I tried to reproduce what you did, but in 2D, and I think N^* cancels. My thoughts:
First, I think $\Gamma = \sqrt{-\left.(F/T)''\right|_{N^*}/2\pi}$, so the characteristic time τ is

$$\tau \approx \frac{1}{D_N|\left.(F/T)''\right|_{N^*}|} = \frac{1}{D_N 2\pi\Gamma^2} \tag{1}$$

Then, since 2D, we have $l \approx \rho^{-1/2}$, so

$$D_N \approx D/l^2 \approx D\rho \tag{2}$$

Finally, $\pi R_d^2\rho = N^*$, so

$$\tau_{nuc} \approx \frac{\ln(2e^\gamma\beta\Delta F^*)}{D_N 2\pi\Gamma^2} \ll \frac{R_d^2}{D} \tag{3}$$

so

$$\frac{\ln(2e^\gamma\beta\Delta F^*)}{D\rho 2\pi\Gamma^2} \ll \frac{N^*}{\pi\rho D} \tag{4}$$

so

$$\ln(2e^\gamma\beta\Delta F^*) \ll 2\Gamma^2 N^* \tag{5}$$

Then, if we want to explicitly add CNT (we already assumed parabolic $\Delta F(N-N^*)$), then from 2D CNT

$$\Gamma \approx \sqrt{\frac{|\Delta\mu|}{4\pi N^* T}} \Rightarrow 2\Gamma^2 = \frac{|\Delta\mu|/T}{2\pi N^*} = \frac{\ln S}{2\pi N^*} \tag{6}$$

so

$$\ln(2e^\gamma\beta\Delta F^*) = \alpha\frac{\ln S}{2\pi}, \quad \alpha = \frac{\tau_{nuc}}{\tau_{Diff}} \ll 1 \tag{7}$$

Then from 2D CNT

$$\frac{\Delta F^*}{T} = \frac{\pi(\sigma/T)^2}{|\Delta\mu|/T} = \frac{\pi}{\ln S}(\sigma/T)^2 \tag{8}$$

which leads to

$$2\pi e^\gamma\left(\frac{\sigma}{T}\right)^2 = S^{\alpha/2\pi}\ln S \tag{9}$$

The conclusion for low surface tension σ/T is the same. E.g. if $\alpha = 0.1$ and $S = 2$ then we need $\sigma/T < 0.25$ and if $S = 1.3$ (I have someting like that for NVT-local according to my estimations) then $\sigma/T < 0.154$.