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SOILS AND RELATED RESOURCE ISSUES

REBUTTAL REPORT

Nevada State Engineer Water Rights Hearing
Spring Valley, Nevada

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SOILS AND RELATED RESOURCE ISSUES

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1.0 Introduction

This rebuttal report addresses opinions presented in the McLendon (2011) report prepared in support of the Southern Nevada Water Authority's (SNWA) water right application in Spring Valley and addresses information presented in the Welch, et.al. (2007) report. In addition to the McLendon and Welch reports, we relied on the Bureau of Land Management (BLM) Environmental Impact Statement dated June 2011, selected documents submitted by the Southern Nevada Water Authority (SNWA), and other existing resource information that is publically available regarding the project area. This report refers only to Spring Valley, specifically the area included in the National Cooperative Soil Survey (NCSS) area identified as White Pine County Nevada East Part (soil survey staff, 2008). Although the impacts in several other groundwater basins would likely be similar to those in Spring Valley, the acreage and potential impacts discussed in this rebuttal report include only those lands within the NCSS report identified above.

The primary assumption made in this evaluation was the predicted level of groundwater drawdown. Depth to water is a critical component in this analysis. It was assumed that the drawdown in the level of groundwater in Spring Valley would be ten feet. Although some references indicated the drawdown may be as much as 50 feet, and other references indicate that there will be no drawdown in certain areas of Spring Valley, all references indicated that the precision of the drawdown prediction was quite low due to the complications of modeling such impacts. Consequently, it was determined that the assumption of a drawdown of ten feet across the Valley would be reasonable for this analysis.

Included in this evaluation was a review of the existing information in Spring Valley that McLendon could have used to predict project impacts; a review of the kinds of impacts that could be expected; and a review of the predicted post-project conditions and predicted impacts. The Welch report discusses the geomorphic land forms, including wet and dry playas, but does not address the conversion from wet to dry playas and the resulting environmental effects. One of the best sources of information that can be utilized in evaluating project impacts is the soil surveys prepared by the Natural Resources Conservation Service (NRCS). It is not clear why this information was not used. The NRCS soil survey information is readily available on-line; it is extensive, comprehensive, site-specific, and is probably the most reliable data source available regarding soil and associated vegetation conditions.

Table 1 (Table of Selected Soil Survey Map Unit Attributes) presents information gathered from the NRCS White Pine County Nevada, East Part soil survey. This table summarizes much of the information that was used in this evaluation regarding playas, wetlands, and phreatophytes.

2.0 Impacts Regarding Playas, Wetlands, and Phreatophytic Ecosystems

For the purpose of this rebuttal report, playas are enclosed concave areas primarily devoid of vegetation, characterized by generally high water tables, possible ponding, and salt crusts of varying thickness and composition.

Wetlands are those areas that meet the Corps of Engineers criteria for wetlands regarding soils, vegetation, and hydrology. Wetlands are underlain by hydric soils with obligate wetland plants (sedges, etc.). They are often periodically ponded or have a high water table that extends to near the soil surface.

Phreatophytic ecosystems are those where the plants depend upon subsurface water supplementing rainfall to exist. These areas are not as wet as wetlands, and the water table is at somewhat greater depths. Phreatophyte areas were identified from the NRCS soil survey by use of the map unit Ecological Site Description (see Table 1). Those Ecological Sites having phreatophytes as part of the plant community were included in the identified phreatophytic ecosystems as used in this report.

2.1 Playas

2.1.1 Extent of Playas

According to Table 1, there are approximately 16,996 acres of playas in Spring Valley (actually these acres are within the NRCS Soil Survey Area identified as White Pine County, Eastern Part; area number NV779, which is dominantly Spring Valley). It is important to remember that there are twelve other NRCS soil survey areas within the entire project, so the acreages presented herein are likely only a fraction of the total area of playas within the groundwater project area.

