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The Investigation of Environmental Radiological Vulnerabilities at Fermilab

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Introduction

During 1997, the Fermi National Accelerator Laboratory (Fermilab) embarked on a program to investigate locations on the Fermilab site where activation of soil and ground water by accelerator operations has possibly occurred in the past and may occur in the course of planned future operations. A considerable body of data has now emerged from this ongoing process. The results are being applied to planned future accelerator operations, to the environmental monitoring program, and to the methodology employed to design and evaluate environmental radiological shielding. The results are already having a significant impact on the design of future accelerators at Fermilab.

Description of the Relevant Environmental Conditions at the Fermilab site

Fermilab is a single purpose high energy physics laboratory, situated on 6800 acres, approximately 35 miles west of Chicago. The Laboratory employs high energy proton accelerators, culminating in the 1 TeV synchrotron (Tevatron), to study the basic units of matter. The Laboratory is located in an area that has undergone a transition from largely agricultural activity to one dominated by suburban residential communities over a period of roughly thirty years. A map showing the location of Fermilab is provided in Fig. 1.

The laboratory is located on a glacial landscape underlain by bedrock, lying on an intermorainal zone east of the north-south trending Minooka Moraine and west of the similarly trending West Chicago Moraine. This region consists of layers of silts, sands and unconsolidated glacial tills ranging in thickness from 60 to 100 feet. These unconsolidated units overlie massive bedrock composed predominantly of dolomite, which varies from approximately 50 to 100 feet thick. The dolomite overlies an older formation that consists of less than 100 feet of shale and dolomite.

The site is relatively flat. Surface elevations on the site range from approximately 790 feet above mean sea level (MSL) where the Minooka Moraine exists on the northwest corner of the site, to around 710 feet MSL along the eastern boundary of the site. Bedrock elevations range from 688 feet above MSL in the northwest corner to 635 feet above MSL in the northeast corner of the site and generally follow the regional trend of a south-southeasterly dip.

Surface waters on the Fermilab property include twelve lakes and three creeks. Two reflecting ponds, various associated transfer ditches, and two isolated unnamed ponds at the eastern boundary of the site make up the remainder of the site's surface waters. Two creeks originate on the site and have established points where waterways of the State of Illinois begin. The third creek flows through the northeastern corner of the site and is classified as waters of the State of Illinois. Class I ground water (i.e., aquifer) is not in direct contact with surface water anywhere on the site.

The overlying glacial soils contain a saturated zone but do not yield sufficient water quantities to classify as an aquifer. Recharge to the glacial deposits is due to local precipitation. The glacial soils have sporadic sand and gravel lenses dispersed within or between predominantly silty/clayey tills. The glacial deposits occur in a sequence that conforms to the currently recognized regional sequence in northeastern Illinois. The sequence has been extensively characterized recently in connection with site monitoring activities.

The sequence of deposits consist of a thin mantle called the Peoria Silt and related deposits less than 5 feet thick overlying a succession of glacial deposits comprising what is called the Lemont Formation. The Lemont Formation is generally 60 feet to 70 feet thick and is subdivided into two members, the Yorkville and Batestown Members. The Yorkville Member is further subdivided into four distinct depositional units. Stratified sediments classified as the Henry Formation can be found locally between these units and above bedrock. These deposits have a generally low hydraulic conductivity. Groundwater movement is predominantly vertical and velocities vary through each of the units depending on the hydraulic gradient.

The uppermost aquifer in the region is the Upper Bedrock Aquifer. This aquifer is made up of the Silurian-aged dolomite and local areas of coarse-grained basal glacial deposits. The horizontal hydraulic conductivity (4.5 x 10^{-3} cm/sec) and an estimated effective porosity of 0.15, results in a calculated horizontal ground water flow velocity through the aquifer of 0.70 ft/day. This value for the bedrock formation is generally high. Horizontal groundwater flow dominates within the unit but seepage velocities are low due to the low hydraulic gradient.

The piezometric surface of this upper bedrock aquifer lies 10 to15 feet above the upper bedrock, indicating that the overlying glacial deposits confine the aquifer. Within the dolomite the ground water occurs in irregularly distributed joints, fissures, solution cavities, and other void spaces. The water yielding openings are irregularly distributed both vertically and horizontally. The upper portions of the dolomite are reported to be more permeable than the lower parts, and recharge is derived locally, mostly from vertical infiltration of precipitation through the overlying glacial deposits and lateral flow from recharge areas. Ground water movement within this aquifer is mainly southerly to southeasterly, although this can be influenced locally by areas of groundwater withdrawal.

Principal Environmental Radiological Conditions Found at High Energy Proton Accelerators

High energy proton accelerators at laboratories worldwide produce unique radiation fields that have been described in detail elsewhere (Co 99). The aspects of those radiation fields that are of importance with respect to the protection of the environment are:

- the potential radioactivation of the environmental media (soil or rock) near target stations and in proximity to locations of significant losses of beam and the consequent potential to contaminate groundwater;
- the possibility of the discharge of surface waters contaminated by radionuclides;
- concerns about potential leaks from beam absorbers and/or cooling water systems;
- the potential emissions of airborne radionuclides; and

- the propagation of prompt radiation consisting of muons, photons, and neutrons to offsite locations.

These considerations, which exist at all large proton accelerators are also of concern at Fermilab.

Description of the Ongoing Fermilab Environmental Monitoring Program

For almost 30 years Fermilab has placed a high degree of importance on its environmental protection program, in particular with respect to environmental radiological protection. For example, as early as 1971, Robert R. Wilson, the Director of Fermilab established a goal to maintain the radiation dose equivalent at any point on the boundary of the Fermilab site at a level less than 10 mrem per year. This policy was implemented as a result of Wilson's foresight concerning the future situation of the laboratory in a suburban setting. Wilson also strongly believed that the laboratory site should be open and available for access by members of the public to the extent possible. The 10 mrem goal was initially conceived to apply to prompt radiation emitted in the course of accelerator operations (principally high energy muons) but has been applied to photon radiation emitted in the course of the radioactive decay of accelerator components being stored for future use[1]. This goal has been exceeded slightly on a small number of occasions, but has been largely adhered to. The maximum dose delivered in a given year was 15.9 mrem, in 1990, and in only four of twenty-five years has the annual dose equivalent exceeded the 10 mrem goal. The mean dose equivalent for the Laboratory from 1974 to 1998 is 3.1 mrem per year. Early in its history, Fermilab also devoted considerable attention to the protection of groundwater. The glacial till at Fermilab has a relatively low value of hydraulic conductivity, which suggests that the downward migration of radionuclides proceeds on a time scale that is long compared with the lifetimes of those same radionuclides. Despite this possibility that the radioactivity might well decay completely prior to its reaching a viable aquifer, facilities at Fermilab have been designed assuming relatively rapid migration of radionuclides through the glacial till to the aquifer. The history of radiation protection at Fermilab has been described in further detail elsewhere (Co 94).

For many years technical specialists in environmental protection and radiation protection engaged in projects designed to better understand the radiological and hydrogeological conditions found in the environs of Fermilab. These projects included theoretical evaluations and the collection and analysis of radiological and hydrogeological data. While this work was comprehensive in nature, it had largely been conducted entirely by the environment, safety, and health organizations, with only limited involvement of the organizations and individuals responsible for operating the accelerators and the associated high energy physics research program. These limited points of interface have nevertheless been important and are ongoing. They consist chiefly of the participation of the radiation and environmental protection staffs in the design of facilities within the specified guidelines; the measurement of environmental radiation fields created by accelerator operations; the tabulation of integrated proton beam intensities; and, to some degree, in the preparation of annual reports. This arrangement has persisted since the early days of the facility and has been conducted in the same manner since the introduction of the Tevatron accelerator, in approximately 1985. As one might naturally expect,

[1] A reasonable bench mark on radiation dose equivalent is provided by the fact that the average dose equivalent due to natural background in the United States is approximately 300 mrem/year (NCRP 87).

the knowledge of design details and operational conditions is more detailed for those facilities that have operated most recently.

