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APPENDICES

SECTION 12. STORMWATER MANAGEMENT

This section summarizes the stormwater management analysis conducted for the proposed Project. The stormwater management system for this development must meet the Basic Standards, General Standards, and Flooding Standards of Chapter 500.

12.A Narrative

12.A.1 Development Location

The West Mountain Project site is an approximately 550-acre tract of land that is roughly bounded by the Sugarloaf Access Road to the east, West Mountain Road to the south, and the existing West Mountain Quad ski lift to the west (the "Site"). The Site lies within the surface watershed of the South Branch of the Carrabassett River, which is not classified as an Urban Impaired Stream as listed in Chapter 502 Stormwater Management Rules. Access to the site will be via new access roads and driveways off of Sugarloaf Access Road, West Mountain Access Road, and Bucksaw Drive.

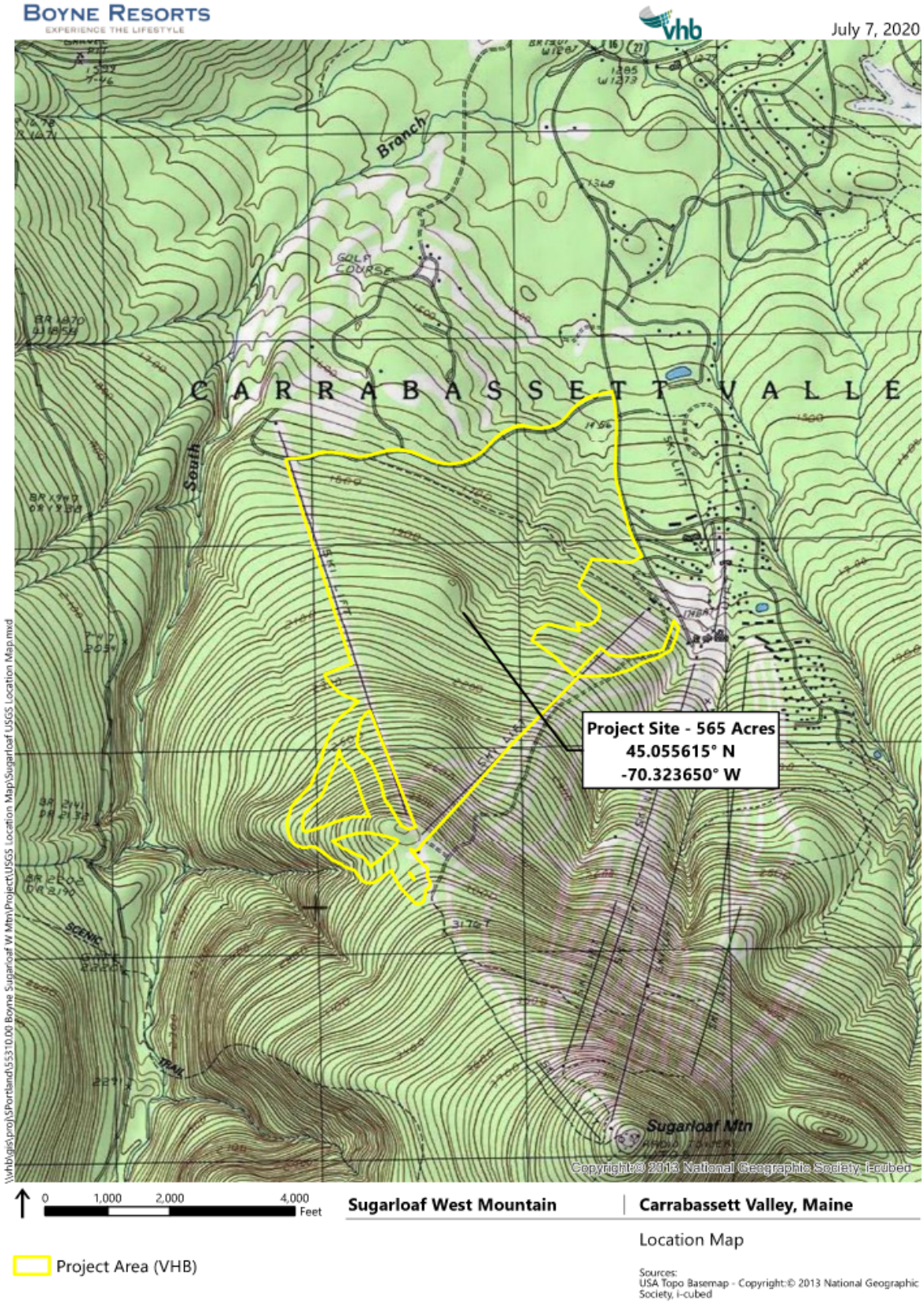
Existing small perennial and intermittent mountain streams generally flow to the north and east across the Site, through several culverts and one bridge at the Sugarloaf Access Road and West Mountain Road and to South Branch of the Carrabassett River. The Project is not located within a lake watershed; therefore, the Phosphorus Standards do not apply. Streams generally increase in size and flow regime moving from west to east across the site (right to left on the accompanying plan views).

