LMS/TUB/S12431

Plan for Interim Treatment During Distillation Shutdown for the Tuba City, Arizona, Disposal Site

April 2015

U.S. DEPARTMENT OF ENERGY | Legacy Management

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I. TASK ASSIGNMENT

DOE correspondence dated October 29, 2014, directs The S.M. Stoller Corporation, a wholly owned subsidiary of Huntington Ingalls Industries, to cease operation of groundwater treatment by mechanical distillation at the Office of Legacy Management (LM) Tuba City, Arizona, Disposal Site (see Figure 1 for site location) and to develop a plan for interim treatment, such as by direct evaporation, while the distillation system is not in operation.

This memorandum presents a plan for interim groundwater extraction for evaporative treatment. The plan describes (1) selection of extraction wells for interim operation, (2) expected evaporative treatment rates, and (3) performance monitoring of the interim system. Enhanced evaporation technology is not evaluated in this plan.

II. BACKGROUND INFORMATION

Groundwater remediation began in 2002 to remove site-related contaminants in the underlying Navajo Sandstone aquifer. Uranium is the primary contaminant of concern; nitrate and sulfate contamination is also significant. The remediation system consists of 37 groundwater extraction wells, treatment by mechanical distillation, trench infiltration of treated water to the aquifer, and passive solar evaporation of brine waste from the distillation process. Remediation progress is assessed using an extensive network of monitoring wells. Monitoring occurs twice a year, and remediation progress is reported annually.

During sustained operation, distillation treatment ranged from about 100 gallons per minute (gpm) initially to about 85 gpm more recently. The treatment rate is limited by aquifer yield rather than by treatment system capacity (about 120 gpm). Decreasing yield is thought to reflect storage depletion (dewatering) in response to remediation withdrawals.

Site features are shown in Figure 2. Figure 3 depicts the distribution of uranium in groundwater. The estimated extent of groundwater capture compared to the extent of contamination is shown in Figure 4. A distal area of the plume apparently escapes capture, but uranium concentrations in this area are typically much lower than concentrations within the capture zone. This condition has been routinely documented in the annual reports.

III. INTERIM TREATMENT PLAN

EXTRACTION WELL PRODUCTIVITY

Figure 5 shows a ranking of uranium removal on a per-well basis. Well productivity was calculated as the product of the pumping rate and uranium concentration in each well during a period of sustained operation. Wells were then ordered according to percent of mass removal of the cumulative total. Figure 5 also shows the corresponding cumulative volume of extracted water. Well rankings are based on pumping and concentration data reported in *Annual Groundwater Report, April 2007 through March 2008, Tuba City, Arizona, Disposal Site* (July 2008, document S04268), in which the latest, most comprehensive data for this purpose are documented.

Productivity ranking shows that compared to full operation, 80 to 90 percent mass removal is possible at about one-half (about 45 gpm) of the current extraction rate using the 10 to 12 wells

of highest rank (wells 1105 to 1110, as ordered in Figure 5). The remaining mass removal (10 to 20 percent) requires additional groundwater extraction of up to 50 percent (or about 40 gpm) of the remaining available well yield.

If interim treatment is limited to the expected maximum pond evaporation rate (possibly up to 15 gpm), mass removal is estimated to be 30 percent of the maximum (at 85 gpm). The highest-ranked extraction wells for 15 gpm withdrawal are wells 1105, 1103, and 1101. Figure 6 shows locations of the extraction wells to achieve 30 and 90 percent mass removal. The wells are clustered in the main body of the plume and nearest to the disposal cell and treatment facility. Distal wells are only marginally productive. Existing monitoring wells at the margins of the contaminant plume (sentinel wells) are strategically located to detect plume advancement.

If contamination is indicated to be spreading beyond its current extent during the interim treatment period, additional pumping wells may be considered to place in operation to intercept that water. The water could be placed in the evaporation pond or possibly into the infiltration trench.

POND EVAPORATION

The available surface area of the pond for treatment is 2.6 acres. Estimated annual passive evaporation from the pond is reported as 5 to 7 gpm in *Final Site Observational Work Plan for the UMTRA Project Site near Tuba City, Arizona* (September 1998; document U00175021) and *Phase I Groundwater Compliance Action Plan for the Tuba City, Arizona, UMTRA Site* (June 1999; document U0027401). These estimates are equivalent to about 2 to 3 gpm of evaporation, averaged annually, per acre of surface area.