Description of the Review Process Initiated in 1997

Since the 1980s, the experiences of society at large have increased public awareness of environmental issues, and especially the hazards of ionizing radiation. At the same time, the rapid development of the area in which Fermilab is located has made the Laboratory extremely visible to many people. Recent developments and incidents at other facilities similar to Fermilab in this country and worldwide have drawn further attention to the importance of environmental radiation protection.

Recognizing this, during 1997, John Peoples, Jr., the Director of Fermilab, along with senior management, launched a program to identify and systematically investigate locations on the site where potentially significant environmental vulnerabilities might exist. The goals of this program were to:

- improve monitoring of environmental conditions;
- increase management involvement in and understanding of environmental issues associated with accelerator operations;
- identify and implement improved practices; and
- improve the technical bases for assuring the neighboring public that Fermilab operations are not significantly affecting the environment.

At the outset, a review of available historical data pertaining to accelerator operations was performed and a list of possible study locations on the Fermilab site were developed. In this process, a large number of such areas were identified where significant losses of the proton beams were known to have occurred due to past operations. The locations were individually assigned a priority of "low", "medium", or "high" for further study based upon answers to the following questions:

- Is the history of operations, including the loss of beam in unintended locations, adequately well-known?
- Have reliable calculations and/or measurements of the production and transport of radiation in the environment been performed?
- Are there indicators of radiological issues found in existing radiochemical analysis of samples taken in the vicinity?
- Are the locations of beam loss adequately shielded or otherwise isolated from the surrounding soils?
- Are there future operations planned that might result in a significant increase in environmental effects?

Available information for a number of sites was reviewed by personnel responsible for accelerator operations in order to obtain valuable input information relevant to potential vulnerabilities, and each site was ranked by its amount of risk to the environment. Although this process is somewhat subjective, the results are as valid as those that might have been obtained using a numerical evaluation system. Such systems are ultimately based upon subjective judgements as well. The results of this initial ranking for the areas considered are tabulated in Table 1. The highest priority was reserved for those locations to which high beam intensities had been routinely delivered, those locations for which there were known gaps in reliable documentation of historical operations and for which "anomalous" monitoring results had been reported. All but one of the "high" priority studies involved accelerator operations that had been conducted in the years prior to the Tevatron, where the delivery of beam power[2] had been higher and the documentation of operations and the environmental monitoring program had been less complete. The table also includes ongoing follow-up activities that are discussed below and provides the names of members of the Fermilab staff who were identified as possible points of contact.

The results of this ranking process have been employed to prioritize the efforts to improve the environmental monitoring program at the Laboratory. These efforts have continued with the support of those responsible for the operation of the accelerators. To augment these efforts, the Fermilab Director formally chartered a series of five review committees to study the available information on the candidate locations of interest as well as to improve the knowledge base concerning past operations and pertinent details of design features. These committees included physicists, engineers, and technicians as well as professional environment, safety, and health staff familiar with past accelerator configurations and operations. In some cases, retired employees were utilized in order to take advantage of their knowledge and experience. The time to start this initiative was chosen in part to take advantage of such "institutional memory" while it was still available. Written reports including recommendations were specifically requested from the committees. Table 1 indicates the locations of interest covered by these particular committees. In concert with the Director's initiative, the Head of the Fermilab Beams Division, the organization responsible for accelerator design, commissioning, operation, and maintenance, established four more committees to address concerns in areas where operations in the near term future were planned. These committees were similarly chartered and staffed. The locations addressed by these committees are also indicated in Table 1. Figure 2 is a map of the Fermilab site that shows the locations of these studies.

Each of the formal committee charters included the following elements:

- the review of the shielding calculations performed to evaluate soil activation;
- the review of current plans of the environment, safety, and health organization for improvements in monitoring programs;
- the review of the legacy of past operations;
- the review, where appropriate, of the impact and needs of future operations; and
- the identification of lessons-learned for future committees.

The committee reviews were chartered over a period of four months. As the committees proceeded in carrying out their tasks, the observations of the other committees were made available to them in order to promote a uniformity of approach. Fifty seven different individuals

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[2] At high energy accelerators, particularly those which accelerate protons, the figure of merit of relevance with respect to most types of radiation concerns is the product of the average intensity and beam energy, the beam power.

were appointed to these nine committees. Figure 3 shows the distribution of these individuals by their roles at the time of this work. In this plot, each individual participant is tabulated only once. Thus, if a physicist was also a senior manager at the time of establishment of the committees, the latter role was the one tabulated.

Upon receipt of the report of the committee, the Director or the Head of the Beams Division, as appropriate, solicited the submittal of a corrective action plan from the appropriate laboratory organization. The organizations involved were the Beams Division, the Environment, Safety, and Health Section, and the Facilities Engineering Services Section. Issues concerning accelerator operations and beam intensity monitoring and tracking naturally were referred to the Beams Division. Suggestions for improvements in the monitoring program were assigned to the Environment, Safety, and Health Section. The Facilities Engineering Services Section became involved to resolve questions concerning civil construction. Coordination between organizations was required to implement several activities. For example, the installation of monitoring wells near the accelerator enclosures might require the coordination of all three organizations to minimize the potential for harming the enclosures or disrupting accelerator operations. Details of follow-up activities will be discussed in more detail below and are also summarized in Table 1.

Observations Concerning the Review Process

Several observations can be made about the functioning of this process that might be useful in future similar endeavors. The involvement of physicists and engineers was generally productive. It effectively utilized “institutional memory”, enhanced awareness of environmental protection matters of concern by personnel responsible for future operations, reinforced the need to properly design and operate the accelerators and target stations, and educated a significant number of personnel on technical details related to this topic.

Lessons learned include the importance of feedback among the various committees as they conducted their individual, parallel investigations, and the usefulness of providing more or less formal presentations on areas in which expertise was lacking (e.g., groundwater modeling assumptions, environmental monitoring program, hydrogeology, etc.). The “staggered starts” for the review committees was useful because it allowed for feedback from one committee to another.

Some committees submitted their written report in a more timely manner than did others. This was presumably a consequence of assigning these tasks to experienced personnel who were heavily involved in other projects and assignments. On a few occasions, there were some tendencies for the committees to pursue particular issues with such enthusiasm that the scope of the original charter was exceeded. In these instances, the committees typically went beyond the identification of a problem or an issue to initiate a detailed investigation, which could have been simply included as a "recommendation".

Common Technical Observations

A number of substantive technical conclusions and recommendations were common to multiple committee reports. Most of these technical observations should be carefully considered when new projects are designed, constructed, and operated. These are discussed below:

- "As-built" drawings were found often to be inaccurate or nonexistent.
- Some beam monitoring instrumentation had been installed for good reasons, and then later "orphaned"; that is, it was not maintained or was subsequently ignored.
- Data from beam operations and environmental monitoring were not always retained in a retrievable, consistent form.
- The monitoring well network should be improved, generally as proposed in recent years, but with some new specific input gleaned from the review process.
- Environmental monitoring needs should be incorporated into designs of future target stations earlier in the design process.
- Soil borings should be done at each target station location during its design, as there may be impacts on the shielding configuration.
- The method of calculating radionuclide concentrations in groundwater from soil activation rates includes some assumptions concerning hydrogeology that were overly simplistic.
- The leaching of radionuclides for the environmental media needs to be better understood.
- Monte-Carlo codes need to be benchmarked and used by people who understand the underlying physics.
- Underdrain discharges do not provide good data on radionuclide migration, contrary to previous thoughts. They were not designed for this purpose and, not surprisingly, fail to achieve this objective.
- Some *infrequently* employed surface water discharge practices were discontinued as they were found to be "allowed" but inadvisable.
- Beam loss points other than targets or large beam absorbers may be important.
- A need to dispose of some cooling water to mitigate risk of leaks/spills was identified.
- Off site muons should continue to be measured. One important measurement that required special scheduling was actually conducted *during* the series of committee meetings.