Existing land cover consists primarily of previously logged forest lands at lower elevations within mixed deciduous forests. Higher elevations feature pine/fir species. An existing gravel work road transects the site in the east-west direction with a few scattered clearings and miscellaneous staging areas located along the work road. An existing water main corridor crosses the Site approximately halfway up the slope.

12.A.2 General Topography

The Site ranges in elevation from approximately 3,000 feet above mean sea level (amsl) at its south extent at the top of West Mountain to approximately 1,430 feet amsl at the northeast corner of the site. Project area topography is fairly steep with slopes ranging from 10% to 45%. Within portion of the Site to be used for housing development, slopes are in the 12%-20% range. Figure 12-1 below depicts general topography on a USGS quad map. Localized topography around the larger streams includes some gully formations, but the majority of streams onsite are smaller intermittent channels with little gullying.

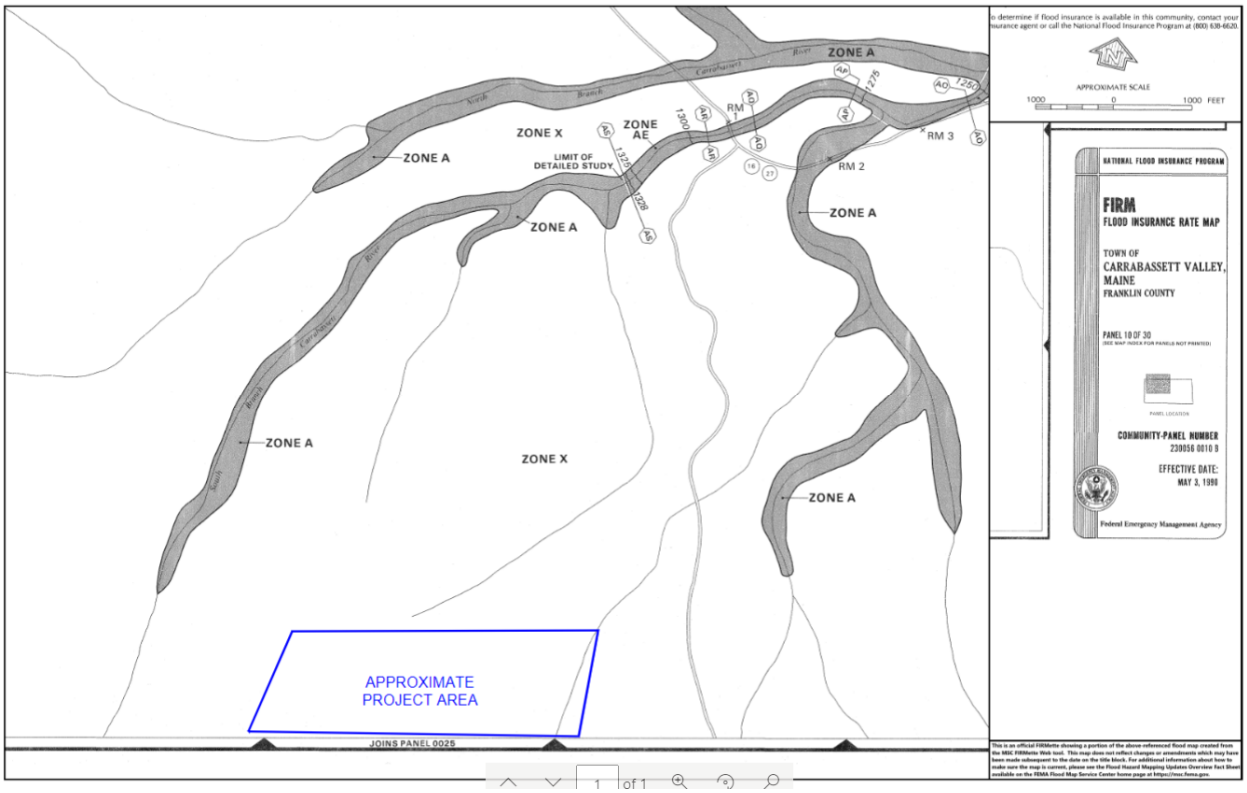
Figure 12-1. Site Location Map



12.A.3 Flooding

The Site where development will occur is located within Zone X (areas determined to be outside of the 0.2% annual chance floodplain) as shown on the Flood Insurance Rate Map 2300560010B, effective May 30, 1990 and 2300560025B, effective May 3, 1990. A copy of the flood zone maps is included in Section 19 of the application.

Figure 12-2. FEMA Floodplain Map



12.A.4 Soils Map

Soil survey mapping, verified by a Maine Certified Soil Scientist, is provided in Section 11: Soils. As determined in the pre-application meeting, high intensity soil survey mapping is only focused on the areas where more dense development is proposed. The medium intensity soil survey mapping obtained from the NRCS *Soil Survey of Franklin County, Maine* was used for the remaining portions of the Site and is included in the drainage plans provided in Appendix 12-1. Additional test pits were also performed on site to verify hydrologic soil type in addition to

other soil characteristics in accordance with Chapter 500. These logs are included in Section 11 of the application.

12.A.5 Alterations to Land Cover