2.1.2 Description of Playas

Playas, as identified in the NRCS soil survey, are identified as a miscellaneous land type. This means that detailed soil profile data are not gathered nor reported in the same way that other map units are described. The playa areas are simply identified as “Playas” and are neither classified nor described in any significant detail. It is important to note, however, that the NRCS soil survey indicates that the playas (1) have long ponding duration; (2) have water tables at “0” feet (meaning at or above the soil surface) for much of the year, including the spring and summer months; and (3) generally have clayey surfaces with clay, silty clay, or silty clay loam substrata. These areas have salt crusts of varying thickness and composition.

2.1.3 Changes as a Result of Groundwater Drawdown

As previously stated, the NRCS soil survey (which is the best resource information available for this area) does not characterize the soil conditions present in the playas. The only details included in the report regarding playas are (1) depth to groundwater and overflow potential and (2) general soil stratigraphy. This information is insufficient to make meaningful predictions regarding the site-specific effects of groundwater drawdown, or to evaluate the environmental impacts or mitigation requirements. Nevertheless, there are indications as to the general conditions that likely exist and these indications are sufficient to conclude that the adverse environmental consequences of groundwater withdrawal could be significant.

From the NRCS soil survey, we know that these areas are dominantly wet, and often ponded. It is common throughout this region, and is obvious from examination of aerial photos, that most of these playas have salt crusts of varying thickness. Other sources of information support this, along with bits of added information. Spring Valley is located in the NRCS Major Land Resource Area (MLRA) identified as Great Salt Lake Area (28A). Their general description of the playa areas within MLRA 28A states:

1. Most of the valleys in this MLRA are closed basins containing sinks or playa lakes.
2. Poorly drained Aquisalids occur in basin floors. (Aquisalids is the taxonomic classification of soils that have wet soil conditions and high levels of salt.)
3. The text discussion includes references to a particularly large "salty playa" in the area.

It is reasonable to conclude, in the absence of more site-specific information, that these playas are salt-encrusted wet areas that in many instances are frequently ponded.

Although it cannot be concluded that the conditions in the playas of Spring Valley are similar to those in Owens Lakebed in California, the studies done at Owens Lake are a valuable resource in the management of saline playas. For example, it is recognized in the Owens Lake area that soil moisture is a prime soil-binder in salt crusts to prevent dust generation. As a matter of fact, shallow flooding (keeping the salt crust/soil moist to the surface) is a major mitigation practice employed on Owens Lakebed. It is also recognized that the chemical composition of the salt crust significantly affects the potential for dust generation, wherein sodium salts tend to be "fluffy", fine-grained, and easily airborne and calcium salts tend to be more stable. In all likelihood, both kinds of salt will occur in the various playas throughout Spring Valley. In

Spring Valley, when these salt-encrusted playas become dry the binding quality provided by moisture will be lost. Depending upon the specific chemistry of the salts, thickness of the crusts, and other factors, these crusts may then become powdery and may be air-borne, especially during the windy season of the year. Given that the area of playas in the White Pine County Nevada, East Part alone is 16,996 acres, the risk of drying these areas by dropping the water table is obvious.

Other recent studies support the conclusion that dust generation from drained playas in Spring Valley is likely. Playas that are close to the groundwater level have been found to be seasonally susceptible to wind erosion within the southwestern U.S. (Gill, 1996; Pelletier, 2006; Reynolds, et al., 2007), and quick exposure of larger areas (such as the case of Owens Lake) can, without proper mitigation, lead to severe dust emissions. At the Salton Sea, soft crusts were found to be significant producers of dust during winter and early spring, as were dry wash areas containing loose particles on the surface year-round. The removal of fluffed salts by wind erosion facilitates the bare soil to continue salt formation on the soil surface.

2.1.4 Summary

An estimated 16,996 acres of playas occur within that portion of the project area included in the White Pine County Nevada East Part. This is only a portion of the project area, and playas are much more extensive in the total area. Considerable research in defining the processes involved in dust generation from playas has been done, and many site factors that cause dust to become airborne have been identified. Determinations of impacts require adequate baseline information, and this information does not exist for the playa areas.

