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Soil activation in various AGS/RHIC sites by Monte Carlo simulation

K. Yip

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Experimental Support and Facilities Division
Collider-Accelerator Department
BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

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As part of the Brookhaven National Laboratory Land Use and Institutional Controls, information on each of the BNL contaminated sites and facilities is needed. For the Collider-Accelerator Department, E. Lessard and the author are responsible for providing historical soil activation information on various AGS and RHIC sites which have had substantial running records and proton irradiation. This is an ongoing and continuous process. The author describes here what has been achieved for various AGS beam lines so far.

The author has used the simulation package MCNPX (http://mcnpx.lanl.gov) maintained by Los Alamos National Laboratory to compute the neutron fluxes (essentially the only concern for soil activation) in the soil deep under various sites. The simulation computational process is very CPU intensive. The author has installed and configured the MCNPX simulation to run in the ***parallel*** mode using MPICH (http://www-unix.mcs.anl.gov/mpi/mpich) for a few years. This mainly works in the godzilla cluster (in C-AD) but occasionally also in other computers such as rlnxsp.rcf.bnl.gov in RCF. The author has also maintained and updated the software for other people such as D. Beavis to make use of.

The soil activation (in the units of pCi/L – pico-Curie per liter) is given by:

$$\frac{\phi}{\lambda} \times N_I \times N_p \qquad \textbf{[Equation 1]}$$

where N_I is the number of atoms per interaction (which is 0.075 for ^{3}H and 0.02 for ^{22}Na), N_p the number of protons which have been recorded by the Main Control Room and λ the interaction length, typically 40 cm.

The author is mostly responsible for producing the neutron flux contours. Therefore, the plots below show just these flux contours at various depths for those sites which we have completed the MCNPX simulation. The flux contours are always in the unit of cm^{-2} per incident proton.

Recently (since version 2.5.f), MCNPX has finally provided their stand-alone mesh tally plotting capability without additional external software. This new feature has made it more convenient for the author to produce detailed contour plots such as those shown in Figure 7 and Figure 8. The geometry of the latter two plots were mainly set up by the author's 2005 summer student N. Sapanski.

The original B Target has seldom been used. There is only one beam dump for the entire B line and this B Beam Dump is just behind the B' Target. Therefore, only one simulation which has included both B' Target and Beam Dump is needed.

Figure 1: Soil Activation (in fluxes cm^{-2}/proton) at East Side of the g-2 Target Blockhouse.

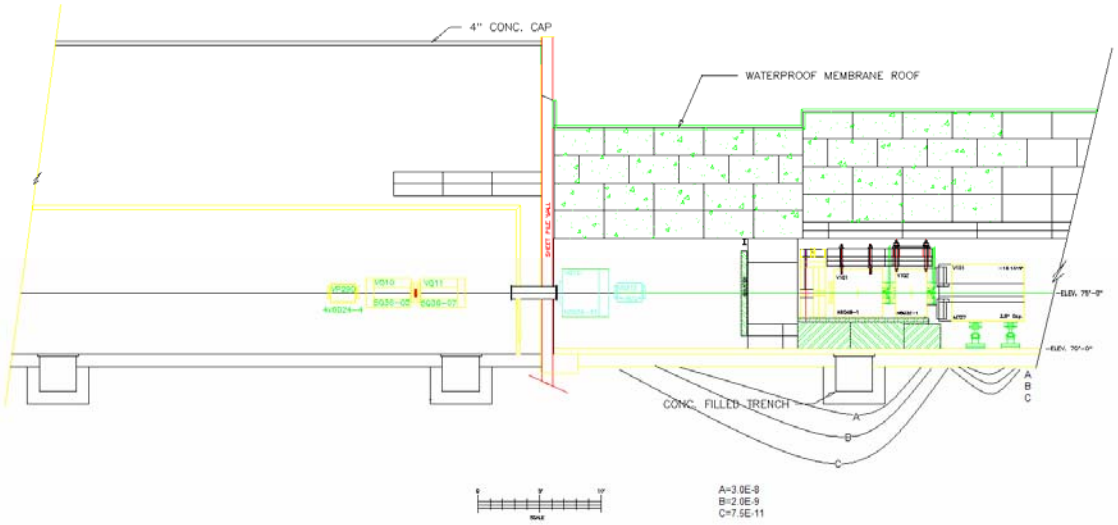

Figure 2: Soil Activation (in fluxes cm^{-2}/proton) below the g-2 Target Blockhouse.