Evaporation from the disposal pond (3.8 acres) at the LM Monticello, Utah, Site was estimated at 7 gpm annually (approximately 2 gpm/acre). Evaporative treatment at the LM Shiprock, New Mexico, Site is about 22 gpm annually from the 11-acre pond (approximately 2 gpm/acre). These rates are equivalent to pan evaporation on the order of 40 to 50 inches of water per year.

Plant operating records indicate that during times of sustained plant operation, brine production is on the order of 10 gpm annually. The rate of passive evaporation of the brine probably meets or exceeds that of brine production because it is observed that the evaporation pond generally has excess freeboard; i.e., operation of the treatment system is not limited by pond capacity/brine evaporation. Therefore, potential evaporation may be greater than 10 gpm annually. Additional evaporative capacity may also be expected during interim treatment because the influent water will be less saline than the brine.

Enhanced evaporation technologies are evaluated in *Alternatives Analysis of Contaminated Groundwater Treatment Technologies, Tuba City, Arizona Disposal Site* (Draft, September 2014; LMS/TUB/S12161), and *Tuba City Spray Evaporation System* (Anderson Engineering Company Inc.; June 2002). Heating the extracted water using existing solar thermal infrastructure may also be a feasible enhancement option to consider. The solar thermal system is operational but requires frequent adjustment to maintain steady operation.

EXTRACTION WELL OPERATION

Passive evaporative treatment in the pond may be able to sustain a groundwater extraction rate of about 15 gpm throughout the year. The selected extraction wells will operate at maximum

capacity while maintaining the level of overflow protection in the pond. Seasonal management of the inflow may be required to prevent overflow or to increase the number of active wells in order of ranking priority. The balance between pond inflow and outflow will be achieved iteratively; a more prescriptive pumping schedule is not recommended at this time. Inactive extraction wells will remain intact, requiring no pump removal, monitoring (water level or water quality), or periodic operation during interim treatment.

MONITORING: Monitoring Wells

Water quality will be monitored quarterly for 1 year at each monitoring well in the current semiannual monitoring program. Two of the quarterly events will coincide with the ongoing February and August events. Water quality monitoring will then resume semiannually. Procedures for sample collection, analytical parameters, and laboratory analysis will follow requirements defined in *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (continually updated; document S04351).

Water levels in all monitoring wells will be measured concurrently with water quality monitoring. In addition, water levels will be measured continuously using pressure transducers currently deployed at 12 monitoring wells within and surrounding the contaminant plume.

MONITORING: Extraction Wells

Water quality of the selected extraction wells will be monitored monthly consistent with current practice. The flow rate for each extraction well will be measured and reported as weekly and cumulative totals, and as the combined total and cumulative inflow to the feed tank, consistent with current practice.

Water quality monitoring will not be required for inactive extraction wells (flow at these locations will be zero) because sampling across the long screen lengths poses uncertainty in data interpretation. For this reason, water level measurement is also not required for the inactive wells. However, water level measurement in the active extraction wells using pressure transducers is recommended to upgrade control of pump operation.

MONITORING: Evaporation Pond

Interim treatment will require continued water quality monitoring at locations 1569 and 1570, located near the northeast and southeast corners of the evaporation pond. These locations will be sampled at the same frequency as the monitoring wells.

The water level or available freeboard in the evaporation pond will be monitored to prevent pond overflow. The current practice of visual observation is acceptable for this purpose while on-site presence is maintained; however, an automated process of water level measurement and recording may be beneficial in maintaining a steady balance between inflow and outflow.

IV. INTERIM TREATMENT PERFORMANCE EVALUATION

Although the scope of interim treatment differs from that of operating the distillation system, the objectives of data collection and analysis are the same. These objectives are to (1) assess plume capture, (2) assess plume migration, (3) track contaminant removal (mass and volume), and (4) evaluate water quality restoration progress. Performance assessments for interim treatment will be documented in annual groundwater reports that will have content and format similar to those of past annual reporting.