Present Status

The operation of these committees resulted in an increased emphasis on environmental protection considerations during design, construction and operation of Fermilab facilities. Since 1996, the ground water monitoring program has been significantly updated by replacing sub-optimal monitoring wells with state-of-the-art wells and well networks. As part of the planning for this activity, a "source-specific" strategy was employed, in which priority potential sources of ground water contamination were identified primarily by incorporating the results and recommendations of the committee reports. In addition to locating and constructing the wells, detailed geologic and hydro-geologic information was obtained during the well construction to better characterize the environment into which potential contamination may be introduced. The result is that the comprehensive monitoring and surveillance program for groundwater was dramatically improved.

Calculational methods for predicting the transport of radionuclides toward ground water have been significantly improved as a result of questions arising from the committees' investigations. The model used previously was extremely conservative, and was predicated on predicting the impact of contamination at a distance from the contamination source. With the addition of much more accurate hydro-geologic information, more sophisticated methods can be used to predict movement of activated water through the ground while maintaining a comfortable level of conservatism. The upgrading of these methods continues.

The design of the next generation of experiments and facilities at Fermilab has already benefited from these studies by making project leaders aware of the importance of designing environmental protections into their projects early rather than having to add them on later. The design of the NuMI and MiniBooNE projects, for example, have held environmental concerns in high visibility positions since their inceptions.

We have adapted the original matrix developed to initially prioritize potentially vulnerable sites into a status sheet for progress on mitigating these vulnerabilities. Many of the categories originally thought to be important have been consolidated or assimilated into others and actions taken to address concerns have been added as updates. The status matrix is, therefore, a continually changing document, reflecting environmental protection activities as they are undertaken and completed. The current matrix is shown here as Table 2.

Acknowledgement: We would like to thank D. Grobe and E. Marshall for the further investigation of historical off-site doses and of the current status of responses to the recommendations of the various committees.

References

(Co 94) J. Donald Cossairt in *A History of Accelerator Radiation Protection*, H. Wade Patterson and Ralph H. Thomas, edit. (Nuclear Technology Publishing, Ashford, Kent, England, 1994).

(Co 99) J. Donald Cossairt, "Radiation Physics for Personnel and Environmental Protection", Fermilab Report TM-1834, 1999.

(NCRP 87) National Council on Radiation Protection and Measurements, *Exposure of the Population of the United States and Canada from Natural Background Radiation,* NCRP Report 94 (Bethesda, MD 1987).

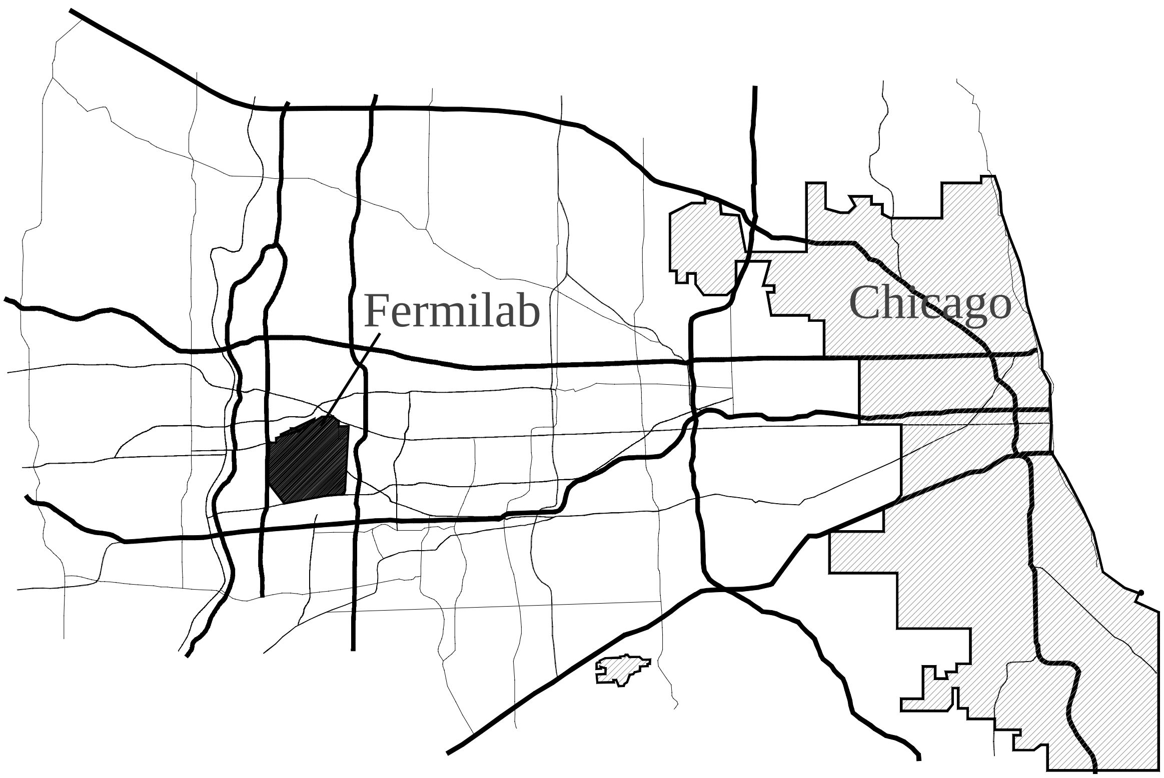

Figure 1 Location of the Fermilab site in the context of the greater metropolitan Chicago area.

