WASTE MANAGEMENT

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WASTE MANAGEMENT
OF NEVADA

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Reno, Nevada 89502
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Reno Disposal Company
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Sparks Sanitation Company
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B & L Disposal Company
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Reno, Nevada 89502

Independent Sanitation Company
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Reno, Nevada 89502

RSW Recycling
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Reno, Nevada 89502

Refuse, Inc.
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Lockwood Regional Landfill
2401 Canyon Way
Lockwood, Nevada 89434

Incline Sanitation Company
1076 Tahoe Blvd.
Incline Village, Nevada 89451
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Capital Sanitation Company
202 E. Washington Street
Carson City, Nevada 89701
(775) 882-3380

Fernley Disposal Company
Churchill County Refuse Service
1100 Hwy 95A
Fernley, Nevada 89408
(775) 575-4964

Feather River Disposal
1166 Industrial Way
Quincy, California 95971
(530) 283-2065

Lassen Waste Systems
125 South Lassen Street
Susanville, California 96130-4321
(530) 257-3553

Alturas Disposal
335 No. Main Street
Alturas, California 96101
(530) 233-2373

December 29, 2011

Mr. Jon Taylor, PE CEM
Staff Engineer III
Bureau of Waste Management
Solid Waste Branch
901 S. Stewart Street, Suite 4001
Carson City, Nevada 89701

Re: Permit Modification Application – Permit Number SW214R01
Lockwood Regional Landfill
Storey County, Nevada

Dear Mr. Taylor,

Please find enclosed our Application for a Modification of Refuse Inc. permit number SW214R01

Also enclosed are supporting documents for the application including:

- Design Report
- Hydrogeologic Report
- Facility Monitoring Plan
- Proposed changes to the Facility Operations Plan applicable to the Modification request
- Proposed changes to the Closure and Post Closure Plan applicable to the Modification Request

We look forward to your review and comments on these documents. Please do not hesitate to contact me at 775-560-9012 or Mark Franc at 801-726-7052 if you have any questions about the attached information.

Sincerely,

William Carr, P.E.
Senior District Manager – Lockwood Regional Landfill

Attachments:

PERMIT MODIFICATION APPLICATION

PERMIT NUMBER SW214R01

LOCKWOOD REGIONAL LANDFILL

STOREY COUNTY, NEVADA

Prepared for:
Waste Management Refuse, Inc.
2401 Canyon Road
Sparks, Nevada 89434
Telephone: (775) 342-0401 Ext 200
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Prepared by:
Applied Soil Water Technologies, LLC.
56 Coney Island Drive
Sparks, Nevada 89431
Telephone: (775) 284-5500
Fax: (775) 284-5504

December 2011

Project No.: 002-047

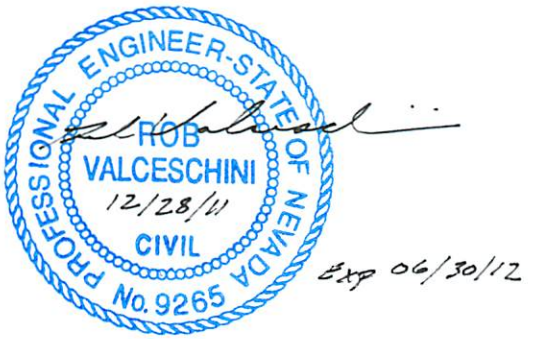
Responsibility Statement

The findings, design, and recommendations presented in this report titled *Permit SW214R01 Modification Application, Lockwood Regional Landfill, Storey County, Nevada* were prepared in accordance with the degree of professional care, prudence and skill of a nationally recognized, properly licensed, professional firm.

We trust this information suits your current need. If you have any questions or would like to discuss this report in more detail, please do not hesitate to contact us at (775) 284-5500.

Sincerely,

Applied Soil Water Technologies, LLC



Robert B. Valceschini, P.E.
Principal/Senior Engineer

Michelle L. Morrow, E.I.
Project Professional

PERMIT SW214R01 MODIFICATION APPLICATION

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LIST OF ACRONYMS

Acronym	Reference
ABS	Acrylonitride-Butadiene-Styrene
AEFC	Alternative Earthen Final Cover
AMSL	Above Mean Sea Level
ASTM	American Society for Testing and Materials
ASUP	Amended Special Use Permit
ASW	Applied Soil Water Technologies, LLC
CFR	Code of Federal Regulations
CWA	Clean Water Act
DRI	Desert Research Institute
EERC	Earthquake Engineering Research Center
ET	Evapotranspirative
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FML	Flexible Membrane Liner
HEC	Hydrologic Engineering Center (Computer Model)
HELP	Hydrologic Evaluation of Landfill Performance (Computer Model)
LCB	Legal Counsel Bureau
LCRS	Leachate Collection and Recovery System
LEL	Lower Explosive Limit
MHEA	Maximum Horizontal Equivalent Acceleration
MSW	Municipal Solid Waste
MSWLF	Municipal Solid Waste Landfill
NAC	Nevada Administrative Code

NDEP	Nevada Division of Environmental Protection
NDEP/BWM	Nevada Division of Environmental Protection/Bureau of Waste Management
NEC	Nevada Environmental Commission
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRS	Nevada Revised Statutes
OII	Operating Industries, Inc.
pcf	Pounds Per Cubic Foot
psf	Pounds Per Square Foot
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
SCS	Soil Conservation Science
SASUP	Second Amended Special Use Permit
SUP	Special Use Permit
SWMA	Solid Waste Management Authority
tpd	Tons Per Day
USCOE	United Sates Army Corps of Engineers
USCS	Unified Soil Classification System
USDOC	United States Department of Commerce
USEPA	United States Environmental Protection Agency
USFHWA	United States Federal Highway Administration
USGS	United States Geological Survey
WCDHD	Washoe County District Health Department

SECTION 1

INTRODUCTION

1.1 BACKGROUND

Applied Soil Water Technologies, LLC (ASW) is submitting this modification to the current permit SW214R01 to assist Refuse, Inc. in obtaining a permit modification to increase the capacity of the Lockwood Regional Landfill (Landfill or Site). Applied Soil Water Technologies has developed a design which increases the volume vertically within the currently permitted Disposal Area. Additionally, the proposed design increases the Disposal Area to the east and south of the currently permitted area. The Landfill currently operates under NDEP/BWM permit SW214R01 and a SUP issued by Storey County. The SUP covers lands currently used for Landfill operations and the area included in the proposed modification. The capacity of the Landfill is proposed to be increased from 64.8 million cubic yards (CY) to 302.5 million CY. The Disposal Area is proposed to be increased from 350 acres to 856.5 acres.

The lateral expansion proposed in areas south and east of the currently permitted Disposal Area will incorporate a high density polyethylene (HDPE) liner system with a leachate collection and recovery system (LCRS). The proposed liner system consists of an 80-mil to 60-mil thick HDPE geomembrane installed on a prepared subgrade surface. The LCRS system consist of a network of perforated pipes enclosed within a free-draining aggregate placed in strategic locations to address build up of hydraulic head on the HDPE liner.

The Lockwood Regional Landfill currently operates under a Design Report developed by Kennedy/Jenks Consultants in 1994 and updated in January 2011 by ASW which is not included in this report. The information contained herein specifically describes and supports the increase in total Landfill volume vertically over the currently permitted Disposal Area and laterally over the proposed Disposal Area.

Applied Soil Water Technologies submits this modification on behalf of Refuse, Inc. to include a lateral expansion of waste volume outside of the currently permitted Disposal Area which will increase the total area available as Disposal Area. The design contained herein is based on the studies performed by Applied Soil Water Technologies details of which are provided in the report titled *Engineering Design Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County, Nevada* (ASW, 2011a) and the report titled *Hydrogeologic Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County, Nevada* (ASW, 2011b).

This report demonstrates compliance with State of Nevada Regulations Nevada Revised Statutes (NRS) and Nevada Administrative Code (NAC), Chapter 444 and Resource

Conservation and Recovery Act (RCRA) Subtitle D regulations regarding Municipal Solid Waste Landfill (MSWLF) siting and design criteria for the Lockwood Regional Landfill.