Within the Site, approximately 218 acres will be disturbed during the construction of the ski terrain, facilities, parking, condominiums and duplex townhome development, as well as roadway, utility, and stormwater management infrastructure. Approximately 17.9 acres of impervious surface will be developed for the ski terrain, skier parking lots, condominium and duplex townhomes and associated parking lots, and roadways serving the single-family lots. Following construction, the areas of proposed ski terrain and the new lift line will be revegetated with grass that will not be mowed more than once per twelve-month period. Due the infrequent mowing and the dense vegetation that is expected to become established at the ski terrain, ski terrain associated with the Project does not meet the definition of a Developed Area as established in Chapter 500. Note that the land cover conversion from HSG D "woods in good condition" CN=77 to ski trail "meadow in good condition" CN=78, itself does not represent a significant increase in runoff generation for proposed trail areas.

Single Family Lots

Because the exact configuration of buildout of the individual 54 of single-family homes is not known at this time, the amount of developed area and proposed impervious cover for each of the lots has been assumed based upon lot size. These proposed areas are summarized in Table 12-1 and are incorporated into the post-development modeling of Appendix 12-2. For the single-family homes, the amount of developed area and amount of total impervious surface is approximately 24.5 acres and 16 acres, respectively, for runoff calculation purposes. The Project will ensure conformance with these assumptions via the Sugarloaf architectural review board and a series of restrictive covenants. These covenants will establish the post-construction stormwater management measures prescribed for the single-family homes as well as the maximum allowable clearing on the land and maximum impervious cover, ESC measures, etc. Prior to development of each single-family lot, the owner will be required to submit for Sugarloaf's approval a plan depicting these features and prepared by a professional engineer registered and licensed in the

state of Maine. Sugarloaf and Boyne Resorts have used this approach successfully for similar past projects.