V. PLAN SUMMARY

- The estimated rate of passive evaporative treatment is 10 to 15 gpm. Enhanced evaporation options will require additional design considerations.
- Three or four ranked extraction wells, pumping at a combined total of 15 gpm, may be sufficient to remove 30 percent of the uranium mass compared to full-scale operation (85 gpm) of the distillation system.
- If an enhanced evaporation system is used, approximately ninety percent mass removal can be attained at approximately one-half of the maximum (85 gpm) groundwater extraction rate.
- Water level and water quality monitoring at all monitoring wells will occur quarterly for 1 year and then resume to semiannually (February and August). Continuous water level measurements will be maintained at 12 monitoring wells that are equipped with pressure transducers.
- Extraction well pumping rates will be measured and recorded as weekly totals per well.
- Water quality from each extraction well will be monitored monthly.
- Water quality of the combined inflow from the extraction wells to the feed tank will be monitored weekly.
- Sample collection and analysis will conform to current, established protocol.
- Interim treatment will require no new monitoring locations or analytical parameters.
- Inactive extraction wells will not be monitored.

VI. RECOMMENDATIONS

- Operate wells 1105, 1103, and 1101 at a combined target rate of approximately 15 gpm and discharge the extracted water to the evaporation pond without prior treatment.
- Monitor water levels in the evaporation pond in accordance with current procedures.
- Monitor production rates, water quality, and water levels as prescribed above.
- Manage well operation (add or subtract operating wells) as needed according to rank to maximize treatment while preserving inflow/outflow water balance in the evaporation pond.
- Analyze plume capture, plume migration, contaminant mass and volume removal, and water quality restoration progress, and document this information in the annual groundwater reports.
- Periods of non-pumping (e.g., if it becomes necessary to lower the pond level) will be evaluated for possible contaminant rebound. This may require temporarily increasing the frequency of sample collection and analysis during those times.

- Upgrade extraction well pump controls to a pressure transducer system (on/off cycling based on water level drawdown and recovery in the extraction well).
- Upgrade pump operation and flow monitoring to SOARS (System Operation and Analysis at Remote Sites).
- Install a pressure transducer in the evaporation pond for water level monitoring and connect to SOARS.

VII. PLUME STABILITY

Infiltration of process water (presumably contaminated) during mill operation (1956 through 1966) likely created a local groundwater mound beneath the mill facility. The resulting increase in hydraulic gradients could have provided a temporary driving force to recharge the aquifer and spread contamination to its current extent (approximately 1,500 feet downgradient of the mill). Available monitoring data are insufficient to characterize water levels and plume development during that period, or to resolve whether plume stabilization occurred between waste encapsulation (April 1990) and the onset of active remediation (2002). Plume stability will be monitored and evaluated during interim treatment and as a task that is separate from this plan using groundwater modeling.

