DOE/GJ/79491-927
CONTRACT NO. DE-AC13-02GJ79491

# QUARRY RESIDUALS OPERABLE UNIT INTERIM REMEDIAL ACTION REPORT

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

**NOVEMBER 2003** **REV. 0**

U.S. Department of Energy
Oak Ridge Office
Weldon Spring Site Remedial Action Project

| MORRISON KNUDSEN CORPORATION<br>MK-FERGUSON GROUP<br><br>Weldon Spring Site Remedial Action Project<br>Contract No. DE-AC05-86OR21548 | |
|---|---|
| | Rev. No. 0 |
| PLAN TITLE: Quarry Residuals Operable Unit Interim Remedial Action Report | |

**APPROVALS**

Groundwater Manager — Date: 11/25/03

Compliance Manager — Date: 11/25/03

Site Project Manager — Date: 11-25-03

Printed in the United States of America. Available from the National Technical Information Service, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

NTIS Price Codes - Printed Copy: A15
Microfiche: A01

DOE/GJ/79491-927

*Weldon Spring Site Remedial Action Project*

# Quarry Residuals Operable Unit Interim Remedial Action Report

Revision 0

November 2003

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for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Office
Under Contract DE-AC13-02GJ79491

## ABSTRACT

The Quarry Residuals Operable Unit interim remedial action report documents the cleanup activities that took place at the Weldon Spring Site Remedial Action Project. The interim remedial action report, which is required by CERCLA and the Federal Facility Agreement (FFA) between the Environmental Protection Agency (EPA) and the DOE, is required to document the cleanup activities at a single operable unit under remedial authority.

The final remedy for the Quarry Residuals Operable Unit includes long-term monitoring, therefore this report is considered interim in accordance with CERCLA. A final remedial action report will be required when the long-term monitoring goals are attained.

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# 1. INTRODUCTION

The Interim Remedial Action report documents that the U.S. Department of Energy (DOE) has completed construction activities at the Weldon Spring Quarry site in accordance with the *Closeout Procedures for National Priorities List Sites*, EPA 540-R-98-016 (Ref. 1). A Record of Decision stipulating the selected remedial action was approved by both the DOE and the Environmental Protection Agency (EPA) in September 1998. Remediation of the Weldon Spring Site Remedial Action Project (WSSRAP) is being addressed through four operable units, consistent with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) requirements. The Quarry Residuals Operable Unit (QROU) is the third of four operable units that comprise the WSSRAP. All construction activities were completed in September of 2002. Long-term groundwater monitoring activities were started in October 2002. This report summarizes the activities performed for the QROU through Fiscal Year 2003 (Sept. 2003).

## 1.1 Purpose and Scope

This interim remedial action report, which is mandated by CERCLA and the Federal Facility Agreement (FFA) between the EPA and the DOE, is required to document the cleanup activities that took place at a single operable unit (QROU) under remedial authority. An interim report is being prepared because of the long delay between the final inspection and achieving the goals of the long-term monitoring strategy for groundwater in the quarry area. This definition of a remedial action report is included in the EPA guidance document *Closeout Procedures for National Priorities List Sites* (Ref. 1). The guidance, which was followed during the preparation of this report, included a recommended outline that consists of the following main topics:

1. Introduction
2. Operable Unit Background
3. Construction Activities
4. Site Conditions
5. Chronology of Events
6. Performance Standards and Construction Quality Control
7. Final Inspections and Certifications
8. Operation and Maintenance Activities
9. Summary of Project Costs
10. Observations and Lessons Learned
11. Operable Unit Contact Information

Each of the topics listed above include subheadings and descriptions. The QROU consists of several actions including but not limited to long-term groundwater monitoring, quarry restoration, institutional controls and additional data collection. These actions, in addition to remedial design, and other QROU activities, are summarized in accordance with the recommended EPA guidance outline listed above.

The final remedy for the Quarry Residuals Operable Unit includes long-term monitoring, therefore this report is considered interim in accordance with CERCLA. A final remedial action report will be required when the long-term monitoring goals are attained.