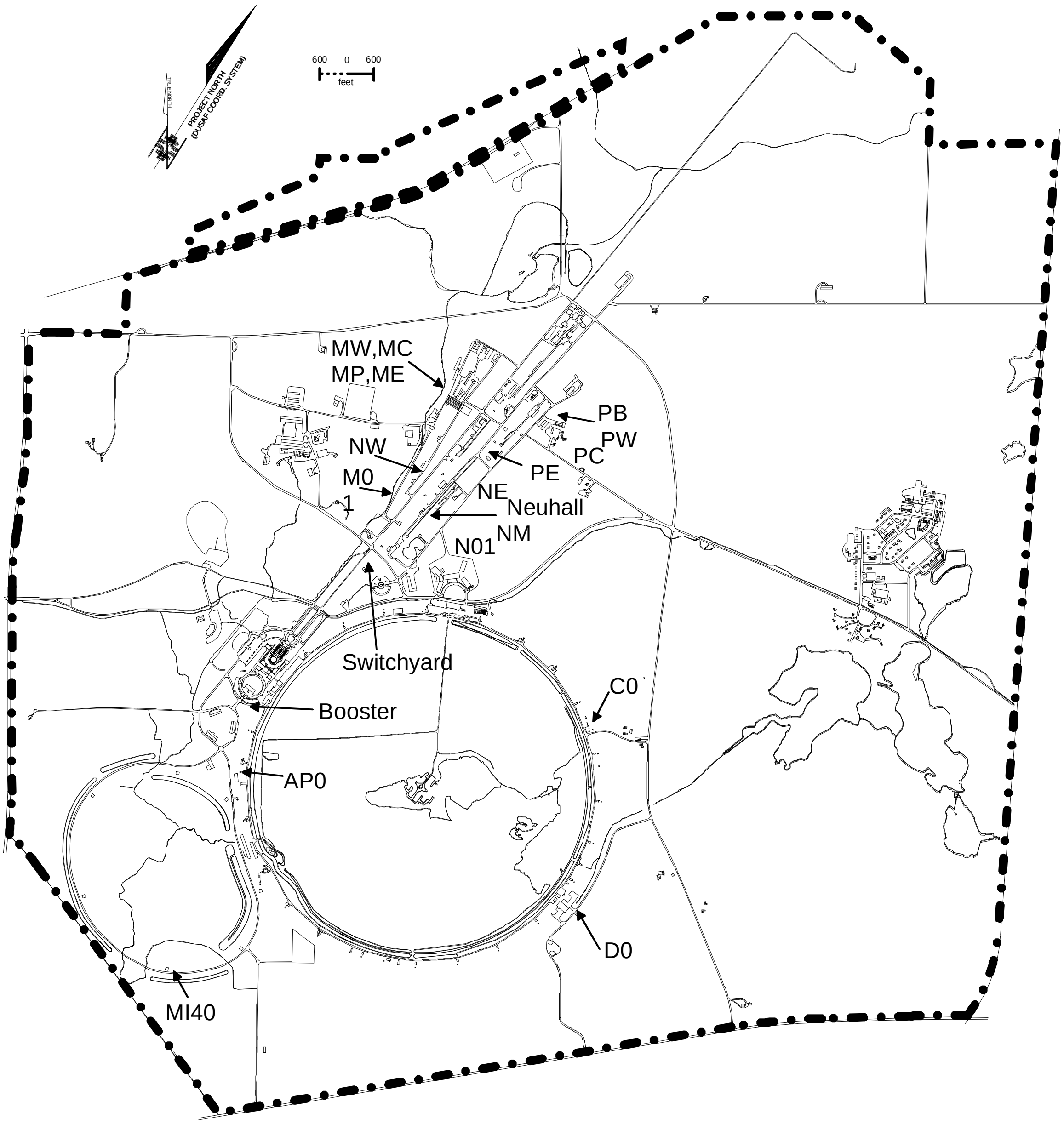

Figure 2. Map of Fermilab showing locations of areas of vulnerability investigated through this process.

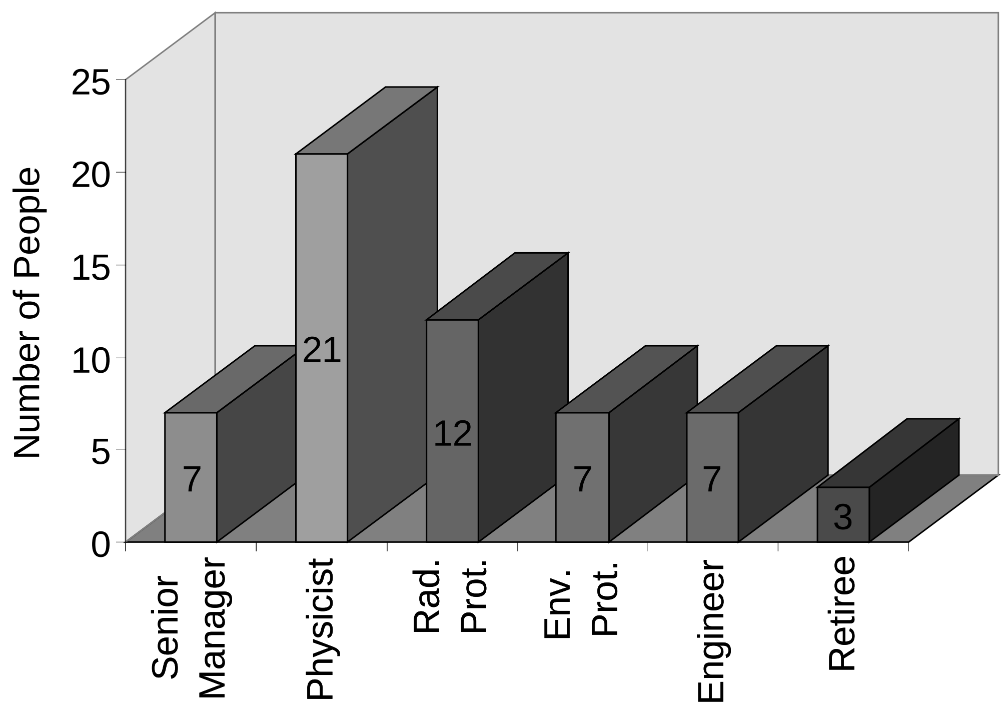

Figure 3. Distribution of participants in the review committees established in 1997. For individuals who have played multiple roles at Fermilab in the past, only the current role (as of 1997) was tabulated. "Rad. Prot." and "Env. Prot" denote radiation, and environmental protection specialists, respectively. "Engineer" generally included mechanical, civil, and electrical engineers with extensive knowledge of the construction and or operations of the appropriate areas. "Retiree" included individuals who have played a major historic role in accelerator operations at Fermilab.

Table 1. Initial matrix of potential vulnerabilities. The analysis of the matrix led to the establishment of the specific committees that were charged with investigating potentially contaminated areas in detail.

Location	Possible points of contact	Knowledge of Beam History	Status of Calculations & Measurements	Leached Water Sump Analysis	Relevant Hydrogeologic Information	Other Relevant Facts about Design	Relationship to other Potential Sources	Observations Drawn from A. Elwyn Note.	Possible Work to be Done (see other columns, too)	Priority for Further Work-Rationale	Status as of 3/10/99
Linac Beam Absorber #1	C. Schmidt	This is presently unknown. Estimates might be possible.	See Beams Division Documentation Center for calculations.	Absorber only used during study periods. Positioned above Booster enclosure so any migrating water likely enters Booster underdrain system and is probably pumped to surface.	In till	Over-designed in length. Soil activation down-stream of absorber very unlikely	None nearby	Early calculations determined that the beams absorberss were conservatively designed.	The Beams Division should clarify the role of this absorber in terms of usage. Also, no documentation appears to exist that establishes why this beam absorber should not be of concern. It may have had fewer protons, but is it also more thinly shielded?	LOW - compare with Linac absorber #2	No need for further work.
Linac Beam Absorber #2	C. Schmidt	This is presently unknown. Estimates might be possible.	See Beams Division Documentation Center for calculations. '93 Soil sample data available from absorber exterior	Soil sample data available from absorber exterior	In till	Over-designed in length. Soil activation down-stream of absorber very unlikely	None nearby	This one is also likely conservatively designed. Sump and boring hole results are < 2 pCi/ml H-3. Soil samples are < 0.3 pCi/ml. The beam history is for this beam absorber is not known.	It would be a good idea to obtain an approximate beam history on this absorber. Then, one could compare the calculations with the measurements and also assure us that this absorber is understood.	LOW - Due to the conservative design and the low values of monitoring results.	No need for further work.
MT	H. Haggerty	800 GeV Data Available	Calculations exist. Targetry here was regarded as "minor".	Sump sample data available.	In till	Targeting was mostly done in Meshall target tube.	Close to Meshall target	Not considered.	Need proton tallies and running mode information. Intensities were believed to be low. Effort would be in the mode of a minor cleanup.	LOW-Due to low intensities and the fact that most of the targeting was done in Meshall over the bathtub.	The targeting should be covered by any study that might be done of Meshall.
Booster	J. Lackey	Absorber line beam foil history available since at least 1987.	See Beams Division Documentation Center for calculations.	None	In till	Mostly under concrete floors of enclosures.	None nearby	No relevant information about the "standard" Booster Absorber appears to exist. However, adjacent sumps consistently have shown 3H concentrations below the detection limit.	The beam history of this beam absorber should be summarized and a calculation should be performed.	LOW-Due to low measured concentrations and the protection provided by all of the concrete over this beam absorber.	Studies have been done and interpreted, in part motivated by last year's civil construction.
AP4 Line Absorber	J. Lackey	No beam history appeared to be readily available.	See Beams Division Documentation Center for calculations.	Sample data exists from tunnel underdrain sump near this absorber	In till	See pbar note #359	None nearby	A calculation by P. Yurista exists. The design was viewed as "adequate" in terms of the SRWM relative to annual beam intensities.	A calculation based upon the Concentration Model should probably be performed. It is not clear that additional monitoring would be helpful.	LOW-Due to the conservatism of the SRWM model and the result obtained.	No need for further work.

