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Memorandum

To: Kingdom Community Wind 6216-INDS Project File

From: Andres Torizzo, CPESC, CPSWQ

Date: 3/3/2011

Re: Draft Permit 6216-INDS Comments

Watershed Consulting Associates, LLC (WCA) has prepared the following comments based a technical review of the draft permit 6216-INDS for operational stormwater discharges from the Kingdom Community Wind Project in Lowell, Vermont. These comments have been prepared on behalf of the following municipalities, nonprofit organizations and landowners:

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Comment #1 – Road/Crane Path/Crane Path Curve Number

The curve number (CN) values used to model runoff from road/crane paths and crane pad gravel surfaces throughout the entire project are inaccurate, and will underestimate the amount of runoff generated by the project in the post development condition.

- The CN value options available in the standard TR-55 CN table for gravel roads were developed by TR-55 engineers by assuming a vegetated right-of-way in good condition equal to 33% of the roadway width. These values were not intended to be utilized to model flow from a gravel surface only. These CN values are referred to as "modified" values in this memorandum. See Attachment, page 1, Exhibit A.

- In the Application, areas entered into the runoff model for linear gravel roads/crane paths and non-linear crane pads appear to represent the area of the gravel surface only, and not the area of the gravel surface plus an additional pervious right-of-way area. The CN assigned to these gravel surface areas are the modified values found in the TR-55 CN table. The use of the modified CN values to represent the area of gravel surface only in the model will result in significantly lower predicated runoff from the project site, since pervious area is being "double counted". In the Application, the modified CN values also account for the native soil hydrologic soil group (HSG) classification as mapped by the NRCS. The existing soil conditions will have no impact on the gravel surface runoff as a compacted fill material is proposed as a road subbase.

- According to HydroCAD technical resources, if a user intends to model a gravel surface only, a minimum CN of 96 is recommended (irrespective of hydrologic soil group classification), which will produce significantly more runoff as compared to the modified CN values (89 for HSG C soils and 91 for HSG D soils) for a gravel road including a right-of-way (Attachment, Exhibit B).

- The road/crane path/crane pad network is proposed to be constructed by first installing a compacted subbase of granular or shot rock fill compacted to at least 95% of the Standard Proctor Value. An 18"-deep run of VAOT 704.05a coarse or 3" to 5" minus stone-equivalent road base and finish surface is proposed to be applied over the compacted subbase. The angular and variable size of this aggregate specification is intended to easily compact once traveled by heavy machinery in order to provide a stabile travel surface. The post construction road/crane path/crane pad surfaces will be highly compacted and provide no measurable infiltration of stormwater runoff following construction. Therefore, a CN of 98, the standard, accepted value utilized to model flow from impervious surfaces, should be used to represent impervious gravel surfaces within the study area. These areas will lose any initial incidental permeability, even if scarified on the surface, as fines in the aggregate are washed deeper into the base material.

- One example of the impact of updating gravel surface CNs is provided here: Subwatershed C1 includes runoff from a crane pad and crane path to level spreader C1_LS. Using the standard CN of 98 to represent this crane pad and crane path instead of the modified CN values used in this Application will produce a 45% increase in the peak discharge and 36% increase in the total volume of runoff to the level spreader system for the 1-year design storm event (Attachment, Exhibit C). Similar increases could be expected for other design storm events. As a result, the level spreader treatment capacity and downstream flow conditions through the buffer and into the receiving water would need to be reevaluated for compliance with applicable treatment & control criteria.

- The runoff modeling analysis should be revised to include new CN values for gravel impervious surfaces, and resulting stormwater peak flows/velocities and volumes should be reevaluated on a project-wide basis. The reevaluation should include at a minimum:

  - Capacity of the stormwater conveyance system
  - Proposed armoring protection for the stormwater conveyance system
  - Stormwater BMP design and treatment capacity including all basins and level spreaders
  - Compliance with CPv, Qp10, Qp100 standards at each discharge point

Comment #2 – Turbine Pad /Laydown/Staging Area Curve Number

Turbine Pads/Laydown/Staging areas are proposed to be constructed by applying a subbase of shot rock fill and a base/surface coarse of shot rock material. The Applicant is claiming these areas as pervious, and therefore, they are not included as proposed impervious area, and no formal treatment is provided for these surfaces.

