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CORRECTIVE ACTION AND STORM WATER CONTROL PLAN VOLUME 4 STORM WATER CONTROL WORKPLAN/TECHNICAL DRAINAGE STUDY

SUNRISE MOUNTAIN LANDFILL

CLARK COUNTY, NEVADA

TASK 4.4

REVISION 2.0, JULY 2011

Prepared for:

REPUBLIC SERVICES, INC.

Republic Services of Southern Nevada
770 East Sahara Avenue
Las Vegas, Nevada 89104

Prepared by:

July 1, 2011

093-9743611

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: _____ Date: _____

Location of Development: a) Descriptive (Cross Streets) North/South _____ East/West _____

b) Sect. _____ Twn. _____ Rng. _____

Name of Owner: _____ Assessors Parcel No: _____

Telephone No: _____ Facsimile No: _____

Address: _____

_____

Contact Person-Name: _____ Telephone No: _____

Firm: _____

Address: _____

Type of Land Development/Land Disturbance Process:

	Rezoning		Subdivision Map		Clearing and Grading Only
	Parcel Map		Planned Unit Development		Other (Please specify below)
	Large Parcel Map		Building Permit		

1. Total Owned Land Area: At Site: _____ Being Developed/Disturbed: _____
2. Is a portion or all of the subject property located in a designated FEMA Flood Hazard Area? YES* NO
3. Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? YES* NO
4. Proposed type of development (Residential, Commercial, Etc.)? _____
5. Approximate upstream land area which drains to the subject site? _____
6. Has the site drainage been evaluated in the past? YES NO If yes, please identify documentation: _____
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: _____
8. Briefly describe your proposed schedule for the subject project: _____

Engineer's Seal

Submit this form as part of the required drainage study to the local entity which has jurisdiction over the subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

* Review and concurrence of the Clark County Regional Flood Control District is Required.

Local Entity File No.

Revision	*Date*

REFERENCE: **STANDARD FORM 1**

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

Project Name:	Map ID:	
Firm Name:	Engineer:	
Address:		
City:	State:	Zip:
Phone Number:	Fax Number:	
Property Owner:		
Address:		
City:	State:	Zip:
Reviewed By:	Date Received:	Date Accepted for Review:

The following checklist is intended as a guide for the engineer preparing a Technical Drainage Study to submit to the local entity and Clark County Regional Flood Control District (if necessary). The listed items are the minimum information required prior to the entity performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the Clark County Regional Flood Control District (CCRFCD) Hydrologic Criteria and Drainage Design Manual (MANUAL).

This document is intended as an aid in preparing Technical Drainage Studies. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all inclusive and does not limit the extent of the information, calculations or exhibits which may be necessary to properly evaluate the intended land use.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT

Yes	No	
____	____	Design Manual **Standard Form 1** with the engineer's seal and signature.
____	____	Design Manual **Standard Form 4**.
____	____	2 copies of the 24" x 36" Drainage Plan.
____	____	A notarized letter from the adjacent property owner(s) allowing off-site grading or discharge.

REFERENCE:	**STANDARD FORM 2**

DRAINAGE SUBMITTAL CHECKLIST

II. MAPS AND EXHIBITS

Yes	No	
____	____	A copy of a current Flood Insurance Rate Map (FIRM) with the site delineated.
____	____	A copy of the current CCRFCD Master Plan Update Figure, (F-x), for Flood Control Facilities and Environmental areas with the site delineated.
____	____	Off-site drainage basin maps for existing, interim and future conditions showing the existing topography, basin boundaries, concentration points, and flows in cfs.
____	____	On-site drainage basin maps for existing and proposed conditions showing the existing topography, basin boundaries, concentration points, and on-site and off-site flows in cfs.
____	____	Vicinity Map with local and major cross streets identified and a north arrow.

III. DRAINAGE PLAN

Yes	No	
____	____	Sheet size: 24" x 36" sealed by a registered engineer in the State of Nevada.
____	____	Minimum scale: 1" = 60'.
____	____	Project name.
____	____	Vicinity Map with local and major cross streets.
____	____	Revision box.
____	____	North arrow and bar scale.
____	____	Engineer's/consultant's address and phone number.
____	____	Elevation datum and benchmark.
____	____	Legend for symbols and abbreviations.
____	____	Cut/fill scarps, where applicable.
____	____	Street names, grades, widths.
____	____	Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street.

REFERENCE:	STANDARD FORM 2

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
___	___	Existing contours encompassing the site and 100 feet beyond with spot elevations for important locations, where appropriate.
___	___	Minimum finish floor elevations with top-of-curb elevations at upstream end of lot.
___	___	Proposed typical street sections.
___	___	Streets with off-set crowns.
___	___	Proposed contours or spot elevations in sufficient detail to exhibit intended drainage patterns and slopes.
___	___	Property lines.
___	___	Right-of-way lines and widths, existing and proposed.
___	___	Existing improvements and their elevations.
___	___	Delineation of proposed on-site drainage basin s indicating area and 10-year and 100-year storm peak flows at basin concentration points.
___	___	Concentration points and drainage flow direction with Q_{100} and V_{100} and D_{100} in streets.
___	___	Cumulative flows, velocity, and direction of flow at upstream and downstream ends of site for the 10-year and 100-year flows.
___	___	Location and cross-section of street capacity calculations.
___	___	Cross-sectional detail for channels, including cutoff wall locations.
___	___	Existing and proposed drainage facilities, appurtenances, and connections (i.e., sidewalk, ditches, swales, storm drain systems, unimproved and improved channels, and culverts, etc.) stating size, material, shape, and slope with plan and profile and HGL calculations.
___	___	Existing and proposed drainage easements and widths shown with sufficient detail. A cross sectional detail must be provided that shows appropriate lining and reinforcement.
___	___	Location and detail of existing, proposed, and future block wall openings. Minimum size is 16" x 48". Wrought iron gate is required for flows > 10 cfs.
___	___	Location and detail of flood walls illustrating depth of flow, proposed grouting height, etc.

