgrass	Chloris Gayana	--	--	MT
Rye (forage)	Secale cereale	--	--	MS*
Ryegrass, Italian	Lolium italicum multiflorum	--	--	MT*
Ryegrass, perennial	L. perenne	5.6	7.6	MT
Saltgrass, desert	Distichlis stricta	--	--	T*
Sesbania	Sesbania exaltata	2.3	7.0	MS
Sirato	Macroptilium atropurpureum	--	--	MS
Sphaerophysa	Sphaerophysa salsula	2.2	7.0	MS
Sudangrass	Sorghum sudanense	2.8	4.3	MT
Timothy	Phleum pratense	--	--	MS*
Trefoil, big	Lotus uliginosus	2.3	19.0	MS
Wheat (forage) (i)	Triticum aestivum	4.5	2.6	MT
Wheat, Durum (forage)	T. turgidum	2.1	2.5	MT
Wheatgrass, standard crested	Agropyron sibiricum	3.5	4.0	MT
Wheatgrass, fairway crested	A. cristatum	7.5	6.9	T
Wheatgrass, intermediate	A. intermedium	--	--	MT*
Wheatgrass, slender	A. trachycaulum	--	--	MT
Wheatgrass, tall	A. elongatum	7.5	4.2	T
Wheatgrass, western	A. Smithii	--	--	MT*
Wildrye, Altai	Elymus angustus	--	--	T
Wildrye, beardless	E. triticoides	2.7	6.0	MT
Wildrye, Canadian	E. canadensis	--	--	MT*
Wildrye, Russian	E. Junceus	--	--	T
Trefoil, narrowleaf birdsfoot	L. corniculatus tenuifolium	5.0	10.0	MT

Trefoil, broadleaf birdsfoot	L. corniculatus arvenis	--	--	MT
Panicgrass, blue	Panicum antidotale	--	--	MT*
Rape	Brassica napus	--	--	MT*
Alfalfa	Medicago sativa	2.0	7.3	MS
Alkaligrass,Nuttall	Puccinellia airoides	--	--	T*
Alkali sacaton	Sporobolus airoides	--	--	T*
Barley (forage) (e)	Hordeum vulgare	6.0	7.1	MT
Bentgrass	Agrostis stolonifera palustris	--	--	MS
Bermudagrass (j)	Cynodon Dactylon	6.9	6.4	T
Bluestem, Angleton	Dichanthium aristatum	--	--	MS*
Brome,mountain	Bromus marginatus	--	--	MT*
Brome,smooth	B.inermis	--	--	MS
Buffelgrass	Cenchrus ciliaris	--	--	MS*
Burnet	Poterium Sanguisorba	--	--	MS*
Canarygrass,reed	Phalaris arundinacea	--	--	MT
Clover, alsike	Trifolium hybridum	1.5	12.0	MS
Clover, Berseem	T. alexandrinum	1.5	5.7	MS
Clover, Hubam	Melilotus alba	--	--	MT*
Clover, ladino	Trifolium repens	1.5	12.0	MS
Clover, red	T. pratense	1.5	12.0	MS
Clover, strawberry	T. fragiferum	1.5	12.0	MS
Clover, sweet	Melilotus	--	--	MT*
Clover, white Dutch	Trifolium repens	--	--	MS*
Corn (forage) (f)	Zea mays	1.8	7.4	MS
Cowpea (forage)	Vigna unguiculata	2.5	11.0	MS
Dallisgrass	Paspalum dilatatum	--	--	MS*
Fescue, tall	Festuca elatior	3.9	5.3	MT
Fescue, meadow	F. pratensis	--	--	MT*
Foxtail, meadow	Alopecurus pratensis	1.5	9.6	MS
Grama, blue	Bouteloua gracilis	--	--	MS*
Hardinggrass	Phalaris tuberosa	4.6	7.6	MT
Kallargrass	Diplachne fusca	--	--	T*
Lovegrass (k)	Eragrostis sp.	2.0	8.4	MS
Milkvetch,Cicer	Astragalus cicer	--	--	MS*
Oatgrass, tall	Arrhenatherum, Danthonia	--	--	MS*
Oats (forage)	Avena sativa	--		MS*
Orchardgrass	Dactylis glomerata	1.5	6.2	MS