1.1.1 Site History

The Lockwood Regional Landfill is a MSWLF that presently has a permitted Disposal Area in a portion of a 2,673.49 acre parcel. Based on the April 2010 aerial survey the Landfill contains a waste volume of 32.8 million cubic yards, of which approximately nine (9) million cubic yards were in place prior to 1994. Based on discussions with Refuse, Inc. personnel and review of historical topographic maps, solid waste disposal at the Landfill has been in continuous operation since the late 1960's. Based on the historical description of the Site presented in the Amended Special Use Permit (ASUP) (Storey County Board of Commissioners, 1990), a previous operator, known as BEMCO, was initially permitted to operate the Landfill in 1969. Refuse, Inc. assumed Landfill operations in 1979 under a lease arrangement with the landowner, Storey County Properties, and operated through 1990 in accordance with a conceptual design plan prepared by EMCON Associates. Refuse, Inc. purchased the Landfill in 1990 and operated it under the ASUP issued by the Storey County Board of Commissioners from July 23, 1990 until it was amended in 2009. On January 20, 2009 a Second Amended Special Use Permit (SASUP) was issued to incorporate an area to the north of the existing Landfill. The Landfill currently operates under this SASUP (Storey County Board of Commissioners, 2009).

Currently, the daily volume of waste received at the Landfill, based on a five (5) day work week (260 working days per year) is approximately 5,000 tons. The estimated waste volume incorporates Municipal Solid Waste (MSW) as well as construction and demolition debris. The Lockwood Regional Landfill also accepts certain approved Special Wastes as detailed in the Site's Operating Plan.

1.1.2 Previous and Concurrent Landfill Siting and Design Studies

Previously prepared geologic, hydrogeologic and engineering design reports were reviewed during the preparation of this permit modification.

Current reports that were used in support of this modification include:

- Applied Soil Water Technologies, LLC., *Engineering Design Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County, Nevada*, December 2011.

- Applied Soil Water Technologies, LLC., *Hydrogeologic Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County, Nevada,* December 2011.

1.2 SCOPE AND OBJECTIVES

1.2.1 Scope

This report proposes modifications to the approved permit SW214R01 to support an increase in capacity to the Landfill outside of the currently permitted Disposal Area. The design modification as proposed will increase the size of the Disposal Area. The proposed design satisfies the regulatory requirements as they relate to Landfill development outside of the currently permitted Disposal Area. In addition to assuring regulatory compliance, the scope of this design report provides the Landfill operators with an economical, constructible, safe and easily maintained final and intermediate Landfill design, while maximizing the disposal capacity and design life of the current facility.

Applicable State of Nevada and Federal (Subtitle D) siting and design criteria relative to the Site that were incorporated for the Landfill design modification presented in this report include the following:

Siting Criteria

- Prohibit location of future landfill development within 1,000 feet of perennial and intermittent surface water courses and lakes, and within 100 feet of the uppermost groundwater aquifer (NAC 444.678).

- Prohibit location of future landfill development within 200 feet of a Holocene fault (i.e. fault which demonstrates movement within the past 8,000 years) (NAC 444.6791).

- Provide landfill design provisions for sites located within a seismic impact zone. The USEPA defines a "seismic impact zone" as areas "having a 10 percent or greater probability that the maximum expected horizontal acceleration in lithified earth materials (i.e., still soil or bedrock), expressed as a percentage of the Earth's gravitational pull (g), will exceed 0.10g in 250 years" (NAC 444.6793).

- Prohibit location of future landfill development within unstable areas, where "unstable areas" are defined by the USEPA as areas exhibiting soil and/or bedrock conditions prone to differential settlement and/or mass wasting (i.e. landsliding) (NAC 444.6795).

- Prohibit location of future landfill development within a designated 100 year floodplain (NAC 444.6785).

- Consideration of wetlands (NAC 444.679).

- Consideration of future landfill development with regard to airport safety (NAC 444.6783).

Design Criteria

- Landfill containment structures must be designed to resist the maximum horizontal bedrock acceleration at the site from an earthquake event (NAC 444.6793).

- The structural integrity of the landfill containment structures and operating elements should not be disrupted by excessive settlement or slope instability (NAC 444.6795).

- Maintain controlled, positive drainage of storm water off of the landfill and direct run-off to collection ponds and run-on waters to suitable discharge points (NAC 444.6885).

- Protect waters of the state from uncontrolled migration of landfill leachate from the site (NAC 444.681).

- Minimize uncontrolled gas migration from the landfill (NAC 444.667).

- Provide composite liner and leachate collection system, or alternative design sufficient to protect the waters of the State, based on the following: (NAC 444.681)

    A. Hydrogeologic characteristics of the site;

    B. Site climate;

    C. Potential landfill leachate generation; and

    D. Other relevant factors.

1.2.2 Objectives

The objectives of this modification to the current permit are to incorporate the increase in capacity in accordance with applicable State of Nevada Regulations, Federal MSWLF

requirements contained in RCRA Subtitle D and performance goals of Refuse, Inc. promoting feasible and prudent design concepts which support economic viability and constructability. These objectives were addressed by performing the following tasks:

- Review performance and operational goals for future Landfill development with Refuse, Inc. personnel.

- Review and incorporate applicable Federal, State, and County regulations into the Landfill design.

- Incorporate the findings of the Permit SW214R01 Modification Engineering Design and Hydrogeologic Reports (ASW, 2011a and 2011b) into the design concept and rationale.

- Perform a study and analysis of Site seismicity for the area outside of the Disposal Area. Perform stability and deformation analyses in accordance with the Seismic Design Criteria.

- Incorporate geotechnical and hydrological analyses for the proposed additional Disposal Area with respect to the final Landfill configuration design, including stability of Landfill foundation materials, slope stability analysis, cover elements, and temporary cut slopes. In addition, perform settlement analysis of Landfill waste for the permit modification.

- Develop a final Landfill bench plan based on existing Landfill conditions and general site topographic constraints, drainage considerations, operator input, long-term operations and maintenance accessibility, and projected operating design life of the Landfill.

- Calculate expected waste capacity for the final design configuration.

- Estimate the operational design life of the Landfill facility based on the final Landfill capacity and the expected waste streams.

- Evaluate interim and final cover volumes and present the design for final Landfill cover.

- Incorporate UNSAT-H modeling and surface water analyses to evaluate potential leachate generation within the Landfill for various stages of the facility design life. The UNSAT-H model addresses soil water infiltration, evaporation, and plant transpiration as a one-dimensional process for cover in the proposed Disposal Area. Surface water analyses addresses surface water from open, lined areas.

- Design the Leachate Collection and Recovery System to minimize development of hydraulic head on the liner.

- Design surface water management and provide run-on/run-off drainage plans, hydraulic calculations, and section details for the construction of drainage collection and retention systems.

- Discuss findings and conclusions and incorporate them into the final design and this permit modification application.

SECTION 2

SITE DESCRIPTON AND SETTING

2.1 PHYSICAL SETTING

The Lockwood Regional Landfill is located within Storey County approximately 10 miles east of Reno and approximately 1.5 miles southeast of the small community of Lockwood, Nevada. The Landfill is in a mountainous area within the northern limits of the Virginia Range and approximately one (1) mile south of the Truckee River. Lagomarsino Canyon and Long Valley Creek are located west of the Facility property boundary.

2.1.1 Site Topography

The Site is positioned on the western flank of Clark Mountain within the northern limits of the Virginia Range. The Site is characterized by steep-walled canyons that drain westerly toward Long Valley Creek. The currently permitted Landfill Disposal Area occupies two (2), narrow, west-draining canyons which outlet to Long Valley Creek. The larger and longer of these two (2) buried canyon drainages, known as the Main Canyon, is located just south of the northern boundary of the Landfill Disposal Area. The smaller of the two (2) canyons, known as Dean's Canyon, is located within the southwestern portion of the current Landfill Disposal Area.

The proposed design modification extends further eastward and to the south of the Main Canyon. The proposed Disposal Area will incorporate portions of two (2) additional canyons, which are referred to as the Center Canyon and the South Canyon. The Center Canyon is located south of the southern boundary of the currently permitted Disposal Area. The Center Canyon begins on the western flank of Clark Mountain and trends west-southwesterly towards Long Valley Creek. The South Canyon, which lies south of the Center Canyon, also begins on the western flank of Clark Mountain and trends west-southwesterly within the proposed Disposal Area. A small canyon that drains west within the Disposal Area joins the South Canyon. The South Canyon drains to Long Valley Creek south of the proposed Disposal Area.