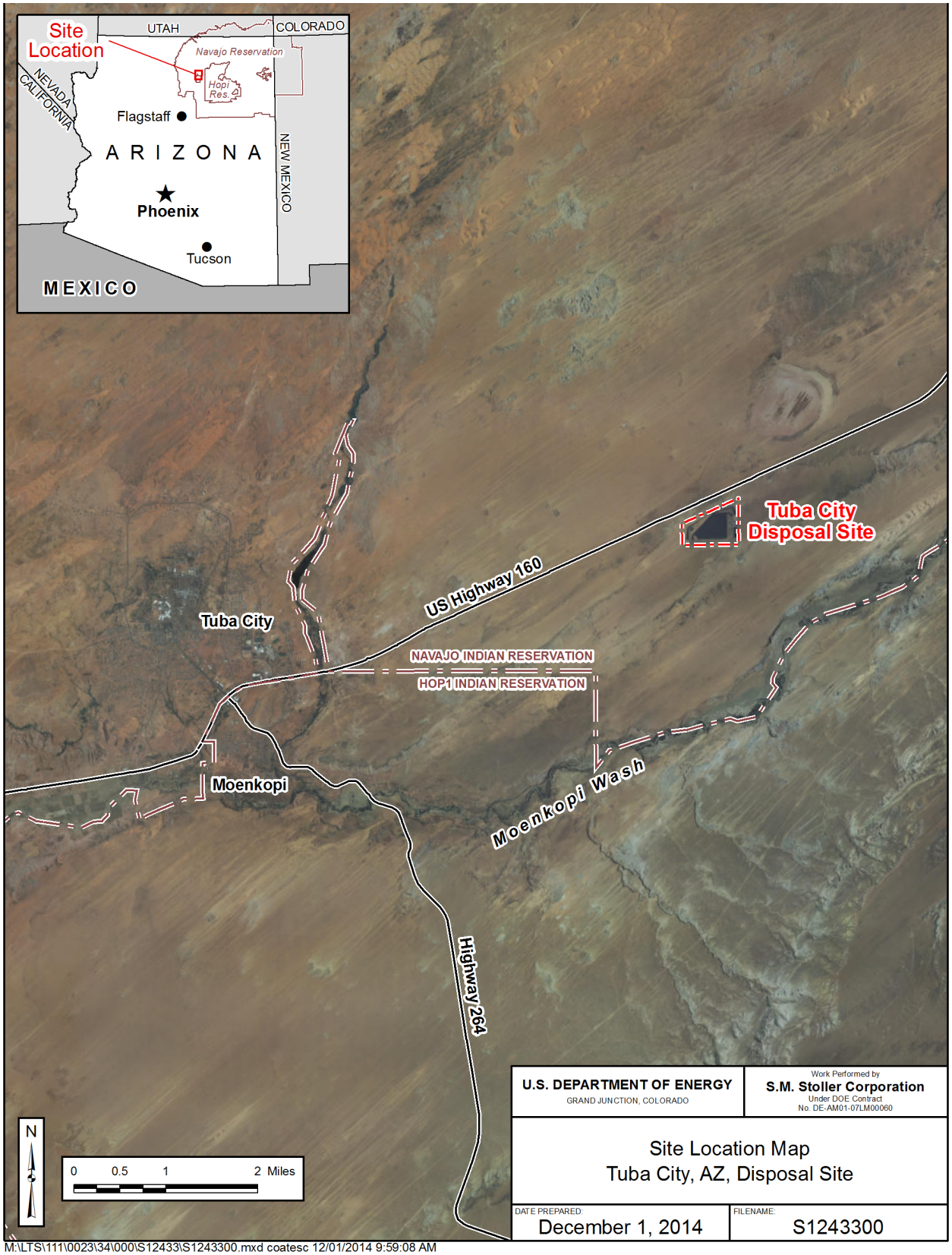

Figure 1. Tuba City Site Location Map

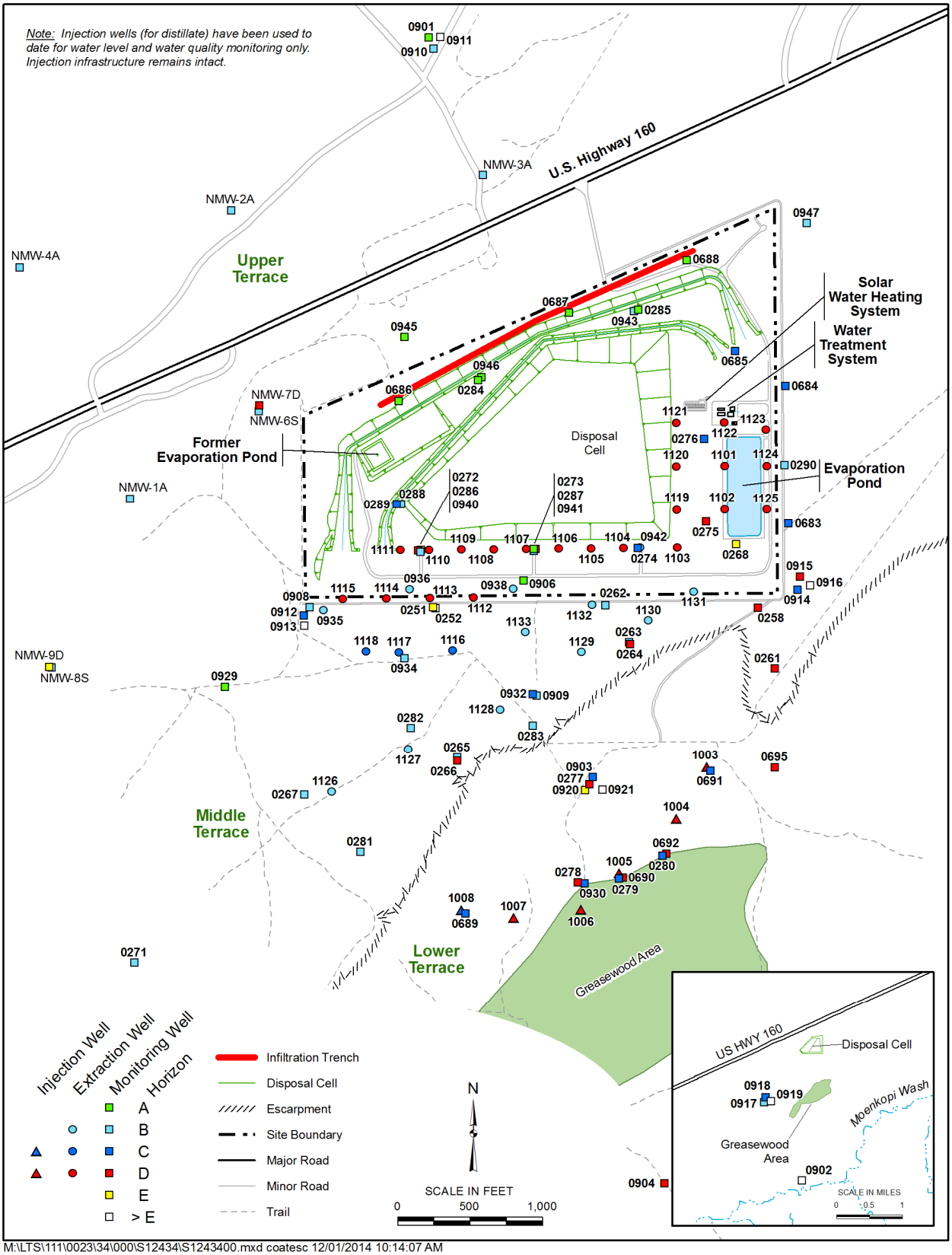

Figure 2. Tuba City Site Features and Well Locations