Salinity Ratings codes

Salinity Ratings refer to the level of salt tolerance: M = moderate; T = tolerant; S = sensitive; MS = moderately

5

Wild Horse Creek Section 20 Summary

In support of:

Echeta Road Unit
WYPDES Permit WY0049697
Modification

September 26, 2005

Prepared for:

Lance Oil & Gas Company
1099 18th Street, Suite 1200
Denver, Colorado 80202

Prepared by:

CBM Associates
345 Sinclair Street
Gillette, Wyoming 82718
307-686-6664

Summary:

- **Primary Issues:** In this examination of direct discharge to Wild Horse Creek there are two primary issues. They are the erosion potential of the channel below the proposed outfall and the allowable water quality at the discharge.

- **First Issue:** The first issue is the erosion potential below the proposed discharge point. This is answered in the Lowham Engineering Report, *The Hydrology of Wild Horse Creek, Downstream of Lance Oil & Gas Company, Inc. Outfall WY0049697-013.* The report clearly shows the channel can handle up to 10 times the proposed permit flow without erosion.

- **Second Issue:** The second issue is the allowable water quality. The University of Nebraska-Lincoln, Hanson, California Water Control Board, and the Montana Department of Environmental Quality all indicate high SARs and ECs significantly reduce crop yields or may be unsuitable for some crops. The SAR of 9 and EC of 3000 is at the upper end of useable irrigation water quality.

  The Water Quality Monitoring Station (WQMS) at the confluence of the Powder River and Wild Horse Creek show that discharge water of 9 SAR and 3000 EC would be well within the WQMS site water quality and at the upper end of the Wild Horse Creek.

  In addition, the Channel Infiltration Calculation Table shows most current flows will not likely get to the irrigation site. The flood flows form the irrigation events. The flood waters will dilute the channel water to below 6 SAR and 2000 EC. This calculation is shown on the Mixing Calculation Table. Since the outfall is part way up Wild Horse Creek, only one quarter (203 ac-ft) of the 2-year event was used as an annual flood event. A week's flow was used as the volume to be mixed.

- **Solution:** The solution is to by-pass the low flow discharge through the irrigation area. This methodology is presented in the Lowham Engineering Report.

Background:

- **Purpose:** Lance is submitting a Wild Horse Creek Section 20 Summary in support of a modification to WYPDES Permit WY0049697 to allow direct discharge of CBM water after treatment. Wild Horse Creek Section 20 Summary references several studies of Wild Horse Creek and other information. This permit modification is to add outfall 013 and allow the direct discharge of treated CBM water.

- **Location:** Wild Horse Creek flows southeast to northwest in northeast Wyoming along the west side of Campbell County and enters the Powder River at Arvada in Sheridan County. The new outfall, 013, is to be located at the northwest end of the Floyd property along Wild Horse Creek. The location is shown on the permit map labeled Echeta Road WY0049697 Wells and Outfalls.

- **Land Use:** The drainage is primarily ranchland.

Surface Geologic Data:

- **General:** The Wild Horse Creek surface comprises recent or Quaternary alluvium along the main channel and tributaries, and the thickness varies greatly with the thicker deposits on the valley floor. The weathering faces in the drainage are primarily Wasatch comprising mudstones to conglomerates. The weathered soils are primarily clayey with some silts and sands. (*Three Horses Watershed Plan – Level I Study*, page 2-20) The *Three Horses Watershed Plan – Level I Study* presents the detail of the soils information in the sections: distribution of the mapped units, soil depth, soil permeability, soil productivity and salinity/sodicity, and available water capacity.
- *An Evaluation of Sodium Adsorption Ratio and Salinity Effects on Soil and Surface Water in the Wild Horse Creek Drainage* shows the soil Abstad-Haverdad association as the soil in the area of the irrigation. Abstad-Haverdad association is a fine loamy soil.

- **Alluvium:** The drainage is characterized by alluvial material of various thicknesses. In areas where the bed shale is nearer the surface, surface flow will appear in the channel. In other areas where the alluvium is thicker, surface flow occurs after a significant precipitation event or snow melt.

