Expert Witness Report
of
Craig L. Fredrickson

Pursuant to
Federal Rule of Civil Procedure
26(a)(2)(B)

Case No. 01 cv 00072 MV/WPL
Subfile ZRB-2-0038

United States District Court
District of New Mexico

June 27, 2016

EXHIBIT A

INTRODUCTION

The water rights associated with well 10A-5-W06, a.k.a. the Rincon Hondo Well, are being adjudicated in accordance with New Mexico water law in United States District Court for the District of New Mexico, Case No. 01 cv 00072 MV/WPL, Subfile No. ZRB-2-0038. The Defendants in this case are Craig and Regina Fredrickson, owners of the well and appurtenant land; Plaintiffs in this case are the United States of America and the State of New Mexico.

This report sets forth the opinions I have formed regarding the historic beneficial use of well 10A-5-W06 for watering cattle and establishes each element of a livestock use component: priority, beneficial use, place of use, period of use, and amount. In accordance with Rule 26 (a)(1)(2)(B) of the Federal Rules of Civil Procedure, this report contains a complete statement of all opinions used to establish these elements, including the basis and reasons for these opinions, as well as the facts or data that were considered.

As particularly described in this report, a combination of documentary evidence, field observation and technical analysis, based upon published data and established methodology, was used to form my opinions. The general approach to forming my opinions included the following:

- Utilize site-specific information and documentation to the maximum extent available,
- Test all statements or assertions, verbal or written, to ensure that they are credible,
- Utilize published data and established methodologies for all quantitative analyses,
- Where assumptions are required, provide the complete bases and reasons,
- Use the same core assumptions throughout to ensure consistency in the analyses,
- Where uncertainty may be involved, err on the side of a conservative result, and
- Cite references such that results can be objectively reproduced by others.

This report contains exhibits, including documents, photographs, figures and tables, that summarize or support these opinions and which may be used at trial. I may find it appropriate to revise or supplement my opinions, analysis, and conclusions stated herein in the future.

EXHIBIT A

Well 10A-5-W06 is located on section 19, township 5N, range 18W N.M.P.M. in Rincon Hondo Canyon. I have owned and maintained this 640-acre section of land since February, 2006. I am an engineer with more than 27 years of experience in conducting complex technical analysis and providing consulting services related to compliance with a wide range of Federal laws and associated regulations. As such, I have both the personal, site-specific knowledge of the land and its improvements, and the qualifications, by virtue of my skills, experience, training and education, to assess the historic beneficial use of well 10A-5-W06 for livestock watering.

I retired in the year 2000 and have not authored any publications in the previous 10 years nor have I ever testified as an expert at trial or by deposition. I represent the Defendants, including himself, in this case without compensation. My resume is included as Attachment 7.

OPINIONS RENDERED

OPINION No. 1: The priority date for well 10A-5-W06 is 1955. The date is without further clarification of actual month or day of first beneficial use and is therefore assumed to be December 31, 1955.

OPINION No. 2: The historic, beneficial use of well 10A-5-W06 included livestock watering. The well supported livestock operations uninterrupted from 1955 through 2000 and, more particularly, a cow-calf operation from at least 1983 through 2000.

OPINION No. 3: The place of use of well 10A-5-W06 is the NE ¼ of the NE ¼ of the NW ¼ of Section 19, Township 5N, Range 18W N.M.P.M.

OPINION No. 4: The period of use of well 10A-5-W06 for livestock watering was throughout the year (12 months).

EXHIBIT A

OPINION No. 5: With a reasonable degree of scientific certainty, the maximum amount of groundwater diverted through well 10A-5-W06 for the beneficial purpose of livestock watering was 3.779 acre-feet per annum.

BASIS FOR OPINIONS

Background

The Cox Ranch was established by Robert L. "Bert" and Anna S. Cox in the 1920s and eventually grew to include approximately 140 sections of private and leased land. A portion of the ranch included land in the region of Rincon Hondo Canyon where cow-calf operations were conducted. A regional map, including well locations, is included as Attachment 1. The upper canyon where well 10A-5-W06 is located is as pictured in Figure 1.

Figure 1 – Upper Rincon Hondo Canyon

In 1955, Bert Cox had well 10A-5-W06 drilled on section 19, township 5N, range 18W. Groundwater was diverted through the well and placed to beneficial use for the watering of cattle. The well was drilled and placed to beneficial use prior to the declaration of the Gallup well had been used to raise cattle through a cow-calf operation whereby beef cows and their calves were grazed within the Rincon Hondo Canyon region and watered at this well.

As a matter of explanation, a cow-calf operator keeps a herd of mature cows to produce calves to sell to other producers. Cows are bred to have a calf every year, usually in late winter or early spring. Generally, calves are weaned at 6 to 10 months of age and generally weigh in the range of 450 to 700 pounds at that time. Other typical beef cattle operations are the backgrounder-stocker operator and the feedlot operator. The backgrounder-stocker operator buys weaned calves and turns them out on pastures until they reach 800 to 900 pounds. The feedlot operator purchases weaned calves or backgrounded calves and feeds them to market weight (Cattlemen's Beef Board and National Cattlemen's Beef Association, 2016).

The specific use of well 10A-5-W06 to support a cow-calf operation was verbally conveyed through several personal telephone conversations the author had in 2006 through 2008 with the two surviving sons of Tommy Cox, Tim A. Cox of Quemado, NM and Tom W. Cox then of Rogers, NM. The deposition of Tom W. Cox, taken on May 18, 2016, confirmed this specific use ([Cox, 2016] Cox Dep. 23:25-24:10) for the period of his involvement in ranch operations, approximately 1983 through 2000. Paragraph 7 of the 1990 Declaration indicates that the well had been used continuously for livestock watering since 1955 (Attachment 2). When the Tom W. Cox deposition and the Tommy Cox declaration are considered together, well 10A-5-W06 had been in continuous use for livestock watering purposes from 1955 through 2000.