- The sieve specification for the base/surface material to cover the turbine pads requires 20 to 70% of the material to be under 0.187” (that is between 1/8 and ¼ inch). Up to 12% can be under 0.003” (dust). This fine material will settle through the aggregate and will reduce permeability in the upper layers. Scarification of the surface may not be effective for improving permeability conditions unless a scarification bar is used to turn over the base/surface coarse to depth.

- Infiltration capacity will degrade substantially over time. The Applicant is proposing that surfaces that are compacted during construction will be scarified to obtain a minimum infiltration rate of 1”/hour. Initial infiltration testing after construction should be performed and reviewed by the Agency to evaluate whether scarification is required. In addition, there is no provision for the long term integrity of the infiltration capacity of the surface material. If the Applicant will rely on the 1”/hour infiltration rate standard to claim the surface is pervious, infiltration testing should be required as a component of future permit inspection and certification requirements. In Addition, the Applicant should confirm runoff is not infiltrating the upper materials then simply running off along the subbase/base interface.

- It appears that turbine pad surfaces have been assigned a CN equivalent to “open space in good condition, grass cover > 75%”, which may not be appropriately representing runoff from these surfaces. While the upper base and surface coarse material may have some incidental permeability initially, fine material in the aggregate will migrate downward forming an impervious layer. A CN that appropriately represents the expected drainage condition on the turbine pads should be used to model runoff from these surfaces, to be based on the aggregate porosity and depth. The CN should not be variable based on native soil HSG classification. The post development model should be revised and reanalyzed with this updated information.

- The Applicant should provide for the Agency’s review, geotechnical plans for the turbine pads, to evaluate if infiltration into the turbine pad surface will be allowable given turbine foundation considerations.

Comment #3 – Alternative Design Standard CPv Waiver

The Alternative Design Standard for waiver of the Channel Protection (CPv) requirement is claimed in numerous locations. The Alternative Design Standard allows for an analysis of downstream conditions to potentially show that CPv control is not necessary along a given receiving water. A test scenario must be run simulating 12-hour control of the CPv storm versus the actual conditions without any detention. If the peak discharge is not increased in the actual conditions run over the simulated run, CPv is able to be waived along the receiving water. CPv waivers are granted on a per-receiving water basis.

- In the post development modeling analysis prepared for this application, the points of analyses for evaluating the applicability of the CPv standard are located too far downstream of the actual point of discharge to the receiving water. The Agency provided a comment to this effect (VT DEC Comment #7) for two specific areas of the project, subwatersheds A3 and A9. When the Applicant did evaluate CPv higher up in the A9 subwatershed, design modifications were subsequently required to comply with the CPv requirement in this location.

- Several additional areas exist on the project site where CPv analysis has been located too far downstream to adequately evaluate project impact. The Alternative Design Standard test should be performed at least as high up in the subwatershed as the lowest point of discharge along each discrete receiving water. Examples of locations where the Alternative Design Standard test should be conducted include (but are not limited to) the following:

    - Along unnamed Stream at SN 021
    - Along Stream 2009-SC18 at SN 026
    - Along Stream 2009-SC19 at SN 027
    - Along Stream 2009-SC-B5 at SN 029

Comment #4 – Level Spreader Sheet Flow Analysis

Level spreader devices are proposed extensively on the project to convert concentrated flow to sheet flow and disperse the runoff over a vegetated buffer area prior to discharge. The level spreader devices along with the anticipated sheet flow and shallow concentrated flow disconnection area below the spreader has been explicitly included in the post development runoff analysis prepared.