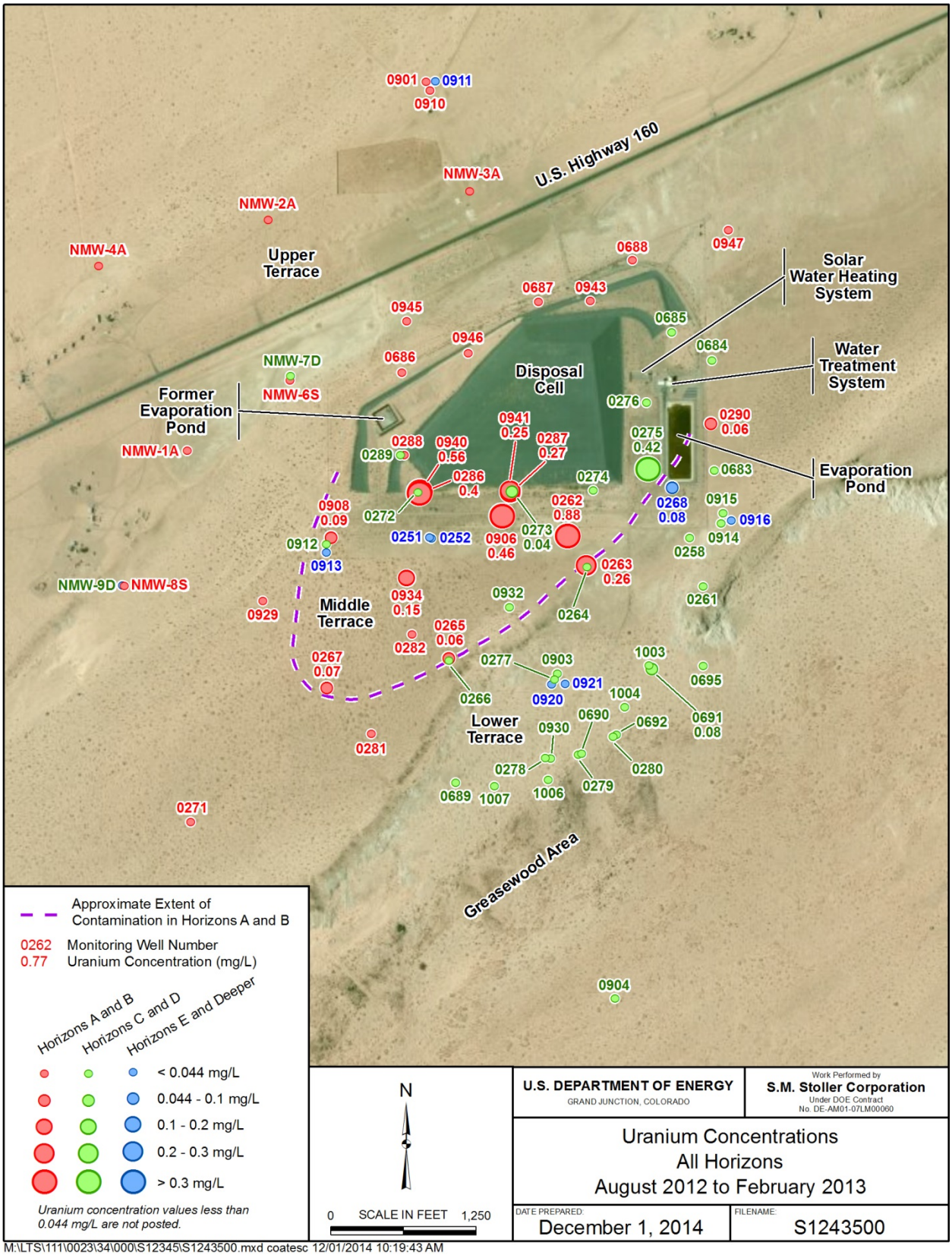

Figure 3. Uranium Concentrations in all Monitoring Wells (All Horizons), August 2012–February 2013

