Honeywell Metropolis Works

Radiological Characterization Report For Site Soils

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List of Acronyms and Abbreviations

CaF_2	Calcium Fluoride
CL	Confidence Limits
cm	centimeter
COC(s)	Constituent(s) of Concern
DCE	Decommissioning Cost Estimate
DCGL	Derived Concentration Guideline Level
DPM	Disintegrations per Minute
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
FSS	Final Status Survey
HSA	Historical Site Assessment
GPS	Global Positioning System
ICP/MS	Integrated Coupled Plasma Mass Spectroscopy
KOH	Potassium hydroxide
LLD	Lower Limits of Detection
m	meter
MAPC	Maximum Allowable Predicted Concentration
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Containment Level
MDC	Minimum Detectable Concentration
µR/hr	MicroRem per hour
mR/hr	milliRem per hour
mrem/yr	millirem per year
MTW	Metropolis Works
NaI	Sodium Iodide

NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NIST	National Institute for Standards and Testing
NRL	Nuclear Reactor Laboratory
NUREG	Nuclear Regulatory Guide
pCi/g	picocuries per gram
RCRA	Resource Conservation and Recovery Act
ROC(s)	Radionuclide(s) of Concern
TCLP	Toxic Characteristic Leaching Procedure
U	uranium
UF_6	Uranium Hexafluoride
USEPA	United States Environmental Protection Agency
USNRC	United States Nuclear Regulatory Commission

1.0 EXECUTIVE SUMMARY

This site radiological characterization was initiated by Honeywell – Metropolis Works (MTW) in response to the Nuclear Regulatory Commission (NRC) Proposed Rule on Decommissioning Planning in which new requirements for contamination control, site characterization and monitoring, and financial assurance were proposed for sites licensed by the NRC. This Proposed Rule is expected to become final in early 2010. The Proposed Rule includes requirements for additional site characterization of subsurface areas (both inside and outside of radiologically controlled areas), groundwater, and areas with potential for chemical contamination.

The purpose of the site radiological characterization at Honeywell – MTW was to collect characterization data to assess the levels of radiological activity for the future decommissioning of the site. Decommissioning projects are performed to remove sufficient radioactive contamination from a facility so that the decommissioning criteria are satisfied. To date, the decommissioning criteria for the Honeywell – MTW have not been defined. This is due to the fact that decommissioning of the site is not anticipated in the near future. Typically the decommissioning criteria are established in the decommissioning plan which is developed when decommissioning of the facility is anticipated.

A decommissioning project can be divided into four phases as follows: assessment, development, operations, and closeout. The site radiological characterization survey is considered part of the assessment phase. Assessment is performed by conducting scoping, characterization, remedial action support, final status and/or confirmatory surveys. Radiological characterization surveys are primarily performed to determine the nature and extent of radiological contamination. Characterization surveys activities often include the detailed assessment of various types of building and environmental media, including building surfaces, surface and subsurface soil, surface water, and groundwater. The focus of the radiological characterization at Honeywell - MTW was on surface and subsurface soil. The other media were not characterized. Groundwater is considered in this radiological characterization report however the existing groundwater monitoring program was deemed sufficient to assess the potential for radiological impacts to groundwater.

Characterization surveys for surface and subsurface soil are designed to determine the horizontal and vertical extent of radionuclide concentrations in soil. In order to assess the horizontal extent of contamination at the Honeywell – MTW site, the property was divided into plant and non-plant areas. These areas were further subdivided into twenty-nine (29) plant areas (P-1 through P-29) (Figure 1) and five (5) non-plant areas (NP-1 through NP-5). For P-1 through P-26, the vertical extent of contamination was determined by collecting soil samples at a depth 6 inches and 36 inches below the existing grade. If warranted, additional sampling was performed at a depth of 72” below existing grade. Due to ongoing operations, the scope of the characterization was limited such that samples of subsurface soil could not be collected near subsurface piping systems (process, sanitary, and storm water) which were designated as P-27, P-28, and P-29. For NP-1 through NP-5, soil samples were typically collected at a depth 6 inches below the existing grade. If warranted, additional sampling was performed at a depth of 36” below existing grade. Soil samples collected from plant and non-plant areas were analyzed for total uranium.

The site characterization was necessary because there was very limited radiological data for Honeywell - MTW. The data collected during the radiological site characterization will be used to update the current decommissioning cost estimate and to provide data for future decommissioning activities. For example, the data will be incorporated into the decision-making process for development of Final Status Survey (FSS) Data Quality Objectives (DQOs) and used to develop Derived Concentration Guidance Levels (DCGLs) per the NUREG 1575 Multi-Agency Radiation Survey and Site Investigation Manual

(MARSSIM) (Reference 1). The survey was designed to determine whether or not elevated levels of radioactive material contamination were present in surface and subsurface soils. Therefore a significant portion of the samples were counted in a field count room to provide more real-time data and to reduce overall project costs. The use of the field count room is estimated to have saved approximately $50,000.

The radiological characterization data collected showed that there are radiologically contaminated areas on site within the fenced in Restricted Area and radiological impacts outside of the Restricted Area that are greater than the potential release criteria.

2.0 PROJECT OVERVIEW

2.1 Introduction

Honeywell - MTW contracted Enercon Services, Inc. (ENERCON) to perform a radiological characterization survey of soils at the MTW site in Metropolis, Illinois. The characterization was initiated by MTW in response to the NRC Proposed Rule on Decommissioning Planning in which new requirements for contamination control, site characterization and monitoring, and financial assurance were proposed for sites licensed by the Nuclear Regulatory Commission (NRC). This Proposed Rule is expected to become final in early 2010. The Proposed Rule includes requirements for additional site characterization of subsurface areas (both inside and outside of radiologically controlled areas), groundwater, and areas with potential for chemical contamination.

The characterization was planned and conducted based upon information and recommendations in the Historical Site Assessment (HSA) (Reference 5). Field characterization activities were initiated on May 15th, 2009, and concluded on August 28th, 2009.

Requirements contained within the Proposed Rule also stipulate that data collected during characterization be utilized to update a site's Decommissioning Cost Estimate. The MTW Decommissioning Cost Estimate tri-annual update is due in fiscal year 2010. Analytical results from the characterization will be utilized to estimate volumes of radiologically impacted soil at the MTW site which would be expected to be remediated during future decommissioning activities. The estimated soil volumes and associated remediation costs will be included in the 2010 update to the Decommissioning Cost Estimate.

2.2 Purpose and Scope

The purpose of the site characterization was to define constituents of concern (COCs) at the MTW site and assess the migration of these constituents within surface and subsurface soil. In order to achieve this goal, soil samples were collected from twenty-six (26) plant areas (Figure 1) and five (5) non-plant areas as defined in the HSA. P-1 through P-25 are located in the Restricted Area. P-26 and NP-1 through NP-5 are located outside the Restricted Area. At MTW, the Restricted Area is the area enclosed inside the inner fence. Samples of subsurface soil were not collected near subsurface piping systems (process, sanitary, and storm water) which were designated as P-27, P-28, and P-29 due to ongoing operations.

Soil samples were collected at the surface and a depth of 36 inches for Plant Areas P-1 through P-26. Soil samples were collected at a depth of 72" below existing grade based upon results at the 36 inch depth and historical information. Samples for Non-Plant Areas NP-1 through NP-5 were collected at the surface and at 36 inches based on field observations or historical information.

Groundwater samples were not collected during the site characterization. Existing groundwater monitoring data was reviewed to determine if there has been any radiological impact to groundwater at the Honeywell – MTW site. Characterization of the buildings and facility structures was not included in the scope of work for the site characterization.

The following major tasks were completed to accomplish the scope of work:

- Preparation of the Historical Site Assessment, Characterization Plan, Soil Sampling Plan, Health and Safety Plan and Sampling and Analysis Plan
- Low background area was established on-site as required for the field count room

- Site and project specific training of characterization personnel
- Excavation permits and survey packages were prepared
- Soil sample were collected at the surface (0" to 6") and subsurface (36") in P-1 through P-26
- Soil samples were collected at the surface for NP-1 through NP-5
- Soil samples were counted in the on-site field count room
- Portion of soil samples were shipped to an off-site analytical laboratory for analysis
- Concrete/asphalt core drilling was performed to access soil in paved areas
- Additional soil samples were collected at a depth of 72 inch below existing grade in P-1 and P-26
- Reviewed existing groundwater monitoring program and results for impacts to groundwater
- RCRA samples were collected from areas with an increased potential of chemical contamination
- Final report was prepared to document the findings of the site characterization

2.3 Summary of Characterization Activities

2.3.1 Soil Sample Collection and Handling

Approximately 1,700 soil samples were collected as part of the MTW site radiological characterization (Figure 2). Soil samples were collected using hand and power tools such as spades, augers (hand and power), and picks. Photograph No. 1 (see Appendix C) shows a power auger that was used during the radiological site characterization. A concrete core drill was used to penetrate concrete and asphalt surfaces to allow sampling of subsurface soil. Photograph No. 2 shows the concrete core drill that was used during characterization. In the background is a water tank which was used to store water to cool the concrete bit during coring. Photograph No. 3 is a close up of the concrete core drill.

ENERCON site personnel prepared 86 excavation permits to facilitate plant and personnel safety as required by Honeywell – MTW plant procedures. Before any sampling in a given area, the excavation permit for that area was approved by the MTW safety department. The excavation permits are included in Appendix B. Preparation of the excavation permits included review of plant drawings for subsurface utilities and health and safety issues. Prior to the excavation permit being issued, ENERCON and MTW personnel walk downed the area to be sampled. Sampling locations in the plant were marked with fluorescent paint prior to sampling to ensure the sampling team only cored in areas which had been cleared of subsurface utilities.

The characterization was performed safely with one minor incident. A subsurface pipe located in the main employee parking lot was struck with a hand auger. The pipe was not damaged and the sample location was relocated to prevent damaging the subsurface pipe. Based on plant drawings, the subsurface pipe was probably part of the storm water collection system.

2.3.1.1 Plant Areas

Plant area samples were collected using hand tools and a power augering machine. A concrete core drill was used to penetrate concrete and asphalt areas to access subsurface soil in paved areas. The original scope of the site characterization required that surface (0" to 6") and subsurface (36") soil samples be collected. In general, samples noted as being collected at a depth of 36" below existing grade were

collected from 28" to 42" below grade. Modifications to the original scope included collecting 18" samples in areas where cohesive soils were encountered at the surface. Time and budget allowed for additional vertical delineation at select locations. Typically, the vertical delineation involved collection of a soil sample at a depth of 72" below the existing grade. Samples noted as being collected at a depth of 72" below existing grade were typically collected from 60" to 72" below grade. The criteria used to select the sampling locations for additional vertical delineation included elevated sodium iodide (NaI) counts (i.e. field laboratory counts) or laboratory results (when available). Historical information provided in the HSA was also a factor used to determine if a sample should be collected at a depth of 72" below the existing grade.

Soil samples were placed in 1 gallon zip lock plastic bags and identified with a unique sample number. Plant area sample locations were identified with a Ground Positioning System (GPS) and marked with a flag containing the sample identification number for future reference. The plant sampling locations are shown on Figure 2. The water used to cool the concrete core drill prevented any solids from accumulating on the core bit and therefore there was no need for decontamination of the core bit. Other sampling equipment was decontaminated to prevent cross contamination by scrubbing with soap and water to remove the gross contamination followed by a rinse with clean water. The soil samples collected during the site characterization have been placed in B-20 boxes for storage. The summary of results and findings for the plant areas are summarized in Section 4.2 of this report.

2.3.1.2 Non-Plant Areas

Non-plant area surface soil samples were collected from the existing grade to a depth of 6" below existing grade with a trench spade and placed into 1 gallon zip lock plastic bag. If required, a sample was collected using a hand auger at a depth of 36" below existing grade. In general, samples noted as being collected at a depth of 36" below existing grade were collected from 28" to 42" below grade. The criteria used to determine if a sample was collected at a depth of 36" below the existing grade included elevated sodium iodide (NaI) counts (which is indicative of radiological contamination) or other field observations such as suspected subsurface soil disturbances (soil discoloration, suspect materials). Historical information provided in the HSA was also a factor used to determine if a sample should be collected at a depth of 36" below the existing grade. Sample volumes were sufficient to support the laboratory analytical requirements and on-site counting in Marinelli containers.

The zip lock plastic sample bag was marked with a unique sample number and a marking flag was placed at the sample location. The sample number was marked on the flag for reference. Sample locations were located with a Global Positioning System (GPS) for future reference. The non-plant sampling locations are shown on Figure 2. To prevent cross contamination, the sampling equipment was decontaminated after each use. Decontamination consisted of scrubbing the sampling equipment with soap and water to remove the gross contamination followed by a rinse with clean water. The soil samples collected during the site characterization have been placed in a B-20 boxes for storage. The summary of results and findings for the non-plant areas are summarized in Section 4.1 of this report.

2.3.1.3 RCRA Sampling

Twenty (20) surface (0" to 6") soil samples were collected in several plant areas and one non-plant area to determine if select metals were present at RCRA levels (Figure 3). The samples were collected in clean 4 oz. glass jars provided by the analytical laboratory. The samples were preserved by packing on ice in a cooler prior to shipping to the off-site laboratory in order to achieve a temperature below four (4) degrees Celsius as required for mercury analysis. The samples were analyzed for seven RCRA metals and

mercury. The summary of results and findings for the RCRA sampling are summarized in Section 4.3 of this report.

2.3.2 Soil Sample Analysis

The site characterization of the Honeywell - MTW required that soil samples be analyzed for radioactive constituents. Sample analysis was performed on-site (field counting with NaI detector) and off-site at an analytical laboratory. On-site sample analysis was performed via sodium iodide (NaI) analyzer calibrated for uranium. Off-site analysis was contracted to Teledyne Brown Engineering, Inc. located in Knoxville, Tennessee (Teledyne – Knoxville). Soil samples sent to Teledyne – Knoxville for analysis were accompanied by a chain-of-custody. Copies of the chains-of-custody for the project are included in Appendix D.