2.1.2 Adjacent Land Uses

Surrounding land use is as follows:

- **North:** Refuse Inc. owns the property north of the permitted Disposal Area. This area is used for solidification ponds and final and interim cover borrow sources.
- **South:** Approximately one (1) mile to the southwest of the site, Cemex Construction Materials owns a sand and gravel quarry. To the south of the Site are unimproved lands that are zoned with a Forestry designation.

- **West:** To the west of the Site are unimproved lands that are zoned with a Forestry designation.
- **East:** To the east of the Site are unimproved lands that are zoned with a Forestry designation.

2.2 CLIMATE

The Lockwood Regional Landfill is located in a high desert region within the rainshadow of the Sierra Nevada mountain range. The combination of the Site's location and elevation influence its moderate, arid climate. Regional and site-specific climate studies have been performed by several organizations, including Kennedy/Jenks/Chilton (Environmental Monitoring Plan, 1991), the National Oceanic and Atmospheric Administration (NOAA, 1992), the U.S. Army Corps of Engineers (USCOE, 1980), and researchers at the Desert Research Institute (Klieforth et. al., 1983). Based on these sources, the Site lies within one of the most arid regions within the United States.

Precipitation at the Site is sparse with average annual precipitation on the order of 7.7 inches (Western Regional Climate Center, Sparks Station). Approximately half of the precipitation occurs as mixed rain and snow from December to March, with the remainder of the precipitation occurring in the form of rain during brief, sometimes intense, summer thunderstorms. Humidity is typically low at the Site during summer and moderate during the winter. Sunshine is abundant throughout the year. Annual potential evapotranspiration at the site is calculated to be 76-inches (Dwyer, 2011), approximately ten times the average annual precipitation.

Winds at the Site have been observed to be predominately from the south and west-northwest, with average and maximum recorded wind speeds of six (6) miles per hour and 80 miles per hour, respectively. Normal daily temperatures are mild overall, ranging between lows of approximately 50 degrees to highs of 80 to 90 degrees Fahrenheit in the summer. Normal wintertime daily temperatures typically range from lows in the mid-20 degrees to highs reaching 50 degrees. Nighttime freezing temperatures occur consistently from October into April, and can occur in September and May (WRCC).

2.3 HYDROGRAPHIC SETTING

The Landfill lies within the Tracy Segment Hydrographic Area of the Truckee River Basin. The Tracy Segment is located in a transition between the Sierra Nevada and the Basin and Range physiographic provinces. Its elevation and location within the rain shadow of the Sierra Nevada mountain range results in a semi-arid high desert environment. The largest drainage basin entirely within the Tracy Segment is Long Valley Creek (approximately 82 sq. mi.), which terminates at the Truckee River.

Bedrock and basin-fill sediments comprise the major hydrogeologic units within the Tracy Segment. Bedrock hydrogeologic units consist of volcanic rock (primarily andesite, basalt, and rhyolite) that have accumulated as sequences of flows, flow breccias, tuffs, tuff-breccias, and conglomerates. Basin-fill sediment hydrogeologic units occur

mostly beneath the relatively narrow Truckee River canyon and to a lesser extent, locally along ephemeral stream tributaries. However, most of the basin-fill sediment units are located above the water table (Kennedy/Jenks, 1994; Thodal and Tumbusch, 2006).

Regionally, the depth to groundwater varies significantly in the Tracy Segment due to topographic relief and varying hydrogeologic conditions. In bedrock units in the vicinity of the Site, groundwater has been observed at depths up to 500 feet below ground surface (ft-bgs).

Inferred elevations of the regional aquifer were presented in Kennedy/Jenks 1994 based on water level data provided in driller's well log reports. The inferred piezometric surface is presented in ASW 2011b, and depicts a regional flow direction to the north-northwest. Additional information to update the conclusions from the 1994 report were not available.

2.4 100 YEAR FLOOD PLAIN

The Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) has produced Flood Insurance Rate Maps (FIRM) which depict flood hazard boundaries for 100-year flood events. Based on FIRM maps for the northern Long Valley Creek drainage system, revised on January 16, 2009 the proposed Disposal Area is outside the 100-year flood boundary. The base flood elevations for Long Valley Creek at the Center Canyon west of the Landfill representing the 100 year flood event is 4539 feet above mean sea level (AMSL). The minimum elevation of the proposed Disposal Area is approximately 4,682 feet AMSL, or a minimum of 143 vertical feet above the base elevation of a 100 year flood within the nearest segment of Long Valley Creek.

SECTION 3

GEOLOGIC AND HYDROGEOLOGIC SETTING

Applied Soil Water Technologies, LLC (ASW) has prepared a report titled *Hydrogeologic Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County, Nevada* (ASW, 2011b) for the Site that details findings and conclusions obtained during investigation of the surface and subsurface geology, as well as hydrologic characteristics of the subsurface. The investigation was undertaken in order to modify Solid Waste Permit SW214R01, issued by the Nevada Division of Environmental Protection, Bureau of Waste Management on December 17, 2009. A synopsis of the results of that study are presented in this section.

3.1 GEOLOGIC SETTING

Large-scale geologic mapping by Harold F. Bonham was performed from 1961-1965 and was reviewed for the current study. In his work entitled *Geology and Mineral Deposits of Washoe and Storey Counties, Nevada* (1969), he describes the Virginia Range as comprised of Mesozoic-age metamorphosed sedimentary and volcanic rocks intruded by granitic plutons and overlain by a thick section of Oligocene to Pleistocene-age volcanic and sedimentary rocks.

Bonham (1969) describes the Landfill vicinity as consisting primarily of Pliocene and Pleistocene basalt and andesite flows representing two separate episodes of volcanism. On the western edge of the Site, he notes the possibility of the presence of Tertiary (Pliocene) age Kate Peak formation and sedimentary deposits correlating to the Coal Valley Formation.

Schwartz and Faulds (2004) published a preliminary geologic map of most of the Chalk Hills quadrangle. The mapped area terminates near the southern extent of the proposed Disposal Area. Geologic units described by Schwartz and Faulds are in general agreement with those described by Bonham (1969).

The geology within the proposed disposal area generally consists of older rhyolite and extensively altered volcanics underlying interfingered Tertiary-age sediments and basalt that are overlain by a sequence of basalt and andesite flows. A geologic map is presented in ASW 2011b.

Geology and stratigraphy of the proposed disposal area are presented in **cross-sections** and in the Geologic Fence Diagram presented in ASW 2011b. Detailed descriptions of the stratigraphic units encountered at the site are also presented in the ASW 2011b.

3.2 HYDROGEOLOGIC SETTING

Pertinent conclusions regarding the hydrogeologic conditions in the vicinity of the proposed Landfill Disposal Area are summarized below and are presented in detail in ASW 2011b. These conclusions are consistent with the hydrogeologic interpretation provided by previous investigators.

- The depth to first groundwater beneath the future Disposal Area ranges from approximately 250 ft-bgs to 500 ft-bgs, or greater. First groundwater occurs under confined conditions primarily in fractured andesitic rock, and is overlain by an extensive vadose zone of generally low permeability materials as described in previous sections. Potentiometric surface maps have consistently shown an inferred groundwater flow direction to the north-northwest.
- Groundwater beneath the future Disposal Area does not appear to receive recharge locally. The lack of seasonal water level responses and the very old age of the water (greater than 20,000 year old) indicates that recharge likely occurs via through-flow from distal locations at higher elevations. The steep terrain in the site vicinity, the extremely low precipitation, the high runoff potential and the extensive vadose zone of generally low permeable materials all appear to greatly limit or preclude any local infiltration or recharge into the volcanic deposits beneath the future Disposal Area.
- The natural groundwater quality beneath the Facility is generally very poor. The groundwater contains high concentrations of TDS, sulfate, arsenic, iron, manganese and other parameters that routinely exceed primary of secondary MCLs. Low pH conditions have also been observed. The elevated concentrations of trace metals, iron, sulfate and the low pH conditions are consistent with the well documented geochemistry of hot springs systems in Nevada (White and Herpoulos 1983, White 1981) and are considered to be reflective of naturally occurring elements present within the hydrothermally altered andesite bedrock. Elevated TDS conditions are commonly associated with very old waters.
- In general, groundwater beneath the Facility occurs in volcanic deposits that have been classified by the Nevada Bureau of Mines and Geology as amongst the lowest potential groundwater yield formations in the state. Single-well pumping tests performed in all LL-series wells on Site confirms a low yield.