## 1.2 Site Description

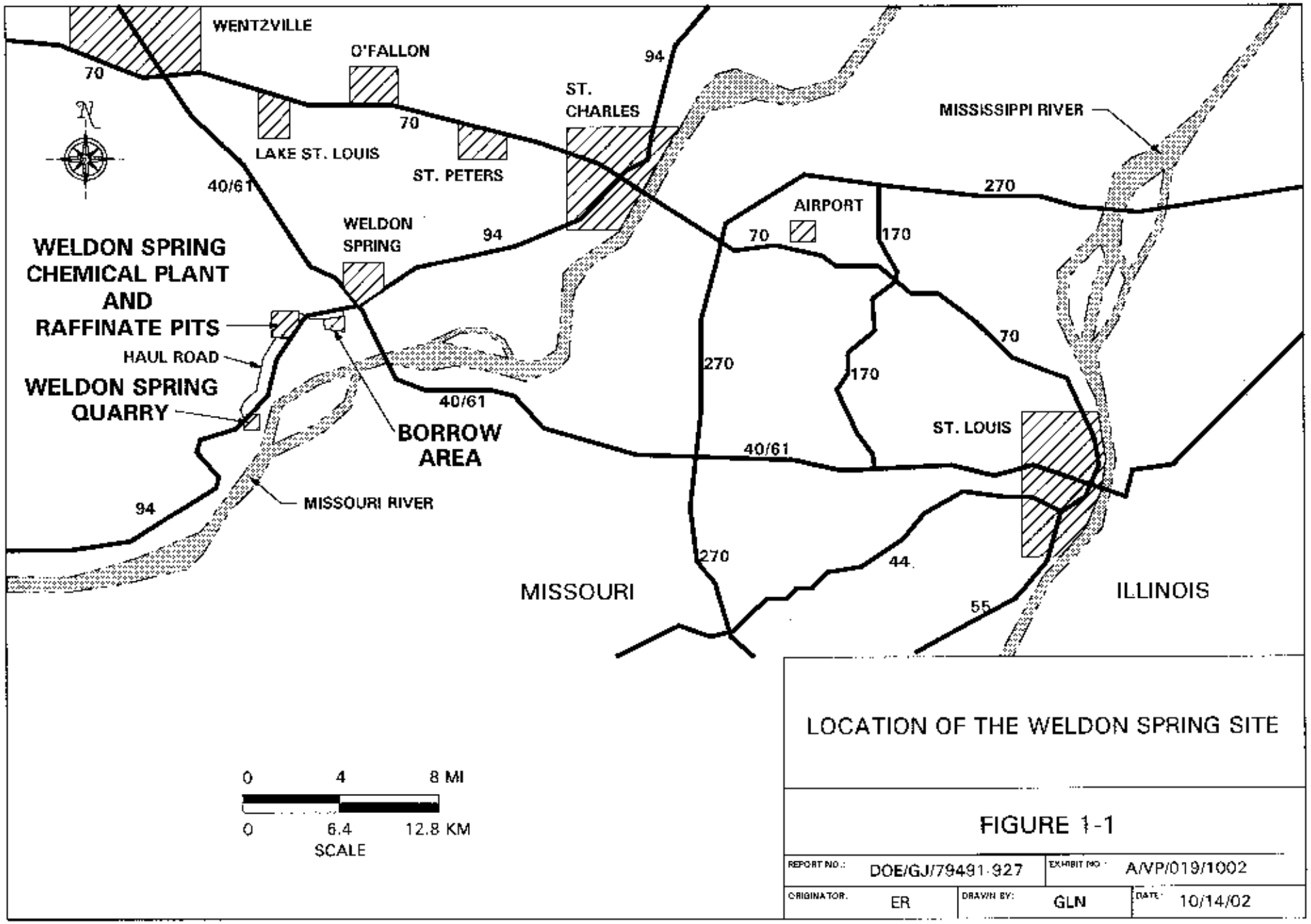
The Weldon Spring site is in southern St. Charles County, Missouri, approximately 30 mi west of St. Louis, as shown in Figure 1-1. The site consisted of two main areas, the Weldon Spring Chemical Plant and the Weldon Spring Quarry, both located along Missouri State Route 94. Actions at the quarry are the focus of this interim report.