Off-site analysis included gamma or alpha spectroscopy for specific radioisotopes as appropriate for detection of the isotope of interest. Off-site analysis also included analysis by integrated coupled plasma mass spectroscopy (ICP/MS) for total uranium content. The following section provides a discussion of the soil sample analysis provided in support of the MTW site radiological characterization.

2.3.2.1 On-site Analysis

On-site sample analysis was performed using a Ludlum Model 2221 single channel analyzer coupled with a 2" x 2" NaI detector. On-site sample analysis was performed such that established and documented Lower Limits of Detection (LLDs) and Confidence Limits (CLs) were achieved. To improve detection capabilities, a counting lab was established in a low radiation background area onsite. A counting cave was constructed using lead bricks to further reduce background radiation and enhance sensitivity to natural uranium detection.

The on-site system was calibrated using soil samples that had been commercially analyzed for uranium. Two soil samples collected from the site were specifically prepared with known but differing quantities of uranium. One sample of clean (natural background) soil was also collected. The two impacted samples and one clean sample were dried, ground, and homogenized prior to laboratory analyses. These three samples were returned to the site after laboratory analyses and loaded into Marinelli beakers for analysis using the on-site NaI system. Threshold and window settings on the Ludlum Model 2221 were set to provide optimum detection for uranium gamma radiation. The laboratory results and the count results obtained from the on-site NaI system for the three known activity samples were plotted. A best fit line through the plot of this data was used to determine the concentration of uranium for samples counted using the on-site NaI system. As additional off-site analytical laboratory results became available the correlation between the off-site laboratory analysis and the on-site NaI system was updated.

A Chi squared test was performed on the on-site NaI system once the calibration was complete to ensure instrument accuracy. Daily background checks and source checks with commercial laboratory prepared samples were performed at the beginning and end of each on-site field counting session. The source checks were recorded in the NaI counting record book. Area radiation surveys were performed with a microR meter to monitor changes in background radiation. Area background radiation was not observed to vary more than 5 to 10 microR per hour. However, fluctuations in background radiation may have impacted sample analysis results. Contributors to background radiation fluctuations may have included UF6 cylinder movement and radiological waste shipping operations.

LLD-MARSSIMs

The Lower Limit of Detection (LLD) was calculated based on a 10 minute background counting time and 10 minute sample counting time. A 10 minute counting time for the NaI detector was selected to minimize counting errors and improve sample count accuracy. The LLD for the NaI system was determined by equation 6-6, page 6-34 presented in MARSSIM (Reference 1). The calculated LLD for the on-site NaI detection system was determined to be 10 pCi/g (Reference 2).

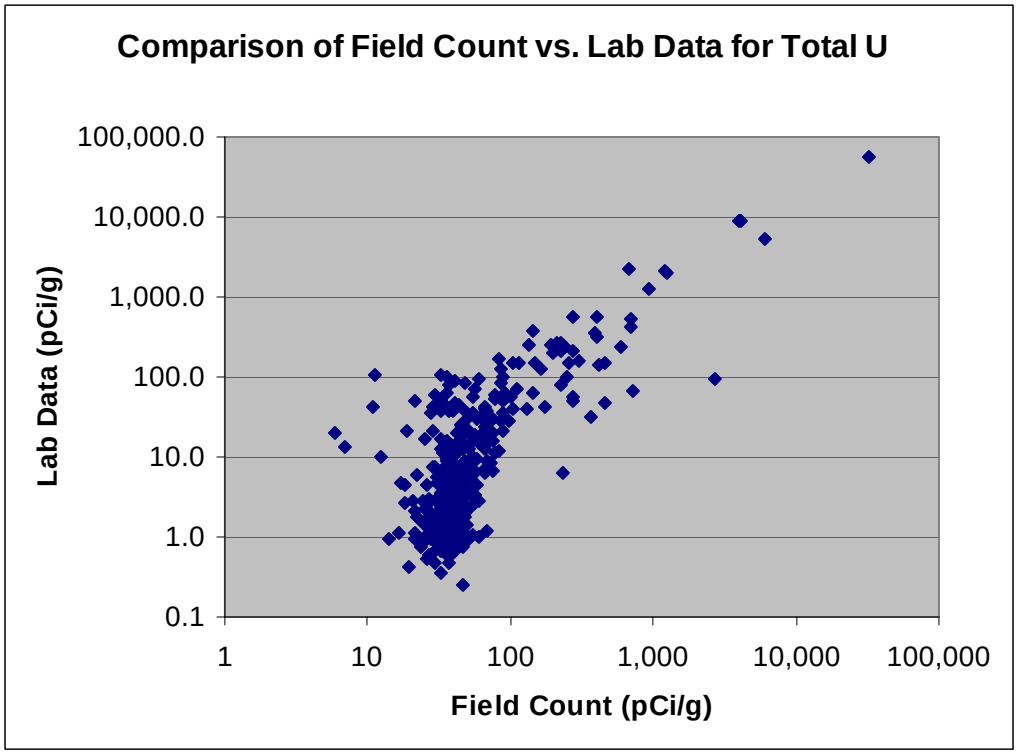
Data Correlation of Field and Laboratory Measurements

Field measurements were made on a significant majority of the soil samples using a counting system coupled with a NaI detector. A calibration curve was established using samples measured by both the field counting system and an off-site analytical laboratory. This process provided data to develop a correlation between the field measurement result and the concentration of total uranium in a sample.

Approximately 400 samples were counted both on the field system and analyzed by ICP/MS in the offsitelaboratory. Samples that were not measured by both techniques are not included in the correlation. This population of results provides for a secondary comparison between the two methods. The result of the comparison, or correlation, between the results is described in this section.

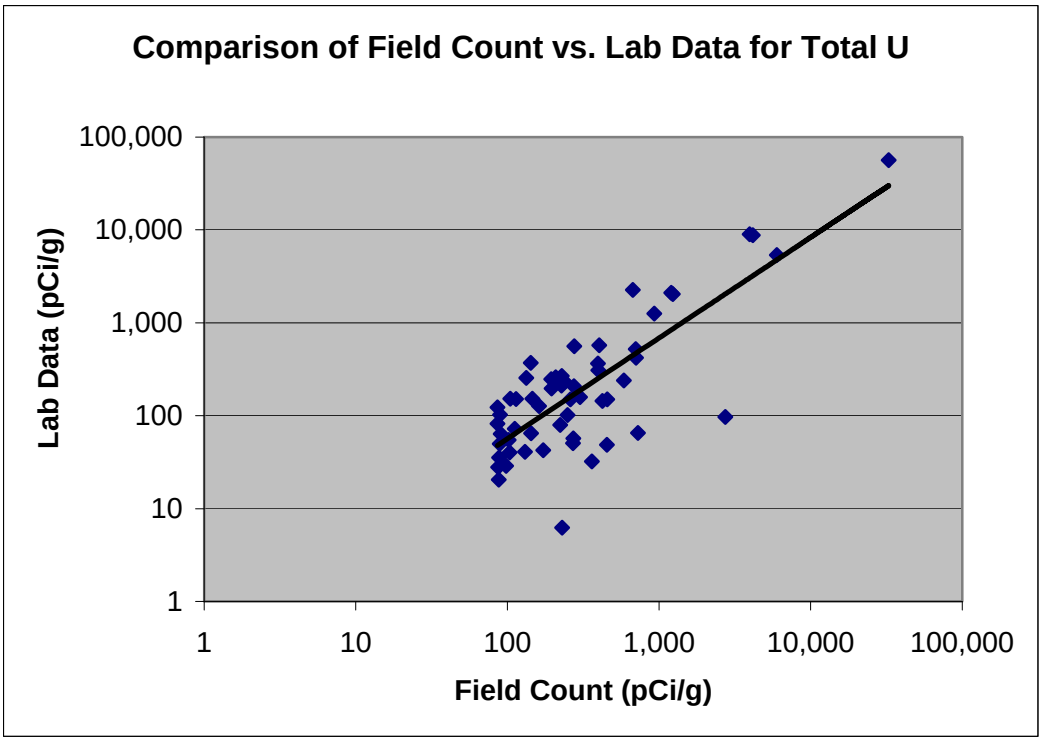
Appendix G provides a listing of the results for samples that were both counted on the field system and analyzed in the analytical laboratory. These results are ordered from lowest to highest based on the value reported by the field measurement system. These results are presented graphically in Figure 1-1.

Figure 1-1: Comparison of Measurements



Based on the information shown on Figure 1-1 it can be seen that the bulk of the measurements are at low concentrations of total uranium. These low concentration results are not considered as important to the development of a correlation between the field and laboratory results for two reasons. First, higher uranium concentrations are important to the decision making for soils that exceed the release (DCGL) criteria. Second, correlations at low uranium concentrations are not as consistent and therefore are not as reliable. Thus it was decided to utilize only the data set for which the field measurement gave a uranium concentration result greater than 85 pCi/g. These results are shown in Figure 1-2.

Figure 1-2: Comparison of Measurements for Field Data >85 pCi/g



Based on this set of data points, the trend line was established which correlates the two measurement sets.

The correlation is:

$$L = 0.3863*F^{1.0832}$$

Or equivalently:

$$F = 2.4063*L^{0.9232}$$

Where:

L = Laboratory measurement value for total uranium (pCi/g), and

F = Field measurement value for total uranium (pCi/g)

The comparison of the two sets of data indicates that the field measurements tended to overstate the total uranium concentration by a factor of 1.4 to 1.8. Table 1-1 provides comparison values calculated using the correlation equation given above.

Table 1-1: Equivalent Laboratory and Field Measurement Values Based on Correlation Equation

Laboratory Measurement (pCi/g)	Equivalent Field Measurement (pCi/g)	Ratio of Field to Laboratory Value
35	64	1.8
105	177	1.7
110	184	1.7
150	246	1.6
336	517	1.5
890	1,271	1.4

In most cases, field counts from the field (NaI) system were higher (by a factor of 1.4 to 1.8) than results reported from the off-site laboratory. The difference between the field (NaI) system and the analytical laboratory values were attributed to the following:

1. Lack of homogeneity of the sample when counted with the field (NaI) system. Samples counted with the field (NaI) system were loaded directly into Marinelli beakers for counting. Samples counted using the field (NaI) system were not dried, ground, and homogenized as they were at the off-site laboratory.

2. The one gallon plastic bag containing the sample was not mixed or blended prior to loading into the Marinelli beaker or selecting a portion to be sent to laboratory for analysis. Therefore a different portion of the sample was analyzed in the field system and at the off-site laboratory.

3. Fluctuations in the area radiation background in the field (NaI) counting room. Fluctuations in the area radiation background may have directly impacted the field (NaI) counting results. Radiation background at an off-site laboratory is more stable than in a field counting facility.

The main advantage of the on-site field counting was the real time data that was used to quickly determine where additional characterization was warranted. For example, concrete coring was required to obtain samples beneath the Ore Storage Pads. Surface (0” to 6”) and subsurface (36”) samples were analyzed using the on-site field count room. This allowed for the collection of subsurface samples at greater depth (72” below the existing grade) based on results of the field counting data. This real time data would not have been available if the samples were shipped to the off-site laboratory.

2.3.2.2 Off-site Analysis

A portion of the soil samples were packaged and sent off-site for analysis at a commercial laboratory as required in the characterization plan. The characterization plan required that approximately ten (10) percent of the soil samples with higher on-site (NaI) field counts be shipped off-site for analysis. This criteria was modified slightly as follows. Samples were selected for off-site laboratory analyses if the on-

site NaI result was below 75 pCi/g to improve the correlation between the on-site NaI system and off-site laboratory in the lower range where the correlation was least consistent. Also soil with elevated on-site field counts were sent to the off-site analytical laboratory to determine if the levels of contamination were above the cleanup criteria. Approximately 20% to 25% of the soil samples were sent off-site for analysis at an analytical laboratory.

Off-site laboratory analysis of selected soil samples was performed by gamma spectroscopy, alpha spectroscopy, and integrated coupled plasma mass spectroscopy (ICP/MS). Each sample submitted for off-site analysis was dried, ground, and homogenized prior to analysis by the laboratory. Samples analyzed by different methodologies were reviewed for correlation. The correlation between laboratory results (i.e. gamma spectroscopy and ICP/MS) was good. It is noted that in two cases sample preparation (grinding/mixing) had to be performed twice to achieve a good correlation between gamma spectroscopy and ICP/MS. This was due to the fact that a significant portion of the sample was granular in nature.

3.0 SUMMARY OF TECHNICAL APPROACH

3.1 Radionuclides of Concern

The 2006 Site Reclamation Cost Estimate (Reference 6, Page 3-1) states that the radionuclides of concern (ROC) are:

> "The radionuclides of concern at these sites are naturally occurring and originate from the processing of uranium ore concentrates that also contain natural thorium not removed in the milling process. Natural uranium contains the two principal isotopes U-238 (99.3%) and U-235 (0.7%). Natural uranium also contains minute amounts of U-234. The other radionuclides of concern include Th-230, Th-231, Th-234, Pa-241, Pa-234m, Pa-234, and Ra-226."

While the listed radionuclides will be present, the development of the DCGLs include the presence of certain radionuclides in the decay chains and therefore they were not considered in the development of the soil sampling protocol for characterization.

The ROC list provided guidance on sampling strategies, methodologies, and analytical protocols selected for characterization. Part of the assessment and evaluation process is consideration of the movement of uranium daughter products and natural thorium and daughters in the plant processing operations. Uranium daughter products and thorium can significantly impact dose and, therefore, analytical protocol considerations. Potential concentration of these radionuclides in a specific waste stream was considered during the site characterization. Identifying the location(s) where those waste streams are, or historically were handled was considered during the characterization.