SECTION 4

LANDFILL DESIGN

4.1 DESIGN CONCEPT

The final bench design for the Lockwood Regional Landfill has been modified to incorporate an increase in capacity by expanding Municipal Solid Waste (MSW) vertically above the currently permitted Disposal Area and laterally by extending the Disposal Area horizontally to the south and east. The modified bench design is presented in the attached Drawings with supporting information provided in the following sections. The design rationale presented herein incorporates design constraints dictated by applicable State and Federal MSWLF regulatory requirements, the geologic and hydrogeologic setting of the Landfill, operations management, and constructability considerations.

4.1.1 Primary Design Elements

A summary of the primary design elements for the proposed modification are presented below. Details of the design are presented in the Engineering Design Report (ASW, 2011a).

- Base Liner System – A high density polyethylene (HDPE) geomembrane is proposed beneath the proposed Disposal Area. The HDPE will be 80-mils thick in areas where the waste is greater than 200-feet thick and 60-mils thick where the waste is less than 200-feet thick.

  Textured HDPE will be placed in the lower reach of the Center Canyon to provide additional frictional resistance for slope stability.

  The HDPE will be placed on a prepared subgrade with a maximum ½-inch particle size. In areas where bedrock outcrops are blasted to achieve design grades, the exposed bedrock surface will be smoothed with shotcrete. The shotcrete will be covered with a minimum 16 oz per square yard cushion geotextile prior to geomembrane installation.

  The base grade is designed with liner anchor benches at strategic locations on steep canyon side slopes to provide support for the geomembrane. The liner anchor benches also serve initially as run-on control ditches and then once covered by waste they become part of leachate collection system as described below.

- Leachate Collection and Recovery System – The proposed design incorporates a leachate collection and recovery system (LCRS). Computer modeling which takes into account climatic conditions and site specific elements of the cover design, indicates that there will be essentially no leachate generated due to infiltration of water through the interim or final cover (Investigation Report, ASW 2011). The primary source of leachate generation will be precipitation that falls on open, lined areas and flows onto or under downgradient MSW. The leachate generation system is designed to accommodate these flows.

  The proposed LCRS consists of the following elements;

  - The down gradient edge of the liner at the north east corner of the currently permitted Disposal Area will incorporate a perforated HDPE LCRS pipe.

  - The bottoms of the center and south canyons will contain a perforated HDPE LCRS pipe designed to accommodate the 100 year, 24-hour storm. These pipes were designed for the larger storm event to provide additional capacity for conveyance. The pipe will be placed in a trench to provide additional support to withstand the overlying waste loads. Fee draining gravel wrapped in a geotextile filter fabric will be placed around the perforated pipe. The LCRS pipes will gravity flow to lined leachate retention ponds constructed outside the toe of the proposed Landfill.

  - The liner anchor benches will act as LCRS collection ditches. As the benches are lined for a subsequent phase of Landfill development, a 4-inch diameter corrugated HDPE pipe encased in filter fabric will be installed in the flow line of what was previously the run-on control ditch as described below. The ditches will flow into lined perimeter ditches which will gravity flow into the lined leachate retention ponds.

  - There are three double lined leachate ponds associated with the proposed modification.

- Run-On Controls – Run-on controls consist of main perimeter diversion channels constructed at the eastern perimeter of the proposed Disposal Area and intermediate diversion channels incorporated as part of the liner anchor benches. In order to minimize the amount of run-on that will contact MSW and to minimize the size of the intermittent run-on control channels, all run-on controls associate with the Center Canyon will be in place prior to waste placement. Development of the South Canyon will occur in the same manner.

The main perimeter diversion channels will discharge run-on flow into existing drainage channels. Total flows into Long Valley Creek will not be increased.

The intermediate diversion channels will transmit run-on flow to the edge of the landfill where they will discharge along the perimeter of the downgradient toe of the landfill into existing drainage channels.

- Run-off Controls – Run-off controls consist of containing sheet flow off of the top deck of the Landfill and transmitting it to riprap lined down chutes. Run-off from bench set-backs flows along the toe of the overlying bench and also discharges into the riprap lined down chutes. The down chutes transmit water down the benches and discharge at the downgradient toe of the Landfill. A ditch along the perimeter of the Landfill transmits run-off to naturally lined retention ponds.

  There are four stormwater retention ponds associated with the proposed modification.

- Final Cover – An alternative earthen final cover (AEFC) consistent with the currently permitted Disposal Area is proposed for this modification. The cover will consist of a minimum of two (2) feet of appropriate soil overlying six (6) inches of interim cover.

- Bench Design – The proposed bench design incorporates surface water controls and minimum slopes as required in the regulations (NAC 444.6885, NAC 444.6887). The Landfill will be developed in thirteen different phases shown on the design drawings.

4.1.2 Currently Permitted Disposal Area

The current Landfill was permitted in 1994 by the Washoe County District Health Department, the SWMA at the time. Kennedy/Jenks Consultants prepared several documents in support of the approved permit application. As part of the permitting effort, an extensive hydrogeological characterization was performed. That characterization resulted in an alternative base liner system being proven equivalent to the prescriptive base liner system for protection of groundwater. This alternative liner is approved under Federal and State standards.

The proposed modification addresses hydrogeologic conditions outside of the currently permitted Disposal Area. The proposed modification increases the overall height within the currently permitted Disposal Area, therefore both waste mass stability and run-off controls are addressed.

4.1.3 Regulatory Requirements

The proposed modification has been prepared in accordance with the regulatory requirements of NAC 444.685. Conformance with specific aspects of the regulation is presented below.

4.1.3.1 Siting Restrictions

- Prohibit location of future landfill development within 1,000 feet of perennial and intermittent surface water courses and lakes, and within 100 feet of the uppermost groundwater aquifer (NAC 444.678).
    - Long Valley Creek is the only surface water course in the vicinity of the Landfill. The proposed Disposal Area, leachate ponds and stormwater retention ponds are set back a minimum distance of 1,000 feet from Long Valley Creek.
    - The Hydrogeologic Report (ASW, 2011b) presents data developed during investigations performed in support of this application to demonstrate that the uppermost groundwater aquifer is not within 100 feet of the bottom of the proposed Landfill.

- Prohibit location of future Landfill development within 200 feet of a Holocene fault (i.e. fault which demonstrates movement within the past 8,000 years) (NAC 444.6791).
    - The Hydrogeologic Report (ASW, 2011b) presents data developed during investigations performed in support of this application that demonstrate there are no Holocene faults within 200-feet of the proposed Disposal Area.

- Provide landfill design provisions for sites located within a seismic impact zone. The USEPA defines a "seismic impact zone" as areas "having a 10 percent or greater probability that the maximum expected horizontal acceleration in lithified earth materials (i.e., still soil or bedrock), expressed as a percentage of the Earth's gravitational pull (g), will exceed 0.10g in 250 years" (NAC 444.6793).
    - The Engineering Design Report (ASW, 2011a) present data, findings and analyses that demonstrate conformance with this criterion.

- Prohibit location of future Landfill development within unstable areas, where "unstable areas" are defined by the USEPA as areas exhibiting soil and/or bedrock conditions prone to differential settlement and/or mass wasting (i.e. landsliding) (NAC 444.6795).
    - The proposed Disposal Area is located within an area underlain by minor areas of shallow colluvium/alluvium and primarily by competent bedrock.

The bedrock will not settle under the loads imposed by the waste, therefore detrimental settlements will not occur.
    - There is no karst topography or other conditions that would develop sink holes at the Site.
    - The Hydrogeologic Report (ASW, 2011b) demonstrates that there are no mass wasting or landslide hazards at the Site.