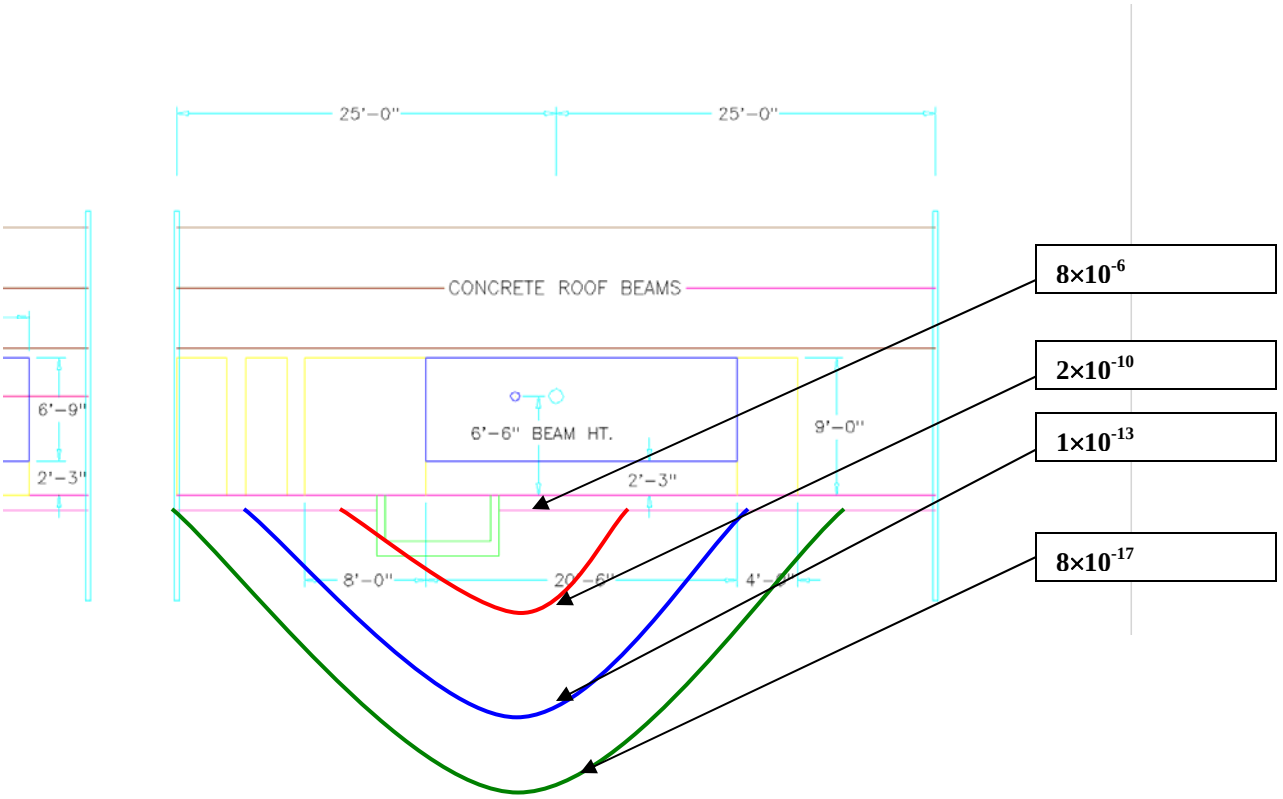

Figure 3: Cross section view of soil activation area below the A Dump.