Appendix C of the Historical Site Assessment (HSA) (Reference 5) was prepared by ENERCON to assess the ROCs in incoming ore concentrate and the plant-specific waste streams. Evaluating the various forms of uranium found in the incoming ore concentrate and the plant waste streams, the following was concluded:

- The dose exposure from the incoming ore concentrate is primarily (more than 90%) driven by the presence of U-234, U-235, and U-238.
- The dose exposure based on on-site and off-site environmental air monitoring data is primarily driven (more than 90%) by the presence of U-234, U-235, and U-238.
- The dose exposure based on uranium recovery solid wastes is primarily driven by the presence of Ra 226, Th-230, and Th-232.
- The dose exposure based on water effluent monitoring data is primarily driven by the presence of Ra 226, U-234, and U-238.

ENERCON designated radionuclides U-234, U-235, and U-238 as the base ROC group. Radionuclides Ra-226, Th-230, and Th-232 were designated as modified ROC group 1. Radionuclides Ra-226, U-234, and U-238 were designated as modified ROC group 2.

Within the plant operational processes, the uranium recovery process occurs in the Feed Materials Building (P-6), the Cylinder Wash Facility (P-13), the Bed Material and Filter Fines Building (P-15), and the Waste Storage Area (P-17). Thus, four (4) of the plant areas were assessed as requiring consideration for the base ROC and modified ROC group 1. All remaining plant operational areas (with the exception of P-27, P-28, and P-29) were assessed as requiring consideration of the base ROC group for

characterization. P-27, P-28, and P-29 were not characterized because operations at the facility are active and any damage to subsurface piping systems could have halted production.

The NPDES outfalls were designated as Non-Plant Area NP-1. NP-1 was assessed as requiring consideration for modified ROC group 2. The remaining non-plant areas (NP-2 through NP-5) were assessed as requiring consideration for the base ROC group.

3.2 Release Criteria

The objective of decommissioning is to remediate to a condition that corresponds to a calculated dose to the public of less than 25 millirem per year (mrem/yr) from the applicable pathways. This dose limit is provided in 10 CFR 20.1402, Radiological Criteria for Unrestricted Use (Reference 3). The Derived Concentration Guideline Level (DCGL) is defined in MARSSIM as the radionuclide-specific concentration within a survey unit that corresponding to the release criterion. The DCGL is dependent upon numerous factors. This is discussed in detail in Appendix C of the HSA (Reference 5). For the Honeywell – MTW site it was assumed that a site-specific release criteria would be developed.

The NRC criterion for residual depleted uranium in soil used to be 35 pCi/g (Reference 4). The current NRC guidance for acceptable license termination screening values for specific radionuclides is presented in NUREG-1757 Table B.2 (Reference 7). However, for the Honeywell – MTW site it is anticipated that applying a site specific release criteria using the guidance in NUREG-1757 Appendix I and the ALARA analysis guidance in NUREG-1757 Appendix N will result in release criterion in excess of 35 pCi/g based on evaluations performed at other similar facilities. For example, the site specific DCGL for uranium was calculated to be 110 pCi/g (using the RESRAD code at the 25 mrem/yr dose limit) for the Sequoyah Fuels Corporation site located in Gore, Oklahoma. In ENERCON's opinion, the 110 pCi/g release limit approved for Sequoyah Fuels is appropriate for Honeywell – MTW and defensible to the NRC for use in decommissioning planning.

3.3 Survey Design

The HSA established the breakdown of the site into twenty-nine (29) plant area (P-1 through P-29) and five (5) non-plant area (NP-1 through NP-5) survey units. Based on the anticipated potential for radiological impact for each survey unit, samples were collected on a biased basis. The sample locations were selected in the field using judgment and the physical constraints imposed by the excavation permits.

3.4 Sample Identification

During the characterization, an identification system was developed to ensure uniqueness and clarity for the numerous samples collected. This section describes the protocol that was employed in identifying the sampling locations. Each location was assigned a unique identifier that included:

- Sample type - identified using SS which designates soil sample
- P or NP
    - P designates sample collected in the plant area (P-1 through P-26)
    - NP designates sample collected in the non-plant area (NP-1 through NP-5)
    - Letter designation (A, B, C, D, etc.) was used per excavation permits

- Unique Sequential Number
- Sample depth below the existing surface (6", 12", 18", 36", and 72")

This resulted in a unique identification for each sample collected. For example, SS-P1-A1-36" is a soil sample collected from P-1 (in the area designated as A on the excavation permit) at location one (1) at a depth of 36 inches. In areas where only one excavation permit was required the letter designation was not required. For example, SS-P17-10-6", is a soil sample collected from P17 at location ten (10) at a depth of 6 inches. The unique sequential number and sample depth below the existing grade were often used interchangeably. For example, SS-P1-A1-36" and SS-P1-36"-A1 are the same sample. Also because only soil samples were collected the SS prefix used to indicate a soil sample was often omitted.

3.5 Survey Instrumentation

As described in Section 2.3.2.1, a field count room was established in order to provide real-time analysis. Details of the counting system instrumentation are provided in Table 3-1. The counting system consisted of a NaI detector housed in a shielded enclosure to minimize background levels. Controls were established to assure that the counting system was operating within established limits. This counting system was used to count most of the collected samples. Hand held survey instruments were sometimes used in the field to provide information on where to locate biased sample locations and to assess the need for additional vertical delineation, however, hand held survey instruments were not utilized to define site conditions.

Table 3-1
Survey Instrumentation

Instrument	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2221	Ludlum Model 44-10	Beta Gamma	Three soil samples with added uranium ore material were analyzed by laboratory to establish radiological controls	Volumetric analysis of soil samples

4.0 SUMMARY OF RESULTS

The following sections summarize the results of the radiological characterization effort. Samples were collected from Plant Areas P-1 through P-26 and Non-Plant Areas NP-1 through NP-5. Samples were not collected from Plant Areas P-27, P-28, and P-29 due to on-going activities at the site. P-27, P-28, and P-29 were not characterized because any damage to subsurface piping systems could have affected plant production. The laboratory analytical data are in Appendix D1. The field count and laboratory analytical data are summarized in Appendix D, Table D-1, 2009 Site Radiological Characterization, Summary of Results. The information obtained during this site characterization effort will be used to update the Decommissioning Cost Estimate.

Typically for Plant Areas P-1 through P-26, samples were collected at 6" and 36" below the existing surface. As time and budget allowed, additional samples were collected at a depth of 72" below the existing surface to provide additional data to delineate the extent of vertical contamination. For example, at sampling location P3-B3, elevated field count data at a depth of 6", 18", and 36" below existing grade indicated the need for additional sampling at this location to better delineate contamination with depth. At plant area sampling locations where cohesive (clay, silty clay, and clayey silt) soil was encountered, a sample was collected at 18" below the existing grade. The 18" sample was collected because the permeability of cohesive soil is typically order of magnitudes lower than granular (sand, gravel, sand and gravel) soil. Therefore water would tend to move at a much lower rate through cohesive soils then granular soils.

For Non-Plant Area NP-1 through NP-5, a sample was collected to a depth of 6" below the existing grade. For a relatively small percentage of the samples collected, a sample was also collected at a depth of 36" below the existing grade based on information in the HSA, field scanning, and/or field observations.

The assumed DCGL or release criteria is 110 pCi/g. Therefore any laboratory result above 110 pCi/g is indicative of radiological impacts above the cleanup criteria. Also based on the correlation provided in Section 2, any field count value above 184 pCi/g is indicative of radiological impacts above the release criteria.

4.1 Non-Plant Areas (NP-1 through NP-5)

4.1.1 Non-Plant Area NP-1, NPDES Outfalls

NP-1 encompasses the NPDES permitted outfalls. These areas are mostly grass and rock covered drainage paths. No plant operations occur in NP-1 however the key discharge points for plant waste streams and storm water runoff are the reason this area was selected for characterization. Field count data indicate impacts to Non-Plant Area NP-1, NPDES Outfalls, along the drainage path located downstream of Outfall 002 (Imhoff Tank) based on the elevated data for NP1-21 through NP1-30 (Figure 4). Samples were only collected to a depth of 6" below the existing grade for all NP-1 sampling locations. Field count data for total uranium ranges (for NP1-21 through NP1-30) from 200.3 pCi/g to 2,384.2 pCi/g. No samples were collected upgradient of NP1-21. However, because the impact at these sample locations is most likely from discharges from Outfall 002 it was assumed that the entire length of the drainage from Outfall 002 to the Ohio River is impacted. Similarly, elevated field count data and laboratory analytical data indicates impacts along the drainage that parallels the northern and eastern perimeter of the Ore Storage Pads. This drainage path was sampled at NP1-31 through NP1-36, NP1-40, and NP1-41 (Figure 2). NP1-31, NP1-32, NP1-33, NP1-34, and NP1-35, are all above the cleanup criteria. Based on field count data, total uranium was detected at 106.6 pCi/g at NP-36 which is below the cleanup criteria.

Based on laboratory data, NP1-40 (30.4 pCi/g) and NP1-41 (33.6 pCi/g) are below the cleanup criteria. Therefore the portion of drainage path represented by NP1-31 through NP1-35 was assumed to require remediation.

The field count data does not indicate any impacts at sampling locations NP1-1 through NP1-19. NP1-20 (157.6 pCi/g based on field count) is slightly elevated and is located downgradient of a potentially impacted area along River Road (NP-4).

Recommendations and Conclusions for NP-1

A significant portion of the impact along the drainage path (which was representatively sampled by NP1-21 through NP1-30) was included in the 2006 Site Reclamation Cost (Reference 6) and therefore this finding was expected. Because Outfall 002 (Imhoff Tank) will continue to be used until the facility is decommissioned it would not be practical to remediate impacts to surface soil unless the discharge from the Imhoff Tank is transmitted via a pipe to the Ohio River and the impacted soil is removed. This option probably would require an amendment to the existing NDPES discharge permit.

The impacts along the drainage that parallels the northern and eastern perimeter of the Ore Storage Pads are most likely due to excess storm water runoff that does not move through the existing storm water collection system. This drainage path was representatively sampled by NP1-31 through NP1-36, NP1-40, and NP1-41 (Figure 2). ENERCON recommends that the inlets (located in the Ore Storage Pads) to the storm water collection system be protected by bollards to prevent blockage of the grates thereby allowing storm water runoff to enter the collection system. Also ENERCON recommends that sump pump capacity be recalculated to ensure that all stormwater can be pumped effectively to the uranium settling ponds for treatment. These measures will mitigate the potential for storm water runoff from leaving the Ore Storage Pads and contaminating soil outside the Restricted Area. Also this will prevent any storm water from ponding on the Ore Storage Pads for a long period of time. The longer water is allowed to pond on the Ore Storage Pads the greater the potential for vertical contamination migration because there is increased hydraulic gradient. ENERCON also recommends that the source of contamination be reduced through better drum management. The number of empty drums should be minimized and drums that are being stored outside that are corroding should be replaced, and the contents transferred into newer drums.

4.1.2 Non-Plant Area NP-2, Surface Drainage Paths

NP-2 encompasses the natural drainage pathways from the plant. Storm water runoff that is not diverted to the plant storm water management system will naturally leave the site via these pathways. Field count and laboratory analytical data do not indicate any radiological impacts based on the 42 sampling locations in Non-Plant Area NP-2. Samples were only collected to a depth of 6" below the existing grade for NP-2 (Figure 4). In general the samples were taken in the area west and southwest of the plant. Field count data ranges from a low of 10.8 (NP2-40) to a high of 60.4 pCi/g (NP2-10). Six samples were sent to the laboratory for total uranium analysis using ICP/MS. The results range from 1.3 to 5.0 pCi/g for total uranium. NP2-10 was also analyzed using gamma spectroscopy which reported total uranium at less than the minimum detectable concentration (<MDC). The HSA indicated a high potential for historical impact but the radiological characterization collected does not indicate any impacts.

4.1.3 Non-Plant Area NP-3, On-Site Landfill and Kickback Area

This area encompasses the old on-site landfill and kickback area located east of the plant. Included in NP-3 is a fenced, placarded area of approximately 3 acres. Samples were collected in NP-3, On-Site

Landfill and Kickback Area as shown on Figure 4. Radiological impacts were found at isolated locations along the road from the plant to the inactive on-site landfill based on elevated levels of total uranium that were detected via field counting at NP3-22 (399.1 pCi/g), NP3-50 (305.8 pCi/g), and NP3-51 (712.0 pCi/g). These impacts were located in the vicinity of concrete debris that was observed along the road to the in-active on-site landfill.

No samples were collected in the fenced in area located generally south of the on-site landfill**.** Also NP3-70 through NP3-75 were not taken along the road to the old on-site landfill but around the northern perimeter of the Restricted Area.

Recommendations and Conclusions for NP-3

The impact to surface soil along the road from the plant to the in-active on-site landfill is most likely attributed to placement of plant debris. This material consists mainly of concrete rubble. Photographs in the HSA (Reference 5, Appendix F, page 14 and 15 of 30) of NP-3 show various concrete rubble piles located along the road from the plant to the in-active landfill. ENERCON recommends that the area be further characterized to delineate impacted surface soil. Furthermore any debris should be characterized to verify that it is the source of the elevated activity detected during the site characterization.

4.1.4 Non-Plant Area NP-4, River Road

NP-4, River Road, encompasses the old River Road that left the southeastern area of the plant and traversed the site in a southeast direction toward the Ohio River (Figure 4). As anticipated based on the information provided in HSA, radiological impacts were detected in NP-4 as shown on Figure 2. Red points are sampling locations where contamination was detected above 110 pCi/g for laboratory results and 184 pCi/g for field count data. Total uranium was detected (based on field counting) at sampling locations NP4-16 (260.5 pCi/g), NP4-17 (400.5 pCi/g), NP4-18 (743.6 pCi/g), NP4-19 (179.7 pCi/g), NP4-20 (5,272.4 pCi/g), NP4-23 (285.0 pCi/g), NP4-24 (713.3 pCi/g), NP4-25 (476.2 pCi/g), NP4-26 (4,083.3 pCi/g), NP4-28 (2,631.2 pCi/g), and NP4-29 (305.8 pCi/g) Total uranium was detected (based on laboratory analysis) at NP4-20 (306.3 pCi/g), NP4-22 (124.3 pCi/g), NP-23 (106.4 pCi/g), and NP4-28 (114.2 pCi/g). Due to the elevated count data for the sampling locations noted, limited sampling at a depth of 36” below the existing surface was performed. Based on the limited sampling at a depth of 36” below the existing surface, the levels of contamination decrease substantially. Using NP4-23 as an example, total uranium was detected (based on field counting) at 29.4 pCi/g at 36” below existing grade versus 285.0 pCi/g at a depth of 6” below the existing grade. Due to the limited sampling it is hard to draw any specific conclusions, however the existing data does not show significant impact to subsurface soil.

