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May 8, 2013

Summit, LLC
c/o Mr. Rick Everson, P.E.
1335 North 5900 East
Eden, Utah 84310

IGES Project No. 01628-005

Subject: Supplemental Grading Recommendations
Cut Slopes and Fill Slopes
Powder Mountain Resort
Weber County, Utah

Reference: IGES, Inc., 2012, Design Geotechnical Investigation, Powder Mountain Resort, Weber County, Utah, Project No. 01628-003, dated November 9, 2012

Mr. Everson:

As requested, IGES has prepared the following supplemental grading recommendations within the Powder Mountain Resort, Weber County, Utah. This letter is in response to recent informal comments/questions regarding cut slopes and fill slopes for planned new roadways, and the potential impact of designing the main roadway (Summit Pass) to be primarily cut, which would eliminate potential issues with building a road on a cut/fill transition zone. This letter is intended to address these issues and to provide guidance for design and construction of roadways and associated cut slopes and fill slopes.

General Recommendations

IGES takes no exception to designing all roadways as 100% cut into the natural slopes, particularly if there are no concerns for balancing cut and fill. Care should be taken so that cut soils are not wasted in future building areas. Cut soils can be used as structural fill for roadway embankments, but would most likely require moisture-conditioning (so as to be compacted wet of optimum) and over-size material would need to be removed.

To accommodate the increased grade change of a 100% cut roadway, the following considerations are presented:

- Up-hill cut slopes should be a minimum of 2H:1V. Cut slopes as steep as 1.5H:1V may be allowed; however, the Owner should understand and accept that some surficial raveling and/or rock fall can be expected from these steeper slopes. Some maintenance of 1.5H:1V slopes should be expected over time. Alternatively, an anchored slope reinforcement system, such as Armormax or similar, may be used on steep slopes to minimize or eliminate future maintenance issues.

- To preserve the natural aspect of the site, cut slopes may not be desirable, particularly where a relatively tall cut slope is required to daylight to natural grade. In these cases,

the grade change may be accommodated with a rockery. Rockeries consist of stacked rocks, typically with a 0.5H:1V batter. Rockeries are analogous to rip-rap or slope armoring – the use of the term 'rock wall' is technically incorrect, as the stacked rocks are not designed to resist lateral earth pressure (e.g., they do not 'retain' earth materials).

- Where the steepness of the grade change precludes the practical construction of rockeries, a conventional wall may be required. For cut slopes up to 8 to 10 feet, a modular block gravity wall (such as Redi-Rock blocks or gabion baskets) may be a good option. For taller cuts, or where a large area needs to be retained, a soil nail wall may be a more practical solution. IGES can assist in the design of modular block retaining walls or soil nail walls upon request.

Fill Slopes

The following recommendations are for proposed engineered fill slopes. Recommendations for grading of proposed fill slopes are intended to minimize the potential for future surficial failures. For purposes of this report, surficial failure includes excessive erosion, sloughing, slumping, mass wasting, and similar relatively shallow failures.

We recommend that fill slopes taller than 15 feet that are adjacent to habitable or critical structures be constructed as a buttress fill, as illustrated on Figure 1, *Buttress Stability Fill Detail*. All keyway and buttress fill designs should be approved by IGES prior to construction. General recommendations for construction of buttress fills and fill slopes are presented in the following paragraphs:

A. General Specifications: Buttress fills should be constructed no steeper than 2H:1V (unless otherwise approved by IGES) and should be constructed with a keyway (see Figure 1). In general, the keyway back cut should be constructed no steeper than 1.5H:1V gradient, assuming the back cut will have a minimum factor of safety of 1.2. Flatter back cuts will reduce the potential for back cut failures. Front cuts should be cut at a maximum 1H:1V slope gradient unless field conditions indicate a flatter gradient should be used to provide adequate stability. In order to decrease the risk of back cut failure, cut slopes should be off-loaded prior to excavating the buttress back cut. In addition, the amount of time the back cut remains exposed and unsupported should be minimized to reduce the risk of back cut failure. All stability fills should be a minimum of 10 feet wide (equipment width) at the top of the slope and at all mid-slope terraces.

B. Keyway Sizing: The minimum recommended keyway length is 9 feet (see Figure 2, *Keying and Benching Detail*). As a minimum, keyways should be excavated 2 feet below toe grade; deeper keyway excavations may be necessary, depending on the height of the slope and prevailing geologic conditions. The width of a keyway is measured horizontally from the toe of slope (top of front cut) to the toe of the back cut (heel), with a 2 percent drop to the heel. The depth of a keyway is measured from the toe of the fill slope to the bottom of the keyway.