- According to TR-55 and HydroCAD user resources, sheet flow can only be maintained if the depth of flow does not exceed 1/10 foot (Attachment, Exhibit D). In several instances in the post development runoff model for the 10-year and 100-year (Qp10/Qp100) events, this maximum depth is exceeded in the "Reach" representing sheet flow below the level spreaders. The result is that the model is including the significant flow retention associated with sheet flow, although sheet flow will not be occurring. Instead, flow would likely be channelized through the Reach in these larger storm events. The result would be significantly reduced detention at the point of analysis downstream. Some examples are as follows:

    - Reach C15_SF - 10-year/100-year peak depth: 0.17'/0.31'
    - Reach D2_SF - 10-year peak depth: 0.24'
    - Reach D1_SF - 100-year peak depth: 0.22'

- The spreader buffer area should be removed from the 10-year/100-year analyses or adjusted as to accurately predict discharges from these larger storm events. Qp10 and Qp100 standards should be reevaluated in downstream locations.

Comment #5 – Downstream Geomorphic Assessment

A detailed downstream geomorphic assessment including an analysis of stream channel thresholds should be prepared for each project receiving water to evaluate current stream conditions, and whether the currently proposed management strategy for CPv is limiting in-stream critical erosive velocities during the 1-year storm event and thus protecting against in-stream erosion. A detailed downstream geomorphic assessment is a critical component of the State-approved Distributed Runoff Control (DRC) method, as outlined in Volume II of the VSWMM. The basis for this recommendation is as follows:

- Modeling of runoff as provided by the Applicant shows that stormwater volume will increase in the post development condition as compared to the pre-development condition in some downstream locations. Given that the receiving waters have small drainage areas, steep slopes, and highly erodible soil conditions, they are extremely sensitive to disturbance. A downstream geomorphic assessment would provide valuable information to determine what conditions the streams are in currently, and if proposed CPv control measures are sufficiently protective to prevent erosion impacts from this project.

- A downstream geomorphic assessment is recommended planning tool for evaluating larger projects and sensitive streams (Memo from CWP to Mr. Larry Becker, VT State Geologist, September 8, 2000; Exhibit E).

Comment #6 – Crane Pad Driveways

The Applicant should confirm the driveways for crane pad sites have been accounted for in the impervious area total and also are represented as impervious area in the runoff modeling. The driveways are not specifically displayed on the post development drainage map along with other proposed impervious surfaces. A confirmatory calculation also suggests these driveways are not included in the runoff model in at least one location. In certain instances, such as Subwatershed LS-C4, the crane pad driveway accounts for a significant amount of impervious area.

Exhibit A - CN Information from William Merkel, TR-55 Design Team, NRCS, Beltsville, MD 2/8/11

WinTR-55 CN for roads (including right of way)
This spread sheet estimates the CN for the road surface. The weighted CN is from the WinTR-55 CN table for the 3 types of road surface.
The CN of the road surface was calculated based on the assumptions described.

	A	B	C	D	
GRAVEL	right of way				
CN (ROW)	39	61	74	80	
Width (ROW)	10	10	10	10	* see Note
CN (road)	88.3	93	94	94.7	
Width (Road)	30	30	30	30	* see Note
weighted CN	76.0	85.0	89.0	91.0	

Conclusion: right of way is assumed to be 33% of the width of the gravel surface.
CN is based on weighted CN for gravel road 88 to 95 and CN for Open Space good condition.
Note: width of right of way of 10 feet and width of road 30 feet are for calculation purposes only.
The important aspect is that the right of way is 33% of the road width.

	A	B	C	D
PAVED	right of way			
CN (ROW)	39	61	74	80
Width (ROW)	10	10	10	10
CN (road)	97.7	98.3	98	97.3
Width (Road)	30	30	30	30
weighted CN	83.0	89.0	92.0	93.0

Conclusion: right of way is assumed to be 33% of the width of the paved surface.
CN is based on weighted CN for paved road 98 and CN for Open Space good condition. CN is not exactly 98 due to rounding.

	A	B	C	D
DIRT	right of way			
CN (ROW)	39	61	74	80
Width (ROW)	10	10	10	10
CN (road)	83	89	91.3	92
Width (Road)	30	30	30	30
weighted CN	72.0	82.0	87.0	89.0

Conclusion: right of way is assumed to be 33% of the width of the dirt road surface.
CN is based on weighted CN for dirt road 83 to 92 and CN for Open Space good condition.

EXHIBIT B

includes new entries in the CN lookup table that allow water surfaces to be classified as pervious or impervious, depending on your reporting requirements. For details, read about impervious surfaces.