Figure 4 is an undated photograph of Donald P. “Donnie” Cox, brother of Tommy Cox, branding a calf at the well location (Fence Lake Book Committee, 1987). As described in the family history of the late Robert (Bert) and Anna Cox, “many people far and wide still talk about

3.0 Basis for Opinion No. 3: Place of Use

Declaration of Ownership of Underground Water Right No. 33-8 documents the place of use of well 10A-5-W06. Paragraph 3 of the referenced document (Attachment 2) specifically identifies the well location as “Rincon Hondo” at the NE ¼ of the NE ¼ of the NW ¼ of Section 19, Township 5N, Range 18W N.M.P.M. The fact that Tommy Cox intentionally added “Rincon Hondo” to the description of the location is important when considered in the context of paragraphs 5 and 7 of the declaration. Paragraph 5 describes the beneficial use as “livestock watering” and paragraph 7 describes the beneficial use as “on all of the above described lands” to include his phrase “Rincon Hondo.” By virtue of its topography, Rincon Hondo Canyon represents a physical obstacle to cattle that might otherwise range outside the confines of the canyon. “Rincón Hondo” literally translates from Spanish as “deep piece of land,” providing insight into the nature of the topography (see Figure 1).

The Cox family owned private property in and around Rincon Hondo Canyon until the years 1999 and 2000 (Attachment 3). In 1999, Tim A. Cox and family members entered into a real estate contract with Great Western Properties, Inc. Subsequently, and over a period of several years, all deeded property within the Rincon Hondo previously owned by Tim W. Cox was sold to others through Great Western Properties, Inc. In addition, in 2000, Tom W. Cox, hereafter referred to as Tom Cox, and family sold additional deeded property within the Rincon Hondo to Edward and Donna Wagner.

Included in these multiple transactions were all or portions of Sections 18, 19, 20 and 29, Township 5N, Range 18W, and all or portions of Sections 12, 13 and 25, Township 5N, Range 19W. All or portions of each of these seven privately-owned sections lie within Rincon Hondo until early April; bulls were also fed hay during this period in drought years (Cox Dep. 26:9-18). Ranchers need to provide hay and other supplements to their cattle during the winter, provide shelter, ensure the availability of fresh water, and maintain the health and viability of their herd (Anderson, 2011).

Accordingly, **the period of use of well 10A-5-W06 for livestock watering was throughout the year (12 months)**.

5.0 Basis for Opinion No. 5: Amount

Cattle ranchers, like farmers, are subject to climatic conditions that are beyond their control; there is no guarantee of profitability in any single year. A successful rancher will strive to be profitable over the long-term with financial losses in years of drought offset by financial gains in years of plenty. To ensure continuing success, herd size and grazing period must be matched with the quantity of forage available within grazable distance of a water source. As such, the amount of water withdrawn for livestock from any particular source, including well 10A-5-W06 (also referred to as the Rincon Hondo Well in this section), would vary from year to year.

The Rincon Hondo Canyon region of the former Cox ranch is generally characterized by rough, broken terrain, including mesas intermingled with steep canyon walls, escarpments and valleys (SCS, 1993). There is no surface water and very few springs. The soils of the region generally support commercial wood cutting and/or cattle ranching. A cow-calf operation was established in this particular part of the ranch. To exploit the available forage, livestock water regional herd. The High Lonesome Well, while classified by NRCS as “undependable,” does appear to meet the minimum design requirement of three days of storage for its respective cattle water duty. Storage is based on the maximum summer water demand (NRCS, 2010). For Rincon Hondo Canyon region cow-calf pairs, this summer maximum was calculated to be 24.05 gallons per day (see Section 5.5, Figure 16). Although both were equipped with windmills, neither the Amado Well nor the Perry Canyon Well, had any storage capability and fail this basic NRCS design requirement.

For perspective, the Amado windmill was allowed to operate continuously, producing water to fill a single, permanent drinker; all excess water produced by the wind was spilled to the ground (Cox Dep. 48:1-7). Based on measurements taken by the author, the drinker measures 92 inches in diameter by 18 inches deep and has a maximum capacity of 518 gallons (see Figure 8). This single volume would support no more than seven cows for three days based on summer water requirements. As with all of the water sources, it is also subject to exploitation by wildlife.

By contrast, water withdrawn from the Rincon Hondo Well was stored in a large holding tank; the tank was kept full (Cox Dep. 50:3-51:2). The stored water supply at the Rincon Hondo Well was more than thirty times greater than that which was available at the Amado Well location and could support 227 cows for three days before the pump jack would need to be used to restore water reserves.

The Perry Canyon Well reportedly had no storage but a drinking tub, and was operated similarly to the Amado Well and windmill; the water was contaminated with gypsum and allowed to continuously spill to the ground (Cox Dep. 52:13-24). This well was shared with a neighbor; no information was provided on the neighbor’s usage or on the associated windmill

(Cox Dep. 41:2-6). As such, it is impossible to determine what contribution it could have made to the water needs of the Rincon Hondo Canyon regional herd. With no storage capability, its usefulness as a water source was marginal.

The Zuni Spring was also represented as a potential water source for the Rincon Hondo Canyon regional herd in the summer. No drinkers were present and water would pool on the ground (Cox Dep. 43:5-10). As shown in Figure 9, very little water is associated with Zuni Spring and no water right was assigned to this source under the Zuni Basin adjudication.

Figure 9 – Zuni Spring

Based on the above, the Amado Well, Zuni Spring and Perry Canyon Well did not represent significant or credible water sources for the Rincon Hondo Canyon regional herd. Moreover, the reported practice of allowing the drinkers at the two wells to continuously overflow would appear to be a significant waste of water, not water put to useful or beneficial purpose. For assessing the maximum quantity of livestock water withdrawn from the Rincon

Hondo Well, these three potentially competing sources are incidental at best and reasonably can be ignored. Tom Cox confirmed that 40% of the regional herd watered at the Rincon Hondo Well from December until the first of July (Cox Dep. 36:22-37:13) (Cox Dep. 66:17-67:1).

For the summer season all cattle, consisting mostly of lactating cows with one to four-month old calves, were moved from the three winter pastures to upper, higher elevation starting with the Rincon Hondo Well (Cox Dep. 37:14-24). Testimony provided by Tom Cox did not suggest that these cow-calf pairs were kicked up Rincon Hondo Canyon and distributed throughout the summer range. He testified that he did not move the cattle within the summer range until they were gathered in the fall (Cox Dep. 42:14-20). Nor were they enticed to use any particular part of the range by the placement of salt (Cox Dep. 67:12-17). Rather, cattle in the summer range were free to roam over more than 15 sections of land (Cox Dep. 43:20-44:1).