It is our recommendation that the following site-specific data, at a minimum, are needed on the playa areas for any expert to make a reasonable evaluation regarding the effects of groundwater drawdown:

1. Ponding frequency and current depth to water table.
2. Depth of water table after project development (predicted).
3. Soil stratigraphy to a depth of six feet.
4. Thickness and chemical composition of salt crusts.
5. Soil chemical composition (especially soluble salt content)
6. Location and extent of the various conditions that occur (soil map).

It is practical to gather this baseline information. Current methodologies employed by the NRCS and many natural resource consulting firms are adequate to characterize these areas. The costs of gathering the required information are nominal, especially considering the size and long-term effects of this project. Information would need to be gathered only on the playa areas, as the soil information already published by the NRCS is sufficient for evaluating soil issues on non-playa areas.

2.2 Wetlands

2.2.1 Extent of Wetlands

As indicated in Table 1, there are 14,419 acres of wetlands in the NCSS soil survey of White Pine County Nevada East Part (primarily Spring Valley). It is important to remember that there are twelve other NRCS soil survey areas within the entire project area, so the acreages presented herein are likely only a fraction of the total area of wetlands within the groundwater project area.

2.2.2 Description of Wetlands

According to the Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, wetlands are: "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

Wetlands have the following general diagnostic environmental characteristics:

1. Vegetation: The prevalent vegetation consists of macrophytes that are typically adapted to areas having hydrologic and soil conditions that meet the site conditions described above in the definition. Hydrophytic species, due to morphological, physiological, and/or reproductive adaptation(s), have the ability grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions.

2. Soil: Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.

3. Hydrology: The area is inundated either permanently or periodically at mean water depths less than or equal to 6.6 feet, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

Wetlands are unique ecosystems that help purify natural waste products, filter nutrients from water, offer wildlife habitat, mitigate floods, and provide aesthetic value and other benefits. The USDA-NRCS (2011c) and USGS (2006) maintain lists of hydrophytic plants that are wetland indicator species. The USCA-NRCS Soil Survey Staff (2011a) maintains a list of soils that meet hydric soils requirements. These materials are readily accessible online. Nevada is in USDA

Region 8, Intermountain. In Spring Valley, all hydric soils meet the following criteria: Soils in Aquic suborders, great groups, or subgroups that are poorly drained or very poorly drained and have a water table at a depth of 1.0 foot or less during the growing season if the permeability is less than 6.0 in/hr in any layer within a depth of 20 inches.

The NRCS soil survey of White Pine County Nevada East Part (Soil Survey Staff, 2007) maps and describes the hydric soils in the survey area. In addition, the survey describes the soil series, map units, physical and chemical properties of the various hydric soils. The information utilized in this report was taken primarily from the NRCS soil survey.

2.2.3 Changes as a Result of Groundwater Drawdown

Wetlands are much more insulated to wind erosion than "drought tolerant grasses and forbs". When one also takes into account the changes in soil chemical properties (especially salinity), the statement in the EIS is much too general. The following information about ecosites, biomass production, and cover are taken from the soil survey of White Pine County, Eastern Part (Soil Survey Staff, 2007, 2011b), NRCS Ecosite Descriptions (USDA-NRCS, 2011a), and McLendon (2011). A 10-ft drop in the water table depth would transition all wetlands and wet meadows at least to dry meadows. This would result in at least 35% reductions in biomass production, with a concomitant 20 to 35% decrease in cover. The salinity and sodicity characteristics of some of the wetlands and wet meadow soils might shift the transitions to dry saline meadows, resulting in an 80% decrease in biomass and 40 to 50% reduction in cover. All wet saline meadows, saline bottoms and saline meadows would likely transition to dry saline meadows, with 60 to 85% decreases in biomass, and 40 to 60% reduction in cover. The additional exposed soil surfaces would be subject to wind and water erosion. As the grass cover decreases, phreatophytic shrubs might invade, causing transition away from meadow (grass-dominated) to shrub-dominated communities.

McLendon concludes "productivity and plant cover may decrease" due to a 10-ft decrease in the water table, which is in direct opposition to the EIS report that "overall plant cover would likely remain similar to baseline conditions over time" (p. 3.4-32, BLM 2011). This statement contradicts the EIS discussion of Phase 3 in the vegetation chapter, "Bare interspaces among shrubs would increase and some of these interspaces could be invaded by annual native and exotic species" (p. 3.5-40, BLM 2011).