Vegetation: "The Haverdad soils contains green needlegrass, cottonwood, needleandthread, slender wheatgrass, western wheatgrass, sandberg bluegrass, and snowberry"

CBM Activity: On Wild Horse Creek there are 20 operators having 701 permitted outfalls. Below the location for outfall 013, there are 261 permitted outfalls. These are illustrated on the Wild Horse Creek Section 20 map.

Water Quality:

- **CBM Discharges:** The CBM well water discharges in the Wild Horse Creek drainage has higher SAR and EC values as the location gets closer to the Powder River. Typical SAR and EC values at the headwaters from WY0040371, at Echeta Road from WY0049697, and near the Powder River at Tincom Butte from WY0050636 are shown on the EC and SAR Comparison Table. The values start at SARs of 8.5 to 12 and ECs of 727 to 1520 from WY0040371 and finish with SAR of ~ 27 and EC of ~2100 from

WY0050636. WY0049697 is in the middle at SAR ~20. However, the EC is ~2000. A typical water quality analysis report from each permit is attached.

- **Water Quality Monitoring Station (WQMS):** The WQMS at the confluence of Wild Horse Creek and the Powder River shows a variety of SAR & EC values, and they are summarized on the WQMS Water Quality Table. They range from SARs of 5.6 to 13.9 and ECs of 2320 to 6180. Most flows are from CBM activity on North and Middle Prong of Wild Horse Creek.

- **Wild Horse Creek:** A few water quality samples have been taken of Wild Horse Creek over the past few years. They show the EC range of 1200 to 3840 and the SAR from 4.7 to 7.3.

Water Quality Discussion

Hanson 1999 - ESP: The Exchangeable Sodium Percentage (ESP) is a good indication of the soils infiltration capacity and crop production.

$$ESP = (1.475*SAR)/(1+.0147*SAR)$$

This relationship is discussed by Hanson etal., 1999. The ESP Table shows typical SAR values and the resulting ESP value. In comparing the ESP Table and the Tolerance for Various Crops to Exchangeable – Sodium Percentage and Salinity (Hanson 1999) the SAR values into the 30s require moderately tolerant plants. This is shown on the Crop Tolerance Table.

From University of Nebraska-Lincoln web site: "When SAR's range from 6 to 9, chances for soil permeability problems increase. Soils should be sampled and tested every 1 or 2 years to determine whether the water is causing a sodium increase."
http://ianrpubs.unl.edu/water/g328.htm. titled: Irrigation Water Quality Criteria

From the Montana Department of Environmental Quality: The entire document can be viewed at http://www.deq.state.mt.us/coalbedmethane/criteria-sar-EC-h.htm