The Weldon Spring Chemical Plant is a 217-acre area that operated as the Weldon Spring Uranium Feed Materials Plant (WSUFMP) until 1966. Buildings were contaminated with asbestos, hazardous chemical substances, uranium, and thorium. Radiological and chemical contaminants (polychlorinated biphenyls [PCBs], nitroaromatic compounds, organics, metals and inorganic ions) were found in the soil and in many areas around the site. Raffinate pits located on the chemical plant property consisted of four settling basins that covered approximately 26 acres. These pits were characterized as being contaminated with uranium and thorium residues and chemical contaminants including nitrate, fluoride, PCBs, and various heavy metals. The two largest pits (Raffinate Pits 3 and 4) were remediated and backfilled in 1999, and the remaining two (Raffinate Pits 1 and 2) were remediated in 2000.

The Weldon Spring Quarry is approximately 1,000 ft. long by 450 ft. wide and covers an area of 9 acres. It is located approximately 4 miles south/southwest from the chemical plant area and is accessible from Missouri State Route 94 (Figure 1-2). Prior to the removal of bulk wastes, it was vegetated with grasses, shrubs, and trees. South of the quarry, the Missouri-Kansas-Texas (KATY) Railroad line had run. This line has been dismantled and the right-of-way was converted to a gravel-based public trail for hiking and biking (KATY Trail State Park). A rail spur entered the quarry from the west at its lower level and extended one-third the quarry's length. The St. Charles County well field is located southeast of the quarry between the quarry and the Missouri River. The nearest well is located approximately 0.5 miles from the quarry.

## 1.3 Site History

From 1941 to 1945, the U.S. Department of the Army produced trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Weldon Spring Ordnance Works, which covered 17,233 acres of land that now includes the Weldon Spring site. Two hundred seventeen acres of the former ordnance works property were transferred in May 1955 to the Atomic Energy Commission (AEC) for construction of the WSUFMP, now referred to as the Weldon Spring Chemical Plant. Considerable explosives decontamination was performed by Atlas Powder Company and the Army prior to construction of the WSUFMP.




LOCATION OF THE WELDON SPRING SITE

FIGURE 1-1

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|---|---|---|---|
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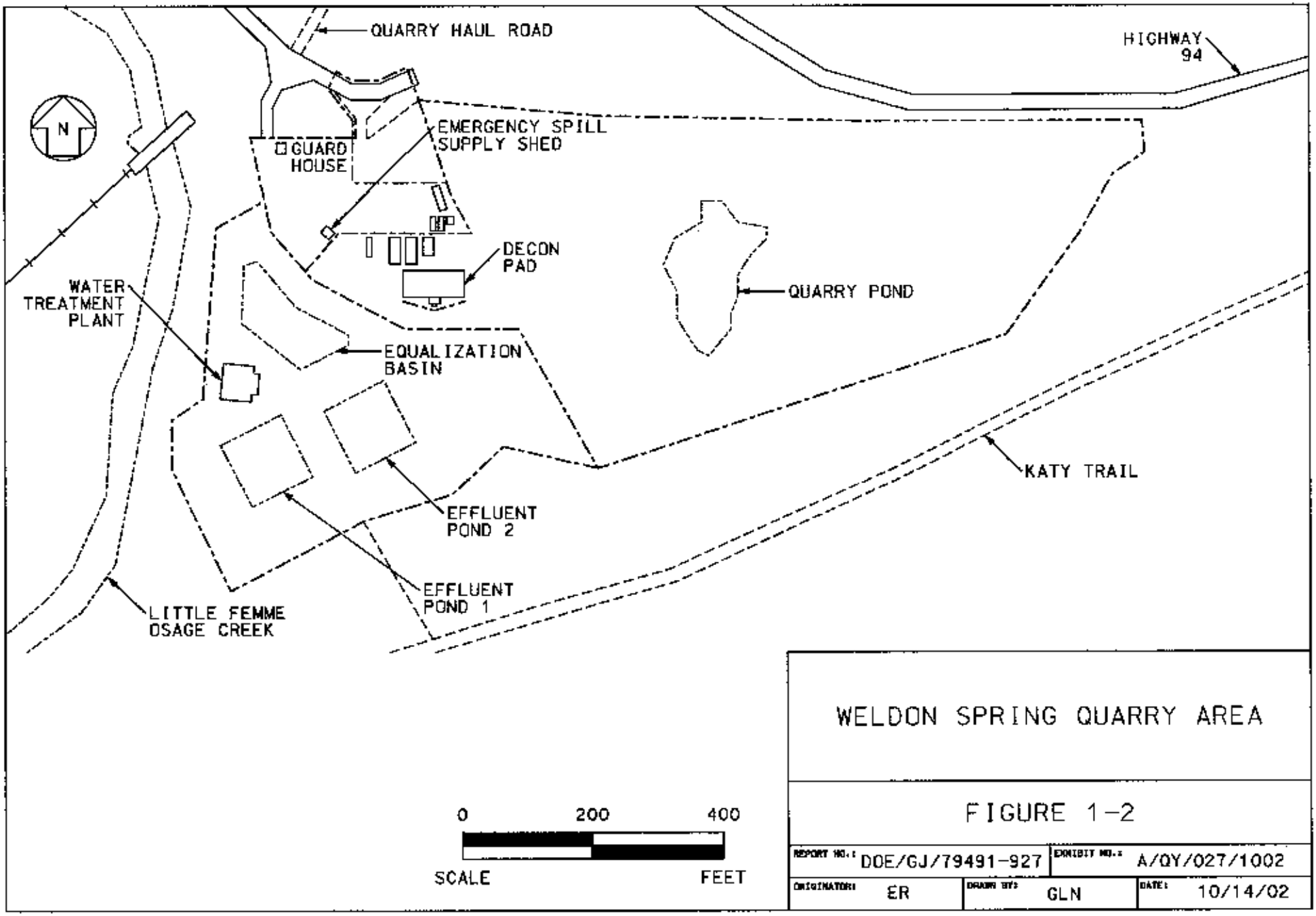
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 10/14/02 | |