Decreasing vegetation will decrease filtering of sediments during runoff events, resulting in more sediment transport, silting-in streams and waterways when deposition occurs. Many organic and inorganic compounds are removed as water passes through wetlands. Constructed wetlands have been used to clean effluent from concentrated animal feeding operations to EPA standards for release into surface waters. Only groundwater quality is addressed in the EIS; surface water quality is not. Loss of wetlands will result in surface water quality degradation. Dense wetland vegetation slows water velocity in channels during runoff events. If vegetation density decreases due to groundwater drawdown, downstream flooding is more likely, and less aquifer recharge will occur as the residence time in the recharge area is decreased.

2.2.4 Summary

Sufficient information exists (primarily in the soil survey report) to reasonably predict the effects of drawdown upon wetland areas within the project. It is estimated that, based upon the assumed groundwater drawdown of 10 feet, all of the 14,419 acres of wetlands in the survey area will be eliminated and converted to drier sites (see Table 1 for conversion predictions). The drawdown of groundwater by 10 feet will effectively eliminate the anaerobic soil conditions required for wetlands. The results of these ecosystem conversions have not been properly addressed by McLendon (2011).

The U.S. Army Corps of Engineers recognizes the presence of jurisdictional wetlands, those subject to regulation under Section 404 of the Clean Water Act, in the project area (see letter from USAC to Kenneth Albright of SNWA dated August 18, 2009 and included as Exhibit 364). The total extent of jurisdictional wetlands, to our knowledge has not been addressed; however the potential destruction of 16,000 acres of wetlands in Spring Valley alone is an issue that will likely be addressed at some point. Such a determination is beyond the scope of this report.

One of the ACMs intended to assist with the vegetative transition is large-scale seeding. However, large-scale seeding in arid and semiarid regions, without irrigation or timely precipitation, has little record of success (Gaus, 2010).

It is our opinion that existing wetlands in Spring Valley will be converted to dry meadows or dry saline meadows, with 30 to 85% reductions in biomass production and 20 to 60% reductions in soil cover. These changes will increase the potential for erosion, surface water quality degradation, downstream flooding, and decrease basin aquifer recharge.

2.3 Phreatophytes

2.3.1 Extent of Phreatophytes

Apart from wetlands, obligate and facultative phreatophytes are present on at least 145,810 acres on thirteen ecosites in the White Pine County Nevada East Part Soil Survey Area. As previously indicated, there are a total of twelve other soil survey areas within the groundwater project area, so the total acreage of phreatophytes is much larger than 145,810 acres.

2.3.2 Description of Phreatophytes

These were identified as soils with a water table between 1 and 5 feet, and/or have a predominance of phreatophytes: alkali sacaton (*Sporobolus airoides*), inland saltgrass (*Distichlis spicata*), alkali cordgrass (*Spartina gracilis*), alkaligrass (*Puccinellia spp.*), greasewood (*Sarcobatus vermiculatus*), and sickle saltbush (*Atriplex falcata*).

2.3.3 Changes as a Result of Groundwater Drawdown

The following information about ecosites, biomass production, and cover are taken from the soil survey of White Pine County, Eastern Part (Soil Survey Staff, 2007, 2011b), NRCS Ecosite Descriptions (USDA-NRCS, 2011a), and McLendon (2011). Eight of the ecosites have water tables between 1 and 5 feet all year. These are grass-dominated meadows that produce 400 to 1500 lbs/ac. If the water table drops 10 feet, the grass component of the vegetation will decrease, and shrubs may increase or invade. Due to the reduced water availability to support plant growth, it was assumed that biomass production would approximate that of an unfavorable year, and will decrease about 40% on sodic ecosites, and about 30% on saline and other ecosites. These reductions in biomass likely would result in 20 to 30% reductions in soil cover.