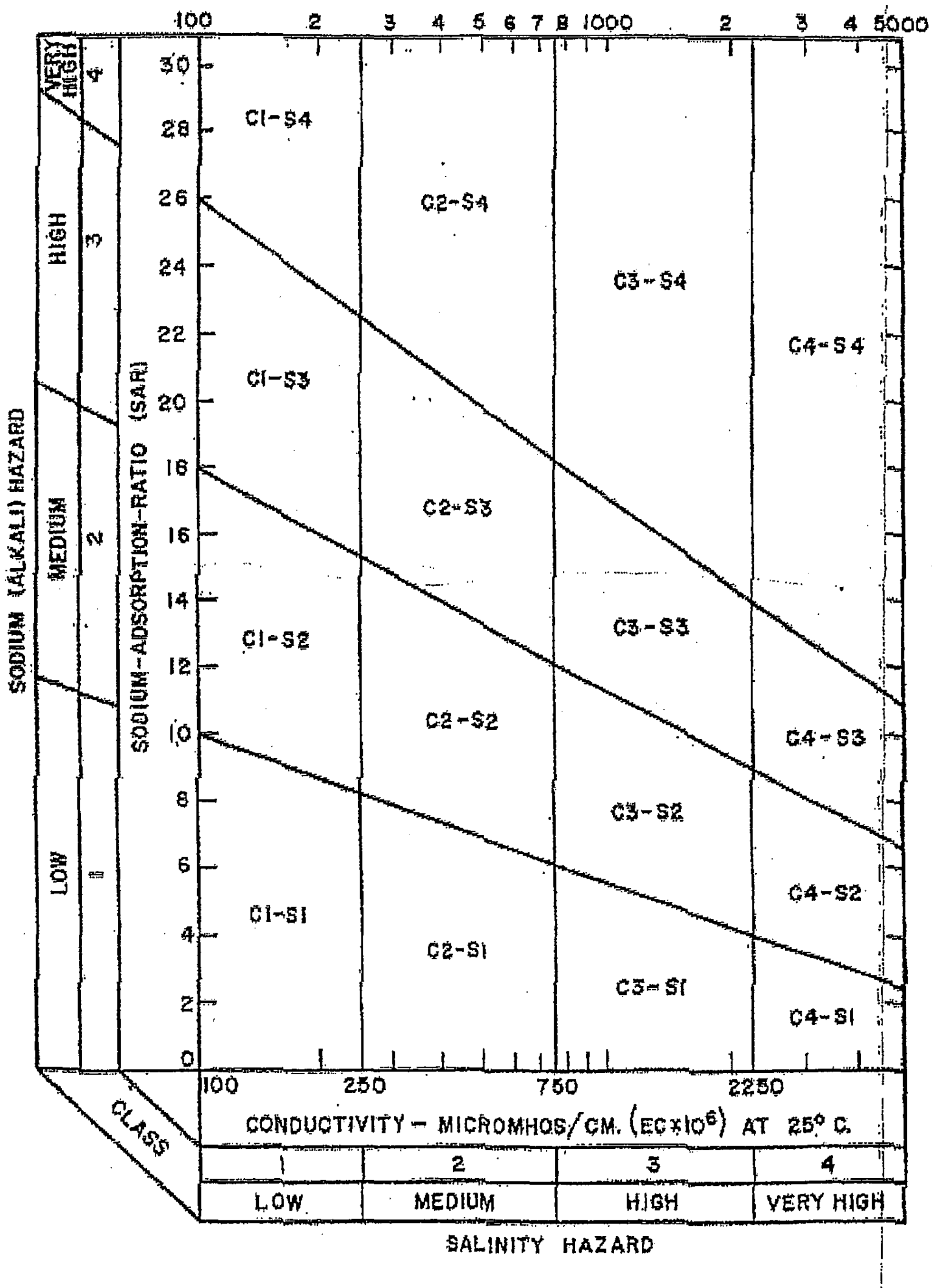
"For example if the natural EC is 2500 µS/cm, discharges at an EC of 2500 µS/cm or less should have no harmful effect on irrigation. This is due to the fact that the discharges will not increase the instream EC.

Threshold or maximum limits for EC and SAR would probably be necessary only for the irrigation season, which extends from March 1 through September 30.

The threshold EC of irrigation water where decreases in crop yield begin in these basins probably lies between 1000 µS/cm and 2000 µS/cm if the leaching fraction ranges from 15 to 30 per-cent. Limiting EC values to between 1400 and 1800 µS/cm would minimize harmful effects the Powder and the Little Powder Rivers and their tributaries, and the tributaries to the Tongue River based on a leaching fraction of 30 percent. "

The following image was taken from the California State Water Resources Control Board, Water Quality Criteria Manual

WATER QUALITY CRITERIA



Water Quality Summary: Various sources suggest a variety of limits for EC & SAR.

General Drainage Characteristics:

NAME	Longest Flow Path_mi	Channel Slope ft/mi	Basin Slope %	Basin Slope ft/mi	Area sq mi
Wild Horse Creek HUC 10	68.92	19.84	13.57	716.62	358.64
WHC @ WY0049697-013	47.87	24.62	12.80	676.06	194.14

Infiltration:

- The permitted irrigation at SE ¼ of section 32 in T54N R76W is about 7.52 miles from outfall 013. At the infiltration rate of 0.1 cfs per mile, the current 0.42 MGD of discharge would infiltrate in 6.5 miles of channel or about a mile short of the irrigation. At the proposed permit rate 0.84 MGD the flow would extend for ~13 miles. The Channel Infiltration Calculation Table shows the permitted production, infiltration capacity from outfall 013 to the irrigation, and distance required to infiltrate the current production.

Hydrologic Data:

- **Annual Precipitation:** The Wyoming Mean Annual Precipitation Map for 1961 thru 1990 indicates the WHC Drainage has an annual rainfall of 11 to 15 inches.