- Prohibit location of future Landfill development within a designated 100 year floodplain (NAC 444.6785).
    - Review of the most recent Flood Insurance Rate Map shows that no portion of the proposed Disposal Area or associated ponds are within the 100-year flood plain.

- Consideration of wetlands (NAC 444.679).
    - A certified wetlands biologist was retained to review the site conditions. A finding was made that there will be no wetlands as defined by NAC 444.679 impacted by the proposed modification (Attached).

- Consideration of future landfill development with regard to airport safety (NAC 444.6783).
    - The nearest airport is the Reno-Tahoe Airport located over 8 miles from the proposed Disposal Area. Therefore, the proposed modification will not have any impact with regard to airport safety.

4.1.3.2 Design Criteria

- Landfill containment structures must be designed to resist the maximum horizontal bedrock acceleration at the site from an earthquake event (NAC 444.6793).
    - Seismic resistant design is addressed in the deformation analysis presented in the Engineering Design Report (ASW, 2011a).

- The structural integrity of the landfill containment structures and operating elements should not be disrupted by excessive settlement or slope instability (NAC 444.6795).
    - Settlement considerations are negligible due to the shallow presence of competent bedrock.
    - Slope stability is addressed in the Engineering Design Report (ASW, 2011a) and summarized herein.

- Maintain controlled, positive drainage of stormwater off of the Landfill and direct run-off to collection ponds and run-on water to suitable discharge points (NAC 444.6885).

- Run-on and run-off are addressed in the Engineering Design Report (ASW, 2011a). Compliance with the regulations is demonstrated.

- Protect waters of the state from uncontrolled migration of landfill leachate from the site (NAC 444.678, NAC 444.681).
  - The overall negligible leachate generation resulting from precipitation is a key aspect demonstrating the proposed Landfill is protective of waters of the State.
  - Waters of the state are protected by the HDPE liner system and leachate collection and recovery system (LCRS).

- Minimize uncontrolled gas migration from the landfill (NAC 444.667, NAC 444678).
  - Uncontrolled gas migration is controlled by the HDPE liner system and a gas collection system that will be installed as the Landfill develops.

- Provide USEPA mandated composite liner and leachate collection system, or in approved states (Nevada is an approved state), provide alternative design sufficient to protect the waters of the State, based on the following: (NAC 444.681)

  A. Hydrogeologic characteristics of the site;

  B. Site climate;

  C. Potential Landfill leachate generation; and

  D. Other relevant factors.

  - The proposed liner system is an alternative to the prescriptive standard. The proposed design is demonstrably protective of the waters of the State as demonstrated by the following:

    - Hydrogeologic characteristics of the Site;
      The hydrogeologic characteristics of the site are summarized in Section 3 of this permit application and are described in detail in the Hydrogeologic Report (ASW, 2011b). It is demonstrated that the Site's hydrogeologic characteristics; namely the depth to groundwater, the generally low hydraulic conductivity of the vadose zone and the fact that there is no apparent local recharge, are naturally protective of the waters of the State.

- Site Climate;
  The site is arid receiving only 7.7-inches of average annual precipitation. Annual potential evapotranspiration (PET) at the site is calculated to be 76-inches, nearly ten times the average annual precipitation. The significance of the arid nature of the Site and the high PET is discussed below regarding leachate generation potential.

- Potential Landfill leachate generation;
  The Engineering Design Report (ASW, 2011a) presents the alternative earthen final cover (AEFC) design. The AEFC design incorporates a detailed evaluation of the Site's climate and vadose zone modeling to predict the amount of water that may percolate through the cover (interim and final) and into the waste.

  The results of the AEFC design show that with the two (2) feet thick final cover and a one and one-half (1 ½) feet thick interim cover, there will be essentially no percolation of water through either the final cover or interim cover.

- Other factors;
  Even though there is essentially no leachate generation potential, a HDPE geomembrane with LCRS system is proposed beneath the Landfill. The LCRS system is designed to collect and rapidly transmit out of the Landfill any leachate that may develop. This system is monitored to ensure compliance with State and Federal regulations.

  In the event leachate is generated in quantities which could develop hydraulic head on the liner system, the LCRS will remove this liquid and direct it to lined solar evaporation ponds. These ponds and the LCRS system are monitored to ensure compliance with State and Federal requirements.

4.2 FINAL LANDFILL BENCH PLAN

The proposed landfill bench plan is presented in the attached Sheets. The landfill is proposed to be constructed in 13 phases which are described below:

- Phase 1 – Consists of placing C & D debris in the expansion portion of benches 4B through 7B at the north east corner of the existing landfill.
- Phase 2 – Consists of installing HDPE up to anchor benches RN-1A and RN-1B and placing waste in benches 2 through 5 in the center canyon.

- Phase 3 – Consists of extending the HDPE liner to anchor benches RN-2A and RN-2B, converting anchor benches RN-1A and RN-1B to LCRS ditches and placing waste in benches 6 through 7 in the center canyon. Bench 7 in the center canyon ties into bench 7 that was placed in the currently permitted Disposal Area.
- Phase 4 – Consists of extending the HDPE to anchor benches RN-3A and RN-3B in the center canyon. HDPE is also placed on top of the C & D extending up to the liner anchor at the north east corner. This phase includes placing waste on bench 8 extending from the north east through the center canyon.
- Phase 5 – Consists of extending the HDPE to anchor benches RN-4A and RN-4B in the center canyon and north east areas and placing waste in bench 9 across the north east area and through the center canyon.
- Phase 6 – Consists of extending the HDPE to anchor benches RN-5A, RN-5B and RN-5C. This phase includes placing waste in bench 10 in the north east area and through the center canyon.
- Phase7 – Consists of installing HDPE in the south canyon to anchor benches RN-6A and RN-6B. This phase includes placing waste in benches 4A through 10A in the south canyon.
- Phase 8 – Consists of extending the HDPE to cover the eastern portion of the ridge between the center and south canyons and extending the HDPE at the north east. This phase includes placing waste in bench 11 which extends from the north east area through the south canyon,
- Phase 9 – Consists of extending the HDPE to cover the remaining portion of the ridge between the center and south canyons and extending the HDPE at the north east. This phase includes placing waste in bench 12 which extends from the north east area through the south canyon,
- Phase 10 – Consists of extending the HDPE in the north east area and placing waste in bench 13. Bench 13 extends from the north east area through the south canyon.
- Phase 11 – Consists of extending the HDPE in the north east area and placing waste in bench 14. Bench 14 extends from the north east area through the south canyon.
- Phase 12 – Consists of extending the HDPE in the north east area and placing waste in bench 15. Bench 15 extends from the north east area through the south canyon.
- Phase 13 – No additional HDPE is required. This phase consists of placing waste in benches 16 through 20.

4.2.1 Current Bench (Cell) Construction Practices

Waste handling and placement procedures are summarized in the following paragraphs. Detailed waste handling and placement procedures are provided in the Site's Operating Plan.

The horizontal cell fill method is used for disposal of solid waste at the Lockwood Regional Landfill. Using this method, the waste is pushed into layers, compacted and adequately covered, lift-by-lift, up the canyon. Successive incoming waste is typically discharged into the Landfill via hydraulic tippers into a trench within the waste located perpendicular to the tipper body frames. The trench is designed to the appropriate width and depth to manage the waste being discharged from the hauling vehicle, and allow the waste to clear the tipper body and completely empty the trailers. The discharged waste is then pushed by mechanical means, from the trench to the top of a disposal cell and compacted horizontally as presented below. Placed lifts generally do not exceed two (2) feet in vertical thickness prior to compaction in accordance with NAC 444.686.

The pubic dumping area is located at least 30 feet away from the edge of the push trench. Barricades and other warning devices are maintained to prevent customers from getting any closer to the push trench while unloading their vehicles. Waste spotters are employed to witness the public's disposal operations, monitor for any excluded wastes and maintain the necessary spacing required for their safety.

Disposal cells are constructed to the appropriate size to efficiently manage the anticipated amount of waste received from the transfer stations. Typically, the constructed cell area is approximately 150 feet x 250 feet. Tippers are typically located at the midpoint of the constructed cell to reduce the number of times that they must be moved as the horizontal fill method is completed. Upon completion of a cell intermediate cover is placed and compacted on the top deck as required. Daily cover, as required, is typically completed using landfill tarps or other approved cover materials, which are removed prior to additional waste placement and disposal. The depth of each completed lift including the intermediate cover is approximately 45 feet. The construction of each disposal cell is monitored using both internal and external surveying services.