C. Drainage: All excavations for buttress fills and/or fill slopes should be provided with subdrains at the heel to reduce the potential for infiltrating water to perch and migrate toward the slope face. Local areas of particularly abundant groundwater may require subdrainage in addition to the typical heel subdrains as detailed on Figure 1. Subdrains placed along the back cut of buttress fills and/or fill slopes may be constructed with 4-inch perforated PVC pipe, surrounded by approximately 6 cubic feet per lineal foot of ¾ inch gravel, wrapped in permeable filter material. Subdrains should be provided with outlet drains every 100 feet. In addition, backdrains consisting of 4-inch perforated PVC pipe, surrounded by approximately 6 cubic feet per lineal foot of ¾ inch gravel, wrapped in permeable filter material, with outlets provided every 100 feet laterally should be constructed every 25 vertical feet along the back cut for buttress fills and fill slopes. All subdrains and backdrains should be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys. Some modification to the drainage recommendations presented herein may be feasible; however, any change should be approved by IGES prior to implementation.

D. Benching: Where fills are to be placed on ground with slopes steeper than 5H:1V, the ground shall be stepped or benched (see Figure 2 for a graphic illustration). At a minimum, benches should be constructed every four (4) vertical feet. Benches shall be excavated a minimum lateral depth of four (4) feet into competent material or as otherwise recommended by IGES. However, the *lowest* bench should be excavated a minimum lateral depth of 9 feet *into competent material* (this measurement may exceed 9 feet depending on actual subgrade conditions).

E. Slope Protection: Slope planting and other measures should be provided immediately following construction. Slope protection polymers, straw waddles, and/or jute mesh should also be considered to limit the amount of erosion on slopes subject to erosion until landscaping and other permanent erosion protection measures are fully in place. Additional slope protection recommendations are presented in the *Erosion Protection and Surficial Slope Stability* section of this letter.

F. Earthwork Recommendations: In addition to the normal compaction procedures for structural fill specified in our referenced geotechnical report (IGES, 2012), compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to IGES. As an alternative to slope compaction, slopes may be constructed 2 to 3 feet 'fat' and trimmed back using a bulldozer with a slope board or similar equipment. Upon completion of grading, relative compaction of the fill out to the slope face shall be at least 90 percent of the maximum dry density per ASTM D 1557 (modified Proctor).

Erosion Protection and Surficial Slope Stability

We understand that the current project specifications indicate that engineered slopes (fill slopes, cut slopes) will be covered with North American Green CS-150 erosion control blankets. We understand that the intent of the erosion control blanket is to provide surficial

stability until vegetation can establish, which will then provide natural erosion protection. The manufacture of CS-150 indicates that the design life of this product is 24 months.

IGES takes no exception to the use of CS-150 for slopes that are 2H:1V or flatter; however, for steeper slopes on the order of 1.5H:1V, IGES recommends the use of a permanent, more durable erosion control blanket such as Propex Landlok 300 or 450, North American Green P300, or similar. For steep-slope applications, erosion control blankets comprised of organic, bio-degradable components should be avoided.

For fill or cut slopes steeper than 2H:1V, the Owner may wish to consider the use of an anchored slope reinforcement system, such as the Armormax product manufactured by Propex, which generally minimizes or eliminates future maintenance issues. Engineered slopes steeper than 1.5H:1V, and possibly as steep as 1H:1V, may be feasible with the use of an anchored slope reinforcement system; such slopes should be evaluated on a case-by-case basis by IGES to assess feasibility.

Roadway Embankment and Fill Settlement Considerations

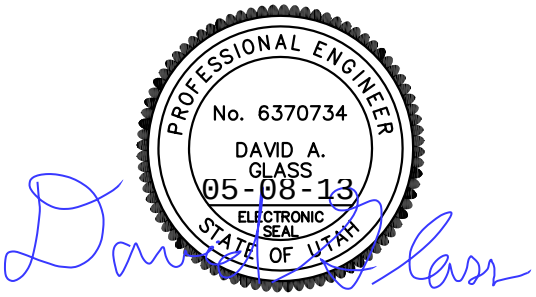
Fills for the proposed roadway embankments are expected to be limited in total height to no more than 15 feet at any given location. Total loads on the foundation soils will generally be less than 2,100 psf. We estimate that total settlement for the foundation soils beneath embankments will generally be less than 1 inch. This estimate has assumed a maximum fill height of 15 feet, no soft spots or otherwise deleterious soils on the subgrade, and that soil conditions will be similar to those encountered in our explorations. If soft soils are encountered or the maximum fill height exceeds 15 feet, the maximum settlement may be greater than 1 inch but should not exceed 2 inches.

Based on the soil stratigraphy observed we estimate the majority of the settlement beneath the embankments will occur during construction. In general, we recommend all embankment fills be allowed to stand prior to final grading and paving for a minimum of 2 weeks after construction to minimize the potential damage to pavements and other structural elements due to localized differential settlement.