REFERENCE:	**STANDARD FORM 2**

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
____	____	Perimeter retaining wall locations. All existing and proposed walls (retaining screen and flood) must be shown with adjacent ground elevations. Flood walls with 8-inch concrete masonry unit.
____	____	Building and/or lot numbers.
____	____	Alignment of all existing, proposed, or future Regional Facilities adjacent to the site.
____	____	Limits of existing floodplain based on current FIRM or best available information; limits of proposed floodplains based on best available information.
____	____	For areas in Zone A, AE, AH, and AO, base flood elevations (BFEs) must be shown for each lot; BFEs may be listed on each lot, or in a table. Finish floor elevations must be a minimum of 18 inches above BFE.
____	____	Appropriately elevated "humps" 6 inches above the 100 year water surface elevation at site accesses where the intent is to protect the site from the Q_{100} flows.
____	____	Street slopes for perimeter and interior streets. The minimum slope is 0.4 percent.

IV. HYDROLOGIC ANALYSIS

Yes	No	
____	____	Appropriate soil information and Soils Map for existing and future conditions with subbasins and property delineated.
____	____	Input and output information for existing conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
____	____	Input and output information for future conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
____	____	Use of correct precipitation values in and around the McCarran Airport rainfall area.
____	____	A discussion in the text of the hydrologic analysis justifying subbasin boundaries and cutoffs, supporting assumptions, and calculations.
____	____	A summary table of stormwater flows showing basin area, Q_{10} and Q_{100} for both individual basins and combined basin flows, where applicable.
____	____	Copies of supporting technical information referenced from a previously approved study and a statement accepting these results.
____	____	On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners in accordance with current Nevada Drainage Law.

REFERENCE:	**STANDARD FORM 2**

DRAINAGE SUBMITTAL CHECKLIST

V. HYDRAULIC ANALYSIS

Yes	No	
____	____	Flow split calculations and supporting documentation or reference for the method of flow split calculations used.
____	____	Normal depth street flow calculations and cross section diagrams for all interior and perimeter streets. Provide "d x v" products for the Q_{100} and Q_{10} flows representing the worst case for interior and all perimeter streets. Q_{100} d x v $\leq$ 8. Q_{10} d x v $\leq$ 6 and 12 foot dry lane for rights-of-way $\geq$ 80 feet. Calculations must be labeled by street name as indicated on the Grading Plan.
____	____	A summary table of interior and exterior street capacity calculations showing the street name, Q_{100} flow, slope, depth of flow, velocity and depth times velocity product and streets needing to meet 12 foot dry lane criteria.
____	____	Appropriate hydraulic calculations for block wall openings assuming a 50 percent vertical clogging factor. (Assume the lower half of the opening is plugged.)
____	____	Appropriate hydraulic calculations at drainage easement entrance and discharge locations to set finish floor elevations. Hydraulic calculations must include submerged weir, superelevation and tee intersection losses, where appropriate.
____	____	Provide necessary freeboard requirements to set the finished floor elevations of all proposed buildings, 2 x depth of flow or depth of flow plus 18 inches of freeboard, whichever is less. The minimum requirement is 6 inches above adjacent upstream top of curb. Buildings adjacent to drainage easements must always be provided with 18 inches of freeboard above the Q_{100} weir height or flow depth, which ever is greater.
____	____	A complete water surface profile analysis (HEC-2, HEC-RAS, etc.) for channel flows and FEMA Zone A flood zones. • Field survey data. • Input and output information. • Plotted cross-sections based on survey with proper encroachments. • A map showing the location of the cross-sections. • Analysis of both sub and super-critical flow segments. • A summary table and a discussion of the results in the text of the report.
____	____	Provide a 50 percent clogging factor in the capacity calculation for drop inlets.
____	____	Hydraulic calculations for culverts and storm drains. D-Load calculations must be provided for storm drain pipes in public rights-of-way, including headwater pool inundation.
____	____	The mitigation of nuisance water, both during construction and in the fully developed condition, must be addressed.

REFERENCE:	**STANDARD FORM 2**

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ACRONYMS AND ABBREVIATIONS

CAP	Corrective Action Plan
CFP	Controlled Flow Plan
DOC	Dam Outlet Channel
EPA	United States Environmental Protection Agency
EPC	Eastern Perimeter Channel
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
NDEP	Nevada Department of Environmental Protection
RSSN	Republic Dumpco, Inc. and Republic Silver State Disposal, Inc., d/b/a - Republic Services of Southern Nevada
SOW	Scope of Work
SWCW	Storm Water Control Workplan
SWPPP	Storm Water Pollution Prevention Plan

1.0 INTRODUCTION

This report presents the Storm Water Control Workplan (SWCW) for the Sunrise Mountain Landfill Site ("Site") as stipulated in Tasks 4.1 (relevant to storm water control) and 4.4 of Appendix A, Scope of Work (SOW), to the Consent Decree and Settlement Agreement, United States v. Republic Dumpco, Inc., Civ. Action No. 2:08-CV-01024-PMP-PAL (D. Nev. entered September 26, 2008) ("Consent Decree"). In addition, this report serves to satisfy the Clark County, Nevada Technical Drainage Study requirements stipulated in the *Clark County Regional Flood Control District Hydrologic Criteria and Drainage Design Manual* minimum criteria, Section 204 (1999). Standard Forms 1 and 2 have been provided at the beginning of this report and also are included in Appendix A. Republic Dumpco, Inc. and Republic Silver State Disposal, Inc., d/b/a - Republic Services of Southern Nevada (collectively "RSSN"), with its consultants, has prepared this SWCW.

1.1 Site Location

The Site is located approximately 3 miles east of Las Vegas at the termination of Vegas Valley Drive, in Clark County, Nevada on the eastern edge of Las Vegas Valley, immediately southeast of Frenchman Mountain. The Site includes the closed Sunrise Mountain Landfill, which lies on a 720-acre parcel of land that is leased to Clark County, Nevada by the Bureau of Land Management; and three adjacent parcels known as the Northeast Canyon Area (an 80-acre parcel), the Eastern Perimeter Area (a 240-acre parcel), and the Western Burn Pit Area (a 20-acre parcel). The northernmost portion of the landfill area is located within the canyon directly east of Frenchman Mountain. However, the majority of the landfill is located on a large alluvial fan that originates at the mouth of the canyon and spreads out south into the adjacent valley. Elevation on the Site ranges from 1,900 to 2,275 feet above mean sea level. The Site is situated within the following Public Land Survey System descriptions:

- Section 36 Township 20S Range 62E
- Section 31 Township 20S Range 63E
- Section 1 Township 21S Range 62E
- Section 6 Township 21S Range 63E
- Section 12 Township 21S Range 62E

The site also comprises of the following parcel numbers:

- 14036
- 14131
- 16101
- 16006
- 16007
- 16111

- 16112
- 16113

Figure 1, "Sunrise Mountain Landfill, Drainage Study Area," provides a map of the principal drainage basin that encompasses the site and surrounding features.