What about unconnected impervious areas?

HydroCAD-9 provides a special procedure for adjusting the CN value for unconnected impervious areas. Details here.

What CN should I use for gravel roads and parking lots?

Although TR-55 provides a CN value for gravel roads *including* the right-of-way, it doesn't provide a CN for the gravel surface alone. However, the TR-55 values appear to be based on 30% gravel with CN=96 and 70% "open space" in poor condition. So 96 would be a reasonable value to use for the gravel alone, which is highly compacted and has minimal absorption capability.

How do I determine the CN value for "special" conditions?

For some conditions, such as a layer of sand over an impervious surface, you may be able to estimate the CN value by using the SCS equation for the *potential maximum retention,* as listed above:

$$S = \frac{1000}{CN} - 10 \quad \text{where S is in inches}$$

If we calculate S as the available voids in the sand, we can estimate the CN value by rearranging the equation as:

$$CN = \frac{1000}{S+10} \quad \text{where S is in inches}$$

For example, 10 inches of sand with 30% voids would have a maximum retention of 3 inches, corresponding to a CN value of 77. This approach may also be useful for roof gardens or other artificial soil profiles in which the total voids are known.

What about artificial turf?

Modeling ***runoff*** from artificial turf requires the determination of an effective CN value, which is sometimes available from the turf supplier. However, the CN value you achieve will depend largely on the base material, so it is important to follow manufacturers recommendations carefully. In some cases, you may be able to estimate a CN value based on the potential maximum retention, as described above.

Modeling ***infiltration*** through artificial turf is a different calculation that requires careful consideration. If your goal is to model sub-turf storage, *and* the turf is expected to capture (infiltrate) *all* the rainfall, the "runoff" (infiltrating through the turf) could be

EXHIBIT C

Summary for Subcatchment C1: with gravel CN of 98

Runoff = 2.09 cfs @ 11.97 hrs, Volume= 0.102 af, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-150.00 hrs, dt= 0.05 hrs
Type II 24-hr 1_Yr Rainfall=2.10"

	Area (ac)	CN	Description
*	0.180	98	gravel C in VHB
	0.150	74	>75% Grass cover, Good, HSG C
*	0.428	98	gravel D in VHB
	0.270	80	>75% Grass cover, Good, HSG D
*	0.010	98	paved
	1.038	90	Weighted Average
	0.420		40.46% Pervious Area
	0.618		59.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment C1: with gravel CN of 98