Table 1. Continued

Location	Possible points of contact	Knowledge of Beam History	Status of Calculations & Measurements	Leached Water Sump Analysis	Relevant Hydrogeologic Information	Other Relevant Facts about Design	Relationship to other Potential Sources	Observations Drawn from A. Elwyn Note.	Possible Work to be Done (see other columns, too)	Priority for Further Work-Rationale	Status as of 3/10/99
ME	C. Brown, A. Wehmann, D. Eartly	800 GeV Data Available	No specific calculation known to exist except for a draft note that was never finalized. This target station is more heavily shielded than is MP, MC, and MW.	No Sumps in this immediate area.	In till	ME, MP, MC, and MW all sit on a concrete floor and under a roof. No credit was given for "protec-tion" of anything under the floor. These are steel shields surround-ed by concrete shielding blocks.	ME, MP, MC, and MW are very close to one another.	A. Elwyn was able to perform a rudimentary soil activation calculation from a draft memo in the file which led to a 0.01 pCi/ml of 3H in soil. The SM12 magnet is also under a roof which reduces the risk of leaching from rainwater.	Monitoring should possibly be considered. Boring under the target stations might be possible with limited risk. "Fresh" calculations, or at least "recovery" of the old calculations now found only in draft form is suggested.	LOW-due to the large amount of shielding provided by the SM12 magnet also also the protection from leaching.	Reviewed by a Beams Division committee. No followup actions with respect to soil activation were indicated to be necessary.
PW6	T. Murphy	800 GeV Data Available	Have results of calculation. Shielding apparently "overdesigned" based on very optimistic view of beam performance. Have a calculation for the present, downstream targeting.	Sump sample data available.	In till	This is a steel shield in a concrete enclosure. The original design was for a much larger number of protons than have every been delivered.	Fairly close to PC, PB, and PE targets.	The design report comments about groundwater were reviewed with a crude estimate of groundwater activation yielding very small values of concentration (<0.01 pCi/ml, 3H). Higher levels (≈10 pCi/ml) have been seen, perhaps due to other targets.	Better beam history data is probably needed and this target should be included in monitoring plans.	LOW-Due to the large amount of shielding provided.	This was reviewed by a Beams Division Committee. Estimates of groundwater activation used by the committee relied solely on calculations.
PC	J. Lach	800 GeV Data Available	Have calculation, which was updated for present run.	Sump sample data available.	In till	Many "minor", and frequent changes in targetry, but intensities were typically "low". This is steel shield surround-ed by concrete shielding blocks under a roof.	Fairly close to PB, PE, and PW	Several CASIM calculations have been done in this area. The estimates of concentrations near the enclosure are <1 pCi/ml 3H with measurements far lower, except for one "high" (91 pCi/ml) in 1991 (documented by e-mail message only).	The documentaiton of the operational history of this target station prior to 1985 should be improved. The documentation of the attempt to understnad the 1991 high reading should be preserved in the files in permanent form.	LOW-Due to the low concentrations estimated and relatively low results seen. Monitoring for the PE and PW beamlines is likely to "cover" PC due to proximity.	Should take measures to assure coverage by monitoring well network.
PW7	W. Freeman or R. Zimmerman n	800 GeV Data Available	Have calculation, which was updated for present run.	Sump sample data available.	In till	A recent calcu-lation document-ed a concen-tration model-based calcula-tion here.	Fairly well isolated.	Relatively low (<0.1 pCi/ml 3H) calculations are predicted. Monitoring has not yet been performed. The integrated beam intensity for this target is to be rather low	The nearest sump should be monitored.	LOW-Due to the low intensity and the results of the calculation that are already in hand.	Same comment as for PW6.

Table 1. Continued

Location	**Possible points of contact**	**Knowledge of Beam History**	**Status of Calculations & Measurements**	**Leached Water Sump Analysis**	**Relevant Hydrogeologic Information**	**Other Relevant Facts about Design**	**Relationship to other Potential Sources**	**Observations Drawn from A. Elwyn Note.**	**Possible Work to be Done (see other columns, too)**	**Priority for Further Work-Rationale**	**Status as of 3/10/99**
DO (As location of beam absorbers used prior to construction of D0 Collision Hall)	None needed?	Knowledge in hand	Calculation exists	Data exists	In till	Excavated to build Collision Hall	Existing drinking water well is fairly close to this location.	S. Baker performed calculations of the radioactivity here and compared with measurements. This may be one of our best existing verifications of the accuracy of the calculations made using CASIM in a direct comparison with concentrations in soil.	None appears to be needed. The area of activation was completely excavated during the construction of the D0 Collision Hall	LOW-In this case it is not clear what work actually COULD be done.	No need for further work.
8 GeV Absorber at P-bar Target Hall	M. Church	No beam history appeared to be readily available.	See Beams Division Documentation Center for calculations	Vault underdrain sump sampled routinely.	Contained within APØ vault	See pbar note #400	None nearby	A calculation by P. Yurista exists. The design was viewed as "adequate" in terms of the SRWM relative to annual beam intensities.	It is not clear that additional calculations or monitoring would be particularly helpful here. This comment is especially relevant to question of monitoring in view of the proximity to AP0.	LOW-Monitoring at AP0 appears to include this beam absorber.	No need for further work.
NW	A. Malensek	800 GeV Data Available	Calculation exists	Sump sample data available.	In till	Somewhat close to Neuhall bathtub. This target was under an enclosure floor in the target tube.	Fairly close to Neuhall and NE targets	No documentation of the details of the soil activation calculation performed by Koizumi are available. This area is contained within the Neuhall bathtub. The nearest sump has showed only one sample with measurable 3H ≈2.5 pCi/ml).	It might be a good idea to track down the operational history of this beam absorber.	LOW-The activity in this region is most likely completely overshadowed by the vicinity of Neuhall.	No need for further action.
MP, MC, MW	D. Eartly	800 GeV Data Available	Have calculations for MW, MC, and MP. Fresh calculations were done for MC and MW for current, 1996-1997, run.	No Sumps directly related to these areas. The only ones available are for the Meson Detector Building target stations as a group.	In till	ME, MP, MC, and MW all sit on a concrete floor and under a roof. No credit was given for "protec-tion" of anything under the floor. These are steel shields surround-ed by concrete shielding blocks.	ME, MP, MC, and MW are very close to one another.	A. Elwyn was able to derive an estimate of soil activation from the "old" calculalations which gives a maximum of 0.5 pCi/ml 3H in soil. The roof over the beamlines provides some protection against leaching. Monitoring should be considered.	One should get complete proton histories. Should consider for monitoring. Boring under the target stations might be possible with limited risk.	LOW-The design calculations lead one to the conclusion that the shielding is adequate for the usage of these target stations that has occurred to date.	No need for further work.

Table 1. Continued

Location	**Possible points of contact**	**Knowledge of Beam History**	**Status of Calculations & Measurements**	**Leached Water Sump Analysis**	**Relevant Hydrogeologic Information**	**Other Relevant Facts about Design**	**Relationship to other Potential Sources**	**Observations Drawn from A. Elwyn Note.**	**Possible Work to be Done (see other columns, too)**	**Priority for Further Work-Rationale**	**Status as of 3/10/99**
NM	A. Malensek	800 GeV Data Available	Have calculation for both Muon Beam and KTEV modes.	Sump sample data available.	In till	Very close to edge of bathtub for Neuhall. This is in a steel shield in an enclosure.	Fairly close to Neuhall, NW, and NE targets	The calculations appear to be adequate for the NM beam as operated for muons. Monitoring results for this area is likely completely interleaved with that for Neuhall due to the location to the point where the NM contribution cannot be cleanly separated.	It would be good to collect the complete proton history for this area. One should check this against the parameters of both KTEV and the proposed KAMI.	LOW-the design is well understood and this beam absorber is almost certainly being monitored by the Neuhall monitoring system.	No need for further action.
NTF Absorber	A. Lennox	May be retrieveable from NTF logbooks	Absorber contained in treatment room wall and is far removed from soil.	na	Contained within Linac Gallery	na	None nearby	Not Considered	Given the low energy, it is probably straightforward to demonstrate that the beam absorber has no ability to significantly activate soil. This calculation should be done.	LOW-the low energy and the geometry essentially preclude this absorber from being a source of groundwater activation.	No need for further work.
AØ TeV Abort	A point of contact needs to be identified.	Very low intensity abort used to cleanup Tevatron during collider operation	See Beam Division Documentation center.	Sample data exists for transfer hall underdrain sump.	In transfer hall enclosure	See TM-1564	None nearby	Not considered	None identified.	LOW-Very low beam intensity involved here.	No need for further work.
PB (PE4)	P. Garbincius or J. Butler	800 GeV Data Available	A calculation exists which was updated for present run.	Sump sample data available.	In till	This is a steel shield in an enclosure.	Fairly close to PC, PB, and PW	It appears that the operational history of this target station is relatively well-known. Due to relatively intense usage during recent fixed target runs, concentrations near the enclosure of approximately 20 pCi/ml 3H could exist. Usable monitoring data does not exist.	The characterization of this target station is probably adequate, but the estimated concentrations indicate that this area should be included in the monitoring plan.	MODERATE-due to estimates of concentrations near the enclosure and the apparent lack of directly relevant monitoring data.	Should be further reviewed, especially for adequacy of monitoring data.
"Old PW" Upstream Absorber PW5	T. Murphy	Need to get from BD	No specific groundwater calculation exists.	Sump sample data available.	In till	Steel shield in a concrete enclosure. The location is in the old "sheet piling" part of the Proton Area.	Fairly close to PC, PE, PC targets	Not considered	The documentation of the operational hisitory should be improved as this target has both been used as a full time target, years ago, and also as a beam parking place. It should be included in monitoring plans.	MODERATE-Due to unknowns about the structure as well as lack of knowledge about the beam history.	The downstream ("newer") parts of PW were reviewed by a Beams Division committee. However, thie review really did not cover "old PW".