The cover material (primarily intermediate and final cover) is graded to prevent water infiltration and minimize leachate. The overall drainage gradient away from each constructed lift is three (3) percent in accordance with NAC 444.688 (1) (f). The working face of the cell at the end of the day is constructed to a slope of approximately 3H:1V (horizontal to vertical).

4.2.2 Proposed Slope Geometry and Drainage

The plan and cross sections of the proposed Final Landfill Bench Plan are provided on the attached Drawings. The currently approved Landfill consists of seven (7), 45-foot-thick refuse benches constructed on top of the Landfill that existed at the time the permit we issued. The proposed permit modification will increase the total number of benches to twenty (20). The proposed volume increase will add additional benches on top of the currently approved Landfill. Laterally, the benches will extend to the south and east of the currently approved Disposal Area. The finish face of the Landfill benches consists of individual cell slopes inclined at 3H:1V with 20 foot-wide setbacks from the underlying

cell. The width and cross-slope of the intermediate slope benches are designed to accommodate access of maintenance equipment and convey slope stormwater run-off during a 24-hour, 25-year storm event. Based on the slope profile described, the overall design Landfill slope inclination is approximately 3.44H:1V.

Stormwater run-off collected within the Landfill is diverted to perimeter run-off collection channels which outlet into on-site retention ponds. Locations of the conveyance structures and retention ponds are shown on the attached drawings. Details of the designs are presented in the Engineering Design Report (ASW, 2011a).

4.2.3 Main Perimeter Access and Maintenance (Bench) Roads

Access to the landfill is achieved through perimeter roads through the completion of bench 7B at the north east area. After completion of bench 7, access to the landfill will be across the landfill itself. Access roads are show on the attached Drawings and briefly described below.

4.2.3.1 Perimeter Access Road

The main Landfill perimeter access consists of a 30-foot-wide, paved roadway to be used as the principle access to the operational portion of the Landfill. The maximum vertical grade of the main perimeter road is approximately six (6) percent and is crowned at the center. As benches 4B through 7B are developed, the eastern portion of the perimeter access road will be re-routed to daylight onto the current bench. After the completion of bench 7B, haul roads will be developed across the Landfill.

4.2.3.2 Landfill Access Road

Where the access road traverses up Landfill slopes it is graded to drain to the Landfill side of the road. Roadway drainage ditches are designed to carry run-off drainage from adjacent areas and will transmit flows to run-off drainage structures. Details of the Landfill access road cross-section are provided in the attached Drawings.

4.2.3.3 Intermediate Slope Bench Maintenance Roads

Slope bench set backs have been provided at the foot of each successive refuse cell (45 foot vertical intervals) within the overall Landfill slope configuration. Slope benches have been designed to intercept and conduct slope stormwater run-off to collection devices at the perimeter of the Landfill, as well as accommodate maintenance vehicle traffic. The attached Drawings provide a cross section of the proposed slope bench construction. The design width and cross slope of the bench is twenty (20) feet and ten (10) percent, respectively. The roadway will be constructed of final cover soils at the outer edge of each refuse bench.

4.3 LANDFILL CAPACITY AND PROJECTED LIFE

The Final Bench Grading Plan shown in the attached Drawings illustrates the proposed Landfill development plan.

The Final Bench Plan design was analyzed for total and incremental storage capacity of selected benches utilizing digital terrain computer models to superimpose successive refuse benches over the existing Landfill topography. Site topography was determined from aerial photogrammetry, provided by aerial surveys (map scale one inch equals 200-feet). The aerial survey from which the topographic map was based was flown in April 2010.

Based on these results, the final bench design yields an increase in refuse volume of approximately 237.7 million cubic yards (CY) for a total capacity of approximately 302.5 million CY.

The proposed modification will extend the life of the Landfill to approximately 2113, based on current volumes.

4.4 LANDFILL COVER

An alternative earthen final cover (AEFC), also known as an evapotranspirative (ET) cover, is proposed for the permit modification final cover design. Sparks, Nevada has an average annual precipitation of approximately 7.7-inches. The climate's annual demand for water referred to as potential evapotranspiration (PET) is approximately 76-inches, nearly 10 times greater than the average annual precipitation (Figure 3.1-1). Additionally, it can be seen in Figure 3.1-1 that for every month of the year, the climate's demand for water (PET) far exceeds the actual supply of water (precipitation). Consequently, an AEFC designed to take advantage of variances between the demand for water and actual supply of water such as an ET Covers is well suited for the Site. To support the AEFC design an extensive borrow source investigation, laboratory testing program and modeling effort were implemented.

The borrow source investigation involved excavating sixty one (61) test pits. Representative samples of the subsurface soils were obtained and tested in the ASW Sparks, Nevada laboratory. The following testing program was performed:

- 117 Sieve analyses,
- 117 Atterberg limits (plasticity),
- 50 Standard Proctor (laboratory compaction),
- 50 Saturated hydraulic conductivity,
- 13 Coarse and fine specific gravity, and;
- 13 Soil water characteristics curves.

The laboratory test results were evaluated and soils selected for input to a computer model.

AEFC cover performance was predicted using the UNSAT-H computer modeling software. UNSAT-H was designed by its developers specifically for earthen covers. It has been recommended for use on AEFCs in the Interstate Technology Regulatory Council (ITRC) design guidance documents (ITRC, 2003).

Conservative assumptions were made when developing the input for the model. The conservative assumptions included, among other things;

- The saturated hydraulic conductivity in the upper one (1) foot of the cover was increased by up to two (2) orders of magnitude so that run-off was zero. This conservatively allowed all precipitation to infiltrate into each cover profile.

- Vegetation on the final cover was specified as only 5-percent plant with a leaf area index (LAI) of 1. These parameters correspond to a poor stand of grass.

- The interim cover was modeled with no vegetation.
- An extreme year with annual precipitation nearly twice the average annual precipitation was applied for three consecutive years in a row.

There was no percolation of water through either the final or interim cover predicted by any of the simulations.

A detailed presentation of the final cover design is presented in the Engineering Design Report (ASW, 2011a). The final cover design demonstrates compliance with NAC

4.5 SLOPE STABILITY ANALYSIS

The Lockwood Regional Landfill is located in a seismic impact zone and therefore an evaluation of the seismic risk is required. Stability of the final slope configurations at the Lockwood Regional Landfill were analyzed under both static conditions and conditions incorporating earthquake loads and pseudo-static conditions.

Stability evaluations were performed by classical limit equilibrium methods and by review of the performance of similar MSWLF slope s under both static and dynamic loading conditions (Siegel et al. (1990), EERC (1994), and Buranek and Prasad (1991)).

Slope stability modeling results of design refuse slopes, with both geomembrane lined base layers and non-geomembrane lined base layers (bedrock), indicate that slopes

analyzed should remain stable under static conditions. All analyses performed resulted in factors of safety greater than 1.5.

Pseudo-static modeling of the same design refuse slopes resulted in several block failures with factors of safety below 1.1. Additionally a "screen" analysis was preformed that resulted in a factor of safety of 0.82. Therefore, a displacement (deformation) analysis was warranted for the project.

The displacement analysis indicated that a permanent mass deformation of approximately one (1) centimeter (cm) can be expected as a result of the anticipated failure due to seismic activity. This estimate deformation will not be detrimental to the HDPE liner system or the final cover elements.

The details of the slope stability analysis are presented in the Engineering Design Report (ASW, 2011). The Report demonstrates compliance with NAC 444.6793 and NAC 444.6795.

4.6 SETTLEMENT

Settlement data from the currently permitted obtained since 1995 were used to estimate settlement for the proposed Landfill. A maximum differential settlement of 3.75 feet distributed over a horizontal distance of 670-feet was estimated.

With respect to final cover integrity, the estimated amount of differential settlement is insignificant. There will be no detrimental impacts to the final cover due to differential settlement.

With respect to surface drainage, over a distance of 670-feet the calculated differential settlement amounts to a 0.5-percent change in surface grade. If required, this minor amount of grade change can be easily mitigated during post closure and care.