1.1.1 Existing Conditions

The Site has a soil cover of varying depths across the waste disposal area. An existing run-on channel manages storm water flow from the north and diverts storm water to the eastern "Rockfall" channel. A number of "half-pipe" downslope channels are also in place to manage storm water at the Site. The existing conditions and current storm water features are shown on Sheet A-1, Existing Conditions, of the Construction Drawings.

The existing topography generally slopes from the north to the south across the Site. The landfill surface is relatively free of vegetation.

1.2 General Project Description

The principal function of the SWCW is to analyze, design and ultimately construct a surface water control system that is capable of safely managing precipitation from storm events, preventing erosion of the final cover, and prohibiting potential exposure and transport of waste off site. The storm water control system design includes a dam and associated detention basin located at the north end of the Site to manage off-site run-on entering the Site. The dam will temporarily detain storm water and prevent debris from inundating downstream channels. The Hydrology and Hydraulics Report for the detention dam is presented in Appendix B. Downstream of the detention basin is a network of channels, berms, and culverts designed to manage stormwater run-on from the Eastern and Western Ridges and stormwater run-off from within the Site. These structures will generally divert flow from north to south and discharge to detention basins located on the south and west sides of the Site with the exception of the Rockfall channel that directly discharges to a natural streambed in the southeastern corner of the Site.

Section 4.4.2.1 of the Scope of Work (SOW) mandates the update of the proposed Controlled Flow Plan (CFP) design and drawings dated December 17, 2003 by fully incorporating EPA comments dated March 18, 2004, and the requirements of the SOW. Revision 0 dated January 2009 of the SWCW and the Construction Drawings satisfied the SOW mandate to update the CFP. On November 10, 2009 the EPA issued the *Required Revisions and Additions to Storm Water Control Plan for Sunrise Landfill* (Required Revisions). The Required Revisions were addressed in Revision 1 to the SWCW which was submitted to the EPA In February 2011. On May 6, 2011 the EPA issued *Storm Water Control Workplan, Construction Drawings, Construction Specifications and Construction Quality Assurance Plan, EPA Approval With Modifications Pursuant to Consent Decree in Civ. No 2:08-cv-1024 entered 9-26-08 (U.S. Dist. Ct. D. NV)*

(EPA Approval with Modifications). This Revision 2 to the SWCW is being presented to document the changes made based on the EPA Approval with Modifications which is included in Appendix C for reference.

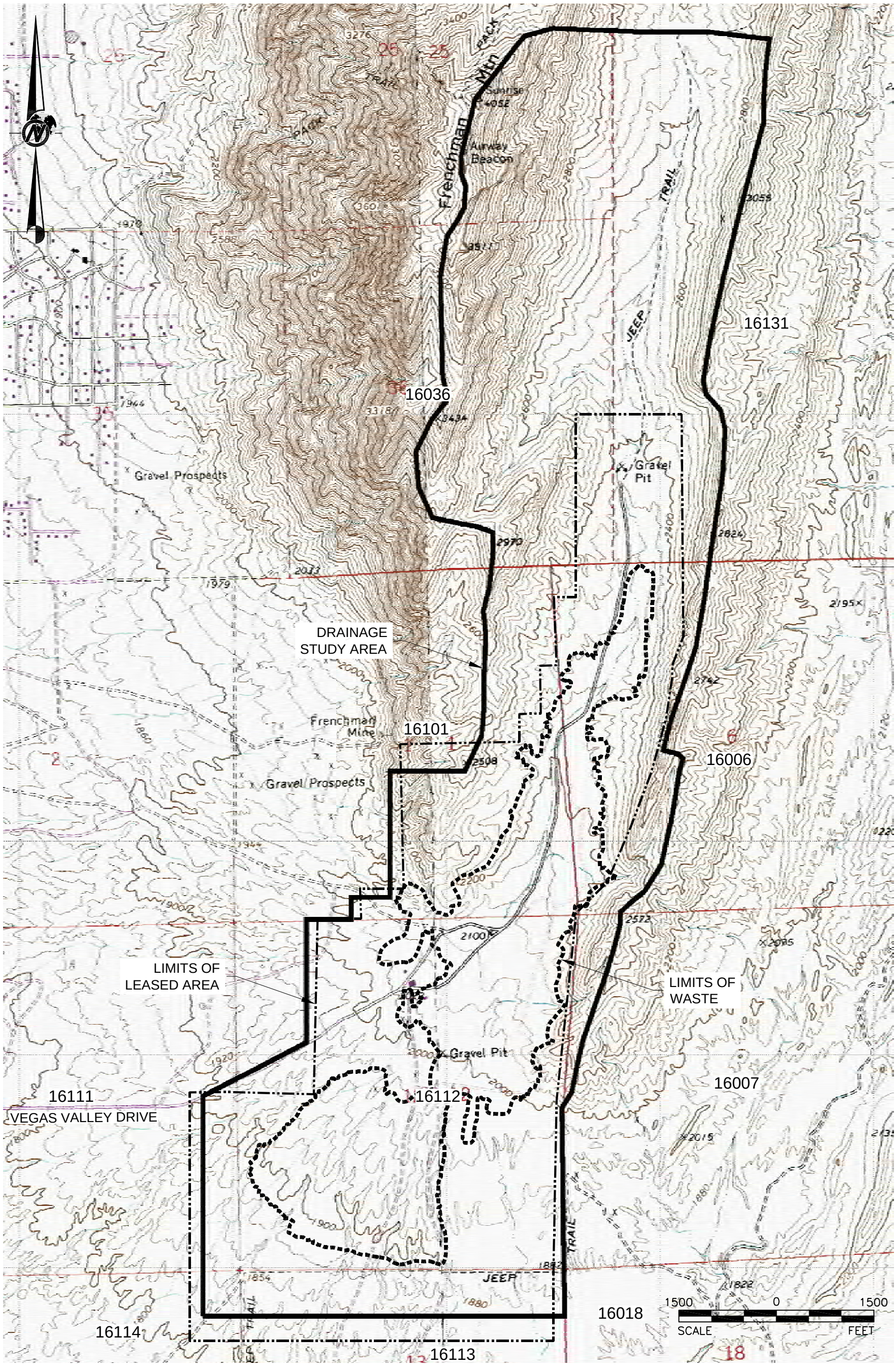

FIGURE 1

DRAINAGE STUDY AREA
SUNRISE MOUNTAIN LANDFILL
LAS VEGAS, NEVADA

Golder Associates
Roseville, California

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2.0 DRAINAGE BASIN DESCRIPTION

Figures 1-1 through 1-4 in Appendix F, provides the delineation of the primary drainage basins downstream of the detention dam. Also provided in Appendix F are corresponding tables providing basin names, discharges, and additional hydrologic data. The subbasins are divided into four primary basins with the detention dam basin delineation provided in Appendix B: The basins are:

- Detention Dam Basin
- Rockfall Basin
- Top Deck Basin
- West Basin
- Southwest Basin
- Southeast Basin

The hydrologic data for the detention dam basin and three basins below the dam are presented in Appendix B and Appendix F, respectively.