Potential water sources in the summer range included the Rincon Hondo Well and High Lonesome Well, as well as the aforementioned Zuni Spring and the Perry Canyon Well (Cox Dep. 37:14-24). As discussed above, these two latter sources are not considered reliable or significant for livestock watering. The straight line distance between the Rincon Hondo Well and the High Lonesome Well is 4.99 miles; this straight line path crosses impassable terrain. The trail path, as identified by ground truth, measures 9.26 miles (Image 1). Both measurements were calculated using the Google Earth, Line and Path Distance Tool.

There is consensus on the placement of water sources used for livestock watering. Distances between water sources in flat country should be no more than four miles and, in rough country, no more than one mile (Holechek, 1997). "Areas over 2 miles from water should be considered unusable by cattle because high energy expenditure in animal travel nullifies

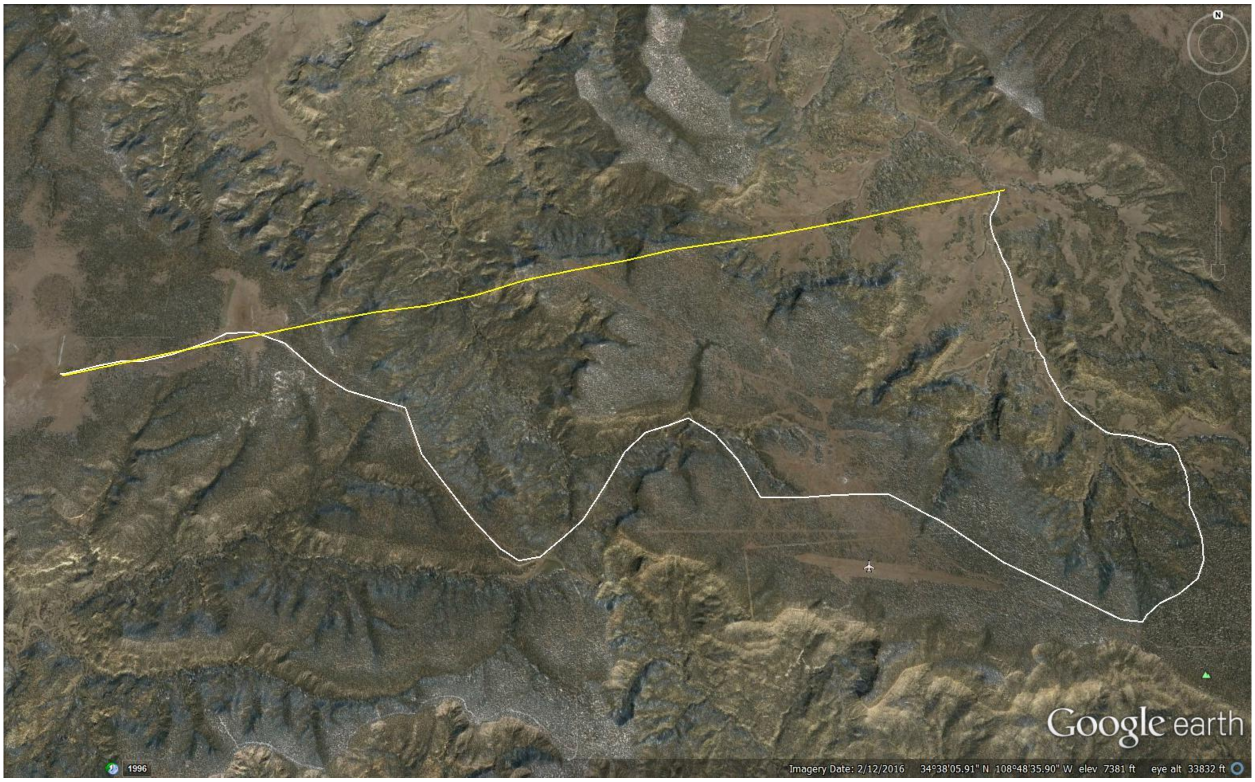

Image 1 – Straight Line and Trail Path between Rincon Hondo and High Lonesome Wells

weight gains, heavy trampling loss of forage occurs from excessive trailing, and severe grazing will occur on forage plants within 1 mile of water" (Holechek, 1997). "Livestock, particularly cattle, are predictable in their grazing behavior. One of their most conspicuous habits is to graze convenient areas. These are generally areas close to water or those that are easily accessible, such as level terrain within an area of rough topography. Given the choice and/or lack of sufficient enticement, cattle will abuse these convenience areas" (Volesky, 1996).

Given the above, it is reasonable to conclude that, starting in July, the regional herd would initially water at and feed on pasture grass surrounding the Rincon Hondo Well; it is the first water source they would encounter. Its infrastructure includes a 15,666-gallon holding tank for water storage and it was identified by Tom Cox as being equipped with a pump jack to allow water production when wind was lacking. In addition, the two permanent livestock drinkers identified in Table 1 provide 39 feet of water access, enough for a herd size of 390 cattle based on NRCS watering facility design criteria (NRCS, 2010).

Unless forage within the grazing area serviced by the Rincon Hondo Well was insufficient for the summer season, cattle would have no incentive to move elsewhere. However, if the available forage within a two-mile radius was depleted, the cattle would have the ability to find new forage and water at the High Lonesome Well. Remaining is the question of available forage to support the herd at these two locations.

5.3 Carrying Capacity

The carrying capacity of a pasture is simply the maximum number of animals a site can support over a given period of time without causing detriment to future forage production. The carrying capacity is initially established by assigning a stocking rate based upon such factors as the class of livestock (lactating cow, bull, growing heifers and steers, etc.), acres available for grazing, topography, water distribution, forage species, forage productivity including regrowth characteristics, and grazing practices.

Setting the appropriate initial stocking rate consists of determining (1) how much forage is produced during the year and how much is available for livestock consumption (available forage); (2) how much forage is required by the type and class of animals raised (forage demand); and (3) how long will animals be using the area (duration of grazing). Successful ranchers balance animal performance and forage production over the long term, while making short-term adjustments to stocking rate and/or duration of grazing as climatic conditions dictate.