- **Precipitation Frequency Data**

NOAA Atlas 2
Wyoming 44.555?N 105.955?W
Site-specific Estimates

Map	Precipitation (inches)	Precipitation Intensity (in/hr)
2-year 6-hour	1.00	0.17
2-year 24-hour	1.40	0.06
100-year 6-hour	2.51	0.42
100-year 24-hour	3.49	0.15

Hydrometeorological Design Studies Center - NOAA/National Weather Service
1325 East-West Highway - Silver Spring, MD 20910 - (301) 713-1669

- **Runoff:** The 2 year event at the drainage mouth is 811 acre-feet with a peak flow of 1335 cfs. These estimates were obtained from using the HEC 2 program, the drainage characteristics, and the 2 year rainfall event. The 2 year event provides 811 acre-feet compared to the annual permitted discharge volume of 944 acre-feet and the current annual flow of 472 acre-feet.

Channel Analysis:

- **Downstream Drainage/Channel Analysis Survey:** The channel was examined by Lowham Engineering to determine the stability of the channel below the Floyd property, which is downstream of the proposed direct discharge point 013. Lowham Engineering developed a report, it follows, and it is entitled: *The Hydrology of Wild Horse Creek, Downstream of Lance Oil & Gas Company, Inc. Outfall WY0049697-013.* Lowham generated the report from field investigations and analysis of the field data.

- Channel Summary: The Lowham report, *The Hydrology of Wild Horse Creek, Downstream of Lance Oil & Gas Company, Inc. Outfall WY0049697-013*, is enclosed. This report shows the channel can handle 15 cfs or about 10 times more flow than the proposed permit discharge of .84 MGD = ~1.3 cfs.

References:

NOAA/National Weather Service, *NOAA Atlas 2*, Wyoming

EnTech, Inc., *Three Horses Watershed Plan Level I Study*, Wyoming Water Development Commission Report, December 2002.

Hydrologic Consultants, Inc., *An Evaluation of Sodium Adsorption Ration and Salinity Effects on Soil and Surface Water in the Wild Horse Creek Drainage*, CMS Energy Oil and Gas Report, May 2000.

Hydrologic Consultants, Inc., *Supplement to An Evaluation of Sodium Adsorption Ration and Salinity Effects on Soil and Surface Water in the Wild Horse Creek Drainage*, CMS Energy Oil and Gas Report, June 2000.

Applied Hydrology Associates, *West Kitty #2 Facility NPDES Application*, NPDES Application for Devon Energy Production Company, January 2002.

Lowham Engineering; *The Hydrology of Wild Horse Creek, Downstream of Lance Oil & Gas Company, Inc. Outfall WY0049697-013*; September 2005.

University of Nebraska-Lincoln web site: http://ianrpubs.unl.edu/water/g328.htm. titled: Irrigation Water Quality Criteria

California State Water Resources Control Board, Water Quality Criteria Manual

Horpestad, Abe, Montana Department of Environmental Quality; Water Quality Analysis of the Effects of CBM Produced Water on Soils, Crop Yields and Aquatic Life; October 2001; http://www.deq.state.mt.us/coalbedmethane/criteria-sar-EC-h.htm

Mixing Calculation Table
Wild Horse Creek Section 20 Summary
Echeta Road Unit - WY0049697
Lance Oil & Gas Company

September 26, 2005

Water Constituents	Storm Water	Channel Volume	WildHrsCrk Water Quality	Treated Water Quality	WildHrsCrk Water Quality	Treated Water Quality	Mixed Water Quality
	ac-ft	ac-ft	mg/L	mg/L	meq/L	meq/L	meq/L
Conductivity	203	9.04	1400	1780	na	na	1416.2
Sodium	203	9.04	140	227	6.1	9.9	6.3
Calcium	203	9.04	110	175	5.5	8.7	5.6
Magnesium	203	9.04	46	2	3.8	0.2	3.6
SAR					2.8	4.7	2.9

WQMS Water Quality Table

Wild Horse Creek Section 20 Summary

Echeta Road - WYPDES Permit WY0049697

Lance Oil & Gas Company September 26, 2005

Water Quality of Wild Horse Creek taken at Water Quality Monitoring Station where Wild Horse Creek enters the Powder River