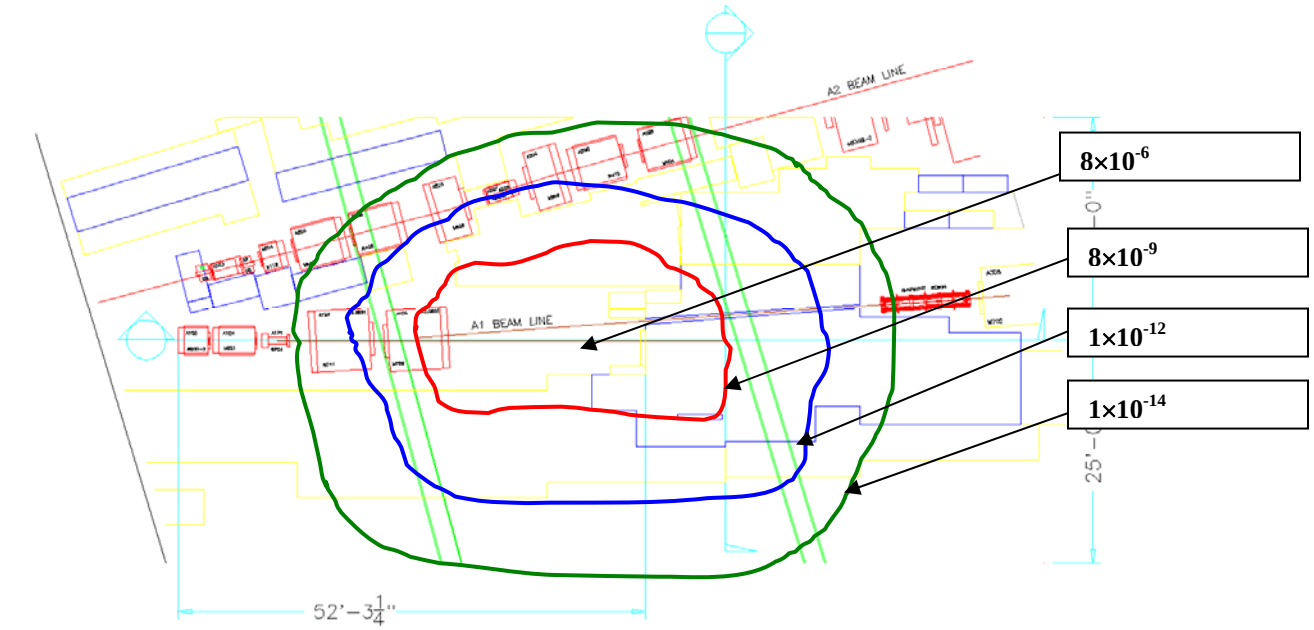

Figure 4: Plan view of soil activation area beneath the A Dump.

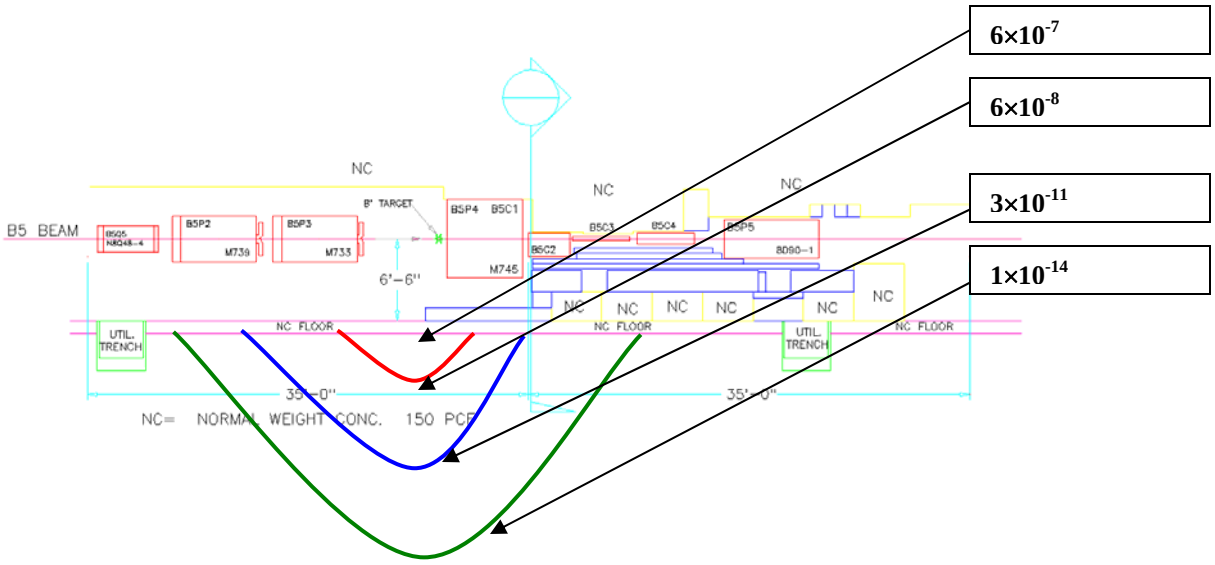

Figure 5: Cross section view of soil activation area below the B' Target and Dump.