Additional delineation was performed to determine the horizontal extent of contamination along River Road. Samples NP5-381 through NP5-400 (Figure 2) were collected to better define the horizontal extent of radiological contamination along River Road. Based on this sampling, most of the contamination is located within 20 to 25 feet of the centerline of River Road. Most of the elevated count results such as NP5-384 (250.6 pCi/g), NP5-390 (715.7 pCi/g), NP5-392 (396.7 pCi/g), and NP5-394 (127.0 pCi/g) are located within 20 to 25 feet of the centerline of River Road. Due to the elevated count data at 6” below the existing surface for the sampling locations noted, limited sampling at a depth of 36” below the existing surface was performed. Based on the limited sampling at a depth of 36” below the existing surface, the levels of contamination decrease substantially. Using NP5-390 as an example, total uranium was detected (using field count data) at 62.4 pCi/g at 36” below existing grade versus 715.7 pCi/g at a depth of 6” below the existing grade. Due to the limited sampling it is hard to draw any specific conclusions, however the existing data does not show significant impact to subsurface soil.

Recommendations and Conclusions for NP-4

The presence of contamination to surface soil along River Road is most likely due to placement of impacted site materials. Photographs in the HSA (Reference 5, Appendix F, pages 24 and 25 of 30) show debris including a wooden cradle (likely used to support UF6 cylinders) placed along River Road. ENERCON recommends that the area be further characterized and remediated by removing impacted surface soil and any debris which might be the source of the impacts. After the area along River Road is remediated, there is low potential for recontamination therefore the funds reserved to perform the remediation can be removed from the Decommissioning Cost Estimate.

4.1.5 Non-Plant Area NP-5 Remainder of the Property

NP-5 includes the remaining non-plant Honeywell-MTW property not included in NP-1 through NP-4. It excludes the area north of U.S. Highway 45. In general, little to no radiological impacts were detected at the NP-5 sampling locations except at the locations adjacent to the Restricted Area in areas downgradient of radiological impacted areas as shown on Figure 8. NP5-301 through NP5-351 (excluding NP5-324) (Figure 2) were collected around the perimeter of the plant outside the outer security fence.

NP5-301 through NP5-315 are sampling locations located east of the plant downgradient of radiologically impacted areas. Field count data for NP5-302, NP5-305, NP5-308, and NP5-311 (Figure 4) indicate radiologically impacted subsurface soil to the area immediately east of the plant.

NP3-71 through NP3-75 and NP5-316 through NP5-319 are sampling locations located north of the plant. In general these samples indicate little to no radiological impacts to the subsurface soil. This is most likely due to the fact that this area is upgradient of site operations.

NP5-320 through NP5-335 (excluding NP5-324) are sampling locations located west of the plant downgradient of areas which have little to no radiological impacts. In general these samples indicate little to no radiological impacts.

NP5-336 through NP5-345 are sampling locations located generally east and south of the UF6 cylinder storage areas. Field count data for sampling locations NP5-337 through NP5-339 (Figure 4) indicate impacts to surface soil and NP5-341 and NP5-343 (Figure 6) indicate radiological impact to subsurface soil.

NP5-346 through NP5-351 are located south of the plant and in general are located south of the calcium fluoride ponds (Figure 2). In general these samples indicate little to no radiological impacts.

Recommendations and Conclusions for NP-5

The radiological impacts to subsurface soil in NP-5 are located near the plant and the mechanism for the contamination is most likely water transport (storm water runoff) of impacted material. The radiological impact to subsurface soil east of the plant (based on data for NP-301 through NP-315) are most likely due to excess storm water runoff from the Ore Storage Pads that does not move through the existing storm water collection system. Similar to NP-1, ENERCON recommends that the inlets (in the Ore Storage Pads) to the storm water collection system be protected by bollards to prevent blockage of the grates thereby allowing storm water runoff to enter the collection system. Also ENERCON recommends that sump pump capacity be reevaluated to ensure all stormwater can be effectively pumped to the uranium settling ponds for treatment. Also drum stacking should be managed to minimize the potential for drums to fall outside the concrete containment curb. ENERCON recommends that a minimum distance equal to the height of the stacked drums be maintained from the concrete curb. ENERCON also recommends

better drum management. The number of empty drums should be minimized. Drums stored outside that are corroding should be removed from service and the contents transferred into a new drum. This will mitigate the potential for storm water to come into contact with impacted material.

The radiological impacts to the surface and subsurface soil located east and south of the UF6 cylinder storage areas (based on data for NP5-337 through NP5-339, NP5-341, and NP5-343) is most likely due to excess storm water runoff from the UF6 Cylinder Storage Area that does not move through the existing storm water collection system. Currently there is no concrete curbing located around the perimeter of the UF6 Cylinder Storage Area**.** ENERCON recommends that a concrete curb (and depending on existing grades possibly a collection pipe) be considered around the perimeter of the area to allow storm water runoff to be collected and pumped to the uranium settling ponds for treatment.

4.1.6 Honeywell property located across U.S. Highway 45

Though not part of the original scope of the radiological characterization, fourteen (14) samples (NP5-352 through NP5-365) were collected north of the Honeywell – MTW on the northern side of U.S. Highway 45 as shown on Figure 2. These sampling locations are located on Honeywell property. Based on field count data, the total uranium levels in for these 14 samples ranged from a low of 6.1 pCi/g to a high of 29.1 pCi/g. In general these samples indicate little radiological impacts to surface soil.

4.2 Plant Areas (P-1 through P-26)

4.2.1 Plant Area P-1, Administration Building and Parking Lot

Plant Area P-1 is an approximate 150,568 square foot area that includes the Administration Building and the employee and visitor parking lots (Figure 1). The remainder of this area is covered with mostly asphalt/concrete with some grass. Storm water drain lines originate in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-1 to be low. Samples were collected from twelve (12) sampling locations in and near P-1 as shown on Figure 2. Field count and laboratory analytical data indicate little to no impact to the surface and subsurface soil in P-1. Based on field count data for total uranium, seven (7) out of the twelve (12) samples collected at a depth of 6” below the existing surface were less than the minimum detectable concentration (<MDC). Field count data for samples collected 36” below the existing surface in P-1 ranged from a low of 27.1 pCi/g to a high of 68.6 pCi/g. It should be noted that P1-C1 through P1-C5 were collected just east of P-1 in P-3 and are not representative of P-1. These samples were collected to delineate the horizontal limit of radiological contamination in P-3. At a depth of 6” below the existing surface, field count data indicates radiological impact at sampling location P1-C5 (258.8 pCi/g). The radiological impact at this location is representative of contamination in P-3. Excluding P1-C1 through P1-C5 which were collected at the border of P-1 and P-3, the site characterization data indicates little to no radiological impact to the surface and subsurface soil in P-1.

The location of the storm water piping located in P-1 is shown on Figure 8. Because there is no indication of any significant radiological impact to the surface and subsurface soil, the area usage has not changed over the history of operation at the facility, and the piping is located upgradient of any impacted areas, the storm water piping located in P-1 was not believed to be impacted.

Recommendations and Conclusions for P-1

There is little to no radiological impact to surface and subsurface soil in P-1. The existing curbing around the employee parking lot is preventing any storm water runoff from adjacent impacted areas from

entering P-1. This curbing should be maintained throughout the life of the facility to prevent potential future migration of contamination.

4.2.2 Plant Area P-2, Laboratory Building and Adjacent Storage Area

Plant Area P-2 is an approximate 34,939 square foot area that includes the Laboratory Building (Figure 1) and an adjacent area that was used as a storage space. The remainder of P-2 is covered with mostly asphalt with some grass. Cracks in asphalt pavement provide pathways to impact surface and subsurface soils. Process and sanitary drain lines originate in this area and continue to plant discharge points. Storm water lines pass through this area. The HSA considered the potential for impact to Plant Area P-2 to be high. Samples were collected from thirteen (13) sampling locations in and near P-2 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at the following sampling locations: P2-A3 (261.3 pCi/g) and P2-C3 (laboratory result of 239.2 pCi/g) (Figure 5). Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact at a depth of 36" below the existing grade as can be seen by the green dots in P-2 on Figure 6. For example at sampling location P2-C3, total uranium (using field count data) was detected at 32.6 pCi/g at a depth of 36" below the existing grade versus 585.5 pCi/g at a depth of 6" below the existing grade. P2-C3-6" was also analyzed at the off-site laboratory and total uranium was detected at 239.2 pCi/g which is above the release criteria.

Due to the impacts to shallow surface soils in P-2, the subsurface piping systems (process and/or storm water) located in P-2 were assumed to be impacted. This assumption is also based on information provided in the HSA regarding the potential for historical impact.

Recommendations and Conclusions for P-2

The impacts to P-2 are most likely due to historical use (storage of uranium ore concentrate drums) of the area as indicated in the HSA (Reference 5). The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems. The radiological impact appears to be limited to the surface soil.

4.2.3 Plant Area P-3, Former Cold Trash Storage Area

Plant Area P-3 is an approximate 65,961 square foot area that was historically used to stage non-hazardous waste prior to disposal in Honeywell's on-site landfill (Figure 1). Prior to the mid-1990's, the area was used to stage empty UF6 cylinders. The area was also used to store drums of uranium ore. Currently there are office trailers in the southern portion of P-3. There are various surfaces in P-3 that include asphalt, grass, and gravel (ballast near railroad tracks). Sanitary and storm water lines are located in this area and continue to plant discharge points. The HSA considered the potential for radiological impact to Plant Area P-3 to be high and this was confirmed during the site characterization. Samples were collected from twenty-one (21) sampling locations in and near P-3 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at the following sampling locations: P3-A2 (188.6 pCi/g), P3-A4 (256.8 pCi/g), P3-B1 (568.6 pCi/g), P3-B2 (3,384.1 pCi/g), P3-B3 (714.9 pCi/g), P3-B4 (228 pCi/g), P3-B5 (760.0 pCi/g), and P3-D6 (983.9 pCi/g) (Figure 5). Also as noted earlier, P1-C5 (258.8 pCi/g) is located in P-3. Field count and laboratory analytical data (based on results for samples collected at a depth of 18" and 36" below the existing surface) indicate impact at a depth of 18" below the existing grade and limited impact at 36" below existing grade. Impacts at a depth of 72" below the existing grade were detected at P3-B2 (confirmed via laboratory analysis) above the release criteria of 110 pCi/g as shown on Figure 7. Also

there are other locations (such as P3-B3 and P3-B4) which show impacts at this depth but the impact is less than the release criteria.

Due to the impacts to shallow and subsurface soils in P-3, the subsurface piping systems (sanitary, and/or storm water) located in P-3 were assumed to be impacted. This assumption is also based on information provided in the HSA regarding the potential for historical impact**.**

Recommendations and Conclusions for P-3

The impacts to P-3 are most likely due to historical use (storage of uranium ore concentrate drums) of the area as indicated in the HSA. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems. There are impacts to both the surface and subsurface soil. Impacts at a depth of 72" below the existing grade were detected at P3-B2 (confirmed via laboratory analysis) above the release criteria of 110 pCi/g. Also there are other locations (such as P3-B3 and P3-B4) which show impacts at this depth but the impact is less than the release criteria.

4.2.4 Plant Area P-4, Fluoride Preparation

Plant Area P-4 is an approximate 89,727 square foot area that includes the fluoride production plants (Figure 1). The remainder of P-4 is covered with mostly asphalt. Cracks in asphalt pavement provide pathways to impact surface and subsurface soils. Process and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-4 to be high. This was confirmed by the site characterization. Samples were collected from twenty-two (22) sampling locations in and near P-4 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at the following sampling locations: P4-A1 (20,090.9 pCi/g), P4-A2 (597.0 pCi/g), P4-A3 (1,368.9 pCi/g), P4-B1 through P4-B6 (from a low of 256.9 pCi/g to a high of 656.9 pCi/g), P4-C1 (351.2 pCi/g), P4-C2 (543.6 pCi/g), P4-C3 (2,191.1 pCi/g), P4-D5 (281.6 pCi/g), P4-D6 (331.2 pCi/g), P4-D7 (933.7 pCi/g), and P4-D8 (207.6 pCi/g) (Figure 5). Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact at a depth of 36" below the existing grade. For example at sampling location P4-C3, total uranium was detected at 44.8 pCi/g (using field count data) at a depth of 36" below the existing grade versus 2,191.1 pCi/g at a depth of 6" below the existing grade. P4-C3-36" was also sent to the off-site analytical laboratory and total uranium was detected (based on ICP/MS) at 25.5 pCi/g. P4-A3-72" was sent to the off-site laboratory and total uranium was detected (based on gamma spectroscopy) at 114.0 pCi/g which is above the release criteria. Therefore a small area was assumed impacted to a depth of 36".

Due to the impacts to shallow and subsurface soils in P-4 the subsurface piping systems (process and/or storm water) located in P-4 were assumed to be impacted. This assumption is also based on information provided in the HSA regarding the potential for historical impact.

Recommendations and Conclusions for P-4

The impacts to P-4 are most likely due to historical use (storage of uranium ore concentrate drums) of the area as indicated in the HSA. The HSA notes that there were a significant number of stored ore drums north of the south fluorine plant. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems. The radiological impact in P-4 appears to be limited to the surface soil with the exception of the impact detected based on sampling at P4-A3-72".