Table 1. Continued

Location	**Possible points of contact**	**Knowledge of Beam History**	**Status of Calculations & Measurements**	**Leached Water Sump Analysis**	**Relevant Hydrogeologic Information**	**Other Relevant Facts about Design**	**Relationship to other Potential Sources**	**Observations Drawn from A. Elwyn Note.**	**Possible Work to be Done (see other columns, too)**	**Priority for Further Work- Rationale**	**Status as of 3/10/99**
Meshall (M01)	D. Eartly	800 GeV data available, but most of the targetry was done per-Tevatron.	No documentation of design calculations related to soil activation have been identified.	Sump sample data available.	In till	This is the other "bathtub" shield that was actually used, besides Neuhall.	None close	Beam intensities were much lower here than at Neuhall. Sump samples near the pre-1982 target, presumably from the bathtub, show 3H levels ≈ 120 pCi/ml. A soil boring shows a level near the target in soil of 0.2 pCi/ml.	The beam history for the Meshall target should probably be obtained. Unlike the situation for Neuhall, the targetry employed here was simpler, with fewer varieties of runing modes, and the activation is likely confined to a localized region.	MODERATE- Since a bathtub was used, monitoring should be employed and the general standard improved.	This one should be reviewed further to determine of caissons to bedrock were used. If this is so, then further monitoring may be indicated.
NE/NT	G. Koizumi, R. Stefanski	800 GeV Data Available	Have calculation both for previous fixed target runs and for present one.	Sump sample data available.	In till	Somewhat close to Neuhall bathtub. This is in a steel shield in an enclosure	Fairly close to Neuhall and NW targets	The calculated values of the concentrations ≈ 20 pCi/ml 3H and are unchecked against sparse sump data. It would appear that monitoring might be needed in this area, given the uncertain connection with sump measurements with actual activation.	The beam history is needed perhaps along with a good calculation of this target station. A monitoring plan for this area is probably needed.	MODERATE- The calculation predicts activation in this area > 20 pCi/ml. "Moderate" is suggested because the monitoring for Neuhall is likely to cover the area of the target station.	We should revisit coverage of this area by Neutrino area monitoring wells.
N01	R. Stefanski, L. Stutte	800 GeV Data Available	Calculation exists	Sump sample data available.	In till	Enclosures were found in bad shape due to poor structural design. This target station has a bathtub that was not used as part of the final ground-water shield, but which may afford some protec-tion.	Fairly close to Neuhall, NM sources	A calculation exists that may not match the actual configuration operated. As with Neuhall, large concentrations within the bathtub are expected. These are similar to predictions based upon this target station operating by itself.	The details concerning the proton history should probably be tidied up. The monitoring plan should be reviewed. It may be readily incorporated into that for Neuhall.	MODERATE- This area is closely tied to the Neuhall area. However, the structural integrity of the beam enclosure itself was found to be suspect, and the intensities here are large.	Reviewed by Director's committee. Followup actions underway.
AP0	M. Church	Knowledge in hand	Good calculation exists. Also see Beams Division documentation center	Good data	In till	Under building roof, in concrete vault	None nearby	A detailed calculation has been performed and is being improved. Rough agreement between predicted specific activity in soil and sump water samples has been found.	This beam absorber is being reviewed by a Directorate committee which is considering the adequacy of the present calculation along with the monitoring proposal by the ES&H Section.	HIGH-because of the results of the calculation as well as the large beam intensities involved.	Reviewed by Director's committee. Initial studies complete, followups underway.

Table 1. Continued

Location	Possible points of contact	Knowledge of Beam History	Status of Calculations & Measurements	Leached Water Sump Analysis	Relevant Hydrogeologic Information	Other Relevant Facts about Design	Relationship to other Potential Sources	Observations Drawn from A. Elwyn Note.	Possible Work to be Done (see other columns, too)	Priority for Further Work-Rationale	Status as of 3/10/99
C0	T. Murphy, F. Turkot	Knowledge in hand	Doing calculation. Also see Beams Division documentation center	Extensive sampling data and tritiated underdrain water removal from this absorber. This absorber is within 100 ft of class I groundwater, in the form of a well.	In till	Double absorber, MR and Tevatron. This is in a concrete vault.	None nearby	A detailed calculation is in preparation. The results will be reviewed by a review committee appointed by the Director	Upon completion of the calculations, the committee needs to review the results and also ES&H Section proposals for monitoring.	HIGH-Due to proximity to Class I Groundwater.	Reviewed by Director's committee. Initial studies complete, followups underway.
MI-40	C. Bhat	As yet unused	Good calculation exists	No data as yet exists	In till	Concen-tration model used to design	None nearby	Not considered	The calculation previously documented should be reviewed in light of our present concerns. This should included consideration of an appropriate monitoring program.	HIGH-due to the importance of this beam absorber to future Fermilab operations.	Reviewed by Beams Division committee. Initial studies complete, followups underway.
Neuhall	D. Theriot or L. Stutte	Some beam totals appear to exist, but several running modes were used the choice of which greatly affects the activation pattern.	Have very old Awschalom calculation. Perhaps need to verify with respect to actual operating history (running mode).	Monitoring Wells sampled by the 7th floor ES&H Section.	In till	The major "bathtub" target station	Fairly close to N01, NM, NW, and NE targets	One cannot use the existing FLUTRA calculation to make a direct comparison with concentration in either soil or water.	A good calculation, perhaps worst case set for "horn" running, seems to be needed. Obviously, the resul of the monitoring program already implemented need to be carefully considered.	HIGH-obvious because of some lack of knowledge found about the history and also because of the observations in the wells.	Reviewed by Director's committee. Followup actions underway.
Switchyard	A point of contact needs to be identified.	Absorber line beam foil history is available since at least 1987.	Draft calculation exists (memo to S. Childress from P. Yurista). See Beam Division documentation center	Samples collected from tunnel underdrain sump at SSB near this absorber	In till	Carries a rather large inventory of high concen-tration (for us!) tritiated water. This absorber is immersed in water contained in a steel tank surround-ed by a poured-in-place, concrete vault in the ground. Photo-graphs of the absorber are available.	None nearby	This absorber is probably too short for Tevatron-era beams as it was sized for 200 GeV. Low concentrations of 3H (≈ 10 pCi/ml) have been seen in monitored sumps, but none in soil.	A good calculation is needed for the absorber as it actually exists which includes the beam history. A plan for monitoring should be proposed. Consideration should perhaps be given for improvements in this absorber if it is to be used in the future.	HIGH-There are a number of unknowns for the major beam absorber.	Reviewed by Director's committee. Report anticipated "soon". Beam absorber water disposed of. Waiting for report for other followups.