WELDON SPRING QUARRY AREA

FIGURE 1-2

| | | | |
|---|---|---|---|
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| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 10/14/02 | |

From 1958 until 1966, the WSUFMP converted processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A small amount of thorium was also processed. Wastes generated during these operations were stored in the raffinate pits. These pits were radiological contaminated with uranium and thorium residues and chemically contaminated with nitrate, fluoride, PCBs, and various heavy metals. The buildings were contaminated with asbestos, hazardous chemical substances, and small quantities of uranium and thorium. Radiological and chemical contaminants (PCBs, nitroaromatic compounds, metals, and inorganic ions) were also found in the soil at many locations.

Prior to 1942, limestone aggregate was extracted from the quarry for use in construction of the Weldon Spring Ordnance Works. The quarry was excavated into a bluff that forms a valley wall at the edge of the Missouri River alluvial floodplain. After 1942, the Army used the quarry for burning wastes produced during manufacture of TNT and DNT and for disposal of TNT-contaminated rubble. In 1958, the AEC acquired title to the quarry and used it from 1963 to 1969 as a disposal area for building rubble and soils from the demolition of a uranium ore processing facility in St. Louis and from the chemical plant. Other wastes disposed of in the quarry included drummed radioactive materials, uncontained wastes, and contaminated process equipment. The bulk waste contained radiological and chemical contaminants including uranium, radium, thorium, metals, nitrates, PCBs, semivolatile organic compounds, nitroaromatics, and asbestos.

The WSUFMP was shut down in 1966, and in 1967 the AEC returned the facility to the Army for use as a defoliant production plant to be known as the Weldon Spring Chemical Plant. The Army started removing equipment and decontaminating several buildings in 1968. However, the defoliant project was canceled in 1969 before any process equipment was installed. The Army retained responsibility for the land and facilities of the chemical plant, but the 20.6 ha (51 acre) tract encompassing the Weldon Spring raffinate pits was transferred back to the AEC.

The chemical plant site was in caretaker status from 1967 through 1985. In 1985, the U.S. Department of Energy (DOE) designated control and decontamination of the chemical plant, raffinate pits, and quarry as a major project. The Project Management Contractor (PMC) for the Weldon Spring Site Remedial Action Project (WSSRAP) was selected in February 1986. In July 1986, a DOE project office was established on site, and the PMC, MK-Ferguson Company and Jacobs Engineering Group, Inc., assumed control of the site on October 1, 1986. The quarry was placed on the Environmental Protection Agency's National Priorities List (NPL) in July 1987. The DOE redesignated the site as a Major System Acquisition in May 1988. The chemical plant and raffinate pits were added to the NPL in March 1989. Remedial activities associated with the chemical plant and the quarry were completed between 1991 and 2002. A decision is still pending for the groundwater at the chemical plant.