McLendon (2011) fails to address the potential impact of salinization on the vegetative community as the water table declines. If soil salinity increases as the water table declines, biomass production may decrease as much as 70 to 95%, with concomitant decreases in surface cover. Salts are common in these soils, so this is a likely scenario. While the water table is near the surface, capillary fringe draws water to the surface, bringing salts with it. As the water table drops, upward movement of salts will diminish. However, there will be little to no water moving down into the soil to leach the salts downward. Increased salt content at the soil surface will decrease germination and establishment of plants. This is a factor that would limit effectiveness of large-scale seeding (ACM C.2.5).

McLendon (2011) provides an excellent discussion of the likely succession that will occur with the change in depth to water. Patten et al (2008) predict a reduction in upland phreatophytic vegetation as the groundwater level drops below the root zone due to pumping and the interconnected nature of the basin-fill aquifer and the carbonate rock aquifer system. Manning (1999) noted that phreatophytic shrub communities in Owens Valley might represent end-succession communities which further disturbance or stress might convert to bare, weedy land.

All these information sources contradict the conclusion of the EIS (Chapter 3, Page 3.4-21, BLM, 2011):

"Based on a literature review of phreatophytic vegetation responses to groundwater drawdown (Section 3.5), it is expected that there would be changes in species composition, but overall plant cover would likely remain similar to baseline conditions over time. Therefore, it is unlikely that there would be an increase in soil erosion due to decreases in hydric soils and associated changes in plant communities. The maintenance of a relatively constant plant canopy cover and soil stabilization by plant roots may vary from place to place, depending on the soil chemistry and texture, alterations of soil biological and physical crusts, and the proximity of seed sources of plants that are adapted to changing soil moisture conditions."

2.3.4 Summary

It is our opinion there will be a decrease in vegetative production and plant cover that accompanies the shift in species composition on much of the area currently supporting phreatophytes. These changes will leave more soil surface area exposed, increasing the potential for wind and water erosion. These effects have not been fully evaluated by McLendon (2011). Current information is likely sufficient to make a reasonable evaluation of the effects of the project.

Table 1 Table of Selected Soil Attributes, p. 1

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
1030	3,082	Toano	70	2,157	3	8-16	1-12	Saline Terrace	350		245
1160	586	Kolda	2	12	2	4-8	0	Dry Meadow	1300		910
1326	6,868	Kolda	4	275	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
1370	2,451	Kolda	5	123	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
1371	3,086	Kolda	5	154	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
1800	5,928	Kolda	4	237	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
2010	1,004	Chuffa	60	602	2	0-8	1-12	Sodic Terrace	600		360
3000	2,028	Toano	55	1,115	3	8-16	1-12	Saline Terrace	350		245
		Playas	5	101	1	0-4	--	--	--		
3004	15,631	Benin	40	6,252	3	8-16	13-50	Sodic Flat	300		180
		Katelana	30	4,689	3	16-32	90-180	Sodic Terrace	400		240
		Playas	15	2,345	1	0-4	--	--	--		
3005	4,442	Playas	30	1,333	1	0-4	--	--	--		
		Benin	15	666	3	8-16	13-50	Sodic Flat	300		180
		Kolda	5	222	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Hogum	3	133	2	2-8	0-12	Wet Clay Basin	100		100
3008	4,945	Benin	65	3,214	3	8-16	13-50	Sodic Flat	300		180
		Playas	20	989	1	0-4	--	--	--		
3041	4,170	Kolda	2	83	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3130	9,461	Timpie	15	1,419	3	16-32	13-50	Saline Terrace	500		350
		Playas	4	378	1	16-32	13-90	Desert Salty SIlt (Iodinebush)	--		
3132	2,123	Playas	6	127	1	0-4	--	--	--		
3174	1,305	Sycomat	45	587	3	2-4	0-5	Sodic Terrace	400		240