Table 1. Continued

Location	**Possible points of contact**	**Knowledge of Beam History**	**Status of Calculations & Measurements**	**Leached Water Sump Analysis**	**Relevant Hydrogeologic Information**	**Other Relevant Facts about Design**	**Relationship to other Potential Sources**	**Observations Drawn from A. Elwyn Note.**	**Possible Work to be Done (see other columns, too)**	**Priority for Further Work-Rationale**	**Status as of 3/10/99**
PE3	D. Eartly	800 GeV Data Available	Old calculation exists with measurements which are presently being reviewed.	Sump sample data available.	In till	Target changes were frequently made in "old days". This is a steel shield in an enclosure.	Fairly close to PC, PW, PB	S. Baker did study, unpublished, with activation of Cu and al tags along with soil samples. A "fresh" CASIM calculation was not performed, but good agreement was found with adjacent sump calculations.	A good calculation is needed given the long term, high intensity use, of this target. It would also be useful to better understand the operational history of this target station. The beam absorber probably merits monitoring	HIGH-This is due to the known large beam intensities and relatively high enclosure radiation levels.	Reviewed by a Director's Committee. Some followup monitoring is being planned.

Table 2. Current modified matrix, reflecting work completed, current status and projected future work as of September 1999.

Location	Point of contact	Beam History	Summary of known information	Future Work	Priority for Further Work-Rationale	Current Status
Meshall (M01)	D. Eartly	800 GeV data available, but most of the targetry was done pre-Tevatron.	Unlike the situation for Neuhall, the targetry employed here was simpler, with fewer varieties of runing modes, and the activation is likely confined to a localized region. However, caissons were apparently sunk to bedrock to support this station, and this represents a potential route to Class I water for local contamination.	The beam history for the Meshall target should probably be obtained, and any details of the use and construction of caissons should be investigated.	HIGH-The use of caissons and the fact that a bathtub was used, indicates that monitoring should be employed at this location. Sampling of the monitoring well installed in 11/99 will begin in CY00.	A monitoring well was installed downgradient of this area in 11/99. It will be included in the routine sampling schedule. Subsequent to data collection, the priority will most likely revert to LOW.
Proton East (Target Station, neutral absorber of the Tagged Photon Beam, beam losses in contiguous PEast enclosures, PE3, PE4)	T. Nash; D. Eartly	Director's Committee Report documents beam history through 1985. Offsite Emissions Tracking documents beam history after January 1, 1990.	The Director's Committee Report, "Proton East Experimental Area Soil Activation Review," concluded there was no problem in this area, in spite of the prediction of 2-3 pCi/ml in the aquifer. As part of the review, groundwater activation calculations were performed using the Concentration Model. The report references sump monitoring data, residual radiation dose rates, monitoring well data and leak history. No soil samples have been taken in the area. Questions have been raised to the appropriateness of the monitoring well data cited in the report.	No recommendations made by the Director's Committee. Considered to be prudent to take core samples in the vicinity of the primary target station (outside the enclosure) and the neutral absorber (through the sheet pile wall). Operational history sketchy between 1985 and 1990. Director requested a decommissioning plan for this area.	MODERATE-Questions have been raised regarding the data associated with this area.	No additional measures have been taken since the Director's Committee Review. Characterization of this area and installation of a monitoring network is slated for FY00.
"Old PW" Upstream Absorber PW5	T. Murphy	Probably could be reconstructed.	No specific calculations exist for this area. Later became PW8. Sump sample data are available.	The documentation of the operational hisitory should be improved as this target has been used both as a full time target (years ago) and also as a beam "parking place". It should be included in monitoring plans.	MODERATE-Due to unknowns about the structure as well as lack of knowledge about the beam history.	The downstream ("newer") parts of PW were reviewed by a Beams Division committee. However, the review really did not cover "old PW". This area will be included with the PE characterization.
C0	T. Murphy, F. Turkot	Annual summary incorporated into EP Note 14.	See the report of the Director's Committee, authored by Turkot, et al. (June 8, 1998), entitled "C0 Main Ring-Tevatron Beam Absorber Review Committee Report." Additional information is contained in EP Note #14. The geology in the vicinity of C0 was characterized in 1998 and a set of three piezometers installed to monitor groundwater levels and local gradient.	Pending completion of the recommendations from the Director, no future work is anticipated. Continue to monitor water levels and gradient. Depending on the future use of the C0 target hall, design monitoring for the area.	LOW-Vulnerabilities at this location have been evaluated.	The majority of the recommendations are still pending completion. Status being tracked through ESHTRK.
AØ TeV Abort	A. C. Crawford	Very low intensity abort used to cleanup Tevatron during collider operation	See TM-1564	None identified.	LOW-Very low beam intensity involved here.	No need for further work.
NTF Absorber	A. Lennox	May be retrieveable from NTF logbooks	This absorber is contained in the treatment room wall at the Neutron Therapy Facility within the Linac Gallery. It is far removed from soil, and therefore the potential for any activation is very low.	Given the low energy, it is probably straightforward to demonstrate that the beam absorber has no ability to significantly activate soil. This calculation should be done.	LOW-the low energy and the geometry essentially preclude this absorber from being a source of groundwater activation.	No work subsequent to evaluation.
NM (KTeV)	V. Bocean, G. Bock	Data available as part of the Offsite Emissions Tracking performed by ESH.	This absorber was addressed separately from the rest of the Neutrino area and focused primarily on its current usage. TM-2023 provides a full description of the target station. The Beams Division Committee report incorporates the CASIM simulations and the results of groundwater activation calculations using the SRWM. Sampling results from the sump pits in NM2, NM3 and NM4 are available. There is a question as to whether the monitoring wells in the Neutrino area are sufficient to address KTeV (see Director's Committee Report on Neutrino Areas). Soil samples taken in the vicinity of particular enclosure vent stacks demonstrate that a regular soil monitoring program not necessary.	Although the SRWM is generally more conservative, the groundwater activation calculations should be redone using the Concentration Model. One should check this against the parameters of both KTEV and the proposed KAMI.	LOW-The design is well understood and the estimates are well below the groundwater limits.	No need for further action.