4.2.5 Plant Area P-5, Ore Staging Area

Plant Area P-5 is an approximate 35,034 square foot area. P-5 is a concrete pad that is used to stage drums of uranium ore concentrates prior to processing (Figure 1). The KOH muds and wet process buildings are also located in P-5. Cracks in asphalt pavement provide pathways to impact surface and subsurface soils. There are no process or storm water lines in this area. The HSA considered the potential for impact to Plant Area P-5 to be high. This was confirmed by the site characterization. Samples were collected from twenty (20) sampling locations in and near P-5 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at 17 out of the 20 sampling locations (Figure 5). Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate impact at a depth of 36" below the existing grade (Figure 6). For example at sampling location P5-A3, total uranium was detected at 13,116.7 pCi/g (based on field count) and 199.8 pCi/g (based on laboratory analysis) at a depth of 6" and 36" below the existing grade respectively. Also there is an isolated location (P5-C5) where radiological impacts were detected at a depth of 72" below the existing surface. However, the laboratory result (101.8 pCi/g) for P5-C5-72" is slightly below the release criteria.

Recommendations and Conclusions for P-5

The impacts to P-5 are most likely due to current use of the area (drums of uranium ore concentrate are stored in P-5) and historical uses as noted in the HSA. The HSA notes that empty drums were washed and crushed in the P-5 area. The current use of the area prevents any remediation of impacted surface soils. There are impacts to both the surface and subsurface soil. Impact at a depth of 72" below the existing grade was detected at P5-C5 (101.8 pCi/g based on laboratory gamma spectroscopy analysis) which is slightly below the release criteria of 110 pCi/g. The current use of the area prevents any remediation of impacted surface and subsurface soil.

4.2.6 Plant Area P-6, Feed Material Building and South Pad

Plant Area P-6, is an approximate 37,011 square foot area that includes the Feed Material Building and the South Pad (Figure 1). The remainder of P-6 is covered with mostly asphalt. Cracks in asphalt pavement provide pathways to impact surface and subsurface soils. Storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-6 to be high. This was confirmed by the site characterization. Samples were collected from thirteen (13) sampling locations in and near P-6 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at 9 of the 13 sampling locations. Field count data (based on results for samples collected at a depth of 36" below the existing surface) indicate isolated (P6-C1 (609.4 pCi/g) and P6-D3 (352.9 pCi/g)) radiological impact at a depth of 36" below the existing grade (Figure 6). Both P6-C1 and P6-D3 sampling locations are located south of the Feed Material Building. Also there is one isolated location (P6-A3 205.8 pCi/g) where radiological impacts were detected at a depth of 72" below the existing surface (Figure 7).

Due to the impacts to shallow and subsurface soils in P-6 the subsurface piping system (storm water) located in P-6 was assumed to be impacted. This assumption is also based on information provided in the HSA regarding the potential for historical impact.

Recommendations and Conclusions for P-6

The impacts to P-6 are most likely due to current and historical use of the area as indicated in the HSA. The 2006 Site Reclamation Cost Estimate (Reference 6) included costs to remediate soil near the Feed Materials Building including the South Pad. The current use of the area prevents any remediation of

impacted surface and subsurface soil and potentially impacted subsurface piping systems. There are impacts to both the surface and subsurface soil. The subsurface soil impacts appear to be isolated (P6-C1 and P6-D3) and are located south of the Feed Materials Building. An isolated sampling location showed impact at a depth of 72" below the existing grade P6-A3 (205.8 pCi/g based on field count data). The current use of the area prevents any remediation of impacted surface and subsurface soil and impacted subsurface piping systems.

4.2.7 Plant Area P-7, Powerhouse, N2 Generation, Laundry, Flammable Storage Building, and Storage Area

Plant Area P-7 is an approximate 47,654 square foot area that includes the powerhouse, N2 generation, laundry, flammable storage building, and storage area (Figure 1). The remainder of P-7 is covered with mostly asphalt. Cracks in asphalt pavement provide pathways to impact surface and subsurface soils. Process and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-7 to be low. This was confirmed by the site characterization. Samples were collected from fifteen (15) sampling locations in and near P-7 as shown on Figure 2. Laboratory data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at two isolated sampling locations: P7-A1 (259.4 pCi/g) and P7-A4 (123.0 pCi/g) (Figure 5). P7-A1 is located at the northern limit of P-7 adjacent to P-4. P7-A4 is located along the northern border with P-4. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact at a depth of 36" below the existing grade as shown on Figure 6.

The location of the subsurface piping located in P-7 is shown on Figure 8. Because there is no indication of any significant radiological impact to the surface and subsurface soil and the piping is not located downgradient of impacted piping, the storm water piping located in P-7 was not considered impacted. The process piping was considered impacted because the piping in P-7 is located downgradient of impacted areas.

Recommendations and Conclusions for P-7

The HSA indicated that the potential for radiological impacts to P-7 were low. This was confirmed by the 2009 site characterization. P-7 is located adjacent to impacted areas in P-4. The impact to surface soil at P7-A4 which is located along the northern border with P-4 indicates the possibility that there is contamination migration from P-4. Existing measures should be examined to limit the migration of contamination as much as is practicable.

4.2.8 Plant Area P-8, Non-Uranium Fluorination Plants (SF_5, SbF_5, IF_5)

Plant Area P-8 is an approximate 53,060 square foot area that includes the non-uranium fluorinations plants (Figure 2) and two other buildings. The remainder of P-8 is covered with mostly asphalt. Process, sanitary, and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-8 to be low. Samples were collected from eleven (11) sampling locations in and near P-8 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at three sampling locations located in the northeast portion of P-8 as follows: P8-A1 (1,585.0 pCi/g), P8-A3 (581.1 pCi/g), and P8-A4 (391.0 pCi/g) (Figure 5). Therefore the surface soil in the northeast portion of P-8 was considered radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. For example at sampling location P8-A1, total uranium was detected (based on field counting) at

<MDC at a depth of 36" below the existing surface and at 1,585 pCi/g at a depth of 6" below the existing grade.

The location of the subsurface piping located in P-8 is shown on Figure 8. There is no indication of any significant radiological impact to the surface and subsurface soil; however the piping systems are located downgradient of impacted piping. Therefore, the process and storm water piping located in P-8 was considered impacted.

Recommendations and Conclusions for P-8

The HSA indicated that the potential for radiological contamination in P-8 to be low. However there appears to be radiological impact to surface soil in the northeast portion of P-8. The radiological impact appears to be limited to the surface soil. The current use of the area prevents any remediation of impacted surface soil and impacted subsurface piping systems.

4.2.9 Plant Area P-9, Ore Sampling and Incoming Ore Storage

Plant Area P-9 is an approximate 69,315 square foot area that includes the Ore Sampling Building (Figure 1). The remainder of P-9 is covered with mostly asphalt. Storm drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-9 to be high. This was confirmed by the site characterization. Samples were collected from twenty-one (21) sampling locations in and near P-9 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at five sampling locations located in P-9 as follows: P9-A1 (1,104.9 pCi/g), P9-B1 (944.3 pCi/g), P9-C1 (237.4 pCi/g), P9-C4 (276.5 pCi/g), and P9-C5 (341.8 pCi/g) (Figure 5). Field count data for P9-A2 through P9-A6 indicate little to no radiological impact to the northern portion of P-9 and therefore the area represented by these samples was not considered impacted. Also field count data for P9-B2 through P9-B6 indicate little to no radiological impact in the western portion of P-9. This data was used to delineate the extent of contamination along the western edge of P-9. Based on field count data for P9-B1 (944.3 pCi/g), P9-C1 (237.4 pCi/g), P9-C4 (276.5 pCi/g), and P9-C5 (341.8 pCi/g) and the laboratory analytical result for P9-C3 (151.9 pCi/g), the surface soil in the southern portion of P-9 was considered radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 18", 36", and 72" below the existing grade. For example at sampling location P9-B1, total uranium was detected (based on field count data) at 5.2 pCi/g at a depth of 18" below the existing surface and at 49.5 pCi/g at a depth of 36" below the existing grade versus 944.3 pCi/g at a depth of 6" below the existing grade. Also the fact that there are numerous samples collected at a depth of 18" below existing grade indicates the presence of a cohesive layer of soil that would slow the migration of contamination. Therefore the subsurface soil in P-9 was not considered impacted.

The location of the subsurface piping located in P-9 is shown on Figure 8. There is indication of significant radiological impact to the surface soil. Therefore, the storm water piping located in P-9 was considered impacted.

Recommendations and Conclusions for P-9

The HSA indicated that the potential for radiological contamination in P-9 to be high. This was confirmed by the site characterization. The radiological impact appears to be limited to the surface soil. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems.

4.2.10 Plant Area P-10, Ore Storage Building

Plant Area P-10 is an approximate 60,982 square foot area that includes the Ore Storage Building (Figure 1). The remainder of P-10 is covered with mostly asphalt. Sanitary and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-10 to be high. Samples were collected from fifteen (15) sampling locations in and near P-10 as shown on Figure 2. Field and laboratory analytical count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at eight sampling locations located throughout P-10 (Figure 5). Therefore the surface soil in P-10 was considered radiologically impacted. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing grade) indicate isolated (P10-A6 374.5 pCi/g) radiological impact to subsurface soil (Figure 6). Also P12-A1-36" (180.0 pCi/g) (field count data) and P12-B1-36" (156.6 pCi/g) (laboratory data) are located near P10-A6 and indicate impacts to subsurface soil. These three sample locations were used to delineate the area of radiological impact to subsurface soil. There also is an isolated location (P10-A5) that indicates impact to subsurface soil to a depth of 72" below the existing grade (Figure 7).

One sampling location (P10-B1-6") was collected from inside the Ore Storage Building (below the concrete). The result for this sample was less than the release criteria. Based on this result, it was assumed that the soil under buildings is not radiologically impacted.

The location of the subsurface piping located in P-10 is shown on Figure 8. There is radiological impact to the surface and subsurface soil therefore the storm water piping located in P-10 was considered impacted.

Recommendations and Conclusions for P-10

The HSA indicated that the potential for radiological contamination in P-10 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil and to subsurface soil in a portion of P-10. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems.

4.2.11 Plant Area P-11, Ore Storage Pads

Plant Area P-11 is an approximate 292,146 square foot area that includes the Ore Storage Pads (Figure 1). The Ore Storage Pads are concrete pads used to manage the incoming and empty drums of uranium oxide. Storm water drain lines are located in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-11 to be high. Samples were collected from seventeen (17) sampling locations in P-11 as shown on Figure 1. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at four sampling locations in P-11 as follows: P11-B6 (252.8 pCi/g), P11-C2 (330.3 pCi/g), P11-C5 (3,069.3 pCi/g), and P11-C6 (343.6 pCi/g) (Figure 5). Laboratory data for P11-C3 (111.8 pCi/g) indicated impact to surface soil at this location. P11-C2, P11-C3, P11-C5, and P11-C6 are located in the southern portion of the ore storage pads. Therefore the surface soil in the southern portion of the Ore Storage Pads represented by these sampling locations was considered as radiologically impacted. Also the surface soil near P11-B6 was also considered as radiologically impacted. Field count and laboratory analytical data indicate isolated impact to subsurface soil based on sampling performed at a depth of 36" below the existing grade (Figure 6). At sampling location P11-C5, total uranium was detected at 495.4 pCi/g at a depth of 36" below the existing surface. Therefore the subsurface soil in the area represented by this sampling location was considered as radiologically impacted.

The location of the subsurface piping located in P-11 is shown on Figure 8. There is indication of radiological impact to the surface and subsurface soil therefore the storm water piping located in P-11 was considered impacted.

Recommendations and Conclusions for P-11

The HSA indicated that the potential for radiological contamination in P-11 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil and to subsurface soil in a portion of P-11. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems.

Materials located on the Ore Storage Pads are most likely the source of contamination found in areas east of the Ore Storage Pads. Therefore ENERCON recommends the following: (1) inlets (in the Ore Storage Pads) to the storm water collection system be protected by bollards to prevent blockage of the grates thereby allowing storm water runoff to enter the collection system, (2) sump pump capacity be reevaluated to ensure all stormwater can be effectively pumped to the uranium settling ponds for treatment, and (3) better drum management. These measures will mitigate the potential for storm water runoff to leave the Ore Storage Pads and contaminate soil outside the Restricted Area. Also this will prevent any storm water from ponding for extended periods of time on the Ore Storage Pads. The longer water is allowed to pond on the Ore Storage Pads the greater the potential for vertical contamination migration because there is increased hydraulic gradient. Standing water can also contribute to corrosion of drums stored on the Ore Storage Pads. ENERCON recommends that the number of empty drums should be minimized and drums that are being stored outside that are corroding should be removed from service and the contents transferred into new drums. ENERCON also recommends that any cracks and joints in the concrete pads be sealed to prevent pathways for future contamination migration. This may not be practical in areas where drums are stored, however, at a minimum cracks and joints should be sealed in aisles and areas where drums are not located.

4.2.12 Plant Area P-12, Tank Farm, Pond Muds Calciner Building, and Fuel Storage Tank

Plant Area P-12 is an approximate 35,188 square foot area that includes the Calciner Building, one underground diesel fuel storage tank, and several above-ground chemical storage tanks (Figure 1). The remainder of P-12 is covered with mostly asphalt. Storm water drain lines are located in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-12 to be high. Samples were collected from thirteen (13) sampling locations in and near P-12 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at eight sampling locations in P-12 (Figure 5). Therefore the surface soil in P-12 was considered radiologically impacted. Field count and laboratory analytical data indicate isolated areas of impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. P12-A1-36" (180.0 pCi/g), P12-B1-36" (156.6 pCi/g) (laboratory data), P12-D2-36" (1,086.3 pCi/g), and P12-D4-36" (437.6 pCi/g) indicate radiological impacts to subsurface soil at a depth of 36" below existing grade (Figure 6). As stated earlier in P-10, P12-A1 and P12-B1 are located near P10-A6 and these samples were used to define the impacted area at a depth of 36" in the southern portion of P-10 and northern portion of P-12. P12-D2 and P12-D4 are located in the southern portion of P-12 and adjacent to P-14. Along with points in P-14 that were impacted at a depth of 36", these were used to define the impacted area at a depth of 36" in the southern portion of P-12 and in P-14. Four locations (P12-A1, P12-A2, P12-B1, and P12-D4) indicate radiological impact at a depth of 72" (Figure 7). These four sampling locations were used to define the vertical extent of radiological impacts to subsurface soil at a depth of 72" in P-12.