2.1 Off-Site Drainage Description

Off-site storm water flow generally enters the Site from three upstream watersheds which are:

1. North Canyon run-on
2. Eastern Ridge run-on
3. Western Ridge run-on

The United States Bureau of Land Management (BLM) currently owns the land that produces run-on entering the Site. At this time no development is planned for these locations that would impact the Site. Appendix D, "Surface Water Management System References and Exhibits," provides the National Resources Conservation Service soil survey for the Site and the off-site drainage areas.

2.2 On-Site Drainage Description

The Site was closed in 1993 after operating as a municipal landfill since the mid 1960s. Upon closure of the facility, a soil cover was placed over the waste and various drainage structures have been installed. The general drainage pattern at the Site is from north to south with existing primary discharge points being the Rockfall Channel and 12 other locations along the south and west property line. These discharge locations are identified on Sheet A-1 of the drawings.

2.3 Master Planning Information

There are currently no Master Plan Flood Control Facilities within the Site. Upon EPA approval of this SWCW, RSSN may request that Clark County make provisions for inclusion of the Site into a Master Plan Flood Control Update. Figure 33 from the CCRFCD Master Plan is provided in Appendix D.

2.4 Floodplain Information

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) were reviewed to identify floodplains within or in the vicinity of the Site. There are no floodplains located within the site boundaries. The floodplain located nearest to the site is the Las Vegas Wash, which does not affect on-site drainage as it is downstream of the Site. The FEMA FIRM maps are included in Appendix D.

2.5 Previous Drainage Studies

Site specific drainage studies have been conducted in the past by consultants of RSSN. The most recent study, *Stormwater Protection for the Sunrise Mountain Landfill*, (Exponent, Inc., 2003) attempted to evaluate alternative plans to provide storm water protection for the Site. The EPA provided comments on these plans and the SOW established the basis for the Site design presented in this SWCW.

3.0 PROPOSED DRAINAGE FACILITIES

3.1 General Description

This SWCW serves to improve storm water control across the Site and protect the surface water of downstream watersheds. The detention dam, channels, diversion berms, and detention basins are designed to reduce overall storm water flow discharging from the Site and improve the quality of storm water discharge.

3.2 Compliance with Regulations and Adopted Plans

The Site is not currently included in a Master Planned Flood Control Facility and therefore compliance with these regulations do not apply. As stated in Section 2.4, the Site is not within a FEMA designated floodplain and no modifications to the current FIRM maps are being proposed at this time.

The southern portion of the Site is located on an existing alluvial fan. This SWCW has been completed to improve storm water control across this region and therefore complies with the Clark County rules and regulations for developments on alluvial fans.

The primary variance within this SWCW from the drainage criteria requirements of Clark County is the exclusion of a pre-development versus post-development flow analysis for the Site. The pre-development versus post-development study has been omitted for the following reasons:

- The detention dam reduces peak run-on flow from the north canyon
- Run-off from the site is temporarily detained with a reduction in peak flow from the proposed detention basins

The detention of storm water within these design features is believed to reduce the post-development flows below the pre-development conditions. This SWCW is also in compliance with the recently adopted Clark County Uniform Regulations. This SWCW includes storm water management features that:

- Promote comprehensive floodplain management
- Require safe flood-prone area development
- Foster sound development policies and construction procedures
- Reduce storm water run-off damage to public and private property

The following sections will demonstrate compliance with the Clark County *Hydrologic Criteria and Drainage Design Manual* (1999) and the SOW.

4.0 HYDROLOGIC ANALYSES

4.1 Calculation of Storm Water Flow Rates

The surface water modeling program, Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS), developed by the U.S. Army Corps of Engineers, was used to model the surface water conditions at the Site including the upstream drainage basins. The following sections describe the hydrologic parameters used in the model. The hydrologic design parameters and HEC-HMS design data are presented in Appendices E and F, respectively.

4.1.1 Design Rainfall

As mandated in the SOW, the Design Storm Event is a 200-year return period, 6-hour duration event of 4.20 inches. This was calculated by Exponent, Inc. (2003):

"Point precipitation calculations are based on recommended procedures in Section 500 in the Clark County Manual. Point precipitation depths are recalculated using Clark County methods for 5-minute through 6-minute durations for the 2-year, 6-hour and 100-year, 6-hour return period rainfall events. To estimate the 200-year, 6-hour event, point precipitation depths for 1-hour through 6-hour durations were extrapolated using least squares analysis using a power function (log-log) fit between return period and depth. To obtain the 5-minute and 15-minurte duration depths, the extrapolated 200-year, 1-hour depths were multiplied by the appropriate factors in Table 504."

Table 1 below, "200-Year Design Storm Rainfall Depths," provides the storm rainfall depths for various durations based on previously completed analyses (Exponent, Inc., 2003).

TABLE 1
200-YEAR DESIGN STORM RAINFALL DEPTHS

Duration	Depth (inches)
5-minute	0.99
15-minute	1.95
1-hour	3.42
2-hour	3.69
3-hour	3.80
6-hour	4.20

4.1.2 Hydrologic Parameters

The subbasin area, curve number, and ground conditions are among the input parameters necessary to model the surface water hydrology of the study area.

4.1.2.1 Subbasin Size

Determining the subbasin size defines the area that produces the surface water flow. Undeveloped subbasins were delineated based on their natural topographic divides illustrated on a photogrammetric

survey of the Site. Developed subbasins were delineated using the design contours of the Site. The locations of the subbasins are shown in Appendix F.