Date	EC	Na mg/L	Ca mg/L	Mg mg/L	SAR	Flow MGD
11/5/2003	5250	985	58	172	14.7	0.200
12/11/2003	5450	901	138	203	11.4	0.143
2/18/2004	4550	648	159	154	8.8	Frozen
3/7/2004	2860	380	74	94	6.9	0.596
4/15/2004	5050	872	125	196	11.3	0.334
5/25/2004	6180	1080	134	272	12.3	0.058
6/18/2004	4020	631	162	97	9.7	0.040
7/30/2004	2390	441	57	59	9.7	1.517
8/30/2004	2730	467	74	95	8.5	0.001
9/12/2004	3190	534	73	111	9.2	0.065
10/25/2004	3790	745	57	116	13	0.335
11/14/2004	2320	123	60	288	5.3	0.275
12/19/2004	4840	967	92	165	13.9	0.294
1/18/2005	4800	963	126	173	13.1	0
3/22/2005	3370	581	115	138	8.6	2.25
4/27/2005	2700	432	99	107	7.2	3.158
5/19/2005	3200	384	142	130	5.6	3.339
6/16/2005	3050	369	189	128	5.1	2.4391

Channel Infiltration Calculation Table
Wild Horse Creek Section Summary
Echeta Road Unit - WY0049697
Lance Oil & Gas Company

September 23, 2005

Inflow

Number of Wells	gpd/well	gpm/well	cfs/well	Total flow	Total flow	Annual flow volume	Annual flow volume
				(cfs)	MGD	(cu feet)	(acre-ft)
78	10,800	7.5	0.02	1.30	0.84	41,106,417	**944**
					0.42	Current flow	**470**

Channel Losses

	Location	Channel Length	Loss/Mile	Loss/Mile	Total Loss	Total Loss (Assuming Continual Flow)	
		(miles)	(gpm)	(cfs)	MGD	(acre-ft)	
	Outfall 013 to	7.52	45	0.10	0.49	**546**	
Floyd's irrigation in section 32 of T54N R76W							
	Outfall 013 to	6.48	45	0.10	0.42	**470**	

Crop Tolerance Table

Wild Horse Creek Section 20 Summary
Echeta Road - WYPDES Permit WY0049697
Lance Oil & Gas Company

July 12, 2005

Tolerance for Various Crops to Exchangeable - Sodium Percentage and Salinity (Hanson 1999)

Tolerance to ESP (Range at which is affected)	Threshold Salinity (uS)	Growth Responsible Under Field Conditions	Crop
Sensitive ESP = 10 - 20	1000 Moderately Sensitive	Stunted growth at low ESP values although soil condition is good	Beans Dallis grass
Moderately Tolerant ESP = 20 -40	1500 Moderately Tolerant 3900	Stunted growth due to both nutritional factors and adverse soil conditions	Clover Oats Tall fescue
Tolerant ESP = 40 - 60	6000 2000 8000 4000	Stunted growth usually due to adverse physical conditions of soil	Wheat Alfalfa Barley Beets
Most Tolerant ESP > 60	7500 7500 Moderately Tolerant	Stunted growth usually due to adverse physical conditions of soil	Fairway crested wheatgrass Tall wheatgrass Rhodes grass

EC and SAR Comparison Table

Wild Horse Creek Section 20 Summary
Echeta Road - WYPDES Permit WY0049698
Lance Oil & Gas Company

July 11, 2005

Location	Permit	SAR	EC
Head waters of Wild Horse Creek	WY0040371	10.3	842
	WY0040371	12	1520
	WY0040371	10.1	771
	WY0040371	11.8	1330
	WY0040371	8.5	727
	WY0049697	16.8	1850
		20.5	2220
		19.3	1860
		18	1630
Near the Wild Horse Creek confluence with Powder River	WY0050636	27.2	1920
		28.1	2220
		25.5	1980

ESP Table

Wild Horse Creek Section 20 Summary
Echeta Road - WYPDES Permit WY0049697
Lance Oil & Gas Company July 11, 2005

Formula: $ESP = (1.475 \cdot SAR)/(1+.0147 \cdot SAR)$

SAR		ESP
3		4.2
6		8.1
9		11.7
12		15.0
15		18.1
18		21.0
21		23.7
25		27.0
30		30.7

6

Memo

To: Water & Waste Advisory Board

From: John Wagner

Date: December 22, 2005

Re: January Board Meeting

Board Members,

Attached is an agenda for the next Board meeting on January 26th and 27th. Also attached are the minutes from the September meeting in Lander. A packet containing the revised, draft Chapter 1 documents were sent to you in late November by Bill DiRienzo and can also be downloaded from our website: http://deq.state.wy.us/wqd/events.asp .