The location of the subsurface piping located in P-12 is shown on Figure 8. There is indication of significant radiological impact to the surface and subsurface soil therefore the storm water piping located in P-12 was considered impacted.

Recommendations and Conclusions for P-12

The HSA indicated that the potential for radiological contamination in P-12 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface and subsurface soil in P-12. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems.

4.2.13 Plant Area P-13, Cylinder Wash Facility

Plant Area P-13 is an approximate 14,206 square foot area that includes the Cylinder Wash Facility building (Figure 1). The remainder of P-13 is covered with mostly asphalt. Storm water drain lines are located in this area and continue to plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-13 to be high. Samples were collected from twelve (12) sampling locations in and near P-13 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at two sampling locations located in P-13 as follows: P13-A3 (555.9 pCi/g) and P13-C4 (214.6 pCi/g) (Figure 5). Based on the elevated reading at P13-A3 the surface soil in the northern portion of P-13 was considered radiologically impacted. Based on the elevated reading at P13-C4 the southeastern corner of P-13 was considered radiologically impacted. Field count data (based on results for samples collected at a depth of 36" below the existing surface) indicate isolated (P13-A5 205.2 pCi/g) impact to subsurface soil in P-13 (Figure 6).

The location of the subsurface piping located in P-13 is shown on Figure 8. There is indication of radiological impact to the surface and subsurface soil therefore the storm water piping located in P-13 was considered impacted. The storm water piping is located downgradient of impacted areas.

Recommendations and Conclusions for P-13

The HSA indicated that the potential for radiological contamination in P-13 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil in the northern and southeastern portions of P-13. There also is isolated radiological impact at a depth of 36".

4.2.14 Plant Area P-14, Uranium Settling Ponds

Plant Area P-14 is an approximate 27,957 square foot area that includes Uranium Settling Pond Nos. 3 and 4 (Figure 1). The remainder of P-14 is covered with mostly asphalt and includes the area once occupied by Uranium Settling Pond Nos. 1 and 2. Process and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-14 to be high. Samples were collected from eight (8) sampling locations in and near P-14 as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface). However, due to remediation required when Uranium Settling Pond Nos. 1 and 2 (and it being impractical to sample below the existing uranium settling ponds) it was assumed under the pond area there are impacts to the surface soil. The surface soil in the northern portion of P-14 was assumed impacted based on results of P12-C1-6" and P12-C2-6" (which are located on the east/west border with P-14) (Figure 5). Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate isolated (P14-A2 152.5 pCi/g laboratory data) impact to subsurface soil based on sampling performed at a depth of 36" (Figure 6). This sample location is located adjacent to the Uranium Settling Pond Nos. 3 and 4 and

therefore it was assumed that the vertical extent of impact below these ponds extends to a depth of 36" below the existing ground surface.

The location of the subsurface piping located in P-14 is shown on Figure 8. There is indication of radiological impact to the surface and subsurface soil therefore the process and storm water piping located in P-14 was considered impacted.

Recommendations and Conclusions for P-14

The HSA indicated that the potential for radiological contamination in P-14 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil in P-14. There also is isolated radiological impact at a depth of 36".

ENERCON recommends maintaining as much freeboard as practical in the uranium settling ponds by lowering the water level to prevent water from overtopping the existing berms. Photographs in the HSA (Reference 5, Appendix E page 53 of 110) show minimal freeboard in Uranium Settling Pond Nos. 3 and 4. Rain events accompanied with high winds could result in a condition where wave action could cause water to overtop the existing berms.

4.2.15 Plant Area P-15, Bed Materials and Filter Fines Building

Plant Area P-15 is an approximate 36,931 square foot area that includes the Bed Materials and Filter Fines Building (Figure 1). Storm water drain lines are located in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-15 to be high. Samples were collected from twelve (12) sampling locations in and near P-15 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at five sampling locations located in P15 as follows: P15-A1 (375.3 pCi/g), P15-A2 (198.6 pCi/g), P15-A4 (175.1 pCi/g), P15-A6 (822.8 pCi/g), and P15-A12 (276.5 pCi/g) (Figure 5). Therefore the surface soil in P-15 was considered radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. For example at sampling location P15-A1, total uranium was detected at 3.4 pCi/g (laboratory data) at a depth of 36" below the existing surface and at 375.3 pCi/g at a depth of 6" below the existing grade.

The location of the subsurface piping located in P-15 is shown on Figure 8. There is indication of radiological impact to the surface soil and the storm water piping is located downgradient of impacted piping. Therefore, the storm water piping located in P-15 was considered impacted.

Recommendations and Conclusions for P-15

The HSA indicated that the potential for radiological contamination in P-15 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil in P-15. The current use of the area prevents any remediation of impacted surface soils and potentially impacted subsurface piping systems.

ENERCON recommends better management of waste materials in the Bed Materials and Filter Fines Building which is mostly likely the source of contamination to the subsurface soil. ENERCON also recommends that any cracks and joints in the concrete foundation inside the Bed Materials and Filter Fines Building be sealed to prevent pathways for contamination migration.

4.2.16 Plant Area P-16, Drum Storage Pad

Plant Area P-16 is an approximate 33,066 square foot area that includes the concrete pad used to manage various site waste streams (Figure 1). Cracks and joints in concrete provide pathways to impact surface and subsurface soils. Storm water drain lines are located in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-16 to be high. Samples were collected from ten (10) sampling locations in and near P-16 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at seven sampling locations located in P-16 (Figure 5). Therefore the surface soil in P-16 was considered radiologically impacted. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate isolated impact to subsurface soil. At sampling location P16-A6, total uranium was detected at 245.9 pCi/g at a depth of 36" (Figure 6). Therefore the subsurface soil beneath the southeastern corner of P-16 was considered impacted.

The location of the subsurface piping located in P-16 is shown on Figure 8. There is indication of radiological impact to the surface and subsurface soil and the storm water piping systems are located downgradient of impacted piping. Therefore, the storm water piping located in P-16 was considered impacted.

Recommendations and Conclusions for P-16

The HSA indicated that the potential for radiological contamination in P-16 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil in P-16. There are radiological impacts to the subsurface soil in the southeastern corner of P-16. The current use of the area prevents any remediation of impacted surface and subsurface soils and potentially impacted subsurface piping systems.

ENERCON recommends that any cracks and joints in the Drum Storage Pad be sealed to prevent pathways for contamination migration. Drums most likely can be moved into aisles so that cracks and joints can be sealed. Also Honeywell should consider covering the Drum Storage Pad. This would prevent storm water from contacting the drums stored in P-16.

4.2.17 Plant Area P-17, Waste Storage Area

Plant Area P-17 is an approximate 54,739 square foot area that is mostly covered with gravel (Figure 1). No process or storm drain lines are located in this area. The HSA considered the potential for impact to Plant Area P-17 to be high. Samples were collected from ten (10) sampling locations in P-10 as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) in P-17 (Figure 5). Therefore the surface soil in P-17 was considered as not radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. There is one isolated point (P17-07-18") that slightly exceeds the cleanup criteria (117.6 pCi/g)(laboratory data). This point was considered an anomaly (given that total uranium was detected at 10.2 pCi/g at a depth of 6") and would result in a quantity small enough to eliminate further consideration.

Recommendations and Conclusions for P-17

The HSA indicated that the potential for radiological contamination in P-17 to be high. The site characterization does not support this conclusion. The data indicates little to no radiological impact to the

surface and subsurface soil in P-17. Existing concrete curbing around the Ore Storage Pads and the Drum Storage Pad is preventing prevent storm water runoff from these areas from entering P-17. Therefore the concrete curbing shall be maintained to prevent future contamination.

ENERCON recommends that any radiological impacted waste and contaminated pieces of equipment be covered to prevent storm water from coming into contact with impacted waste or contaminated equipment stored in this area.

4.2.18 Plant Area P-18, UF6 Cylinder Storage Area

Plant Area P-18 is an approximate 184,489 square foot area that is used to store UF6 cylinders (Figure 1). P-18 is covered with mostly concrete and there are small area of gravel. Process and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-18 to be high. Samples were collected from twenty-two (22) sampling locations in P-18 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at twelve sampling locations located in P-18 (Figure 5). Therefore a substantial portion of the surface soil in P-18 was considered radiologically impacted. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" and 72" below the existing surface) indicate isolated (P18-B18-36" 208.3 pCi/g and P18-B17-72" 151.2 pCi/g)(laboratory data) impact to subsurface soil (Figure 6 and Figure 7). The areas represented by these two samples were considered radiologically impacted.

The location of the subsurface piping located in P-18 is shown on Figure 8. There is indication of radiological impact to the surface soil and the piping systems are located downgradient of impacted piping. Therefore, the process and storm water piping systems located in P-18 was considered impacted.

Recommendations and Conclusions for P-18

The HSA indicated that the potential for radiological contamination in P-18 to be high. This was confirmed by the site characterization. There are radiological impacts to a significant portion of the surface soil in P-18. There are isolated radiological impacts to the subsurface soil (both at 36" and 72" below the existing grade) in the southeastern corner of P-18. The current use of the area prevents any remediation of impacted surface and subsurface soils and potentially impacted subsurface piping systems.

The source of contamination in P-18 is most likely due to the historical use of the area to stage various site materials. ENERCON recommends that measures are established to prevent this from happening in the future. Current use of this area includes storage of UF6 cylinders which present little to no potential to introduce additional contamination in this area. No samples were collected beneath concrete in this area due to the storage of the UF6 cylinders. ENERCON recommends that additional characterization beneath the concrete be performed in the future to determine if subsurface contamination is widespread or limited to the subsurface located beneath gravel/rock covered areas.

4.2.19 Plant Area P-19, Drum Crushing Facility

Plant Area P-19 is an approximate 20,234 square foot area that includes the drum crushing facility building (Figure 1). The remainder of P-19 is covered with mostly asphalt. Process and storm drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-19 to be high. Samples were collected from six (6) sampling locations in and near P-19 as shown on Figure 2. Field count data for total uranium indicates radiological impacts to surface soils (based on sampling at 6" below the existing surface) at three sampling locations located in P-19 as

follows: P19-A4 (311.1 pCi/g), P19-B1 (4,334.9 pCi/g), and P19-B2 (3,293.7 pCi/g) (Figure 5). Therefore the surface soil in P-19 was considered radiologically impacted. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact to subsurface soil at a depth of 36" below existing grade. However, there is one isolated location (P19-B2 (406.0 pCi/g)) which indicate radiological impact at 72" below the existing grade (Figure 7). This isolated location was considered an anomaly.

The location of the subsurface piping located in P-19 is shown on Figure 8. There is indication of radiological impact to the surface soil and the piping systems are located downgradient of impacted piping. Therefore, the process and storm water piping systems located in P-19 was considered impacted.

Recommendations and Conclusions for P-19

The HSA indicated that the potential for radiological contamination in P-19 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil in P-19. The current use of the area prevents any remediation of impacted surface and subsurface soils and potentially impacted subsurface piping systems.

ENERCON recommends that any cracks and joints in the concrete pad in the Drum Crushing Facility be sealed to prevent pathways for contamination migration.

4.2.20 Plant Area P-20, EPF and Warehouse

Plant Area P-20 is an approximate 47,846 square foot area that includes the Environmental Protection Facility and the Warehouse (Figure 1). The remainder of P-20 is covered with mostly asphalt. Storm water drain lines are located in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant Area P-20 to be high. Samples were collected from ten (10) sampling locations in and near P-20 as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) in P-20. Therefore the surface soil in P-20 was not considered radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. Therefore the surface soil in P-20 was assumed not to be radiologically impacted.

The location of the subsurface piping located in P-20 is shown on Figure 8. There is no indication of any significant radiological impact to the surface and subsurface soil; however the storm water piping system is located downgradient of impacted piping. Therefore, the storm water piping located in P-20 was considered impacted.

Recommendations and Conclusions for P-20

The HSA indicated that the potential for radiological contamination in P-20 to be high. The site characterization does not support this conclusion. The data indicates little to no radiological impact to the surface and subsurface soil in P-20.

4.2.21 Plant Area P-21, Calcium Fluoride Ponds

Plant Area P-21 is an approximate 1,203,955 square foot area that includes the calcium fluoride (CaF_2 ponds) (Figure 1). No process or storm water drain lines are located in this area. The HSA considered the potential for impact to Plant Area P-21 to be high. It should be noted that the remediation of the CaF_2 is being addressed as part of a RCRA closure of the ponds and pond sampling was not included in the

scope of this site characterization. Samples were collected from ten (10) sampling locations in and around the CaF_2 ponds as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) located in P-21. Therefore the surface soil in P-21 was considered as not being radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade.

Recommendations and Conclusions for P-21

The HSA indicated that the potential for radiological contamination in P-21 to be high. The site characterization does not support this conclusion. The data indicates little to no radiological impact to the surface and subsurface soil in P-21.

Honeywell is currently addressing the disposition of the calcium fluoride ponds as part of a RCRA action. Whatever course of action is taken, measures shall be put in place during the RCRA action to prevent cross-contamination of unaffected surface and subsurface soil. This is critical because the berms serve as a stabilizing force if the ponds are closed in place.