4.1.2.2 Curve Number and Ground Condition

A determination of the ground conditions at the Site is necessary to calculate the amount of rainfall that will become surface water flow. If the ground conditions consist of highly permeable soils with dense vegetation, less run-off will be produced. Conversely, if the soils have low permeability and minimal vegetation, the run-off rate will be higher. The study area is generally located in an area of hydrologic soils classified as A, B, and D. Soil data obtained from the United States Department of Agriculture, SCS Web Soil Survey is provided in Appendix D. Soils included in hydrologic soil group D are associated with higher run-off coefficients. Soils included in hydrologic soil group A are associated with lower run-off coefficients. Flow calculations for modeling purposes were conservatively-based on the hydrologic soil group D. Field survey and analysis of aerial photography indicated that the current condition of the study area consists mainly of unvegetated granular soils. A granular soil cover is proposed for the closure of the site, therefore this assumption will remain valid after the final cover soils are placed. A curve number of 88 was used for all the subbasins included in the hydrologic analysis below the detention dam. A curve number of 98 was used for impermeable areas within the Facility, such as detention basins. A summary of all hydrologic parameters used in the analysis is provided in Appendix E, “Hydrologic Parameters.”

4.1.2.3 Sediment Bulking Factor

To account for the potential of sediment inflow in the storm water, a sediment bulking factor was applied to the peak in-flow to all storm water structures. A bulking factor of 30 percent and 10 percent was applied for undeveloped and developed areas, respectively. All areas within the limits of waste were considered developed. The bulking factors were applied to the hydraulic analysis of the surface water structures to insure the structures could manage the bulked storm water flow.

5.0 SITE DESIGN

5.1 Scope of Work Task 4.1 – Design Compliance

The following sections address the tasks pertinent to storm water control included in Task 4.1 – Final Cover Corrective Measures Workplan of the SOW. Hydrologic Engineering Center River Analysis System (HEC-RAS) was used to model the hydraulic performance of the surface water structures. The model results are presented in Appendix G-1. Additionally, hydraulic design calculations used to evaluate adequate freeboard and erosion protection for the surface water structures are provided in Appendix G-2.

5.1.1 Task 4.1.8.2 – Surface Water Control Features

Surface water control features including diversion berms, inlet structures, and channels have been designed to control storm water run-off in a manner that controls erosion and manages sediment loss and infiltration. The surface water control features incorporated the following:

- Run-off to accommodate the 200-year rainfall design storm event. Standard Form 4 from the Manual was followed for calculating time of concentration and HEC-HMS input.
- Lining or hardening to convey the computed flows. Typically loose riprap, grouted riprap, or concrete will be used for channel lining.
- Additional conveyance depth needed to carry water through bends, curved sections, and hydraulic jumps. Typically diversion berms were not held to the same hydraulic criteria as these structures are considered as diversions and not conveyances.
- Freeboard necessary to accommodate irregular flow conditions that are in addition to computed normal flow depths, bend or curve depths, and hydraulic jumps. The minimum freeboard was computed per the SOW and as presented in supporting calculations for the surface water control features.
- All channels conveying 300 cubic feet per second or more run-off have been designed with a continuous parallel maintenance road on one side of the channel. The Rockfall channel was exempt from this requirement.
- Surface water control features were designed to minimize run-off from the western slopes (Area E on Attachment 4 of the SOW) from reaching the southern flats (Areas B and C on Attachment 4 of the SOW).
- Additional control features were designed for concentrated off-site run-on flows entering the Site, identified in orange on Attachment 4 of the SOW. Each of these areas identified were considered in the design and, where appropriate, additional riprap or 14-inch erosion layer was placed at these locations to manage the concentrated flows.
- Concentrated on-site flows identified in yellow on Attachment 4 of the SOW were considered in the Site design. Where appropriate, additional diversion berms or channels were designed to minimize the erosion potential across the final erosion layer. Provided in Appendix L is the concentrated flow analysis that includes both off-site and on-site flows.
- Berms and channels have been designed to control flow across steep side slopes within the Site and divert flow to the detention basins.
- Berms and channels have been spaced to meet the maximum flow lengths stipulated in Attachments 7g in the SOW on slopes greater than 10% and Golder's "Design Curves – 13 inch Layer Thickness" for slopes less than 10%. The flow length analysis is provided in Appendix G-2, Attachment 5.

5.1.2 Task 4.1.8.3 – Perimeter Drainage Diversions (Perimeter Drainage Berms)

Two perimeter drainage diversions on the top deck have been designed and are identified as B-TD1 and B-TD2 on the plan set. The top deck is graded in a "stepped" fashion to minimize the required fill. The two perimeter diversion berms and one central channel, C-TD1, convey water to three down chute culverts that surface discharge to Channel 3. Additional valleys on the top deck were included in the concentrated flow analysis and it was determined that the 13-inch erosion will not erode in those areas.

5.1.3 Task 4.1.8.4 – Diversion Berms (Tack-On Berms)

Diversion berms are designed to divert run-off across the erosion layer to limit the length of the drainage slope in conformance with the soil gradation design of the erosion layer. The complete design basis for erosion layer thickness with respect to slope and drainage length is provided in Appendix G-2, Attachment 5. The berms were designed to carry a volume of storm water equal to the volume of the Design Storm Event. Additionally, appropriate erosion protection was designed for each berm. Typical diversion berm details are presented on Sheet B-7 in the Construction Drawings and design information and supporting calculations are provided in Appendix G-2. HydroCAD was used to model each diversion berm to calculate flow velocity, Froude Number, and normal depth.

An additional HEC-RAS analysis of diversion berm, B-E1, was conducted and is summarized on Attachment 1, Pages 2 and 3 of Appendix G-2. As shown in the analysis with grouted riprap n values within the allowable range of 0.028 and 0.03, the berm will remain supercritical. The supercritical transition from B-E1 to channel, C-E1 was also designed as shown on Sheet B-5 of construction drawings and summarized in Appendix G-2. Berm, B-W1 slopes were modified to insure that the flow remains subcritical at the transition into channel C-1. B-E1 and B-W1 transition lengths were designed according to Clark County design requirements for contracting supercritical and subcritical flow transitions, respectively.

5.1.4 Task 4.1.8.5 – Pipe and Channel Inlet Structures

Inlets to culverts and channels have been designed to limit erosion. A "Y" inlet structure has been designed for Channel C-2A that collects off-site run-on. This inlet structure is shown on Sheet B-3 of the Construction Drawings.