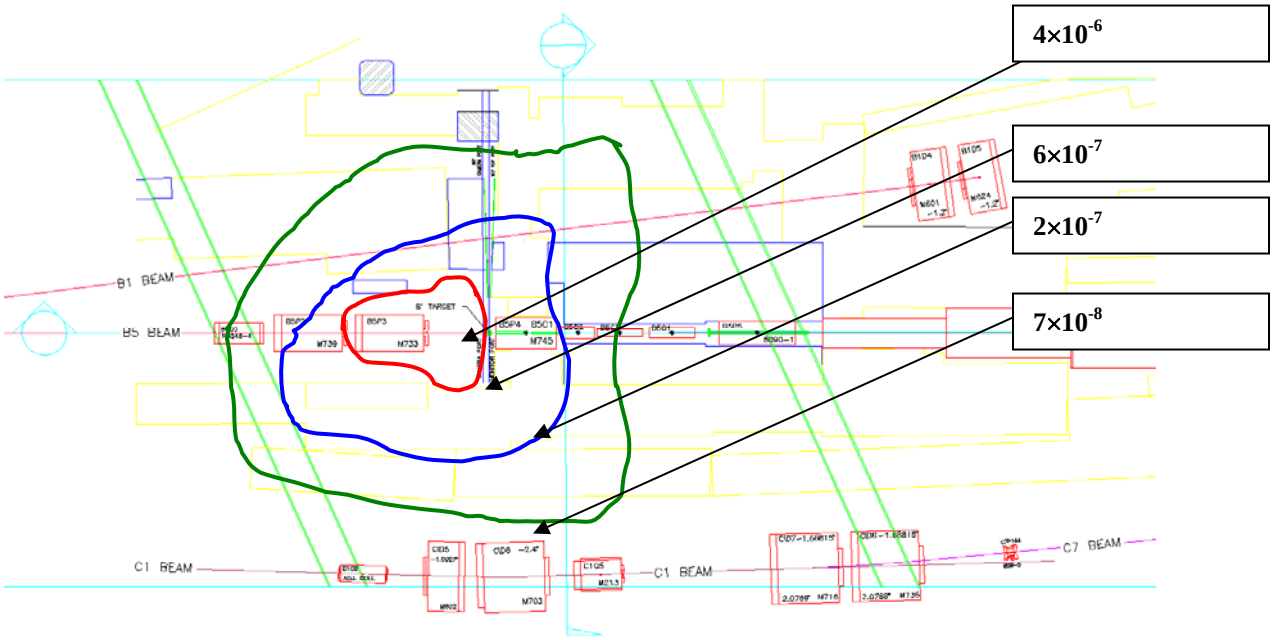

Figure 6: Plan view of soil activation area beneath the B' Target and Dump.