The Applicant wishes to maintain voluntary visual forested 100-foot-wide buffers to the extent practicable along the existing Access Road and West Mountain Road. Stormwater management facilities, skier parking lots and entry points to new Project access roads will be located within this 100-foot buffer where no feasible alternative locations for these facilities is available.

12.B Stormwater Runoff Analysis

12.B.1 Alterations to Natural Drainage Ways

Wherever possible, existing drainage and grading patterns were maintained in the proposed design. Some unavoidable rerouting of flow occurs due to the need to collect, treat, and discharge managed stormwater from a given area that may currently drain to two different culverts under West Mountain Road. In this instance, the goal of the proposed stormwater BMPs is to match or reduce peak flow at any one study point up to the 25-year 24-hour type II event.

The Project utilizes open bottom arch culverts at all significant intermittent or perennial stream channel crossings as part of an effort to preserve aquatic organism passage with the Project area. In addition, 13 existing perched culverts will be removed from existing streams, and the associated stream channel restored.

12.B.2 Modeling Assumptions

VHB analyzed the stormwater runoff characteristics of the proposed Project using the SCS TR-20 methodology. The hydrologic program HydroCAD, as developed by HydroCAD Software Solutions, LLC., was utilized to compute and develop the stormwater runoff model. HydroCAD's SCS TR-20 program is designed to model complex watersheds, such as the watershed analyzed in this report. The complexity of the watershed has been based on multiple land uses (surface conditions) with varying soil conditions and inter-connected subwatersheds reflecting complex hydrologic flow patterns.

The pre-development stormwater analysis consists of twenty-four separate subwatersheds totaling approximately 630 acres in size, approximately two thirds of which are contributing offsite drainage areas. Twenty-four study points (SP1 through SP24) are the analysis points for each of the subwatersheds of the pre- and post-development analysis.

The post-development stormwater analysis consists of the same area, analyzed as one hundred separate subcatchments contributing to the same 24 study points analyzed under pre-development conditions. Times of concentration for offsite areas was changed for pre- to post-development conditions in response to anticipated proposed drainage patterns.

Due to the size of the Project and the stormwater runoff model, this application section does not include modeling of each culvert and stormwater collection line anticipated to be constructed at the site. Certain pipe nodes in the accompanying modeling are still unpopulated with data, pending determination of compliance with treatment standards. Once the proposed stormwater strategy has preliminary approval, the applicant can provide modeling of key pipe crossings and collection and conveyance features as needed for DEP review. It should be noted that short pipe runs contribute very little additional lag time in the model which is not expected to significantly impact modeling results.

12.B.3 Design Storms

VHB analyzed the site and stormwater features during the 2-, 10- and 25-year design storms. These rainfall events are based on a 24-hour storm duration using a Type II distribution curve for Franklin County. The rainfall amounts of 2.4, 3.4, and 4.2 inches, respectively, are taken from Appendix H. of Chapter 500.

12.B.4 Curve Number

VHB developed weighted curve numbers (CN) for each subwatershed based on the different ground covers and hydrologic soil group types found within each area. All curve numbers were based upon the SCS TR-20 methodology and are included in the Stormwater Calculation Package located in Appendix 12-2. As described above it should be noted that that the land cover conversion from HSG D “woods in good condition” CN=77 to ski trail “meadow in good

condition" CN=78, itself does not represent a significant increase in runoff generation for proposed trail areas.

12.B.5 Time of Concentration Calculations

VHB calculated the Time of Concentrations (Tc) for each of the individual subwatersheds using the hydraulically most distant point within each area. The length of the sheet flow component of each Tc flow path was estimated using NRCS NEH Chapter 15, equation 15-9 methodology with site specific ground cover type and slopes of the subcatchment surface. Due to the large nature and long overland flow paths found at the site, Tc flowpaths within certain large subcatchments have numerous flow segments. The Tc's for concentrated flows are based upon SCS TR-55 methodology and are tabulated in the accompanying HydroCAD output in the Stormwater Calculation Package located in Appendix 12-2.