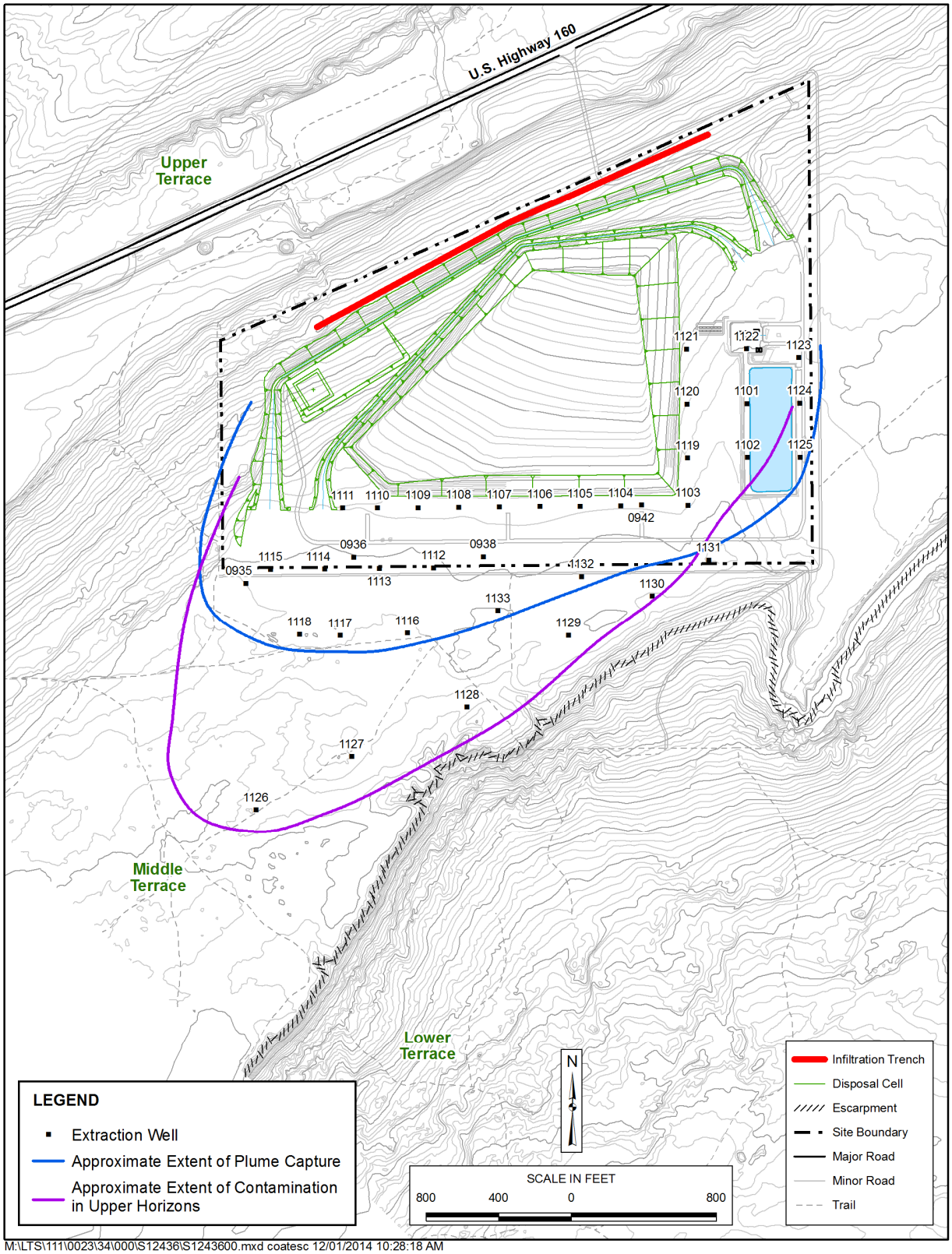

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Figure 4. Approximate Extent of Groundwater Contamination and Extraction System Capture Zone, Horizons A and B