5.1.5 Task 4.1.8.6 – Down Drains

Six corrugated metal pipe down drains are utilized to convey flow from the top deck and from the eastern ridge as shown on the plans. The down drains are designed to be constructed above the final cover slope and are terminated above the normal water elevation of receiving channel. A concrete headwall and thrust block have been designed for the down drains at the inlet and outlet, respectively. Appendix H, "Culverts," includes design calculations for the down drains.

5.1.6 Task 4.1.8.7 – Construction Drawings and Specifications

The Construction Drawings include grading plans to show the layout and details of all cover materials and surface water control features. Specifications for all surface water control features are provided in the Construction Specifications.

5.1.7 Task 4.1.9.1 – Detention Basins

The SOW calls for the design of detention basins to reduce run-off velocities at the southern lease boundary of the site and for collection of surface water monitoring samples. This SWCW is proposing three detention basins designed to detain surface water run-off from the site. The detention basins are capable of managing flow from the Design Storm Event and are not located over waste. The basins have been designed with a vertical primary pipe riser outlet to drain the basins in less than three days and an emergency spillway to safely pass flows from storms in excess of the Design Storm Event. The complete detention basin design, including the time required for run-off from the Design Storm Event to drain from the basins, is provided in Appendix I, "Detention Basins." Access roads are designed to each basin to allow for the periodic removal of sediments from the basins.

Concrete plunge pools are provided at the channel discharge points (basin inlets) to limit scouring of the basin bottom, as shown on the construction drawings. The plunge pools consist of 12-inch thick concrete pad surrounded by an 8-foot wide riprap apron.

5.1.8 Task 4.1.9.2 – Road Surfacing

The Site will utilize two access roads, C-RD1 and C-RD2, as storm water conveyances. These roads will be asphalt paved (3-inch minimum thickness). The berm on the downslope side of each road is designed to accommodate the required freeboard. A 6-inch high asphalt dike is designed on the upslope side of the berm. Where the dike was located on the outside of a horizontal curve, the dike was increased in height to 1-foot to insure freeboard was achieved on both sides of the road. Where the deepest flow in the road changes from the left to right side near Station 20+00 of C-RD1, berms are located on both sides of the road for 100-ft. Having berms on both sides of the road insures that the flow is contained during the cross slope transition. Hydraulic information is provided in Appendix G-2 for the Road Berms. C-RD1 is designed to facilitate the periodic movement of construction equipment on the road to the Upper Deck for maintenance. Appendix M provides an analysis of the asphalt and road base to accommodate periodic loading caused by heavy equipment. The analysis concluded that from Stations 0+00 to 23+00, of C-RD1 the road base would be increased from 6-inches to 12-inches.

5.1.9 Task 4.1.9.3 – Black Lagoons

The Black Lagoon Area, also known as the Western Burn Pits, is protected from run-off from the landfill with a diversion berm, S-BP1.

5.2 Culverts

Reinforced concrete box (RCB) culverts are proposed where surface water control features cross access roads for the Site. Appendix H, "Culverts," includes design calculations for the culverts.

5.3 Surface Water Control Structure Linings

Three primary erosion linings are proposed for diversion berms and channels. Table 2, "Maximum Permissible Velocities," provides the erosion protection proposed and the maximum permissible velocity. Maximum permissible velocities were obtained from Table 703 of the Manual (Clark County Regional Flood Control District, 1999).

TABLE 2
MAXIMUM PERMISSIBLE VELOCITIES

Material / Lining	Maximum Velocity (feet per second)
Riprap	10.0
Grouted Riprap	15.0
Concrete	35.0

Riprap was appropriately sized using equation 736 provided in the Manual. The riprap will be bedded with a minimum of 12-inches of Type II Class B aggregate and/or 10 oz/sy geotextile and constructed in accordance with the Construction Specifications. The geotextile is to be placed over the Class B aggregate for loose riprap lined channels. Riprap design calculations are provided in Appendix G-2.

Grouted riprap is used where flow velocities exceed 10-fps or to maintain stable channel flow. A 16-inch thick grouted riprap layer with a d50 of 6-inches is designed for this layer.

Concrete lined channels have been designed in accordance with the Manual. Concrete lining will be a minimum of 6-inches in depth for flow velocities less than 30 fps and a minimum thickness of 7-inches for flow velocities of 30 fps or greater. Expansion and contraction joints have been designed in accordance with the Manual and are shown in details on Drawing B4. Concrete lined channels are bedded with a minimum of 6-inches of Type II Class B aggregate over a minimum of 12-inches of soil barrier layer.

5.4 Scope of Work Task 4.4 – Design Compliance

The following sections address the tasks included in Task 4.4 – Storm Water Control Workplan of the SOW.

5.4.1 Task 4.4.1 – Storm Water Pollution Prevention Plan

An updated draft Storm Water Pollution Prevention Plan (SWPPP) was previously submitted as Volume 6 of the Corrective Action and Storm Water Control Plan. The SWPPP has been updated to reflect the Surface Water Control Workplan and will be finalized following construction of the final cover and storm water controls.

5.4.2 Task 4.4.2.1 – Changes to Controlled Flow Plan Design

A Controlled Flow Plan was submitted in December by RSSN (2003). The SWCW serves as the update to the plan, and along with this report fully incorporates EPA comments from March 18, 2004 (except for those comments relating to an above ground pipeline) and the SOW.

5.4.3 Task 4.4.2.2 – Eastern Ridge Drainage Channel (Eastern Perimeter Channel)

The Eastern Perimeter Channel (EPC) receives storm water flow from the Dam Outlet Channel (DOC) as well as the Eastern Ridge and discharges to Channel 2. The EPC is a trapezoidal channel, has 2H:1V side slopes, generally sloped at 1.5 percent, and is a minimum of 8.5-feet deep. The EPC will be lined with 6-inch concrete and founded on a minimum of 6-inches of bedding and 12-inches of clean, recompacted fill. The channel was designed away from the Eastern Ridge to ensure that rock debris and sediment will not compromise the channel capacity. An access road parallels the EPC across its entire length. The EPC HEC-RAS model outputs and design calculations are provided in Appendices G-1 and G-2, respectively. The plan view and profile of the EPC is presented on Sheet RF3 and RF4 of the Construction Drawing.