12.B.6 Drainage Plans

Drainage plans have been developed that show contours, cover types, soil groups, subwatershed boundaries and analysis points, hydrologic flow lines, time of concentration flow lines, existing features, and drainage ways for both pre- and post- development conditions. The Pre-Development Drainage Plan and the Post-Development Drainage Plans for the proposed Project are provided in Appendix 12-2. Due to the relatively large size of the Site, and to allow for intuitive review of the Project drainage patterns, these plans have been provided at 1" =200' scale and 1" =300 scale.

12.B.7 Peak Discharge Runoff Rates

Peak discharge rates are compared at the 24 Study Points along West Mountain Road. A summary of pre- and post-development peak discharge stormwater runoff rates for each analyzed subwatershed is provided in Table 12-4 in the Flooding Standards section 12.E below.

Of the 24 Study Points, only six locations correspond to where a delineated intermittent or perennial stream directly connects to a crossing structure at West Mountain Road. Study Point 1 represents the location where the largest onsite stream flows under West Mountain Road. A simple steel beam bridge with wood decking spans this crossing. This is one of two locations

associated with a perennial stream, the other being at SP-6, which flows through a wetland before crossing under the road in an existing pipe culvert. The remaining stream crossings (SP's 4, 12, 13, 20) are all intermittent streams that cross under the road generally in 18" or 24" diameter metal or HDPE culverts. The remaining SPs are also all 18" to 24" culvert pipes fed from wet weather event flow originating from the Site and surrounding area, but no delineated or intermittent channels are directly connected to these pipes.

12.C Basic Standards

The Basic Standards apply to all projects that require either a Stormwater Management Law or Site Law permit. Erosion and Sedimentation Control, Inspection and Maintenance and Housekeeping standards are required for submission to meet the standard.

12.C.1 Erosion and Sedimentation Control Plan

In accordance with the Basic Standards, stormwater conveyance structures will be designed, constructed, and stabilized using erosion and sedimentation (E&S) BMPs. The Erosion and Sediment Control narrative and plan sheets contains the details and specifications for general stabilization measures to be used during construction and stabilization of the Project. These measures will be used to protect exposed soils during the construction of the Project.

The stabilization measures for the site will include temporary and permanent E&S controls, appropriate design of swales, culverts, and erosion protection for earthen cut and fill slopes. Locations and details of the erosion and sediment control measures and the erosion and sediment control notes are shown on the site plans included in Section 14 of this application package.

12.C.2 Inspection and Maintenance Plan

An Inspection and Maintenance (I&M) Plan has been developed for inspection and corrective actions both during construction and post-construction. The I&M Plan provides the inspection frequency, minimum maintenance and inspection requirements and sample logs. The standalone Inspection and Maintenance Manual is included in Appendix 12-3.

12.C.3 Housekeeping

Housekeeping requirements such as spill prevention and reduction of pollution through groundwater protection, de-watering practices and regulating authorized and non-authorized non-stormwater discharges are addressed either through the Erosion & Sedimentation Control Plan or the Inspection and Maintenance Manual.

12.D General Standards Submissions

The General Standard is required when a project discharging to a non-lake or urban impaired stream, results in more than 1.0-acre of impervious area or 5-acres or more of developed area.

12.D.1 Narrative

A description of the Pre- and Post-development conditions, including alterations to the land cover has been provided in Section 12.A.5.

12.D.2 Drainage Plans

The Pre-Development Drainage Plan and the Post-Development Drainage Plan for the proposed Project are provided in Appendix 12-2.

12.D.3 Calculations

The stormwater best management practices were designed to treat the Water Quality Volume (WQV) based on the criteria outlined in Chapter 500 for pollutant removal and treatment. The requirement includes treating 95% of the impervious area and 80% of the developed area. Linear portions of projects that do not discharge to an urban impaired stream, are required to treat 75% of the impervious area and no less than 50% of the developed area.

