Background

Radiation is the spontaneous emission of matter and energy from an atom, as these decay into what will eventually be a more stable substance. Each step of the decay produces a unique substance called an isotope which can last for billions of years or decay again in a fraction of a second. The energy given off may be in the form of a beta particle (a small negatively charged particle with the mass and charge of an electron), an alpha particle (a heavier positively charged particle with the charge and weight of two protons and two neutrons) or a gamma photon (a bundle of energy without mass given off after an alpha or beta particle is emitted). When elements decay into isotopes, each step gives off a specific form of particle or photon as it sheds mass and energy. Each type of energy can be measured with a specific detector and then linked back through a known radiation decay profile to determine what is present and what relative risk it may present.

Alpha particles are relatively large and since they have a positive charge, will interact easily with surrounding matter. As an external risk, it can be stopped by external layers of skin, paper or by being able to travel only a few centimeters through air.

Beta particles are smaller and negative so can travel farther (possibly several meters from a source) and penetrate deeper through tissue but can blocked by a layer of plastic, glass or metal.

Gamma radiation can travel farther and is more difficult to block because it doesn't have a mass or charge.

Detection and Measurement

When the presence of radioactive substances is suspected, specialized detectors, either passive (special units that absorb any radiation but must be sent to a laboratory for analysis) or active (field-usable detectors that give a general reading of radioactive strength) are used to determine the area of interest. Samples of the potential radioactive material (whether gas, liquid or solid) and then taken and sent to a specialized lab for analysis. The first and quickest test looks for gross alpha and beta activity to see if levels are near or above regulatory standards. If this is the case, more detailed analyses are performed to determine what isotopes are present and what levels of radiation are being produced.

There are three main techniques for measuring isotopes, with each having different processes as well as benefits and limits:

1. Gamma ray spectroscopy is fast (less than 1 day), needs minimal sample preparation and doesn't destroy the sample but has a high minimum detection limit.
2. Beta particle counting is slow (10-30 days), needs special and destructive sample preparation but has a low detection limit.

3. Alpha spectrometry is very slow (months), requires extensive sample preparation but can achieve the lowest detection limits.

Knowing the relative limits and characteristics of each technique, chemists can draw an effective picture of the concentrations of a range of isotopes and their contribution to localized radiation from a particular sample. The differences in timing may be used as a quality check on the other methods. Samples from the wastewater at Kennetcook and the materials sent to AIS in Debert were screened for gross alpha and beta the further analyzed by gamma spectroscopy and alpha spectroscopy.