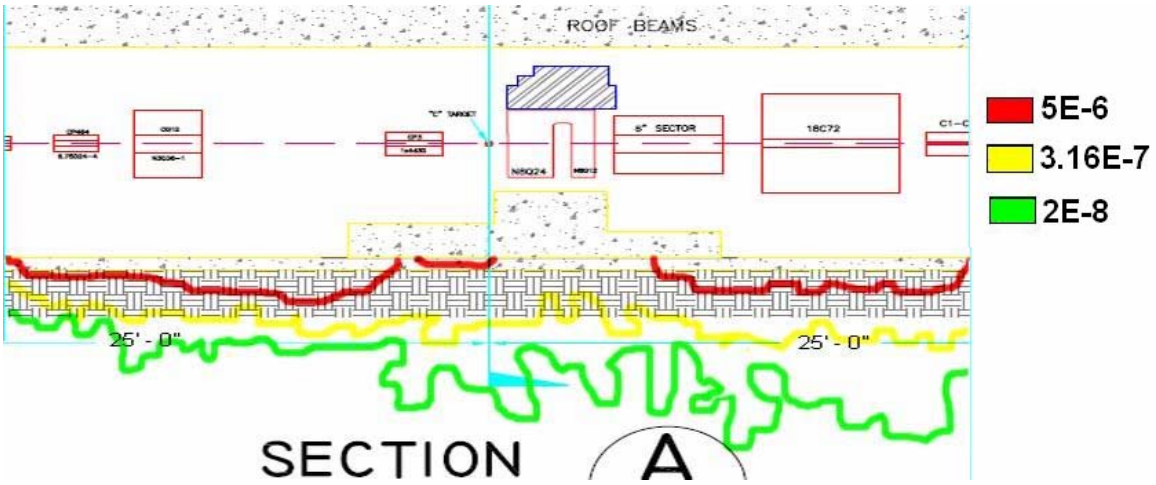

Figure 7: Cross section view of soil activation area below the C Target.

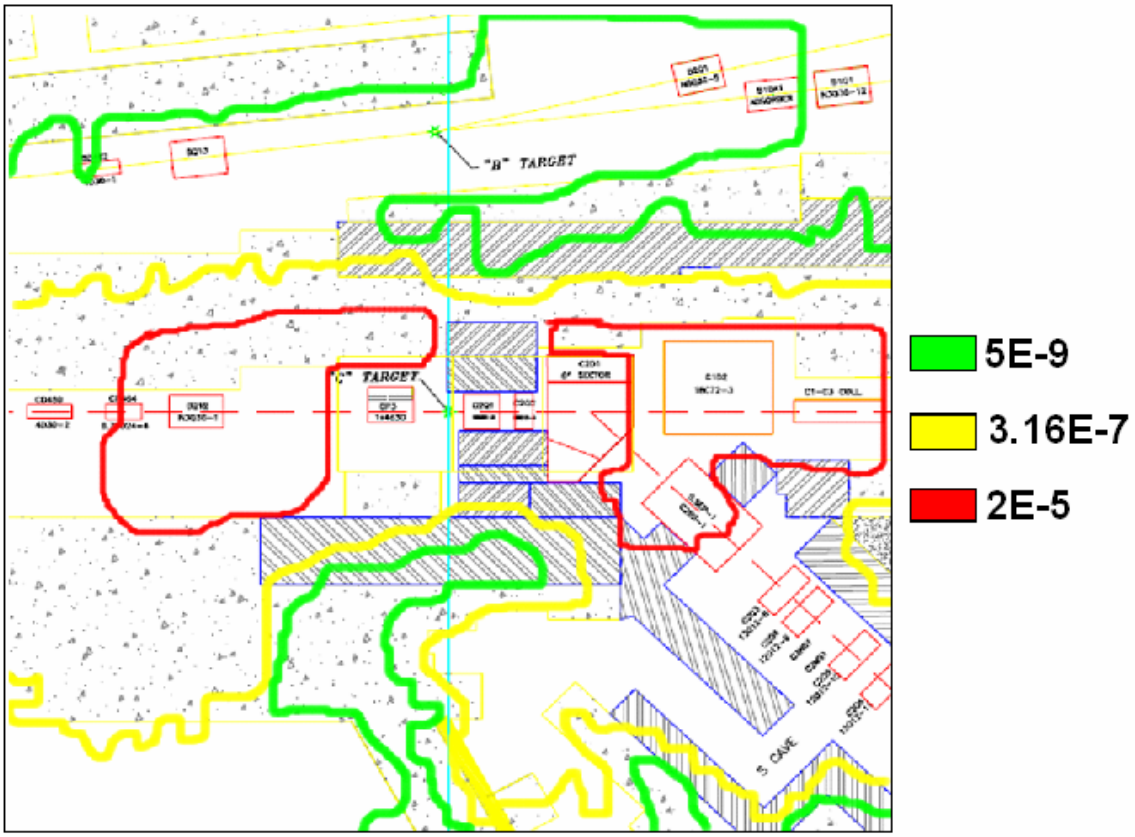

Figure 8: Plan view of soil activation area beneath the C Target.