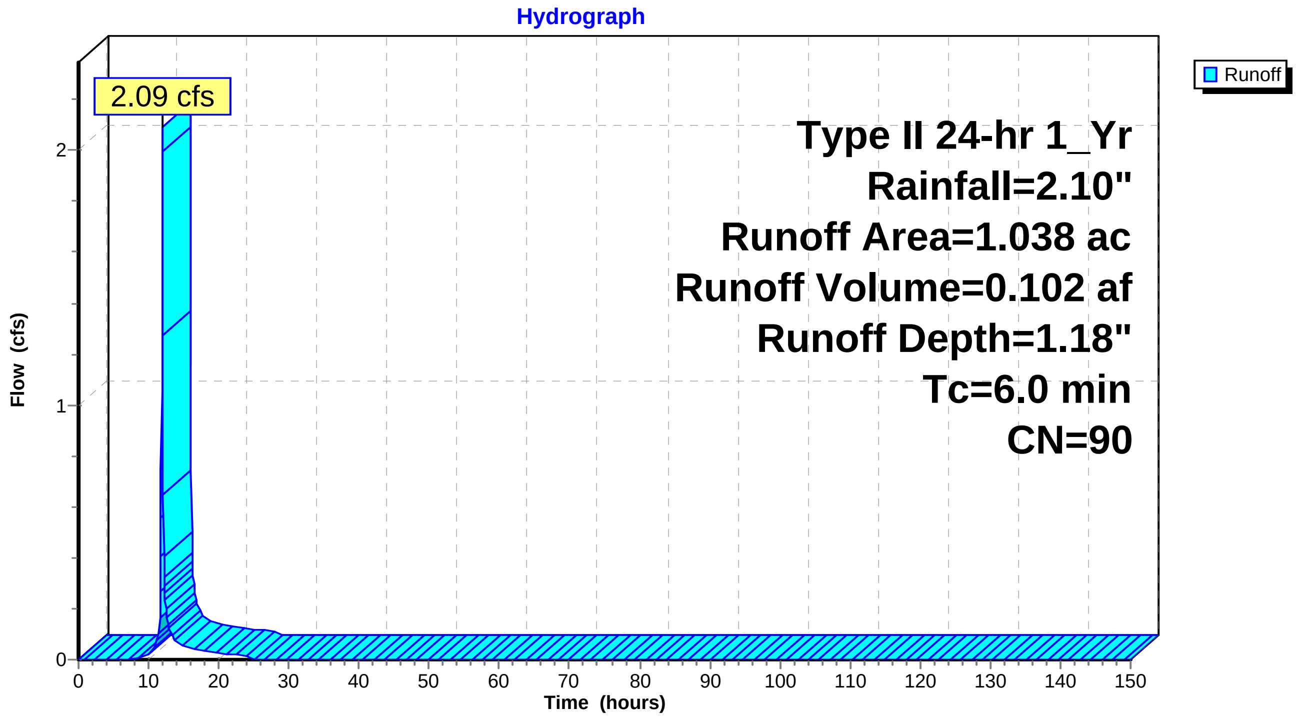

EXHIBIT D

Manning's Number Lookup

This form is provided as an aid to determining the appropriate "n" value for use with Manning's equation.

- To use the lookup table, select the desired value and click "OK" -or- double-click a value to select and "OK" in a single operation.
- Note that you can edit the final description and n value before you click OK.

This table includes selected Manning's values that are most frequently used in HydroCAD design and modeling work. Other values may be entered directly, such as those listed in Appendix C of the HydroCAD Owner's Manual.

The table also includes certain Sheet Flow roughness coefficients, which may be appropriate when using a reach routing to model artificially induced sheet flow. (Such as overland flow from a level-spreader.) This situation calls for higher values than would normally apply to the same surface under deeper channel flow conditions. When using these coefficients, the resulting flow depth (in the reach summary) should be verified to ensure that sheet flow is actually occurring. A maximum flow depth of 1/10 foot is recommended when using these values. Greater depths will require the use of a lower "n" value.

If you frequently use values that are not listed in the table, you can customize the standard lookup table to include your own data. For details see the **Mannings.txt** file in your HydroCAD installation folder:

EXHIBIT E

ATTACHMENT A

Detailed Geomorphic Assessment for Evaluating Channel Protection Requirements for Streams

Where proposed development sites are large (i.e., residential development sites greater than 50 acres and commercial development sites greater than 15 acres), the receiving stream is classified as A1, B1, or A2 under the Vermont Water Quality Standards, or where a local jurisdiction deems a detailed study and analysis is warranted, the following three step process is recommended (adopted from Cappuccitti, 2000 and Aquafor Beech Ltd., 2000) :

1. Assess stream geomorphic conditions and identify stability thresholds.
2. Determine the relationship between stability thresholds, bankfull, top of bank, and floodplain.
3. Identify an allowable release of stormwater runoff to protect the stream channel.

Assess Stream Geomorphic Conditions

- Conduct site reconnaissance and rapid geomorphic assessment to determine channel conditions and stability.
- Determine imperviousness of watershed upstream of channel assessment location.
- Measure channel cross-section dimensions (width, depth, and area) at multiple locations along study reach, longitudinal slope, and particle size distribution of bed material.
- Identify and measure bankfull and floodplain elevations.
- Characterize bank material
- Determine channel hydraulic geometry relationships and hydraulic parameters (e.g., Manning's n, water surface slope).

Determine Stability Thresholds

- Determine a stable channel discharge and associated channel stage through estimates and analysis of critical shear stress, discharge/shear stress relationships, and shear stress ratios at variable depths.
- Validate stable channel discharge determined from field measurements with other empirical equations that describe critical flow.

Identify Allowable Release Rate

- Determine the allowable release rate and associated storage volume requirement in association with applying the distributed runoff control approach.