Due to the challenging topography and slopes present at the Site and challenges associated with treating isolated linear impervious surfaces on steep terrain with HSG C and D series soils, the Project proposes to treat runoff from approximately 0.2 acres of existing West Mountain Road and 3.13 acres of existing impervious surface associated with an untreated gravel parking lot (Lot E) and to use this surface as an offset for proposed isolated roadway and ski terminal impervious surfaces for which treatment is infeasible. From a Water Quality and peak flow

mitigation standpoint this approach is favorable because it proposes to address more significant concentrated flows and pollutants from gravel parking lots in lieu of treating new paved roads and two townhome building rooftops which produce much less nutrient and sediment loading and predominantly sheet flow to adjacent vegetated terrain. Compliance with the WQ requirements is demonstrated in Table 12-1 below. Note that on a sitewide average basis the Project exceeds the required treatment for impervious surfaces and developed areas once the treatment of the existing untreated impervious surfaces is taken into account.

The 12 soil filters have been designed with a control orifice paced on the underdrain in order to detain the Water Quality volume over a period of no less than 24 hours and no greater than 48 hours, as required by Section 4a(ii) of Chapter 500.

In accordance with Section 4C(2) of Chapter 500, the 4 proposed wet ponds have been designed to provide 12-hour detention of the runoff volume from the 1-year, 24-hour storm event. This is demonstrated by noting the center of mass detention time exceeds 720 minutes (12 hours) in the accompanying modeling output (Ponds P1, P11, P13, P14). For the 11 soil filters, an orifice has been placed on the outlet of the underdrain pipe where it enters the control structure in order to provide the 720 minutes center of mass detention time, or 1" diameter circular orifice is used. It is VHB's experience that a 1" diameter orifice is the smallest practicable orifice that can be utilized in stormwater treatment applications.

Table 12-1. Project Treatment Summary

Water Quality Treatment Percentages					
Impervious Classification		**Total Area (Acres)**	**Area Treated (Acres)**	**Percent Treated**	**Percent Required**
Non-Linear Portion	Impervious Area	10.83	9.66	89%	95%
	Developed Area	22.17	15.93	72%	80%
Linear Portion	Impervious Area	7.09	4.47	63%	75%
	Developed Area	13.13	6.55	50%	50%
Single Family Lot Development	Impervious Area	16.00	15.20	95%	95%
	Developed Area	24.42	19.54	80%	80%
Offsite Treatment/Mitigation	Impervious Area	3.36	3.36	100%	0%
	Developed Area	-	-	-	-

Total New Impervious (AC)	**33.92**
Total Impervious Treated (AC)	**32.69**
Percent Impervious Treated	96.4%
Total Developed (AC)	**59.72**
Total Developed Treated (AC)	**42.02**
Percent Developed Treated	70.4%

Tables 12-2 and 12-3 below summarize the sizing criteria that is being used to size the structural stormwater treatment practices for the Project.

Table 12-2. Vegetated Underdrained Soil Filter Sizing Summary

Practice ID	Treatment Areas (AC)			Sediment Trap Volume (CF)	Provided Sediment Trap Volume (CF)	Filter Surface Area (SF)			
	Total	Impervious	Developed			Impervious (5%)	Landscaped (2%)	Minimum Surface Area	Surface Area to be Provided
P2-Townhomes 3-6	3.21	0.82	2.39	45.5	448.0	1784	2085	3869	3904
P3-Townhomes 1-2	4.16	1.23	2.93	68.6	128.0	2688	2551	5239	5240
P4-Bottom of Road A	0.68	0.16	0.52	8.8	120.0	346	456	802	802
P5-Road A, Near Condos	2.35	0.90	1.45	49.9	82	1956	1261	3217	3217
P6-Lots R43-R44	1.08	0.41	0.68	22.5	116.0	882	592	1474	2234
P7-Lot R42, Road C	1.55	0.48	1.07	26.6	38.0	1041	930	1972	1972
P8-Lot R40, Road C	1.82	0.49	1.34	27.0	93.0	1059	1165	2223	2235
P9-Road D, Lot R51	1.25	0.27	0.98	15.0	69.0	588	852	1440	1440
P10-Road A, Lot R31	3.46	1.26	2.20	69.8	90.0	2736	1916	4651	4651
P12-Drop-off Parking Lot	2.08	0.92	1.16	51.1	167.0	2004	1014	3018	3179
P16-Timbers 10	0.66	0.23	0.43	12.8	179.0	503	374	877	877
P17 -Timbers 11-14	1.83	0.64	1.19	35.6	119.0	1394	1036	2430	2430