Impacts of differential settlement on intermediate benches will be minor. The life of the Landfill spans on the order of 100-years, therefore, any impacts will be mitigated during routine operations and maintenance.

4.7 SURFACE WATER CONTROLS

Surface water control entails control of run-on and run-off. Run-on, in the context of a landfill, is defined as stormwaters that tend to flow from natural slopes toward the Disposal Area. Run-off is defined as stormwaters that tend to flow off of the interim and final cover of a landfill. The design presented demonstrates compliance with NAC 444.680 and NAC 444.684.

Run-on is controlled through two systems of control channels; perimeter channels and intermediate channels. The majority of run-on collection from contributing watersheds to the Site will be handled by perimeter run-on collection channels constructed outside the eastern limits of the proposed Disposal Area. These run-on collection channels are to be constructed in phases and each ultimately discharges into natural drainage channels, west of the Landfill. The design flows from the upgradient watershed areas was determined for the 100-year 24-hour precipitation event to size the perimeter collection channels.

Intermediate run-on control channels will be constructed inside the proposed Disposal Area to minimize run-on coming in contact with areas that have MSW. The intermediate run-on channels will transition into liner anchor benches and then once covered by waste they become leachate collection ditches. Intermediate run-on channels were designed for the 25-year 24-hour precipitation event over the maximum amount of exposed lined area contributing to the channel.

Run-off originating from the Landfill will be conveyed within a separate drainage system to a set of three (3) existing collection ponds and three (3) new collection ponds. The run-off channels and collection ponds have been sized to contain, and subsequently evaporate, the run-off produced by a 25-year, 24-hour storm event. Based upon the ultimate Landfill configuration, the design storm would produce a total of approximately 55.6 acre-feet of run-off which includes some natural watershed areas between the Landfill and the run-on collection system.

Detailed discussion of surface water controls and presentation of the hydraulic tables for each channel are presented in the Engineering Design Report (ASW, 2011a).

4.8 LEACHATE COLLECTION AND RECOVERY SYSTEM

A leachate collection and recovery system is proposed for the permit modification. Typically an LCRS system is designed to accommodate leachate that may be generated through percolation of precipitation through the interim and final cover. It is demonstrated in the final cover design that, even with very conservative assumptions, there is essentially no percolation of precipitation through either the interim or final covers.

Therefore, the LCRS for the proposed modification was designed to accommodate precipitation that falls on the exposed liner surface regardless if it ever comes in contact with waste. Consequently, water that has only contacted interim cover and water that has come into contact with waste will be collected together and drained into designated leachate collection ponds.

There are two general pipe networks associated with the LCRS. One network is designed for the canyon bottoms and eastern perimeter between the currently permitted and proposed Disposal Areas and the other network will be placed in the intermediate run-on channels on the liner anchor benches.

For the LCRS network designed for the canyon bottoms and eastern perimeter, collection of leachate occurs through gravel packed, geofabric wrapped, standard dimension ratio smooth wall perforated polyethylene pipes. Pipes in this network were divided into sections by construction phase, and sized to accommodate maximum flow and overburden pressure. For added conservatism, the maximum flow was determined for the 100-year 24-hour precipitation event that occurs when the maximum amount of lined area is exposed.

For the LCRS network designed for the intermediate run-on channels on the liner anchor benches, collection of leachate occurs through gravel packed, geofabric wrapped, 4-inch corrugated perforated polyethylene pipes. The lined channels in which these LCRS pipes are located are sized sufficiently to handle the 25-year 24-hour precipitation event over the maximum exposed liner. Once covered with waste and interim cover the leachate reporting to these pipes is essentially zero.

The proposed LCRS includes the construction of four lined ponds. The ponds were sized to accommodate runoff from the 25-year 24-hour precipitation event.

Hydraulic tables and design details are presented in the Engineering Design Report (ASW, 2011a).

SECTION 5

REFERENCES

American Society of Civil Engineers (ASCE), 2002. *Guideline for Analyzing and Mitigating Landslide Hazards in California*. Special Publication 117. June 2002.

Applied Soil Water Technologies, LLC. 2011(a), *Engineering Design Report, Lockwood Regional Landfill, Storey County, Nevada*. December 2011.

Applied Soil Water Technologies, 2011(b). *Hydrogeologic Report, Permit SW214R01 Modification, Lockwood Regional Landfill, Storey County Nevada*.

Applied Soil Water Technologies, LLC. 2009, *Second Semiannual Environmental Monitoring Report, Lockwood Regional Landfill, Storey County, Nevada*. January 2010.

ASTM C127 Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

ASTM D422 Standard Test Method for Particle Size Analysis of Soils

ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)

ASTM D854 Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D2216 Laboratory Determination of Moisture Content by Mass

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils

ASTM D4718 Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles

ASTM D5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

ASTM D6836 Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge

Bell, J.W., 1984, *Quaternary Fault Map of Nevada – Reno Sheet*, Nevada Bureau of Mines and Geology, Map 79.

Benson, C.H., 2008, "An Introduction to Water Balance Modeling", in Alternative Covers for Landfills, Theory, Design, and Practice, September 2008, Rutgers EcoComplex, New Jersey.

Bonham, H.F., 1969, *Geology and Mineral Deposits of Washoe and Storey Counties, Nevada*, Nevada Bureau of Mines and Geology Bulletin 70.

Briggs, R.W. and S.G. Wesnousky, 2005, *Late Pleistocene and Holocene Paleoearthquake Activity of the Olinghouse Fault Zone, Nevada*, Bulletin of the Seismological Society of America, 95:4, p. 1301-1313.

Briggs, R.W. and S.G. Wesnousky, 2004, *Late Pleistocene fault slip rate, earthquake recurrence, and recency of slip along the Pyramid Lake fault zone, northern Walker Lane, United States*, Journal of Geophysical Research, 109, B08402, doi:10.1029/2003JB002717.

Buranek, D., and Prasad, S., 1991. Sanitary Landfill Performance During the Lora Prieta Earthquake. Proceedings from the Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics. University of Missouri-Rolla, Missouri, 11-15 March 1991. Volume II, pp. 1155-1160.

CDMG (2008). "Guidelines for Evaluating and Mitigating Seismic Hazards in California," California Division of Mines and Geology, CA, Special Publication 117A.

Cohen, P. and Loeltz, O.J. 1964, *Evaluation of Hydrogeology and Hydrogeochemistry of Truckee Meadows Area, Washoe County, Nevada.* U.S. Geological Survey Water Supply Paper 1779-S, 63 p.

dePolo, C.M., et al., 1997, *Earthquake Occurrence in the Reno-Carson City Urban Corridor,* Seismological Research Letters, Vol. 68, p. 401-412.

Decagon Devices, Inc. 1998-2007. "WP4 Dewpoint PotentiaMeter Operator's Manual for Models WP4 and WP4-T." Version 5.

Duncan, J. Micheal and Wright, Stephen G., *Soil Strength and Slope Stability*, Jon Wiley and Sons, Inc, 2005

Dwyer, SF. 2003. Water Balance Measurements and Computer Simulations of Landfill Closures. PhD Dissertation. University of New Mexico, Albuquerque, NM.

Earthquake Engineering Research Center (EERC), 1994. Preliminary Report on the Seismological and Engineering Aspects of the January 17, 1994 Northridge Earthquake. Report No. UCB/EERC-94/01. January 1994.

EMCON Associates, 1979. *Geotechnical Investigation and Waste Management Studies, Lockwood Disposal Site, Storey County, Nevada.*

Fayer, M.J. (2000). UNSAT-H Version 3.0: Unsaturated Soil Water and Heat Flow Model, Theory, User Manual, and Examples. Pacific Northwest Laboratory, Richland, WA.

Hoek, E. and Bray, J.W. 1981. "Rock Slope Engineering". Institution of Mining and Metallurgy, London, (1981).

ITRC. 2003. Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers. Interstate Technology and Regulatory Council, Alternative Landfill Technologies Team, Washington DC.