Available Forage: Available forage was calculated for both the Rincon Hondo Well and the High Lonesome Well. The acreage of grazing pasture was determined assuming a grazing distance of no more than two miles from each well (NRCS, 2009) (Holechek, 1988). In the case of the Rincon Hondo Well, the acreage available for grazing was further reduced by limiting the pasture to only that which is contained within Rincon Hondo Canyon and not on the mesa tops that surround it. Available forage was then calculated using soil survey maps prepared by the Soil Conservation Service (SCS, 1993).

Rincon Hondo Well Forage: From the SCS soil survey of Rincon Hondo Canyon, only two soil units provide forage for cattle and lie below the surrounding mesa tops: soil unit 25, Hickman-Catman complex; and soil unit 515, Rock Outcrop-Vessilla-Mion complex. The Hickman-Catman complex soils are in valleys and swales and on alluvial fans. The Rock Outcrop-Vessilla-Mion complex soils are on escarpments, ridges and hills (SCS, 1993).

The SCS soil survey is supplemented by 102 detailed maps of the region. Sheet 71 of 102 includes Section 19, Township 5N, Range 18W N.M.P.M., the location of the Rincon Hondo Well, and the surrounding sections of land. Figure 10 is a scanned image of that portion of Sheet 71 of 102. To determine the acreage of land associated with each of these two soil units, the scanned image shown in Figure 10 was colorized to delineate each soil unit using the GNU Image Manipulation Program (GIMP), see Figure 11. The yellow-shaded area corresponds to soil unit 25, Hickman-Catman complex and the blue-shaded area corresponds to soil unit 515, Rock Outcrop-Vessilla-Mion complex.

GIMP is a cross-platform image editor and its use in this way allows the number of pixels of each color, corresponding to a soil unit, to be counted. This provides the means to accurately

Soil Unit 25: Hickman Catman Complex, 1 to 6 percent slopes							
Unit Composition by Soil	Hickman	Catman	Other (totaling 15% of acreage)				
			Silkie	Vessilla	Goesling		
Percent of Unit Acreage (%)	45%	40%	5%	5%	5%		
Favorable Year Production Rate (lb/acre)	3,000	3,200	1,100	750	1,100		
Favorable Forage Production Rates (lb/unit acre)	1,350	1,280	55	38	55		
Unfavorable Year Production Rate (lb/acre)	1,200	1,250	600	375	600		
Unfavorable Forage Production Rates (lb/unit acre)	540	500	30	19	30		
Distance to Water (miles)	≤ 1		> 1 ≤ 2				
Pasture Area (acres)	616		462				
Total Favorable Forage Production Rate (lb/unit acre)	2,778		2,778				
Total Unfavorable Forage Production Rate (lb/unit acre)	1,119		1,119				
Utilization Based on Slope (%)	100%		100%				
Utilization Based on Distance (%)	100%		50%				
Utilization to Preserve Pasture (%)	45%		45%				
Favorable Year Usable Forage (lb)	769,923		288,721				
Unfavorable Year Usable Forage (lb)	310,118		116,294				
Soil Unit 515: Rock Outcrop-Vessilla-Mion Complex, 3 to 55 percent slopes							
Unit Composition by Soil	Rock	Vessilla	Mion	Other (totaling 15% of acreage)			
				Nogal	Hickman	Catman	Flugle
Percent of Unit Acreage (%)	45%	20%	20%	3.75%	3.75%	3.75%	3.75%
Favorable Year Production Rate (lb/acre)	0	700	0	750	3,000	3,200	1,100
Favorable Forage Production Rates (lb/unit acre)	0	140	0	28	113	120	41
Unfavorable Year Production Rate (lb/acre)	0	300	0	375	1,200	1,250	600
Unfavorable Forage Production Rates (lb/unit acre)	0	60	0	14	45	47	23
Distance to Water (miles)	≤ 1		> 1 ≤ 2				
Pasture Area (acres)	1,065		2,038				
Total Favorable Forage Production Rate (lb/unit acre)	442		442				
Total Unfavorable Forage Production Rate (lb/unit acre)	188		188				
Utilization Based on Slope (%)	70%		70%				
Utilization Based on Distance (%)	100%		50%				
Utilization to Preserve Pasture (%)	45%		45%				
Favorable Year Usable Forage (lb)	148,238		141,835				
Unfavorable Year Usable Forage (lb)	63,216		60,486				
Total Usable Forage of Rincon Hondo Well Pasture							
Favorable Year Total Usable Forage (lb)	1,348,717						
Unfavorable Year Total Usable Forage (lb)	550,113						
Favorable Year Carrying Capacity of Pasture (AUDs)	51,874						
Unfavorable Year Carrying Capacity of Pasture (AUDs)	21,158						

Table 3 – Available Forage and Carrying Capacity of the Rincon Hondo Well Pasture

without creating detrimental effects to future forage production; available forage for "unfavorable years" was calculated to be 550,113 pounds. While trampling, soiling and insect damage could impact harvest efficiency, the relatively high stocking density helps ensure that forage will be consumed before it senesces, transfers to litter or otherwise leaves the area. The dominant grasses of the Rincon Hondo Canyon region, cool-season western wheatgrass and warm-season blue grama, provide for the regeneration of forage during the grazing period (Allison, 2011).

High Lonesome Well Forage: From the SCS soil survey of Santa Rita Mesa, only two soil units provide forage for cattle and lie on the mesa top: soil unit 535, Millpaw Loam; and soil unit 515, Rock Outcrop-Vessilla-Mion complex. The Millpaw Loam soils are in swales and valleys. The Rock Outcrop, Vessilla-Mion complex soils are on escarpments, ridges and hills (SCS, 1993).