4.2.22 Plant Area P-22, Maintenance Storage Area, Switchyard, and Fuel Depot

Plant Area P-22 is an approximate 73,577 square foot area that includes Maintenance Storage Area, Switchyard, and Fuel Depot (Figure 1). P-22 is covered with mostly gravel and with some asphalt and grass. No process or storm water drain lines are located in this area. The HSA considered the potential for impact to Plant Area P-22 to be high. Samples were collected from eleven (11) sampling locations in and near P-22 as shown on Figure 2. Field and laboratory count data for total uranium indicates isolated radiological impacts to surface soils (based on sampling at 6" below the existing surface) at two sampling locations in P-22. These include: P22-A2 (363.6 pCi/g) (laboratory data) and P22-B2 (232.5 pCi/g) (laboratory data) (Figure 5). Therefore the surface soil in a portion of P-22 was considered radiologically impacted. Field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact to subsurface soil based on sampling performed at a depth of 36". Therefore it was assumed that there is no radiological impact to the subsurface soil in P-22.

Recommendations and Conclusions for P-22

The HSA indicated that the potential for radiological contamination in P-22 to be high. This was confirmed by the site characterization. There are radiological impacts to the surface soil a portion of P-22. The source of the contamination to the surface soil is mostly likely storm water that has come into contact with contaminated equipment stored in the area.

ENERCON recommends Honeywell consider remediation of this impacted area. ENERCON believes this action is warranted due to the potential for migration of contamination outside the Restricted Area due to the various culverts that divert storm water runoff from P-22 to unrestricted areas west of the plant. ENERCON recommends that contaminated equipment be wrapped or covered to prevent storm water from contacting the equipment.

4.2.23 Plant Area P-23, Maintenance Shop and Stores and Loading Docks

Plant Area P-23 is an approximate 72,891 square foot area that includes the Maintenance Shop and Stores (Figure 1). P-23 is covered with asphalt and gravel. Storm water drain lines originate in this area and continue to the plant discharge point (Outfall 002). The HSA considered the potential for impact to Plant

Area P-23 to be low. Samples were collected from twelve (12) sampling locations in and near P-23 as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) in P-23. Therefore the surface soil in P-23 was not considered radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade. Therefore no radiological impacts to subsurface soil was considered in P-23.

The location of the subsurface piping located in P-23 is shown on Figure 8. There is no indication of any significant radiological impact to the surface and subsurface soil. Therefore, storm water originating in P-23 was considered not impacted.

Recommendations and Conclusions for P-23

The HSA indicated that the potential for radiological contamination in P-23 to be low and this was confirmed by the site characterization.

4.2.24 Plant Area P-24, LPG Area

Plant Area P-24 is an approximate 117,401 square foot area that includes the Liquid Propane Gas Area (Figure 1). P-24 is covered with mostly gravel and asphalt. No process or storm water drain lines are located in this area. The HSA considered the potential for impact to Plant Area P-24 to be low. Samples were collected from ten (10) sampling locations in and near P-24 as shown on Figure 2. Field count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) in P-24. Therefore the surface soil in P-24 was considered not radiologically impacted. Field count and laboratory analytical data indicate little to no impact to subsurface soil based on sampling performed at a depth of 36" and 72" below the existing grade.

Recommendations and Conclusions for P-24

The HSA indicated that the potential for radiological contamination in P-24 to be low and this was confirmed by the site characterization.

4.2.25 Plant Area P-25, Roadways and Ground Areas

Plant Area P-25 is an approximate 85,437 square foot area that encompasses the roads and miscellaneous ground areas within the plant footprint (Figure 1). P-25 is mostly covered with asphalt and some gravel and little grass. Process and storm water drain lines are located in this area and continue to plant discharge points. The HSA considered the potential for impact to Plant Area P-25 to be high. Samples were collected from twenty-five (25) sampling locations in P-25 as shown on Figure 2. Field and laboratory count data for total uranium indicates little to no radiological impacts to surface soils (based on sampling at 6" below the existing surface) at sampling locations located in P-25. Therefore the surface soil in P-25 was considered not radiologically impacted. Similarly, field count and laboratory analytical data (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no impact to subsurface soil. Therefore it was assumed that the subsurface soils in P-25 are not radiologically impacted.

The location of the subsurface piping located in P-25 is shown on Figure 8. There is no indication of any significant radiological impact to the surface and subsurface soil in P-25. Therefore, the process storm water piping systems located in P-25 were addressed based on whether they were located downgradient of impacted areas.

Recommendations and Conclusions for P-25

The HSA indicated that the potential for radiological contamination in P-25 to be high. The site characterization does not support this conclusion.

ENERCON does recommend that any cracks and joints in the roadways be sealed to prevent pathways for contamination migration in the event of spills.

4.2.26 Plant Area P-26, Plant Exclusion Zone

Plant Area P-26 is an approximate 484,341 square foot area that includes the Plant Exclusion Zone (Figure 1). Areas within P-26 are outside the Restricted Area of the plant. P-26 is covered with grass and gravel. Process and storm water drain lines are located in this area at plant discharge points. The HSA considered the potential for impact to Plant Area P-26 to be high. Samples were collected from sixty-seven (67) sampling locations in and near P-26 as shown on Figure 2.

Sampling locations P26-A1 through P26-A13 are located west of the plant. Field and laboratory count data for these thirteen (13) samples (based on results for samples collected at a depth of 6" and 36" below the existing surface) indicate little to no radiological impact to surface and subsurface soil. This is expected because most of the plant areas adjacent to the exclusion zone on the western side of the plant indicate little or no impact to surface and subsurface soil. Therefore the surface and subsurface soil located in the exclusion zone west of the plant was assumed to be not radiologically impacted.

Sampling locations P26-B1 through P26-B26 are located south of the plant perimeter. There are several samples located south and east of the UF6 Cylinder Storage Area that indicate radiological impacts to surface soils. Also there are several samples located south of the Drum Storage Pad (P-16) and the Waste Storage Area (P-17) that indicate radiological impacts. Therefore the surface soil in these areas was assumed impacted.

Sampling locations P26-C1 through P26-C19 are located east of the plant. Field and laboratory count data for these nineteen (19) samples (based on results for samples collected at a depth of 6" and 36" below the existing surface) collected in P26-C indicate little to no radiological impact to surface and subsurface soil. This finding was unexpected because the area east of the plant is located downgradient of the Ore Storage Pads. Therefore the surface and subsurface soil exclusion area located east of the plant was not considered impacted.

Sampling locations P26D1 through P26D9 are located north of the Ore Storage Pads (P-11). Field and laboratory count data for these nine (9) samples (based on results for samples collected at a depth of 6" below the existing surface) indicate isolated (P26-D2 (976.5 pCi/g)) radiological impact to surface and subsurface soil. Therefore the surface soil in the area represented by P26-D2 was considered radiologically impacted. Field and laboratory count data for these nine (9) samples (based on results for samples collected at a depth of 36" below the existing surface) indicate little to no radiological impact to subsurface soil.

Recommendations and Conclusions for P-26

The HSA indicated that the potential for radiological contamination in P-26 to be high. The site characterization confirmed this conclusion.

In general impacts to P-26 are due to storm water runoff from upgradient areas. Therefore recommendations made for the various impacted areas on site should reduce the potential for further introduction of contamination of the plant exclusion zone.

4.3 RCRA Sampling

ENERCON collected twenty (20) surface (0" to 6") soil samples to determine if Resource Conservation and Recovery Act (RCRA) Toxic Characteristic Leaching Procedure (TCLP) metals were present in the surface soils at Honeywell – MTW to determine the potential for mixed waste. A mixed waste is defined as a waste that is impacted both radiologically and chemically above the RCRA criteria. The seven RCRA metals chosen for analysis include the following: arsenic, barium, cadmium, chromium, lead, selenium, and silver. The samples were also analyzed for mercury. The samples were analyzed for total metals and were not analyzed for other leachable TCLP parameters. The twenty (20) sampling locations were based on information in ENERCON's draft waste assessment of the MTW. This draft waste assessment report identified the locations where the potential for chemical contamination was more likely based on historical and present usage at Honeywell - MTW. The areas include the following:

- RCRA Permitted Laboratory Storage Area
- RCRA Permitted Storage Pads (North of the Bed Materials and Filter Fines Building)
- Location north of Uranium Settling Pond No. 3
- Location within the perimeter fence along the eastern side of the facility
- Location outside of the perimeter fence along the eastern side of the facility near Outfall 004
- Location outside of the perimeter fence near Outfall 002

The approximate location of these 20 sample locations is shown on Figure 3. The 20 samples were sent to the laboratory for total metal analysis. The results of the total metal analysis are summarized in Table E-1 (see Appendix E) and the laboratory data is included in Appendix E. It should be noted that there are other chemical constituents of concern that could result in mixed waste that were not analyzed. For example, there is an underground diesel fuel storage tank and several above-ground chemical storage tanks in Plant Area P-12. It was assumed that any leaks or spills from tanks and other storage vessels would be remediated as part of a RCRA action and therefore the probability of encountering mixed waste during decommissioning from leaks and spills is very low.

Typically a TCLP analysis is used to determine if a chemical constituent is above the RCRA limits. However, the EPA allows for the total metal analysis to be converted to TCLP levels based on the 20 times rule. The EPA website states, "Section 1.2 of the TCLP does allow for a total constituent analysis in lieu of the TCLP extraction. If a waste is 100% solid, as defined by the TCLP method, then the results of the total constituent analysis may be divided by twenty to convert the total results into maximum leachable concentration. This factor is derived from the 20:1 liquid-to-solid ratio employed in the TCLP." For ease of reference, the total metal results have been divided by twenty (20) in Table E-1. The TCLP limit for the seven constituents of concern are shown on Table E-2 (see Appendix E). Comparing the limits with the maximum values shown on Table E-2, it is clear that the levels of contamination are well below the TCLP limits for the seven metals chosen for analysis. Based on these results it was assumed that mixed waste would not be encountered during decommissioning. Again this assumes that any leaks or spills from tanks and other storage vessels would be remediated as part of a RCRA action.

4.4 Groundwater

The scope of the characterization included identifying and quantifying the nature and extent of radionuclides present in groundwater at Honeywell - MTW. Based on ENERCON's review of the existing groundwater monitoring program, the existing groundwater monitoring program was deemed sufficient to assess if there has been any impacts to groundwater. A description of the existing monitoring network, monitoring program, and findings are presented in the following section. The following table summarizes the applicable radionuclide Maximum Contaminant Level (MCLs):

Contaminant	Radionuclide MCL
Gross alpha particle activity	15 pCi/L
Beta/photon emitters	4 mrem/year
Combined Ra-226/Ra-228	5 pCi/L
Uranium	30 µg/L

An MCL is defined as the highest level of a contaminant that is allowed in drinking water. MCLs are drinking water standards set by the US EPA.

Illinois EPA also requires that maximum allowable predicted concentration (MAPCs) be established based on groundwater modeling. ENERCON did not perform any groundwater modeling but obtained the MAPCs for the Honeywell – MTW site from Andrews Engineering. Andrews Engineering is currently contracted by Honeywell – MTW to perform groundwater sampling and reporting. The MAPCs obtained from Andrews Engineering are as follows:

Contaminant	Radionuclide MAPC
Gross alpha particle activity	3.5 pCi/L
Gross beta activity	4.5 pCi/L
Ra-226	2 pCi/L
Ra-228	2.5 pCi/L
Uranium	-

MAPCs are projected concentrations of contaminants/constituents in the uppermost aquifer that, when exceeded within the zone of attenuation, indicate the potential for exceedance of a groundwater quality standard at the limit of the zone of attenuation.

4.4.1 Existing groundwater and compliance monitoring wells

There are numerous groundwater monitoring wells on the Honeywell Metropolis Works (MTW) site. Locations of the various groundwater monitoring wells on site are shown on Figure 9. There are ten (10) observation wells related to compliance (RCRA Part B) monitoring located within the approximate 22 hectare (54-acre) restricted fenced area. There are two (2) wells that are common to RCRA Facility Investigation and landfill monitoring wells. The landfill is located beyond the Restricted Area of the facility and is no longer active. There are eight (8) wells which are used to monitor impacts from this inactive landfill. Similarly, there are six wells which are used to monitor impacts from the Creosote Area

and Kickback Area. The Creosote Area and Kickback Area are located outside the Restricted Area of the facility. As part of a RCRA investigation, the plumes from the Creosote Area and the Kickback Area are monitored using sixteen (16) wells. There are also various other wells that are sanitary, process, or wells not in a monitoring program.

4.4.1.1 RCRA (Part B) Groundwater and Compliance Monitoring Wells

The RCRA (Part B) groundwater compliance monitoring network consists of ten wells. These wells are located in and around the restricted area. Nine of the ten wells (G101, G102, G103, R104, G105, G106, G107, G108, and R110) are sampled for radiological constituents of concern. The tenth well (G109) is monitored for groundwater surface elevation only. Groundwater from these nine monitoring wells is sampled and analyzed quarterly for pH, specific conductance, fluoride, gross alpha and gross beta.

4.4.1.2 RCRA Groundwater Investigation Wells

There are fourteen (14) RCRA Groundwater Investigation wells (G12S/G12D, G16S/G16D, G1A1, G1A3, G1A4, G1A5, G1B3, G1B7, G1B8, G1B9, G1C1, G14S/G14D, G20D/G20S, and G22D/G22S). G1A1, G1A3, G1A4, G1A5, G1B7 are located within the Restricted Area. The remaining portion of the RCRA groundwater investigation wells are located outside the Restricted Area either south, east, or west of the facility. Groundwater from these fourteen (14) monitoring wells is sampled and analyzed semi-annually for pH, specific conductance, fluoride, other environmental constituents, gross alpha and gross beta. Gross alpha and gross beta analysis was added to the list of monitored parameters during the second quarter of 2009.

4.4.1.3 Landfill Wells

There are eight wells (SU-1122, SU-1126, SU-1129, SU-1142, SU-1143, SU-1144, SU-1145, and SU-1146) that monitored groundwater near the inactive landfill. Groundwater from these eight (8) wells is sampled and analyzed quarterly for pH, specific conductance, other environmental constituents, gross alpha, gross beta, radium-226, and radium-228.