5.4.4 Task 4.4.2.3 – Western Ridge – Storm Water Run-Off Control

The Site design includes a series of channels along the Western Ridge as shown on Sheet A-2, Overall Channel Layout, in the Construction Drawings. The channels are designed to capture and route storm water from the Western Ridge to limit the potential for erosion from this off-site source. The HEC-RAS model outputs and design calculations for these channels are provided in Appendices G-1 and G-2, respectively.

5.4.5 Task 4.4.2.4 – Specific Technical Comments to the Storm Water Control Workplan

5.4.5.1 Detention Dam

The detention dam and principal spillway designs are provided in Appendix B.

5.4.5.2 Dam Approach Channel

The detention dam RCC spillway was designed with an unlined approach channel prior to the RCC armoring. The approach channel is 1.5 feet lower than the spillway crest. Erosion of the unlined approach channel during design flows was evaluated using a shear stress approach. The maximum shear stress during the PMF design flow exceeds the threshold for initiation of erosion in the approach channel. Golder evaluated the depth of downcutting for the average flow for the period of exceedance of the erosion threshold and determined the maximum depth of erosion would be 0.06 feet. Calculations are included in Appendix B.

5.4.5.3 Dam Emergency Spillway and Stilling Basin

The dam emergency spillway was sized to route the 6-hour PMP event through the detention structure. The spillway consists of a converging stepped roller compacted concrete (RCC) spillway overtopping the

embankment at spillway crest elevation of 2,357.5 ft. AMSL. The spillway crest is a broad-crested weir with a width of 156-ft. on the downstream side of the spillway approach/broad-crested weir. The spillway flows into an RCC stilling basin designed using the methods shown in the USACE HDC 112-5/1. This method was developed by the USACE for sites where tailwater deficiencies might be present that could lead to the formation of an inadequate hydraulic jump using other methods. The basin's length and end sill were sized to accommodate the entire length of the hydraulic jump during the probable maximum flood 2/3-PMF discharge (2/3 of the peak discharge from the 6-hour PMP rainfall event). The training wall height is designed to safely contain full PMF discharge.

5.4.5.4 Dam Outlet Channel

The DOC is designed to convey storm water from the detention dam as well as run-on from the northern third of the Western Ridge. The DOC is trapezoidal in shape, with 2H:1V side slopes, and designed with depths of 5.5 and 8.5 feet with a 10-foot bottom width. The channel depth complies with the freeboard requirements of the SOW and Clark County. The DOC will be concrete lined across the entire width of the channel. The DOC HEC-RAS model outputs and design calculations are provided in Appendices G-1 and G-2, respectively. An access road parallels the DOC across its entire length. The DOC plan view, profile, and typical section are shown on Sheets RF1 and RF2 in the Construction Drawings.

5.4.5.5 Channel 1

Channel 1 conveys storm water run-on from the Western Ridge as well as run-off from the landfill. Channel 1 discharges to the EPC. Channel 1 is trapezoidal in shape, with 2H:1V side slopes with a 6.0-ft depth and 10-foot bottom width. Channel 1 will be lined with grouted riprap. Channel 1 HEC-RAS model outputs and design calculations are provided in Appendices G-1 and G-2, respectively. Channel 1 plan view, profile, and typical section are shown on RF11 in the Construction Drawings.

5.4.5.6 Channel 2

Channel 2 is designed to accept storm water flow from the EPC, convey run-on from a 29-acre drainage basin of the Eastern Ridge, and discharge to Channel 3. Channel 2 is trapezoidal in shape with 2H:1V side slopes and a 10-foot bottom width. An inlet structure is designed for Channel 2 to direct run-on from the Eastern Ridge drainage basin. The inlet structure detail is presented on Sheet B3 of the Construction Drawings. Channel 2 will be concrete lined. HEC-RAS model outputs and design calculations are provided in Appendices G-1 and G-2, respectively. Channel 2 plan view, profile, and typical section are shown on Sheet RF5 of the Construction Drawings.

5.4.5.7 Channel 3

Channel 3 is designed to convey storm water from Channels 1 and 2 as well as run-on from the Eastern Ridge and discharges to the Rockfall Channel. Channel 3 is trapezoidal in shape, with 2H:1V side slopes, and is a minimum of 11-feet deep. Channel 3 will be lined with 7-inch thick concrete. Channel 3 HEC-RAS model outputs and design calculations are provided in Appendices G-1 and G-2, respectively.

Channel 3 plan view, profile, and typical section are shown on Sheets RF6 and RF7 of the Construction Drawings.

5.4.5.8 Rockfall Channel

The existing Rockfall Channel conveys storm water from Channel 3. The channel is founded in limestone bedrock with sporadic gypsum outcrops. An analysis of the hydraulic performance of the Rockfall Channel and the potential erosivity of the gypsum outcrops was conducted and is provided in Appendix K. The analysis concluded that the upper reaches of the Rockfall Channel are susceptible to erosion and therefore the channel will be improved with concrete lining as shown on Sheet RF8 of the Construction Drawings.

5.4.5.9 Construction Debris Area

An existing concrete structure protects the construction debris area from a 37 acre off-site watershed. The watershed was modeled in HEC-HMS to compute the peak discharge from the design storm event. The results of the analysis indicated that the existing structure is capable of providing adequate erosion protection and is appropriately sized. Appendix G-2 includes the analysis of the existing concrete structure.

5.4.5.10 Debris Control Fence

A debris control fence is to be used along certain locations of the Eastern Ridge. The fence serves to protect Channel 3 from boulders that may inhibit storm water flow. An analysis of a rock fall protection system was prepared by Exponent, Inc. in August (2003). The analysis evaluated the impact energy from falling boulders and specified debris control fence manufactured by Geobrugg North America, LLC that meets the requirements of the design load. Geobrugg was contacted prior to the submittal of this report and indicated that modifications have been made to the fence since 2003. The Exponent analysis required Rockfall fence to be designed for a service load of 134,000 foot-lbs and an ultimate load of 200,000 foot-lbs. The Rockfall fence has been specified on the drawings as per the manufacturer (Geobrugg) and the latest design manual by the manufacturer has been included in Appendix J that meets the service and ultimate loads specified in Exponent's analysis.

5.4.6 Task 4.4.2.5 – Design Package

The CAP includes the design drawing package with plan view, profile, typical section, and detail drawings of all features described in the sections above.

5.4.7 Task 4.4.2.6 – Schedule

A summary of the construction schedule for completion of the Volume 1 – Final Cover Corrective Measures Workplan and Volume 4 – Storm Water Control Workplan is provided in TABLE 3, "Storm Water Control Workplan Construction Schedule." Actual timing of the specific construction activities to be determined by the contractor.