The SCS soil survey is supplemented by 102 detailed maps of the region. Sheet 71 of 102 includes Section 29, Township 5N, Range 19W N.M.P.M., the location of the High Lonesome Well; the surrounding sections of land are included on sheets 70, 87 and 88. Figure 13 is a scanned image of relevant portions of Sheet 70, 71, 87 and 88. To determine the acreage of land associated with each of these two soil units, the scanned image shown in Figure 13 was

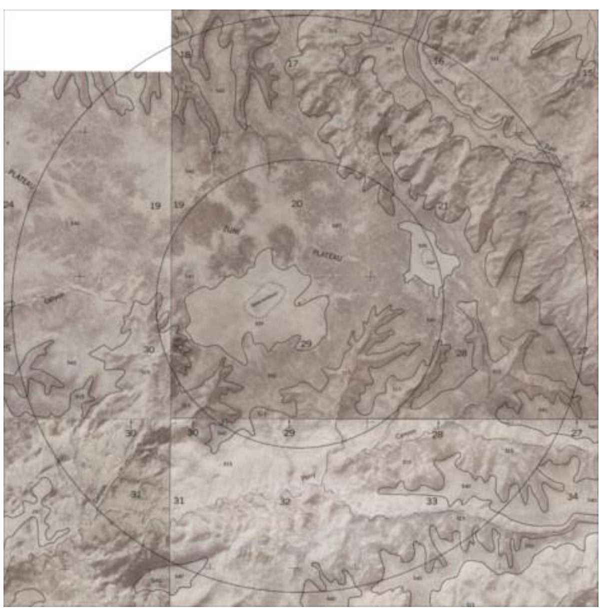

Figure 13 - Sheets 70, 71, 87 and 88 of 102

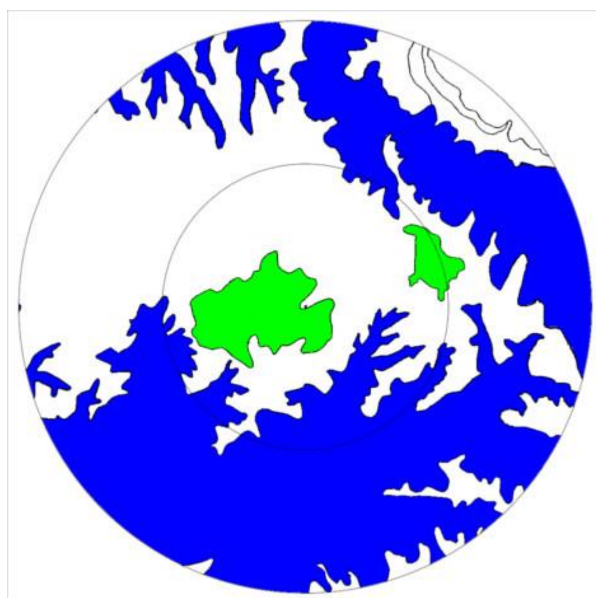

Figure 14 - Unit 535 (Green), Unit 515 (Blue)

Data reported by the SCS soil survey was used to determine the quantity of forage available to cattle utilizing both "favorable" year forage production rates and "unfavorable" year forage production rates for each soil type and the percentage of the soil unit it represents (SCS, 1993) (NRCS, 2007). The favorable year production rates were used to establish the upper limit carrying capacity of the pasture.

Using established methodology, forage utilization was limited to 45% to prevent overstocking of the pasture; additional restrictions were placed on utilization based on the actual slope of the land and grazable distance to water (Holechek, 1988). For soil unit 535, Millpaw Loam, the slope of land is less than 10% throughout its area of occurrence and therefore, no reduction of utilization is necessary. For soil unit 515, Rock Outcrop-Vessilla-Mion complex, the slope of land varies between 3% and 55% and, as such, an average slope reduction factor of 30% was applied to utilization. This is considered conservative since the Hickman and Catman loams that dominate actual production for this soil unit grow in the low-sloped valley; the steep rock outcrop contributes nothing to forage production for this soil unit. Utilization of all pasture beyond a one-mile radius of the High Lonesome Well was reduced by 50%.

Table 4 compiles these results based on soil unit and distance. Collectively, a total of 453,656 pounds of forage was calculated to be available for consumption in "favorable years" without creating detrimental effects to future forage production; available forage for "unfavorable years" was calculated to be 213,353 pounds. While trampling, soiling and insect damage could impact harvest efficiency, the relatively high stocking density helps ensure that forage will be consumed before it senesces, transfers to litter or otherwise leaves the area. The dominant grasses of the Rincon Hondo Canyon region, cool-season western wheatgrass and

AU per bull (Manske, 1998). All cows are assumed to weigh an average of 1,000 pounds and all bulls are assumed to weigh an average of 1,600 pounds (see Section 5.5).

The total AUDs of forage available in “favorable” years (from Table 3) is greater than the AUDs corresponding to the “favorable” year herd composition (Table 5). As such, years of “favorable” rainfall and forage conditions provide more forage within grazable distance of the Rincon Hondo Well than is required annually. Moreover, and consistent with the behavior of cattle (Lyons and Machen, 2001), there is no incentive for cattle to range beyond the Rincon Hondo Well in “favorable” years. Therefore, the herd composition in favorable years (Table 5) can be used to establish the maximum amount of water withdrawn from the Rincon Hondo Well for livestock consumption.

Table 6 represents the composition of the herd watering at the Rincon Hondo Well based upon “unfavorable” year forage conditions and includes a total Rincon Hondo Canyon regional herd consisting of 150 cows and 15 bulls. The relative proportion of cattle of each class is the

Month	Days	Pregnant Cows	Lactating Cows	Mature Cows	March Calves	April Calves	May Calves	Bulls		AUDs
January	31	58.02	0.00	1.98				6		2,125
February	28	58.02	0.00	1.98				6		1,919
March	31	43.52	14.03	2.46	14.03			6		2,125
April	30	14.58	42.00	3.42	13.95	28.05		6		2,056
May	31	0.00	55.82	3.90	13.88	27.91	14.03	6		2,116
June	30	4.47	55.53	0.00	13.81	27.77	13.95	6		2,056
July	31	11.87	138.13	0.00	34.36	69.07	34.71	15		5,312
August	31	12.58	137.42	0.00	34.18	68.71	34.53	15		5,312
September	30	13.28	136.72	0.00	34.00	68.36	34.35	15		5,140
October	31	13.97	136.03	0.00	33.83	68.02	34.18	15		5,312
November (1-15)	15	14.67	135.33	0.00	33.66	67.67	34.00	15		2,570
November (16-30)	15							6		128
December (1-15)	15							6		128
December (16-31)	24	58.02	0.00	1.98	0.00	0.00	0.00	6		1,645
Total AUDs										37,943

Table 6 – Herd Composition and Animal Unit Days at Rincon Hondo Well in Unfavorable Years

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water consumption rate of 800-pound beef cattle confined to a feedlot (Wilson and Lucero, 1997).