Table 2 Table of Selected Soil Attributes, p. 2

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
3175	4,157	Gravier	30	1,247	3	0-2	13-30	Sodic Terrace	400		240
		Kunzler	20	831	3	4-16	40-60	Sodic Terrace	600		360
3180	8,842	Playas	1	88	1	0-4	--	--	--		
3189	2,017	Kawich	40	807	3	4-8	1-5	Sodic Dune	500		500
		Ewelac	25	504	3	8-16	46-90	Dry Saline Meadow	400		280
		Biji	20	403	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	5	101	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3190	3,424	Kawich	70	2,397	3	4-8	1-5	Sodic Dune	500		500
		Benin	15	514	3	8-16	13-50	Alkali SIlt Flat	350		210
		Playas	3	103	1	0-4	--	--	--		
3191	6,850	Katelana	65	4,453	3	16-32	90-180	Sodic Terrace	400		240
		Benin	20	1,370	3	8-16	13-50	Sodic Flat	300		180
		Playas	6	411	1	0-4	--	--	--		
3192	1,595	Kawich	25	399	3	4-8	1-5	Sodic Dune	500		500
		Katelana	15	239	3	16-32	90-180	Sodic Terrace	400		240
3193	2,928	Benin	50	1,464	3	8-16	13-50	Sodic Flat	300		180
		Biji	20	586	3	4-8	46-90	Saline Bottom	1500		900
		Katelana	15	439	3	16-32	90-180	Sodic Terrace	400		240
3194	1,126	Sycomat	45	507	3	2-4	0-5	Sodic Terrace	400		240
		Benin	40	450	3	8-16	13-50	Sodic Flat	600		360
3195	1,099	Ewelac	50	550	3	8-16	46-90	Sodic Flat	300		180
		Benin	20	220	3	8-16	13-50	Sodic Flat	600		360
		Biji	15	165	3	4-8	46-90	Saline Bottom	1500		1050

TABLE 3 TABLE OF SELECTED SOIL ATTRIBUTES, P. 3

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
3196	12,863	Benin	40	5,145	3	8-16	13-50	Alkali SIlt Flat	350		210
		Benin	30	3,859	3	8-16	13-50	Sodic Flat	300		180
		Katelana	15	1,929	3	16-32	90-180	Sodic Terrace	400		240
		Playas	2	257	1	0-4	--	--	--		
3197	1,578	Benin	40	631	3	8-16	13-50	Sodic Flat	300		180
		Katelana	30	473	3	16-32	90-180	Sodic Terrace	400		240
		Ewelac	15	237	3	8-16	46-90	Dry Saline Meadow	400		280
3198	1,633	Kunzler	35	572	3	4-16	40-60	Sodic Terrace	600		360
		Kawich	30	490	3	4-8	1-5	Sodic Dune	300		180
3231	3,310	Benin	30	993	3	8-16	13-50	Alkali SIlt Flat	350		210
		Sondoa	15	497	3	8-16	91-130	Shallow Silty	300		180
3270	2,718	Benin	50	1,359	3	8-16	13-50	Alkali SIlt Flat	350		210
		Sondoa	20	544	3	8-16	91-130	Shallow Silty	300		180
		Playas	15	408	1	0-4	--	--	--		
3271	3,335	Benin	75	2,501	3	8-16	13-50	Alkali SIlt Flat	350		210
		Playas	15	500	1	0-4	--	--	--		
3290	8,681	Kunzler	55	4,775	3	4-16	40-60	Sodic Terrace	600		360
		Sycomat	30	2,604	3	2-4	0-5	Sodic Terrace	400		240
		Kolda	1	87	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3291	4,305	Kunzler	70	3,014	3	4-16	40-60	Sodic Terrace	600		360
		Katelana	20	861	3	16-32	90-180	Sodic Terrace	400		240
		Kolda	2	86	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3293	4,408	Kunzler	45	1,984	3	4-16	40-60	Sodic Terrace	600		360