Table 12-3. Wet Pond Sizing Summary

Practice ID	Treatment Areas (AC)			Sediment Trap Volume (CF)		Calculated Minimum Volumes (CF)		Proposed Volumes (CF)		Gravel Trench Length (FT)	
	Total	Impervious	Developed	Minimum	Provided	Permanent Pool Volume	CP Volume	Permanent Pool Volume	CP Volume	Required	Provided
P1-Condo Complex	11.94	4.06	7.87	225.7	228.0	52,363	26,182	54,189	19,882	78.5	80
P11-Parking Lots E, F, G	8.30	3.90	4.40	216.7	733.0	41,108	20,554	49,963	23,481	61.7	70
P13-Parking Lot H	2.92	1.17	1.75	65.0	233.0	13,579	6,790	14,847	5,841	20.4	25
P14-Timber Duplexes 1-7	7.62	1.81	5.81	100.7	233.0	30,032	15,016	31,523	9,202	45.0	50

12.D.4 Soil Logs

Efforts were made to anticipate stormwater treatment facility locations during the design process and while the terrain was accessible to tracked excavator for deep test pits. However, despite these efforts, not all proposed stormwater pond locations have a deep test pit exploration due to access challenges in the project terrain. Where a stormwater management measure is proposed and a test pit was done, a detailed log is provided which includes relevant soil characteristics, elevation of seasonal high groundwater and bedrock to a depth at least three feet below the lowest component of the stormwater measure. The logs are included as part of the Stormwater Calculation Package located in Appendix 12-2.

12.D.5 Details, Designs and Specifications

The Project proposes to use twelve vegetated soil filters and four wet ponds for stormwater management. Infiltrative practices, while generally desired for runoff reduction purposes, is not feasible at this site due to the heavier underlying Peru and Colonel series soils. Plans depicting the details of the stormwater management measures are provided in Appendix 12-1. Impermeable liners are anticipated to be required due to the low permeability of the native soils.

Single-family homes will be required to provide treatment via individual standalone practices designed to meet the Basic and General Standards. The Flooding Standard is intended to be achieved in the structural treatment practices listed in Table 12-2. Based upon Site conditions it is expected that these practices will consist of a combination of raingardens, vegetated underdrained soil filter, or use of treatment buffers (as feasible).

12.D.6 Phosphorus Export Calculations

The Project is not located within a lake watershed, and therefore the Phosphorus Standards do not apply.

12.D.7 Maintenance Contract

The responsible party in charge of the inspection and maintenance is documented in the Inspection and Maintenance Manual, included in Appendix 12-3.

12.E Flooding Standards Submissions

The Flooding Standard is required for this Project because it results in 3-acres or more of impervious area or 20-acres or more of developed area and a Site Law permit or modification is required.

12.E.1 Control of Peak Flows

A HydroCAD model using TR-20 methodology was developed to evaluate the existing and proposed drainage conditions on the Site. The pre- and post-development peak discharge values are presented in Table 12-5 below. The Project's approach to conformance with the Flooding Standard utilizes a combination of peak flow mitigation and culvert analysis.

Significant effort has been made to minimize rerouting of runoff within the Project area while still providing protection of proposed ski facilities and roadway infrastructure. The 15 structural stormwater practices have all been designed to significantly detain runoff for storm events up to and including the 25-year, 24-hour event. Peak flow is maintained below pre-development levels at 15 of the 24 study points. The remaining 9 of the 24 study points (1, 4, 6, 11, 12, 15, 16, 20, 24) experience higher peak flows than under existing conditions. Due to existing slopes, streams, and channel locations, additional centrally located stormwater detention practices are challenging to implement without undue environmental impacts or creation of in-stream ponds. These are discussed in further detail below.