The water use report makes no mention of the term "animal unit" nor does it suggest that the water consumption rate of an 800-pound animal confined to a feedlot is the reliable equivalent to the water consumption rate of a 1,000-pound lactating beef cow with calf on rangeland. In fact, the 10-gallon per day "estimate" for feedlot animals was based solely on undocumented personal communication, i.e., hearsay (Sweeten, 1990). As an alternative, this section provides a comprehensive assessment of the drinking water requirements associated with the Rincon Hondo Canyon, cow-calf operation on west-central New Mexico rangeland as derived from published research data on this subject.

The National Research Council has published guidance on total daily water intake rates for beef cattle based on cattle class (lactating cow, bull, growing heifers and steers, etc.) and animal weight as a function of ambient temperature (NRC, 2000). This guidance was taken from a more comprehensive study of this topic conducted by the U.S. Department of Agriculture that contains the full compilation of water intake rates appropriate to the analysis conducted herein (Winchester and Morris, 1956). As noted therein, "the difference between total water intake, which includes the moisture content of the feed, and free water consumption is small, and in practical situations can be ignored."

The free water intake rates used to determine the seasonal quantity of water consumed by the cattle herd grazing within Rincon Hondo Canyon and drinking from well 10A-5-W06 are provided in Table 7 (Winchester and Morris, 1956). The water intake rates for fattening, two-year old cattle were assigned to mature cows on the basis that no other class of cattle more closely correspond to non-pregnant cows in the tabulated rates (Winchester and Morris, 1956).

Ambient Temperature (°F)		40°	50°	60°	70°	80°	90°
Cattle Class	Weight (lb)	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons
Growing Heifers, Steers and Bulls							
	400	4.0	4.3	5.0	5.8	6.7	9.5
	600	5.3	5.8	6.6	7.8	8.9	12.7
	800	6.3	6.8	7.9	9.2	10.6	15.0
Wintering Pregnant Cows							
	1000	6.0	6.5	7.4	8.7		
Lactacting Cows							
	900-1100	11.4	12.6	14.5	16.9	17.9	16.2
Mature Cows							
	1000	9.0	9.7	11.2	13.1	15.1	21.4
Mature Bulls							
	1600+	8.7	9.4	10.8	12.6	14.5	20.6

Table 7- Total Daily Water Intake

It is evident from a summary review of these guidelines that 10-gallons per day, as assumed in the hydrographic survey for the Zuni River Basin, is a gross understatement of the free water consumption rate of 1.00 AU equivalent of beef cattle. This is particularly true for lactating cow-calf pairs where the drinking water rates of the cow and the calf are combined.

Ambient temperature, meaning the temperature of the surrounding environment, is variable by time of day and by time of year. Over the temperature range of interest, water intake by cattle increases exponentially with increasing temperature. "Until the ambient temperature exceeds 80° F, cattle tend to do most of their drinking in the forenoon and late afternoon and evening while very little water is consumed during the night or in the early morning and early afternoon hours;" thereafter they drink more often (Winchester and Morris, 1956). Since free water intake requirements are correlated with temperature and water consumption occurs primarily during the daytime, it is necessary to consider the ambient daytime temperature when by the age of weaning (Cattlemen's Beef Board and National Cattlemen's Beef Association, 2016). Using the average birth and weaning weights, and at a linear rate of growth, calves grow at an average rate of approximately 62 pounds per month, approximately two pounds per day.

The average beef cow produces 13 pounds of milk per day during the suckling period (Eversole, 2009). Initially, the nutrient requirements of a calf are met by the cow's milk alone and the quantity of forage and free choice water that is consumed by the calf is small. However, even very young calves require water, e.g. to prevent dehydration, and the relationship between environmental temperature and water intake is exponential rather than linear (Jenkins, 2014). Calves don't start grazing in earnest until they reach approximately three months of age, the age that their rumens start to work. From this point onwards they eat more forage than milk to meet their nutrient requirements and the cow's milk production will gradually decline.

The National Research Council provides no specific guidance for water intake by calves prior to developing a functional rumen, the period during which their nutritional requirements are provided by milk. By one or two days of age, calves may drink as little as a pint or two of water per day; by two months of age they require between 10 and 12 quarts of water per day (Earleywine, 2015). Using this data, the water consumption of young calves during the first three months after parturition was modeled as a temperature-dependent function of weight and age, starting at zero gallons per day at birth and exponentially increasing to the age of three months when their rumen is functional.

Thereafter, linear interpolation (or linear extrapolation) was used to determine the water intake rate for a given weight of calf using the temperature-dependent rates for growing heifers, steers and bulls from Table 7. These temperature-dependent water intake rates are based upon a

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consumptive water use by cattle. Based on the existing infrastructure, drinking water delivery to cattle at well 10A-5-W06 was exclusively by drinkers and troughs as opposed to a livestock pond.

Cattle drink with their heads down, drawing water in and then swallowing. Cattle and other ungulates can be observed raising their heads during this process allowing water to spill from the sides of their mouths, Figure 20. While some of this water will spill back into the drinker, some is lost to the ground. Additional loss mechanisms during drinking include adults using their hooves to break ice and young animals entering and exiting the drinkers, Figure 21.

Figure 20 - Consumptive Water Loss

Figure 21 – Splashing Water Loss

No data has been found that provides the basis for assigning an efficiency rate to the consumption of water by cattle. Field observations by the author and observation of video of cattle drinking suggest that there is relatively little loss associated with the drinking process. For the purposes of determining historic consumptive losses at the well 10A-5-W06 location, it is assumed that water was consumed by cattle at a 90% efficiency rate; of the remaining 10%, half is assumed to be spilled back into the drinker and the other half is assumed to be spilled to the ground. This division of water spilled into the drinker versus water spilled to the ground is reasonable, particularly when applied to large groups of thirsty cattle vying for position to drink. On this basis, it is calculated that 40,790 gallons of water were lost per year in association with cattle drinking at well 10A-5-W06.

Infrastructure-Related Losses: A variety of infrastructure-related losses would have been associated with the pumping, storage and delivery of water at the location of well 10A-5-W06. These generally fall within three categories, maintenance-related losses, chronic leakage and accident-related losses.