Table 4 Table of Selected Soil Attributes, p. 4

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
3294	3,394	Kunzler	45	1,527	3	4-16	40-60	Sodic Terrace	600		360
		Ragnel	40	1,358	3	0-4	1-5	Sodic Terrace	600		360
3340	7,037	Playas	5	352	1	0-4	--	--	--		
3341	2,876	Yelbrick	15	431	3	4-16	13-30	Alkali SIlt Flat	350		210
		Playas	6	173	1	0-4	--	--	--		
3342	6,456	Playas	2	129	1	0-4	--	--	--		
3343	16,758	Kolda	2	335	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3344	7,292	Kolda	1	73	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Fluvaquentic Endoaquolls	1	73	2	0	0	Wet Meadow	1700		1700
3443	3,421	Kolda	5	171	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3500	5,980	Ewelac	40	2,392	3	8-16	46-90	Sodic Flat	300		180
		Biji	30	1,794	3	4-8	46-90	Saline Bottom	1500		1050
		Medlaval	15	897	3	0-2	1-5	Dry Meadow	1100		770
		Kolda	6	359	2	4-8	1-5	Wetland	2800	Dry Meadow	1300
3505	2,121	Ewelac	55	1,167	3	8-16	46-90	Dry Saline Meadow	400		280
		Biji	30	636	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	2	42	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3506	563	Ragnel	55	310	3	0-4	1-5	Sodic Terrace	600		360
		Biji	35	197	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	4	23	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300

TABLE 5 TABLE OF SELECTED SOIL ATTRIBUTES, P. 5

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
3507	7,618	Ewelac, occ. Flooded	35	2,666	3	8-16	46-90	Dry Saline Meadow	400		280
		Ewelac	30	2,285	3	8-16	46-90	Sodic Flat	300		180
		Biji	20	1,524	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	6	457	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3508	1,363	Ewelac	70	954	3	8-16	46-90	Dry Saline Meadow	400		280
		Hogum	5	68	2	2-8	0-12	Wet Clay Basin	100		100
3509	4,102	Ewelac	50	2,051	3	8-16	46-90	Clay Hummocks	900		540
		Katelana	15	615	3	16-32	90-180	Sodic Terrace	500		300
3510	4,873	Biji	60	2,924	3	4-8	46-90	Saline Bottom	1500		1050
		Ewelac	30	1,462	3	8-16	46-90	Dry Saline Meadow	400		280
		Kolda	4	195	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3512	3,618	Kolda	1	36	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
3515	3,875	Ragnel	65	2,519	3	0-4	1-5	Sodic Terrace	600		360
3600	1,186	Biji	45	534	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	30	356	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Ewelac	15	178	3	8-16	46-90	Saline Bottom	400		280
3610	1,459	Threedogs	65	948	3	2-4	13-30	Saline Floodplain	1200		1200
		Slaw	20	292	3	16-32	13-30	Saline Floodplain	1200		1200
3612	2,383	Littlespring	35	834	3	2-4	5-13	Sodic Terrace	400		240
		Bigspring	30	715	3	2-4	8-12	Sodic Terrace	600		360

TABLE 6 TABLE OF SELECTED SOIL ATTRIBUTES, P. 6

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Pre Development: Ecological Site	Pre Development: Production (lbs/acre)	Post Development: Ecological Site	Post Development: Production (lbs/acre)
3614	3,023	Littlespring	45	1,360	3	2-4	5-13	Sodic Terrace	400		240
		Bigspring	40	1,209	3	2-4	8-12	Sodic Terrace	600		360
		Playas	5	151	1	0-4	--	--	--		
3616	3,583	Sycomat	35	1,254	3	2-4	0-5	Sodic Terrace	400		240
		Kunzler	30	1,075	3	4-16	40-60	Sodic Terrace	600		360
3700	10,765	Kolda	55	5,921	2	4-8	1-12	Wet Meadow	2000	Dry Meadow	1300
		Duffer	30	3,230	3	8-32	13-90	Saline Meadow	1000	Dry Saline Meadow	400
3702	1,664	Kolda	45	749	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Biji	30	499	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	15	250	2	4-8	1-5	Wetland	2800	Dry Meadow	1300
3715	1,101	Ewelac	50	551	3	8-16	46-90	Saline Bottom	400		280
		Kolda	20	220	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Bigspring	15	165	3	8-16	46-90	Sodic Terrace	600		360
3721	1,568	Katelana	30	470	3	16-32	90-180	Sodic Terrace	400		240
3723	6,527	Katelana	45	2,937	3	16-32	90-180	Coarse Gravelly Loam	500		300
3751	2,583	Katelana	85	2,196	3	16-32	90-180	Sodic Terrace	400		240
3752	5,459	Raph	40	2,184	3	0-4	13-45	Sodic Terrace	400		240
		Benin	35	1,911	3	8-16	13-50	Sodic Terrace	400		240
		Gravier	15	819	3	0-2	13-30	Sodic Terrace	400		240
3770	1,294	Ewelac	35	453	3	8-16	46-90	Saline Bottom	400		280
		Kawich	30	388	3	4-8	1-5	Sodic Dune	500		500
		Biji	20	259	3	4-8	46-90	Saline Bottom	1500		1050
		Kolda	4	52	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300