Table 2. Continued

Location	**Point of contact**	**Beam History**	**Summary of known information**	**Future Work**	**Priority for Further Work-Rationale**	**Current Status**
MP, MC, MW	D. Eartly; C. James performed recent assessment	Beam history readily available since 1990.	Calculations to predict soil activation in the Meson area were performed in 1983 (TM-1235) against the SRWM. The calculations give a limit of 3.4E18 protons per year in the MW, MC and MP beamlines combined because individual effects on soil activation can not be separated. Using the CM, limits is 6.4E19 protons/year. No test wells, so no measurements of soil activation. Current design drawings for MC6 are referenced in the "Review of the Meson Center Target Station in MC6," dated October 15, 1997.	Should get complete proton histories prior to 1990.	LOW-The design calculations lead to the conclusion that the shielding is adequate for the usage of these target stations that has occurred to date. Given the proton economics and the off-site muons, the beamlines never reach 50% of maximum number of protons.	No need for further work.
AP0	M. Church	Annual summary incorporated into EP Note 7. All protons incident assumed to be at 120 GeV.	See E.P. Note #7 and the report of the Director's Committee, authored by Hojvat, et al. (June 9, 1997). Both documents contain references to other information relevent to this beam absorber.	Pending completion of the recommendations made by the Director's Committee no future work is anticipated.	LOW--Several of the actions had inconclusive results. These should be reviewed to see if there are alternative ways to obtain the desired information or if based on information gained from other reviews whether this data is still needed.	3 of the 5 recommendations have been completed. Status being tracked through ESHTRK.
8 GeV Absorber at P-bar Target Hall	M. Church	No beam history appears to be readily available.	This absorber is completely contained within theAP0 vault. The vault underdrain system is regularly sampled. More information is in "P-Bar Note #400", Calculations done by P. Yurista concluded that the design was adequate by the SRWM criterion, given annual beam intensities. Some calculations available in BD Documentation Center.	It is not clear that additional calculations or monitoring would be particularly helpful here. This comment is especially relevant to question of monitoring in view of the proximity to AP0.	LOW-Monitoring at AP0 appears to include this beam absorber.	No work subsequent to evaluation.
MI-40	C. Bhat (performed groundwater calculations)	Commissioning began in Sept/October 1998.	Groundwater monitoring system in place, installed 1998. See the "Report of the Committee to Review the Environmental Vulnerabilities Associated with the MI-40 Beam Absorber", dated December 7, 1997 and the associated action plan, dated July 17, 1998. Much of the relevant documentation is contained in the Accelerator Readiness Review (ARR) and the Safety Analysis Document (SAD). TM-1985 documents the Groundwater Activiation calculations. Revisions to these calculations were documented as part of the ARR.	Pending completion of the recommendations made by the Director's Committee no future work is anticipated.	LOW-Groundwater monitoring and geological characterization are complete	Many of the recommendations have been completed as they were incorporated into the ARR process. Status is being tracked through ESHTRK.
PW7	W. Freeman or R. Zimmermann	Data available as part of the Offsite Emissions Tracking performed by ESH.	The absorber was designed and built specifically for E872. Estimates of groundwater activation were performed by W. Freeman using both the Concentration Model and the Single Well Resident Model. Both indicated concentrations below the 20 pCi/ml limit, however, the values are not negligible. During the summer 1998, a RAW leak was documented and actions taken to prevent contamination of the sumps in the vicinity. Operations were reinstated with special operating procedures. Because of this leak, the experiment may not run in the future. A committee report was prepared following the leak to assess the hazard. The report contains references to design drawings, the RAW system leak, the groundwater activation calculations and sump results.	Dependent on experimental operation.	LOW-Due to the low intensity and the results of the calculation that are already in hand.	na
PC	J. Lach	800 GeV Data Available	Several CASIM calculations have been performed for this area. Estimates near the enclsoure are low, with the exception of one calculation documented by e:mail in 1991 with a result of 91 pCi/ml. Frequent changes occurred in the targetry, but intensities typically low. Sump sample data in the vicinity are available. Area fairly close to PB, PE and PW.	The documentation of the operational history of this target station prior to 1985 should be improved. The documentation of the attempt to understand the 1991 high estimate should be preserved in the files in permanent form.	LOW-Due to the low concentrations estimated and relatively low results seen. Monitoring for the PE and PW beamlines is likely to include PC due to proximity.	Should take measures to assure coverage by monitoring well network.

Table 2. Continued

Location	Point of contact	Beam History	Summary of known information	Future Work	Priority for Further Work-Rationale	Current Status
PW6	T. Murphy	800 GeV Data Available	Calculations are available for this location. Shielding was apparently more than adequate, since overly optimistic assumptions about beam performance were made in designing it initially. Sump data are available. Steel shield within a concrete enclosure. This area is part of the general area that includes PC, PE and PB.	Better beam history data is probably needed and this target should be included in monitoring plans.	LOW-Due to the large amount of shielding provided.	na
ME	C. Brown, A. Wehmann, D. Eartly	800 GeV Data Available	No specific calculations exist for this area other than some unbublished "drafts". A. Elwyn calculated in 1997, approx. .01 pCi / ml H-3 in soil under this area based on the draft calculations. There are no sumps in the area. ME, MP, MC and MW all sit on a concrete floor and are under roof. This targeting area is steel shielded, surrounded by additional concrete shielding.	Monitoring should possibly be considered. Boring under the target stations might be possible with limited risk. "Fresh" calculations, or at least "recovery" of the old calculations now found only in draft form is suggested.	LOW-due to the large amount of shielding provided by the SM12 magnet. Protection from leachingis provided by the roof and floor.	na
AP4 Line Absorber	J. Lackey	No beam history appears to be readily available.	There are sample data from the tunnel underdrain sumps in near this absorber. More information is in "P-Bar Note #359", Calculations done by P. Yurista concluded that the design was adequate by the SRWM criterion, given annual beam intensities. Some additional calculations may be available in BD Documantation Center.	A calculation based upon the Concentration Model should probably be performed. It is not clear that additional monitoring would be helpful.	LOW-Due to the conservatism of the SRWM model and the result obtained.	No work subsequent to evaluation.
Booster	J. Lackey; Peter Kasper	Absorber line beam foil history available since at least 1987. As part of the calculation performed by N. Mokhov in November 1997, the annual Booster Integrated Intensity since 1973 was documented.	No relevant information about the "standard" Booster Absorber appears to exist. However, adjacent sumps consistently have shown 3H concentrations below the detection limit. During normal operations, this area is a loss point because of the extraction to the Main Ring / Main Injector. Extensive soil borings were conducted during the fall / winter 1997. These samples were analyzed for tritium. Shielding was increased to accomodate Main Injector operations.	None planned	LOW-Due to low measured concentrations.	The extensive soil boring provided an opportunity to document the radionuclide distribution resultant from operations during the Main Ring era. Subsequent calculations PATCH3D were performed to estimate the risk during operations with the Main Injector. The calculations demonstrate a minimal risk.
MT	H. Haggerty	800 GeV Data Available	Targeting in this area was minimal. Most targeting was carried out in the Meshall target tube. MT is fairly close to the Meshall target tube. Sump data are also available for this area.	Need proton tallies and running mode information. Intensities were believed to be low. Effort would be in the mode of a minor cleanup.	LOW-Due to low intensities and the fact that most of the targeting was done in Meshall over the bathtub.	The targeting should be covered by any study that might be done of Meshall.
DO (As location of beam absorbers used prior to construction of D0 Collision Hall)	None	Knowledge in hand	The area of activation was completely excavated during the construction of the D0 Collision Hall	None appears to be needed.	LOW-All potentially contaminated soil has been removed	No need for further work.
Switchyard	S. Childress (Chair of Director's committee)	The Director's Committee report presents the history of beam delivery to the Switchyard and also includes available Al tag data.	Analytical results from sump samples during the Tevatron era are available as are the results of soil samples taken in the vicinity in October 1997. Groundwater calculations performed have been summarized in the Director's Committee report for the beam absorber and areas with high losses (PLAM / MLAM, MUSEP,PSEP). Where comparision feasible, good agreement with results of the simple Concentration Model calculations and samples.	Pending completion of the recommendations made by the Director's Committee no future work is anticipated.	LOW -- Unless the absorber will be used in the future and the fixed target program expands with XHIGH expected losses. Committee conclusion that current Switchyard sources do not pose an environmental concern.	2 of the 3 committee recommendations have been completed. The status of the third is being tracked through ESHTRK.
Neutrino Beamlines (Neutrino Target Tube, Enclosure 100, Target Manhole, N01, NE8, NW3, NM)	D. Cossairt	Documented as part of Director's Committee Report	Monitoring well installation at NS1 in during 1997 covers the groundwater. Congestion in the area down-gradient makes installation of additional well(s) problematic.	Calculation of total tritium inventory in the area may be beneficial. Pending completion of the recommendations made by the Director's Committee no future work is anticipated.	LOW - Groundwater monitoring is in place.	2 of the 5 recommendations have been completed. Recommendation status is being tracked through ESHTRK.

Table 2. Continued

Location	Point of contact	Beam History	Summary of known information	Future Work	Priority for Further Work-Rationale	Current Status
Linac Beam Absorber #2	C. Schmidt	This is presently unknown. Estimates might be possible.	There are sump and soil sample data from this absorber location. All sump samples < 2 pCi/ml H-3, and soil samples are < 0.3 pCi/ml. Like Linac #1, this absorber was overdesigned in terms of length and downstream contamination is not expected. Some calculations available in BD Documentation Center.	It would be a good idea to obtain an approximate beam history on this absorber. Then, one could compare the calculations with the measurements and also assure ourselves that this absorber is understood.	LOW - Due to the conservative design and the low values of existing monitoring results.	No work subsequent to evaluation.