Maintenance-related losses are associated with the requirement to provide clean water to livestock. Livestock water is subject to contamination by minerals, manure, microorganisms and algae, some of which are sources of disease or infection and others that may affect water intake rates. A study of calf performance relative to the frequency of cleaning and rinsing drinking water vessels suggests that, although daily rinsing/cleaning is preferred, intervals between rinsing/cleaning of these single-user vessels should not exceed seven days (Weidmeier, 2006). A study of water use in feedyards reported that water troughs are cleaned about every three days in the winter and every two days in the summer (Parker, 2000).

Based on these reported practices and recommendations, the historic frequency of refreshing the water in shared drinkers at the well 10A-5-W06 location is estimated to have been at least twice per week. Despite the reported industry practice of actually cleaning drinkers, which would have resulted in additional water usage, testimony provided by Tom Cox indicated that he never scrubbed it down (Cox Dep. 51:17-52:8). Each draining and refilling of the two, permanent drinkers at the well location would produce a water loss of approximately 615 gallons (Table 1). At a rate of twice per week, this would have resulted in the use of 59,054 gallons of

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water over the eleven-month period December 16 through November 15; it is assumed that this practice was not employed during the intervening time period when only bulls were present. Existing valves and piping allow the rinse water to be diverted to agricultural benefit.

Chronic losses are those associated with leakage from water delivery infrastructure including well pipe, holding tanks and interconnecting piping. The primary losses of these types are discussed below.

As described above, cattle made use of water withdrawals from well 10A-5-W06 throughout the year, drinking a calculated 815,802 gallons per year at an annual average of 2,689 gallons per day. Extrapolating from recent observations, wildlife would have made use of water during the entire year as well, Figure 22 (also see wildlife discussion below).

Figure 22 – Cattle and Wildlife Share the Water Source

Given these conditions and the magnitude of the associated water withdrawals, the windmill would have been set to pump continuously throughout the year except when or if the main storage tank became full (Cox Dep. 50:3-51:4). To do so, the windmill vane would have

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Other chronic losses are associated with leakage through the concrete bottoms of the holding tank and water troughs as well as from leaks associated with interconnecting pipe fittings and valves. Infrastructure at the well 10A-5-W06 location was 45 years old in 2000 when last used significantly for livestock watering purposes. To reduce excessive leakage, the Defendants have replaced or repaired the concrete bottom of two tanks, three times in the past ten years. The Defendants removed one water drinker in 2007 to mitigate these kinds of losses (Figure 23). Despite Tom Cox testimony that he didn't recall any leaks (Cox Dep. 75:14-20), Figure 24 shows at least seven leak repairs in this drinker as well as corrosion failure at the base.

Figure 23 – Removal of Leaking Drinker

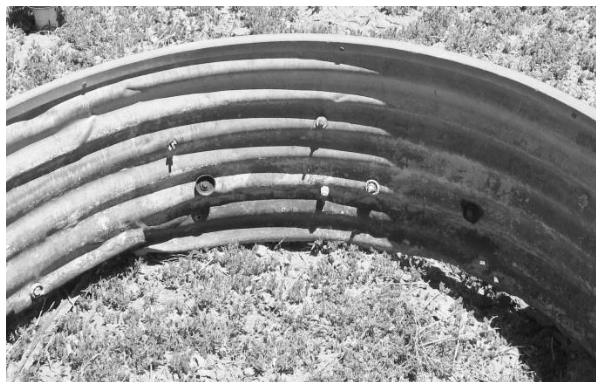

Figure 24 – Prior Repairs to Drinker

Evidence of previous leaks and repairs is readily observable at the well site; Figures 25 and 26 represent examples. Failure of the concrete is associated with freeze-thaw cycling, frost heave and weathering of the concrete itself. The main holding tank is known to be a significant and unmitigated source of leakage as evidenced by standing water below ground level in the main storage tank valve box, Figure 27. Valve stem packing failure and aging piping and fittings contribute smaller amounts to the chronic leakage total as well.

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Figure 25 – Storage Tank Leak

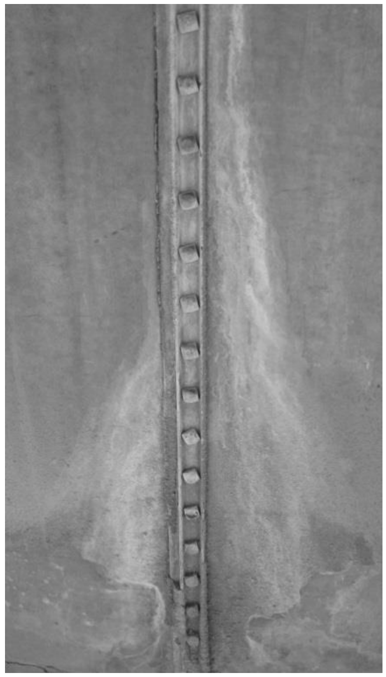

Figure 26 – Seam Leak

Figure 27 - Water in Valve Box

The cumulative effect of chronic leaks for the well 10A-5-W06 infrastructure can be determined by observing the rate of water level drop in the 10-foot tall, main holding tank. Based on my observation, the water level drops approximately one foot per week. Subtracting evaporation and wildlife usage, the system leakage rate appears to be at least 0.1 gpm. The historic annual loss of water due to chronic leaks is projected to have been 52,560 gallons.

Although the leaks are likely to be distributed throughout the entire water delivery and storage system, this annual loss is the equivalent of leakage through a single, 0.05-inch diameter hole in the bottom of the main holding tank at 10 feet of pressure head. Chronic leakage associated with water delivery systems is reported by the cattle industry and is not unique to the subject infrastructure. A study of water use in feedyards found that 7% of total water delivered to troughs was lost through threaded fittings alone (Parker, 2000). The annual leakage of 52,560 gallons per year calculated above is similar in magnitude to the 57,106 gallon loss that can be calculated by applying a 7% loss rate to the 815,802 gallons of water consumed each year as determined in Section 5.5.

Another significant loss was associated with the removal of ice from the drinkers during the winter months. Based on testimony, the drinkers serviced by well 10A-5-W06 would ice over, generally from mid-December until the first of March. Daily average temperatures are at or below freezing from December 7 through February 1 (Intellicast, 2016); cold air accumulates at the well location and air temperature is frequently sub-zero on winter mornings (see Figures 28 and 29).