Jonathan D. Bray, F. ASCE, Dimitrios Zekkos, M. ASCE, and Scott M. Merry, M. ASCE (2011). "Shear Strength of Municipal Solid Waste," Geotechnical Characterization, Field Measurement, and Laboratory Testing of Municipal Solid Waste. Geotechnical Special Publication 209. Chapter 2, pp 44-75.

Kavaznajian, E., 1994. Performance of a Geosynthetic Landfill Liner System in the 1994 Northridge Earthquake. An Interview in Geotechnical Fabrics Report, March 1994.

Kavazanjian, E. and Matasovic, N. 1994. Seismic Analysis of Solid Waste Landfills. Draft Manuscript Submitted For Publication at the ASCE *Geoenvironment* 2000 Specialty Conference, 22-24 February 1995, New Orleans, Louisiana.

Kavazanjian, E. et al., 1994 Evaluation of MSW Properties For Seismic Analysis. Extended Manuscript of a Paper Submitted For Publication at the ASCE *Geoenvironment 2000* Specialty Conference 22-24 February 1995, New Orleans, Louisiana. Prepared For the U.C. Berkley/EERC Workshop on Seismic Design of Landfills, 4 June 1994. 16 pp.

Kennedy/Jenks Consultants, 1996. *Installation of Monitoring Well LL-8, Lockwood Regional Landfill, Storey County, Nevada* , K/J 967001.01.

Kennedy/Jenks Consultants, 1994. *Revised Hydrogeologic Report, Lockwood Regional Landfill, Storey County, Nevada* , K/J 937059.03.

Kennedy/Jenks/Chilton, 1991. *Siting Report and Environmental Monitoring Plan for the Lockwood Landfill, Storey County, Nevada*. K/J/C 907006.12

Klieforth, H. et al. 1983. *Measurement, Tabulation and Analysis of Rain and snowfall in the Truckee River Basin*. Desert Research institute Report to Regional Administrative Planning Agency, August 1983.

Orr, W.R. and Finch, M.O., 1990. Solid Waste Landfill Performance During the Lorna Prieta Earthquake. Geotechnics of Waste Fills – Theory and Practice, ASTM STP 1070. American Society for Testing and Materials (ASTM), Philadelphia, pp. 22-30.

Plastics Pipe Institute (2011). *Handbook of Polyethylene Pipe*. 2nd edition.

Sawyer, T.L., compiler, 1999, Fault number 1647, Mount Rose fault zone, in *Quaternary fault and fold database of the United States*: U.S. Geological Survey website, http://earthquakes.usgs.gov/regional/qfaults.

SCEC (2002). "Recommended Procedures for Implementation of DMG Special Publication 117 – Guidelines for Analyzing and Mitigating Landslide Hazards in California," SCEC Publication, June.

Schroeder, P., C. Lloyd and P. Zappi. (1994). The Hydrologic Evaluation of Landfill Performance (HELP) Model User's Guide for Version 3.0. U.S. Environmental Protection Agency, EPA/600/R-94/168a, Cincinnati, OH.

Schwartz, K.M. and J.E. Faulds, 2004, *Preliminary Geologic Map of Most of the Chalk Hills Quadrangle, Storey County, Nevada*, Nevada Bureau of Mines and Geology Open File Report 04-11.

Shevenell, Lisa, 1996, *Statewide Potential Evaporation Maps for Nevada*. Nevada Bureau of Mines and Geology, Report 48.

Siddharthan (2011), Raj Siddharthan Ph.D., P.E., Professor of Civil Engineering, SEISMIC STABILITY AND DISPLACEMENT AT MSWLF SITE, Lockwood, Nevada, December 2011.

Stephens, D.B. and Neuman, S.P. 1980. *Analysis of Borehole Infiltration Tests Above the Water Table*, Technical Report No. 35, Technical Reports on Natural Resource Systems, The University of Arizona, Tucson, Arizona.

Terracon, 2003, *Geotechnical Exploration Report, Hafed Road, Storey County, Nevada*, Project No. 64035501.

USBR 5600-89 United States Bureau of Reclamation 5600-89 Permeability and Settlement of Soils, Fixed Wall Saturated Hydraulic Conductivity

USGS (2008) USGS 2008 Interactive Deaggregation: http://eqint.cr.usgs.gov/deaggint/2008/index.php

Van Genuchten, M.Th., Leij, F.J., and Yates, S.R. 1991. "The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils." Version 1.1. US Salinity Laboratory, US Department of Agriculture, Agricultural Research Service, Riverside, CA. December 1991.

Zekkos, D., Matasovic, N., El_Sherbiny, R., Athanaopoulos-Zekkos, Towhata, I., and Maugeri, M. (2011). "Dynamic Properties of Municipal Solid Waste," Geotechnical Characterization, Field Measurement, and Laboratory Testing of Municipal Solid Wastes, Geotechnical Special Publication 209, Chapter 4, pp. 112 – 134.

Thodal, Carl E. and Mary L. Tumbusch, 2006. *Hydrology, Water Chemistry, and Revised Water Budgets for Tracy Segment Hydrographic Area, Storey, Washoe, and Lyon Counties, West-Central Nevada, 1998–2002*, U.S. Geological Survey Scientific Investigations Report 2006-5010.

Thompson, G.A., 1956, *Geology of the Virginia City Quadrangle, Nevada*: U.S. Geological Survey Bulletin 1042-C.

U.S. Department of the Army, Corps of Engineers (USCOE), Sacramento District, 1980 *Truckee River, California and Nevada Hydrology*. February 1980.

U.S. Department of Commerce, National Oceanic Atmospheric Administration (NOAA). 1992. *Monthly Station Normals of Temperature, Precipitation and Heating and Cooling Degree Days, 1961-90, Nevada*. Climatography of the United States No. 81, January 1992.

U.S. Department of the Interior Bureau of Reclamation (USBR), 1988, *Engineering Geology Field Manual*, Second Ed., Volume 1

Van Denburgh, A.S., Lamke, R.D. and Hughes, J.L. 1973. *A Brief Water Resources Appraisal of the Truckee River Basin, Western Nevada.* Nevada Department of Conservation and Natural Resources, Water Resources Reconnaissance Series Report 57, 122 p.

Western Regional Climate Center (WRCC), http://www.wrc.dri.edu; Sparks Station 267697.

White, D.E. 1981. *Active Geothermal Systems and Hydrothermal Ore Deposits*, Economic Geology 75th Anniversary Volume, pp 392-423.

White, D.E. and Herpoulos, C. 1983. *Active and Fossil Hydrothermal-Convection Systems of the Great Basin*. Geothermal Resources Council, Special Report No. 13, pp 41-53.

Winterkorn, H.F. and Fang, H. 1975. *Foundation Engineering Handbook.* Van Nostrand Reinhold: New York. 729 p.

ATTACHMENT

CSCON
Carter Schleicher Consulting

4141 Ramsey Circle
Carson City, Nevada 89706-0550

December 20, 2011

Mr. Mark Franc
Refuse Inc.
Lockwood Regional Landfill
2401 Canyon Way
Sparks, Nevada 89431

RE: NAC 444.679 Review of the South Area Parcel of the Proposed Lockwood Expansion Project, Waste Management's Lockwood Facility
Storey County, Nevada

Dear Mr. Franc:

On December 19, 2011, CSCON personnel conducted an on-site review of Waste Management's South Area Parcel of the Proposed Lockwood Expansion Project, Waste Management's Lockwood Facility, in relation to NAC 444.679.

NAC 444.679 1. states that ***a new municipal solid waste landfill unit or a lateral expansion may not be located in wetlands unless the owner or operator satisfactorily demonstrates to the solid waste management authority and the Administrator that***... The remainder of this section lists the items that need to be demonstrated.

NAC 444.679 2. Defines wetlands as ***those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and which under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils, including swamps, marshes, bogs and other similar areas.***

On December 19, 2011, CSCON personnel conducted an on-site review of the proposed South Area Parcel Project Area to determine whether any wetlands, as defined at 444.679 2. occurs within the project area.

The area is dominated by upland vegetation. Wetlands do not occur on the site as seeps and springs or pools in the ephemeral drainages.

CSCON feels that the results of the on-site review constitutes compliance with 444.679 in its entirety.

If you have any questions, please contact me at 775 885-1944.

Sincerely,
CSCON

Carter Schleicher C.W.B.®
Principal