4.4.1.4 Creosote Area

There are six wells (G151 through G156) that are used to monitor impacts to groundwater near this area that was impacted by a previous owner of the property. The Creosote Area is located outside the restricted area of the facility southeast of the inactive landfill. Groundwater from these six (6) monitoring wells is sampled and analyzed semi-annually for pH, specific conductance, fluoride, other environmental constituents, gross alpha and gross beta. Gross alpha and gross beta analysis was added to the list of monitored parameters during the second quarter of 2009.

4.4.1.5 Kickback Area

There are six wells (G120 through G125) that are used to monitor impacts to groundwater near the Kickback Area that was potentially environmentally impacted by a previous owner of the property. The Kickback Area is located outside the Restricted Area of the facility and is located east of the inactive landfill. Groundwater from these six (6) monitoring wells is sampled and analyzed semi-annually for pH, specific conductance, fluoride, other environmental constituents, gross alpha and gross beta. Gross alpha and gross beta analysis was added to the list of monitored parameters during the second quarter of 2009.

4.4.1.6 Other sanitary, process, and unmonitored wells

There is a sanitary well located in the northwest portion of the Restricted Area. There are three process wells (Well No. 1, Deep Well No. 2, and Well No. 3) that are located throughout the Restricted Area of the facility. There are various wells that are currently not part of any monitoring program that are located throughout the restricted area and other parts of the MTW site. They include the following:

- SU-1132, SU-1133, SU-1135, GB08, GB09, GB10, and GB11;
- GB06, GB07, and G1B5;
- B2-91, T3-99, T2-99, T1-99, SU-1127, SU-1128, and SU-1130; and
- G140, G141, and G201.

The wells listed in the first bullet are located throughout the restricted area. GB06, GB07, and G1B5 are located down gradient (for G1B5 may be cross gradient) from the restricted area. The wells listed in the third bullet are inactive wells located near the inactive landfill. G140, G141, and G201 are inactive wells located near the Creosote Area.

4.4.1.7 Historical Radiological Groundwater Monitoring Data

From first quarter of 2000 to second quarter of 2009, the RCRA (Part B) groundwater and compliance monitoring and inactive landfill wells were the only wells that were monitored for radiological constituents. Data from first quarter 2000 to the fourth quarter 2001 is provided in Table 3.4-12 (Historical RCRA Compliance Monitoring Data) of Environmental Report Renewal of Source Material License SUB-526 dated May 25, 2005 (Reference 8). The data from first quarter of 2002 to the first quarter of 2009 for the inactive landfill and the RCRA (Part B) and compliance monitoring wells was provided by Andrews Engineering for review.

Starting with the second quarter of 2009, the following wells were also sampled and analyzed for total (gross) alpha and beta activity:

- Creosote Area wells (G151 through G156);
- Kickback Area wells (G120 through G125);
- RCRA Groundwater Investigation wells (G12S/G12D, G16S/G16D, G1A1, G1A3, G1A4, G1A5, G1B7, G1B8, G1B9, G1C1, G20D/G20S, and G22D/G22S); and
- Sanitary Well and Process Well No. 3.

4.4.1.8 Assessment of existing groundwater monitoring information and programs

ENERCON performed an assessment of the existing groundwater data and monitoring programs by comparing existing groundwater monitoring data with US EPA radionuclide MCLs and MAPCs developed for the site as required by Illinois EPA. This assessment included an examination of the existing data and comparison to these criteria. No groundwater modeling was performed. The finding of this assessment is in the following sections.

4.4.1.9 Inactive Landfill Wells

The groundwater monitoring data from the wells used to monitor impacts to groundwater from the inactive landfill are below the MAPC (maximum allowable predicted concentration) criteria of 3.5 pCi/L for gross alpha and 4.5 pCi/L for gross beta with a few exceptions. Those exceptions are:

- For SU-1129 a gross beta value of 45.7 pCi/L was recorded during the second (2^{nd}) quarter of 2006; and
- For SU-1129 slight exceedance of 4.8 pCi/L for gross beta during the third (3^{rd}) quarter of 2008.

Because there were very few exceedances of the MAPC no plots were made to determine trends due to the very low levels of activity measured in groundwater wells near the inactive landfill. The 45.7 pCi/L of gross beta detected at SU-1129 most likely is an aberration which may be attributed to total suspended solids. The slight exceedance for gross beta activity at SU-1129 during the third quarter of 2008 does not appear to be a trend (readings for the three subsequent quarters are 1.15, 2.2, and 1.63 pCi/L for gross beta) and also appears to be an aberration. Based on the existing historical data it does not appear that there has been any radiological impact to groundwater downgradient of the inactive landfill. It is postulated that the two spikes above the MAPCs for gross beta observed at SU-1129 may be attributed to to total suspended solids (TSS) in the groundwater. The elevated readings may be due to total suspended solids in the groundwater and are not true indicators of the soluble activity in the groundwater.

ENERCON assessment is that the extensive groundwater monitoring network established to monitor environmental impacts should detect any radiological impacts from the inactive landfill based on the current groundwater monitoring program which includes analysis for gross alpha, gross beta, radium-226, and radium-228. ENERCON recommends Honeywell continue to monitor the wells installed around the inactive landfill on a quarterly basis. ENERCON recommends that the groundwater be filtered to remove any total suspended solids so that only the soluble activity is being measured. If this is cost prohibitive, it is recommended that TSS be measured during groundwater sampling and recorded for future reference in the event that a spike occurs. If at any time in the future radiological impacts are detected then the need for additional monitoring of the wells located near the inactive landfill (B2-91, T1-99, T2-99, T3-99, SU-1127, SU-1128, and SU1130) can be assessed by a qualified hydrogeologist.

4.4.1.10 RCRA (Part B) Groundwater and Compliance Monitoring and RCRA Groundwater Investigation Well

The RCRA (Part B) Groundwater and Compliance wells are located in the Restricted Area and therefore would be indicators of impacts from the current operations at Honeywell – MTW. The groundwater monitoring data for the RCRA (Part B) Groundwater wells shows little to no impact to the shallow groundwater at the site. Rarely has gross alpha and beta have been detected above the MAPC (maximum allowable predicted concentration) criteria of 3.5 pCi/L for gross alpha and 4.5 pCi/L for gross beta. The highest gross alpha activity of 22.2 pCi/L was detected in G106(D) during the third (3^{rd}) quarter of 2003. Using this well as an example, most of the data indicated that the levels of gross alpha were below the MAPC with two other exceptions (gross alpha activity was measured at 4.8 pCi/L during the third quarter of 2002 and 8.2 pCi/L during the first quarter of 2007). The highest level of gross beta activity of 65.4 pCi/L was detected in G103(A) during the fourth (4^{th}) quarter of 2003. The elevated readings may be attributed to suspended solids in the groundwater and may not be true indicators of the soluble activity in the groundwater. Andrews has resampled when aberrations are discovered and the levels of gross beta and alpha fall below the MAPC.

ENERCON's review of the existing groundwater data from the RCRA (Part B) Groundwater and Compliance Monitoring Wells indicates little to no radiological impact to groundwater. ENERCON assessment is that the extensive groundwater monitoring network established to monitor environmental impacts should detect any radiological impacts downgradient of the plant based on the current groundwater monitoring program which includes analysis for gross alpha and gross beta. This analysis is relatively inexpensive and should detect significant radiological impacts to the groundwater downgradient of the plant. Therefore the recommendation is to continue to monitor the wells on a quarterly basis. If at any time in the future radiological impacts are detected then the need for additional monitoring of these wells can be assessed by a qualified hydrogeologist. ENERCON recommends that the groundwater be filtered (if not already) to remove any total suspended solids so that only the soluble activity is being measured. If this is cost prohibitive, it is recommended that TSS be measured during groundwater sampling and recorded for future reference in the event that a spike occurs.

Beginning in the second (2^{nd}) quarter of 2009, groundwater from the fourteen (14) RCRA Groundwater Investigation wells (G12S/G12D, G16S/G16D, G1A1, G1A3, G1A4, G1A5, G1B3, G1B7, G1B8, G1B9, G1C1, G14S/G14D, G20D/G20S, and G22D/G22S) were analyzed for gross alpha and gross beta. Data from this sampling event was reviewed to determine if there have been any impacts to the groundwater. With a few minor exceptions, most of the data indicated levels below the MAPC for gross alpha and gross beta. ENERCON recommends that these wells continued to be sampled on a semi-annual basis for gross alpha and gross beta activity. This analysis is relatively inexpensive and should detect significant radiological impacts to the groundwater. Also ENERCON recommends that water levels be recorded to better access groundwater flow and improve linear interpolation between existing monitoring points. Based on the data from the single sampling event for the RCRA Groundwater Investigation wells, there is no impact to groundwater, but monitoring should continue.

4.4.1.11 Creosote Area

Starting in the second quarter of 2009, groundwater was collected from six wells (G151 through G156) to monitor radiological impacts to groundwater near the Creosote Area. Previously these wells were monitored only for environmental constituents of concern from impacts from a previous owner. With the exception of G156, the limited data indicates that the gross alpha and beta activity are below the MAPC. In G156, gross alpha was detected at 27.1 pCi/L and gross beta was detected at 22.1 pCi/L. However, gross alpha and gross beta were detected at 2.5 and 2.49 pCi/L respectively in G154 which appears to be down gradient of the Creosote Area (but at a greater distance away from the Creosote Area). ENERCON recommends that the existing semi-annual sampling for gross alpha and beta continue with particular attention to the results from G154 and G156. ENERCON recommends that the groundwater be filtered (if not already) to remove any suspended solids so that only the soluble activity is being measured.

4.4.1.12 Kickback Area

Starting in the second quarter of 2009, groundwater was collected for these six wells (G120 through G125) to monitor radiological impacts to groundwater near this area. Previously these wells were monitored only for environmental constituents of concern from impacts from a previous owner. The limited data indicates that the gross alpha and beta activity are below the MAPC. ENERCON recommends that the existing semi-annual sampling for gross alpha and beta continue.

Summary of Groundwater Monitoring Program

In general, ENERCON's review of the existing groundwater data indicates little to no radiological impacts to the groundwater on the MTW site. ENERCON recommends that the existing groundwater

monitoring program (including the recent addition of Creosote Area, Kickback Area, RCRA GW Investigation, and drinking water wells to the radiological monitoring program) continue to be implemented. ENERCON believes the existing radiological groundwater monitoring program is sufficient to detect radiological impacts adjacent to areas suspected to have the potential to impact groundwater. For example, there are 21 groundwater wells (RCRA Part B and RCRA GW Investigation) located within or near the Restricted Area of the MTW site to monitor potential radiological impacts to groundwater. Also there are thirteen (13) lysimeters located beneath the calcium fluoride ponds which are analyzed for parameters that would detect a potential leak. Due to the various spikes in the data, ENERCON recommends that samples collected for radiological analysis be filtered to minimize total suspended solids.

The existing groundwater monitoring network was established to monitor suspect areas either due to chemical or radiological contamination or both based on information available to date. The groundwater monitoring data collected to date based on the extensive network of monitoring wells shows little to no impact to the shallow groundwater at the site.

The new data collected during the 2009 radiological characterization does warrant a review by Honeywell's groundwater consultant due to impacts found outside the Restricted Area. ENERCON believes that Honeywell should have their groundwater consultant examine these impacts and determine if it is necessary to install wells downgradient of these areas. For example, the radiological characterization along River Road has determined that there are radiological impacts to the surface soil in this area. It would seem unlikely that impacts to the surface soil would be able to migrate through the subsurface soil and impact groundwater. Also, a qualified geologist might determine that the existing groundwater monitoring system (G12D and G12S are located near the impacted area along River Road and appear to be located down or cross-gradient from the impacted area) is sufficient to detect any radiological impacts along River Road. These types of assessments should be made by a qualified geologist who is familiar with the geology of the Honeywell – MTW site geology and is considered outside the scope of the characterization.

5.0 CONCLUSIONS AND LIMITATIONS

The results of the site characterization indicate that there is contamination above background levels at various locations both inside and outside the Honeywell restricted area. Based upon review of site process history and predictions made within the Historical Site Assessment, these results were expected. RCRA sampling results indicate that there is low probability that these impacted areas contain RCRA metals which would yield a mixed waste.

This report also includes an assessment Honeywell's groundwater monitoring program and available groundwater data which was completed to determine the potential that uranium had migrated to site groundwater. Conclusions from this review indicate that there is a low probability that site groundwater has been impacted from uranium.

ENERCON has presented the results of the site characterization in various figures in Appendix A. For the purposes of decommissioning planning, ENERCON has assumed that Honeywell will be successful in establishing a site DCGL of 110 pCi/g total uranium and has prepared base case drawings depicting locations where contamination exceeds 110 pCi/g. ENERCON has also developed a set of figures depicting those locations where total uranium exceeds 35 pCi/g total uranium (Figure 10 through Figure 13). These figures have been provided for informational purposes only. All of these figures are located in Appendix A.

ENERCON performed a series of initial Microshield calculations to predict external dose consequence to individuals who may occupy areas at the site with elevated surface contamination. These calculations were performed at various levels of surface contamination and are presented in Appendix F.

This report was prepared at the request of Honeywell for their use. Conclusions and recommendations were limited to the information available to support this effort, and the time available to complete this task. All parties understand that these opinions are based upon available information and professional judgment. In the event that additional information becomes available after the date of this report, ENERCON retains the right and may request the opportunity to re-evaluate additional information and modify, if warranted, the conclusions and recommendations presented in this report.

6.0 REFERENCES

1. NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1.
2. Memo, AJ Nardi, 6/02/09
3. Code of Federal Regulations, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use
4. Federal Register / Vol. 46, No. 205 / Pages 52061-3 / October 23, 1981 Nuclear Regulatory Commission, Disposal or Onsite Storage of Thorium or Uranium Wastes From Past Operations".
5. *Historical Site Assessment*, April 2009, ENERCON Services, Inc.
6. *Site Reclamation Cost Estimate for Plant Located in Metropolis, Illinois*, May 2006, Duratek Inc.
7. NUREG-1757, Consolidated Decommissioning Guidance, Volumes 1, 2 and 3
8. Environmental Report Renewal of Source Material License SUB-526, May 2005, ENERCON Services, Inc.