Figure 28 – Ice Covered Drinker at -7 °F

Figure 29 – Ice Covered Float Tank at - 15 °F

Cattle require water daily and sub-freezing winter temperatures demand that active measures be taken to remove ice cover. The well location would be visited every other day (Cox Dep. 64:23-65:13); the ice would be broken up with an axe and thrown out (Cox Dep. 66:3-16). To account for this loss, it is estimated that the combined, average thickness of ice and water removed from the two drinkers was four inches and that the well location was visited every other day, mid-December until March, for ice removal purposes. The volumetric loss is determined to have been 6,917 gallons per year.

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Based on game camera observations, the elk visitation rate averages 20 individual animals per day with the same animals reappearing approximately once every three days. The elk browse over the long distances separating sources of water, those currently being distributed five-miles apart in the near region. Home ranges for elk average between one and 95 square miles (Innes, 2011). The visitation frequency averages once per day, 75% of the days per year. The population appears stable and is dominated by many small groups of bull elk in the summer and larger herds of cow elk in the winter (author's observations). Spatial patterns and the timing of habitat use are important factors in elk and cattle interaction. Although these elk would share Rincon Hondo Canyon with cattle, elk range over a much larger area than cattle and there is not complete dietary overlap between them (Launchbaugh, Not dated).

For the purpose of this analysis, free water intake is estimated to vary between 3 and 10 gallons per day depending on time of year and animal size and status. Using a free water intake rate of 6.5 gallons per day, and an annual well use frequency of 75%, the historic total water loss by elk is projected to be 35,588 gallons per year.

Other wildlife observed and photographed drinking at well 10A-5-W06 include mountain lion, black bear, coyote, bob cat, fox, badger, skunk, jack rabbit, rock squirrel, chipmunk, bat, and a large variety of birds. Stray cattle and horses are less frequently observed. Although antelope and cottontails are also present, they have never been observed drinking water at the well. The combined free water use by these animals is considered to be small by comparison to that of mule deer and elk and is conservatively ignored.

Summary: Consumptive and other losses associated with well 10A-5-W06 are compiled in Table 8 and are conservatively determined to total 415,522 gallons per year, i.e., 1.275 acre-

CRAIG L. FREDRICKSON

Experience Summary

Mr. Fredrickson has diverse professional and management experience derived from a 27-year career within the commercial and federal government nuclear and hazardous waste management industries. His technical expertise includes the assessment of public health and environmental risks posed by chemical and radiotoxic materials, nuclear facility safety analysis, and application of regulations pursuant to the Atomic Energy Act, Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act, Clean Air Act, the Nuclear Waste Policy Act, and the National Environmental Policy Act (NEPA). Mr. Fredrickson directed several multi-million-dollar subcontracts to U.S. Department of Energy (DOE) prime contractors, and managed project staffs and organizations composed of up to 80 engineers and scientists. He was a founder and managing director of Benchmark Environmental Corporation. Mr. Fredrickson retired with Benchmark in 2000.

Education and Selected Training

B.S., Nuclear Engineering, Pennsylvania State University, University Park, Pennsylvania, 1973

Basic Management Program, University of New Mexico Graduate School of Management, Albuquerque, New Mexico, 1993

Site Remediation (40-Hour Occupational Safety and Health Administration [OSHA] training), International Technology (IT) Corporation, Albuquerque, New Mexico, 1988

Project Management Professional Development Course, IT Corporation, Albuquerque, New Mexico, 1986

Professional Experience

Benchmark Environmental Corporation
Albuquerque, New Mexico
1989–2000

As a managing director, Mr. Fredrickson was responsible for program management, business development, office operations, and other functions necessary to support an environmental services consulting firm. He served as the president of the company, as its financial officer, and developed and maintained corporate infrastructure including corporate accounting in accordance with the federal acquisition regulation, quality assurance in accordance with nuclear standards, and development of physical facilities. He was one of the founders of the firm.

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Mr. Fredrickson's technical expertise is in nuclear facility safety, radioactive mixed waste risk assessment, and regulatory compliance issues. As a consulting engineer, Mr. Fredrickson assisted in conducting nuclear facility safety analysis of the Waste Isolation Pilot Plant (WIPP). He conducted radiological risk analyses and public health evaluations for the WIPP *Final Supplemental Environmental Impact Statement*. He supported the development of the RCRA Part B permit application for the WIPP and was project manager responsible for preparing a National Emission Standards for Hazardous Air Pollutants' quality assurance project plan for the WIPP radioactive emission monitoring and sampling system.

Mr. Fredrickson managed several task order agreements to provide technical support services to Los Alamos National Laboratory (LANL). Mr. Fredrickson directed the preparation of safety analysis reports (SARs) for various LANL facilities including a project to retrieve transuranic (TRU) waste from earthen-covered storage, a TRU waste characterization and transport loading facility, a radioactive waste characterization, reduction, and repackaging facility, and a TRU waste storage and low-level radioactive waste (LLW) disposal facility.

Mr. Fredrickson was project manager and conducted radiological dose modeling for a proposed commercial LLW disposal facility in the mid-qawest. He directed various studies for DOE's Hanford Reservation site, and was the project manager of a subcontract to provide radioactive waste management support services to the Idaho National Engineering Laboratory (INEL).

International Technology (IT) Corporation
Albuquerque, New Mexico
1984–1989

As business unit manager, Mr. Fredrickson was responsible for business development, project management, and technical oversight and supervision of the Environmental Compliance and Assessments business unit at IT's Albuquerque Office. He directed a staff of up to 20 engineers and scientists, managed six major subcontracts with DOE prime contractors, and performed technical assignments related to the management of radioactive and hazardous waste. As program director, he managed a master services agreement with EG&G Idaho, Inc. to provide industrial/hazardous waste management support services at the INEL; his duties included preparing task order proposals, negotiating contracts, performing cost and schedule accountability/reporting, and maintaining responsiveness to client needs.

U.S. Department of Energy - Albuquerque Operations Office
Albuquerque, New Mexico
1982–1984

Within the Facility Design and Safety Analysis Branch of the ES&H Division of DOE-AL, as project engineer, Mr. Fredrickson developed criteria, reviewed designs, performed safety analyses, assessed risks, appraised preoperational safety, and evaluated NEPA compliance for nonreactor facilities (e.g., plutonium processing, tritium, high explosives, and waste management) in the DOE complex. He conducted