Closure

We appreciate the opportunity to provide you with our services. If you have any questions please contact the undersigned at your convenience (801) 748-4044.

Respectfully Submitted,
IGES, Inc.



David A. Glass, P.E.
Senior Geotechnical Engineer

Attachments:

Contact List

Figure 1 – Buttress Stability Fill Detail

Figure 2 – Keying and Benching Detail

Contact List

The following suggested vendors are recommended based on past successful working relationships with IGES.

Redi-Rock

Castlerock Precast (local distributer/manufacturer)
Micah Martin
mmartin@castlerockprecast.com
(801) 376-7546

Armormax

ACF West (distributor)
Bill Kilpack
bill@acfwest.com
801-521-5141

Propex (Manufacturer)
Andy Durham
Andy.Durham@propexglobal.com
423-710-5110

Gabions

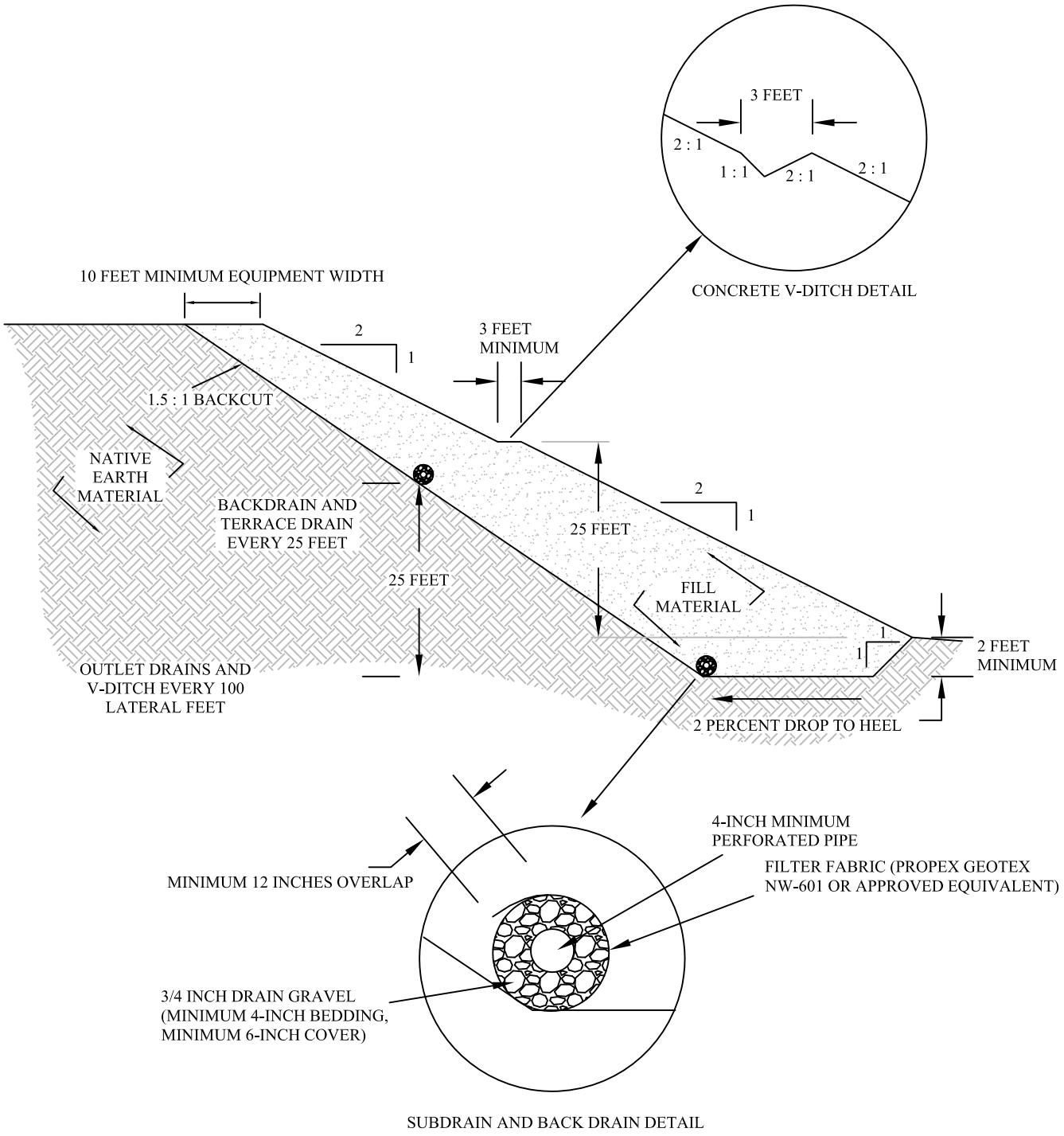
ACF West (distributor)
Bill Kilpack
bill@acfwest.com
801-521-5141