In addition to these documents, I would like to make you aware of some relevant information regarding the topics of the Water Quality Division portion of the meeting.

Chugwater Creek

The first WQD agenda item on January 26 concerns an objection to the division's listing of Chugwater Creek as an impaired waterbody. The objection has been raised by the Platte County Natural Resources District (PCNRD) who has requested a review of the listing before the Advisory Board under the provisions of the WQD Continuing Planning Process (CPP).

The CPP is a guidance document outlining the administrative processes relating to various agency actions, including the development of the 303(d) list of impaired waters. The CPP provides that

... "*Interested or affected parties may request a review of the proposed 303(d) list of impaired waterbodies before the Water and Waste Advisory Board where there are major objections to proposed waterbodies on the list. The advisory board may consider the comments and objections and make recommendations to the WQD. In accordance with the required schedule, the administrator will submit an adopted 303(d) list of impaired waterbodies to the EPA*".

Attached at the end of this memo is a briefing paper that explains in some detail the Chugwater Creek issue. DEQ staff will make a presentation of this information at the board meeting and a representative from the PCNRD will also be there to tell their side of the story. We will be requesting a recommendation from the board concerning the WQD's 303(d) listing action.

Chapter 1 & Policies

New information has been brought to our attention which may result in changes to the draft rules and policies. We became aware of this new information after the close of the comments on the 2nd draft and the publication of the 3rd draft, so it is not reflected in any of the current documents. We intend to discuss these new developments in detail at the Board meeting since they may affect your actions and recommendations, but want to make you aware of them at this time so that you do not feel blindsided when they are brought up.

1. Chapter 1, Appendix B

In the 2nd draft, most of the human health values for fish consumption in the appendix B tables have been updated to the most recent EPA recommendations. Some of these new values, however, are based on an average fish consumption of 17.5 grams of fish/day. The previous values were based on a consumption rate of 6.5 grams of fish/day. The current footnote *(footnote number 8)* still refers to the 6.5 grams/day consumption rate and will need to be changed to 17.5 for those values that are actually based on a 17.5 gram/day consumption rate.

2. Agricultural Use Protection Policy

On December 5, we received a letter from Ginger Paige, Assistant Professor of Water Resources at the University of Wyoming. Dr. Paige served on the technical workgroup that we convened to help refine the policy. Dr. Paige expressed concerns that the policy as it is now drafted is flawed in several areas and does not represent her understanding of the conclusions of the workgroup.

Her first objection is to the use of the "NRCS Bridger Plant Materials Center 1966 Technical Notes No. 26 publication as the primary reference for the soil EC values that will be used to set default EC permit limits. Her concern is that the Bridger document is a limited study that was not peer reviewed and not valid for the purposes proposed. As a result of her letter, we contacted Mark Majerus, the author of Technical Note 26 who confirmed that he would not recommend our proposed use of the reference document.

Dr. Paige's second objection is to the use of the Hansen diagram to extrapolate SAR limits based upon irrigation water EC. She contends that though this practice would address the infiltration hazard associated with each application, it may lead to a long-term build-up of sodium in the soil. The adverse effects of this build-up would not be recognized until the application of product water ceases and irrigation reverts to natural precipitation and runoff.

I intend to meet with Dr. Paige and the other members of the policy workgroup early in January to get a better understanding of these technical issues and hopefully, a resolution prior to the board meeting. We will be prepared to discuss the details of that meeting on the 26th.

Advisory Board Policies

At the last board meeting I committed to writing policies for the board to follow. However, Mr. Corra is considering whether such a document should be developed for all of the DEQ advisory boards rather than for just the Water/Waste Board. For this reason, this project has been put on hold until Mr. Corra decides which direction to go.

Attachments:

Agenda

Meeting Minutes – 9/13/05

Chugwater Cr. Briefing Paper