The existing culverts at Study Points 4, 11, 16 should have adequate capacity to convey these flows. At the existing bridge crossing associated with SP1, the modeling suggests a 2% increase in 25-year storm peak flow rate which is not expected to result in any significant change at SP-1, given the nature of the existing crossing.

The provisions of Chapter 500 Section 4F(2)(d) state that the primary access road to the Project shall not be flooded during the 25-year, 24-hour storm event. Upon review of the post development modeling results from this event, VHB recommends replacing 5 existing culverts along West Mountain Road with new enlarged culverts to pass this storm event. These culverts correspond to study points 4, 6, 11, 12, 15, and 24 and are depicted on the Project plans.

Receiving channels associated with the Project converge at several locations just downstream of West Mountain Road within lands owned by the Applicant. Peak flow rates at these confluence points are not expected to increase significantly due to balancing of peak flows from reductions achieved at the other contributing discharge points. Treatment practices associated with the single-family home lots are not represented in the modeling at this time. Implementation of those practices will further mitigate peak flows at the discharge points. The applicant will consult with the DEP to determine what modeling, if any, is necessary to demonstrate compliance with the Flooding Standard for areas downstream of these culverts.

Table 12-4. Peak flow summary for 24-hour Type II storms of 2-, 10-, and 25-year return frequency

Study Point	2-YR		10-YR		25-YR	
	Pre-dev.	Post-dev.	Pre-dev.	Post-dev.	Pre-dev.	Post-dev.
SP1	85.81	86.53	203.85	204.79	313.66	*320.25*
SP2	1.93	0.89	4.20	1.84	6.24	2.69
SP3	1.20	0.31	3.48	0.51	3.60	1.63
SP4	13.77	20.35	30.76	48.22	47.39	*75.21*
SP5	1.48	1.34	3.20	2.89	4.74	4.27
SP6	11.72	30.78	26.28	70.14	39.48	*106.30*
SP7	8.91	0.83	19.98	1.69	30.05	2.45
SP8	0.58	0.43	1.09	0.81	1.52	1.13
SP9	2.45	0.20	5.70	0.37	8.69	0.51
SP10	0.67	0.00	1.38	0.00	2.89	0.00
SP11	3.60	6.60	8.37	13.41	12.76	*19.42*
SP12	3.87	11.40	8.97	25.13	13.63	*37.51*
SP13	3.35	0.73	8.27	2.92	12.94	12.09
SP14	1.49	1.06	3.45	2.17	5.24	3.15
SP15	5.99	9.18	14.75	19.76	23.10	*29.86*
SP16	0.51	0.77	0.96	1.73	1.36	*2.60*
SP17	2.29	1.78	5.72	3.61	8.94	5.20
SP18	0.57	0.27	1.48	0.52	2.34	0.74
SP19	1.86	0.56	4.87	1.20	7.75	1.77
SP20	10.25	13.64	24.64	31.43	38.07	*47.79*
SP21	1.83	0.61	4.58	1.10	7.16	1.77
SP22	2.86	0.35	6.22	0.70	9.25	1.00
SP23	1.33	0.58	2.95	1.07	4.42	1.65
SP24	3.98	10.49	8.39	21.69	12.32	*31.67*

12.E.2 Details, Designs and Specifications

Plans depicting the details of the stormwater management measures are provided in Appendix 12-1 as previously noted in Section 12.D.5.

12.F Deed Covenants, Restrictions, or Easements

No deed restriction or covenants are proposed at this time. The Applicant will retain ownership of the land upon which the stormwater treatment practices are to be located.

APPENDIX 12-1
PRE- AND POST-DEVELOPMENT DRAINAGE PLANS
SITE AND STORMWATER DETAILS

APPENDIX 12-2
STORMWATER CALCULATION PACKAGE

Sugarloaf West Mountain Project
Stormwater Management Calculations

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APPENDIX 12-3
INSPECTION AND MAINTENANCE MANUAL