Terra Aqua (manufacturer)
http://www.terraaqua.com/

Soil Nail Walls

Jones Shoring and Excavating (contractor)
Mr. Kevin Garside
keving@jonesshoring.com
801-656-8670

BUTTRESS STABILITY FILL DETAIL



IGES

No. | Revision/Issue | Date

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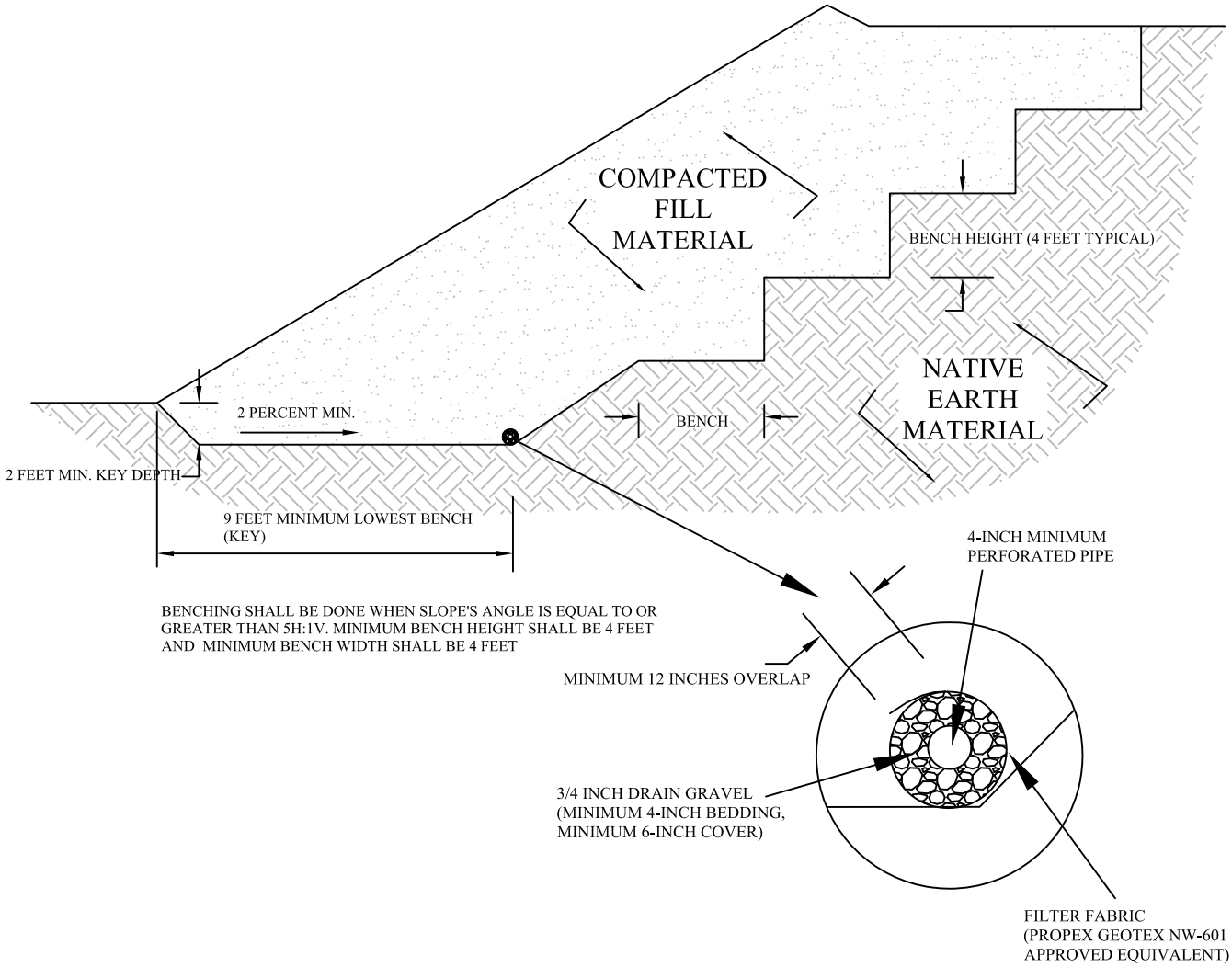
Drawing Notes

FIGURE
1

KEYING AND BENCHING DETAIL



SUBDRAIN DETAIL
(FOR FILL SLOPES IN EXCESS OF 15 FEET IN HEIGHT)

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Drawing Notes

FIGURE
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