TABLE 3
STORM WATER CONTROL WORKPLAN CONSTRUCTION SCHEDULE

Task	Duration	Start Date	End Date
Mobilization	10 days	9/13/11	9/27/11
Pre-Construction Survey	20 days	9/13/11	10/11/11
Begin material processing of on-site borrow soils and stockpiles	145 days	10/25/11	5/12/12
LFG system improvements	72 days	10/25/11	2/2/12
Overall site grading to remove existing berms	17 days	11/25/11	12/20/12
Excavate dam foundation and prep rock bedding	50 days	12/1/11	2/9/12
Construct dam, associated outlets, abutments & drainage features	165 days	2/9/12	9/28/12
Prepare storm water control features outside the limits of waste	68 days	12/20/11	3/23/12
Place barrier soil layer starting in the North area	127 days	2/9/12	8/5/12
Excavate storm water ditches	149 days	2/13/12	9/8/12
Install aggregate base in ditches	99 days	4/30/12	9/15/12
Place the erosion layer	128 days	5/1/12	10/26/12
Construct concrete lined storm water conveyance structures	146 days	3/22/12	10/12/12
Install pipe and box culverts	13 days	9/18/12	10/5/12
Install rip rap	15 days	9/28/12	10/19/12
Demobilize	5 days	11/6/12	11/11/12

5.4.8 Task 4.4.3 – Inspections and Reports

Quarterly pre-rain settlement, and post-rain storm water inspections and reports, including documentation of corrective actions taken will continue to be conducted pursuant to the Surface Water Monitoring Plan.

5.4.9 Task 4.4.4 – Surface Seeps

The probable source and potential for recurrence of observed leachate surface seeps from the Landfill will be assessed, characterized, and repaired as appropriate. Surface seeps, unrelated to leachate, will be assessed for the probable source, need for repair or corrective measure, and, if warranted, perform repairs or corrective measures. Where surface seeps are observed that are not clearly leachate, testing and analysis will be performed to determine if the seep is leachate and assess the probable source, need for repair or corrective measures, and, if warranted, perform repairs or corrective measures. Seep assessments and corrective measures will be included in quarterly and post-rain storm water inspections and reports consistent with the Storm Water Monitoring Plan.

5.4.10 Task 4.4.5 – Maintain Storm Water Pollution Prevention Plan Records

SWPPP records will be maintained, including inspections and certifications for a minimum of three years.

5.4.11 Task 4.4.6 – Report Storm Water Discharge

Storm water discharges from the Rockfall Channel and the four detention basins will be reported both orally and in writing. Such discharges will be reported orally to both EPA and Nevada Department of Environmental Protection (NDEP) within 24-hours and written reports will be submitted within 10 days. Initial telephone reports to the EPA will be made to the Alternate Project Coordinator, currently Ann Murphy at (415) 972-3640, or any replacement representative designated by the EPA. Initial reports to the NDEP will be made to Jon Palm at (775) 687-6353 or to any replacement representative designated by the NDEP. Written reports will be made in accordance to Task 3.7 of the SOW.

5.4.12 Task 4.4.7 – Costs of Storm Water Pollution Prevention Plan Installation and Maintenance

Within 60 days of the SWPPP certification, installation costs and estimated costs for annual (short-term) and 30-year (long-term) maintenance will be submitted to the EPA and Clark County Regional Flood Control District Hydrologic Criteria and Drainage Design.

5.4.13 Task 4.4.8 – Debris Inspection and Removal

Debris inspection and removal reports will be submitted annually, as part of the first monthly progress report of the year. Additionally, the debris inspection and removal reports will be incorporated into post-rain, storm water inspections, and reports as stipulated in Task 4.4.3 of the SOW.

5.4.14 Task 4.4.9 – Reporting on Implementation and Compliance

Regular reports will be submitted on the implementation of this SWCW as part of monthly progress reports, and certify compliance will all requirements, or report any instances of noncompliance.

5.4.15 Task 4.4.10 – Implementation of SWCW

Following Clark County and EPA approval, this SWCW will be implemented in accordance with the approved schedule.

6.0 CONCLUSIONS

This SWCW and Technical Drainage Study define stormwater facilities designed to efficiently manage run-on and run-off from the facility.

This facilities described in the SWCW will detain run-on from off site at the northern upstream portion of the Site by constructing a dam. The dam will reduce the flow rate and velocity of storm water flowing across the landfill final cover during a storm event. The dam will also reduce the potential for downstream channels being negatively affected by debris during a storm event. Additionally, off-site run-on from the canyon walls around the site will be managed by channels at the toe of the canyon slope on each side of the Site. The management of the run-on from off-site drainage areas will prevent erosion of the landfill final cover. Key components of the run-on management system are the detention dam; dam outlet channel; eastern ridge drainage channel; channels 1, 2, and 3; and the Rockfall channel.

Similarly, the run-off from the landfill final cover will be managed through a series of diversion berms, channels, and culverts to further reduce the potential for erosion. The run-off from the landfill final cover will be routed to a series of detention basins. Key components of the landfill run-off management system include diversion berms, channels, the west basin, southeast basin, and southwest basin.

The facilities defined in the SWCW were designed for the 200-year rainfall event meeting the requirements of the SOW; the Clark County *Hydrologic Criteria and Drainage Design Manual* (1999); and the EPA, FEMA, and State of Nevada regulations. No Master Plan Flood Control facilities exist within the site boundaries. Additionally, the site is not located within a floodplain. A SWPPP was developed to monitor the storm water discharges from the Site. This SWCW also provides assurance that future end-use plans for the Site can be implemented without the potential for damage from storm events.

This SWCW defines facilities designed to prevent storm flows from inundating the channels and landfill final cover. When the storm water control features of this SWCW are constructed and implemented, the landfill final cover should be stable throughout future storm events.

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7.0 CERTIFICATION

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

W. [signature]
RSSN Representative

6/28/11
Date

ALBA ENVIRONMENTAL MANAGER
Title

8.0 REFERENCES

Clark County Regional Flood Control District, 1999, Clark County Regional Flood Control District, Hydrologic Criteria and Drainage Design Manual, Las Vegas, Nevada, August 12.

Exponent, Inc., 2003, Stormwater Protection for the Sunrise Mountain Landfill, January 24.

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