TABLE 7 TABLE OF SELECTED SOIL ATTRIBUTES, P. 7

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
3780	716	Benin	90	644	3	8-16	13-50	Sodic Terrace	400		240
3785	503	Ewelac	60	302	3	8-16	46-90	Saline Bottom	400		280
		Ewelac	30	151	3	8-16	46-90	Sodic Flat	400		240
4050	15,548	Playas	5	777	1	0-4	--	--	--		
4051	3,569	Playas	5	178	1	0-4	--	--	--		
4052	16,719	Kolda	5	836	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
		Playas	5	836	1	0-4	--	--	--		
4053	867	Katelana	30	260	3	16-32	90-180	Sodic Terrace	400		240
4055	2,613	Izamatch	40	1,045	3	0-4	13-30	Sodic Terrace	400		240
		Katelana	30	784	3	16-32	90-180	Sodic Terrace	400		240
		Gravier	20	523	3	0-2	13-30	Sodic Terrace	400		240
4060	7,054	Ocala	45	3,174	3	4-8	31-90	Saline Bottom	1500		1050
		Duffer	25	1,764	3	16-32	46-90	Saline Meadow	1000	Dry Saline Meadow	400
		Kolda	15	1,058	2	4-8	0	Wet Meadow	2000	Dry Meadow	1300
4112	1,783	Playas	5	89	1	0-4	--	--	--		
4113	753	Raph	25	188	3	0-4	13-45	Sodic Terrace	400		240
4121	10,520	Katelana	40	4,208	3	16-32	90-180	Sodic Terrace	500		300
		Biji	15	1,578	3	4-8	46-90	Saline Bottom	1500		1050
5000	7,270	Playas	100	7,270	1	0-4	--	--	--		
5010	6,322	Biji	30	1,897	3	4-8	46-90	Saline Bottom	1500		1050
		Hogum	3	190	2	2-8	0-12	Wet Clay Basin	100		100
5020	12,815	Kunzler	40	5,126	3	4-16	40-60	Sodic Terrace	700		420

TABLE 8 TABLE OF SELECTED SOIL ATTRIBUTES, P. 8

Spring Valley Nevada, NRCS Soil Survey Area 779, White Pine County, Nevada, East Part

								Pre Development		Post Development	
Map Unit	Total Acres in MU	Name of MU Component	% of MU	Acres of Component	Wetness Category	ECe	SAR	Ecological Site	Production (lbs/acre)	Ecological Site	Production (lbs/acre)
5022	1,029	Kunzler	25	257	3	4-16	40-60	Sodic Terrace	600		360
5030	2,714	Biji	30	814	3	4-8	46-90	Saline Bottom	1500		1050
		Duffer	30	814	3	16-32	46-90	Saline Meadow	1000	Dry Saline Meadow	400
		Hogum	25	679	2	2-8	0-12	Wet Clay Basin	100		100
6139	191	Logan	85	162	2	2-4	0	Wet Saline Meadow	3000	Dry Saline Meadow	400

Wetness Catgory 1, Playas Acres: 16,996
Wetness Catgory 2, Wetlands Acres: 14,419
Wetness Catgory 3, Phreatophytes Acres:145,810

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4.0 Signature

Cliff Landers — Date: 8/25/11

Dr. Clay Robinson — Date: 8-25-11