So –

$$\frac{1}{r^D}(\;) \longrightarrow \mathbb{E}\left[|\det \nabla^2 X(t_0)| \mathbb{1}[A(t_0) \mid \nabla X(t_0) = 0\right] \times p_{\nabla X(t_0)}(0)$$

as $r \longrightarrow 0$. (8)

I.e get $\cancel{\mathbb{E}\left[|\det \nabla^2 X(t_0)| \mathbb{1}[X(t_0) > v, |\nabla^2 X(t_0)\right.}$

$$\mathbb{E}\left[|\det \nabla^2 X(t_0)| \mathbb{1}\left[X(t_0) > v, \left|\frac{\nabla^2 X(t_0)}{X(t_0)} + \frac{\Lambda(t_0)}{\sigma^2}\right| > u\right] \mid \nabla X(t_0) = 0\right] \times p_{\nabla X(t_0)}(0)$$