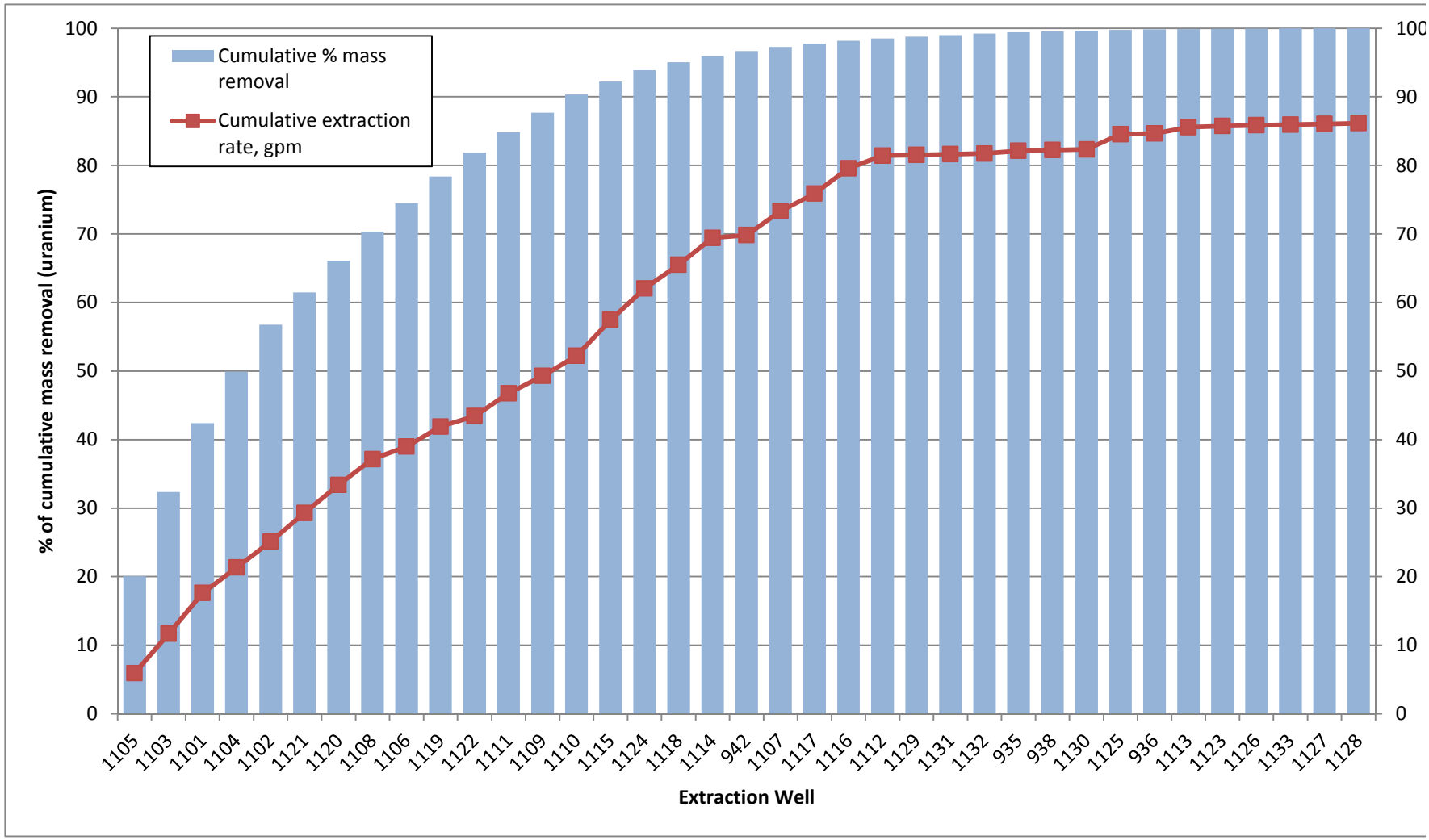

Figure 5. Extraction Productivity Ranking for Uranium Removal

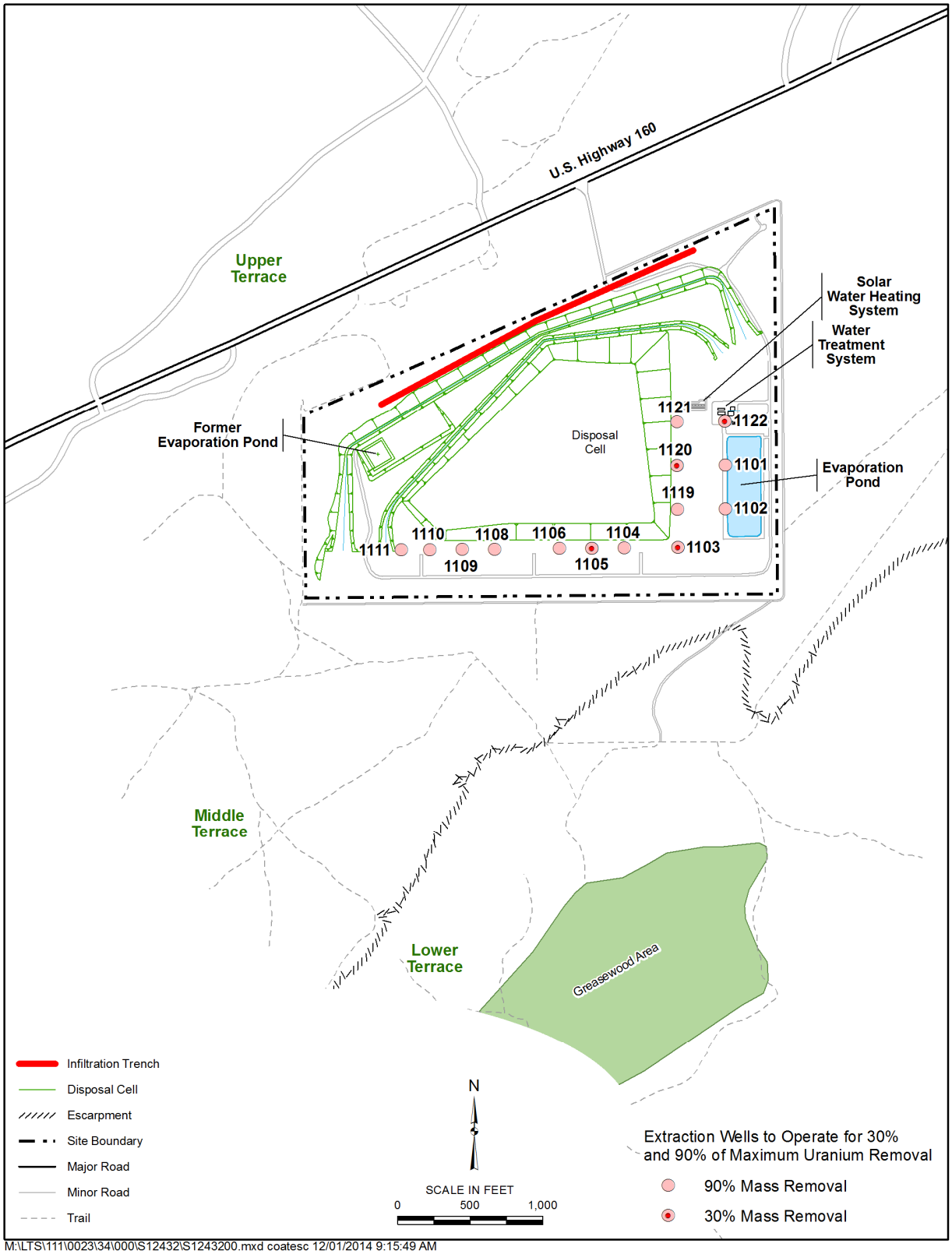

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Figure 6. Extraction Wells to Operate for 30 Percent and 90 Percent of Maximum Uranium Removal

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