The project transferred long-term surveillance and maintenance responsibility for the WSSRAP from DOE-Oak Ridge Office to the DOE-Grand Junction Office (GJO) on October 1, 2002. The GJO office is responsible for the Long-term Surveillance and Maintenance (LTSM)

Program at DOE facilities, providing long-term care for low-level radioactive material disposal sites. The technical assistance contractor for the project is S.M. Stoller, Inc.

In 1986, the Environmental Protection Agency (EPA) and DOE entered into a Federal Facilities Agreement (FFA). This agreement was amended in 1992 and is consistent with the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA), Section 120. The amended FFA includes agreements to ensure that the environmental impacts associated with past and present activities at the Weldon Spring site are thoroughly investigated and that appropriate remedial action is taken, as necessary, to protect public health and the environment. This FFA also facilitates the exchange of information among the EPA, DOE, and the State of Missouri and contains procedures for resolving disputes, assigning penalties for nonconformance, and ensuring public participation in the remedial action decision-making process.

### 1.4 Pre-Remedial Action Status

The Weldon Spring Quarry is approximately 1000 ft long by 450 ft wide and covers an area of approximately 9 acres. Waste materials disposed of in the quarry consisted of: (1) materials associated with the processing of uranium and thorium concentrates, (2) uranium- and radium-contaminated rubble, (3) high thorium content materials (most of which were subsequently removed from the quarry for the purpose of recovering rare earth elements), and (4) 3% thorium residues. The radioactive contaminants of concern are those associated with the U-238 and Th-232 decay series. Radioactive contamination on the main floor covered an area of almost 60,000 sq ft and extended to a depth of about 40 ft. Radioactive contamination in the entire quarry covered an area of about 171,000 sq ft and extended to an average depth of about 13 ft.

Characterization results indicated that chemical contamination was also present throughout much of the quarry bulk waste and that the distribution of contaminants was highly heterogeneous. Nitroaromatic compounds, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons were detected in bulk waste samples. Elevated levels of some metals were also found. General locations of various waste types could be defined in some cases. For example, nitroaromatics were found in the eastern and western sections of the quarry, consistent with the known disposal history. PCBs did not show a defined pattern of distribution but were typically limited to near-surface depths. A full description of the wastes present and the history of waste accumulation is presented in the *Remedial Investigations for Quarry Bulk Wastes* (Ref. 40).

### 1.5 Site Preparation

Initial site preparation took place during the transition period between the signing of the Project Contract on May 6, 1986, and the assumption of control of the site by the PMC on October 1, 1986. The transition team consisting of DOE and PMC personnel replaced the

caretaker contractor, Bechtel National, Inc. (BNI), which had been performing preliminary characterization and site maintenance. Permanent PMC staff began to occupy the site on August 13, 1986, replacing the BNI personnel.

There were numerous existing WSSRAP programs that had to be assumed by the PMC during this period. Contracts and agreements for site security and local emergency assistance had to be replaced to reflect the increased activity. The U.S. Geological Survey (USGS) had a groundwater characterization study in progress, and wells were being drilled in the St. Charles County Well Field area to evaluate the impact of the quarry waste on the groundwater. In addition, Argonne National Laboratory (ANL) needed support for a historical dose report and the environmental impact statement, while the DOE office in Oak Ridge needed support to prepare a materials balance report. The DOE and the EPA developed a Federal Facility Agreement to define the roles of the various participants and the regulatory requirements of the remediation.

Also during this period, the key assumption driving the project was that the *National Environmental Policy Act* (NEPA) would be the primary law governing the final disposition of the wastes. Community relations efforts were focused on preparation for a meeting scheduled for April 10, 1987, when the Environmental Impact Statement (EIS) describing the disposition of both the chemical plant and the quarry and the proposed on-site disposal remedy would be presented to the public. Prior to 1986, DOE facilities were exempt from the cleanup requirements of CERCLA. The only regulatory process for remediation (primarily for its consensus building aspects) available for former DOE sites was NEPA. In 1986, CERCLA was amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA). The chemical plant and quarry were subsequently placed on the *National Priorities List* (NPL). This new regulatory process required the DOE and EPA to agree on how remediation decisions would be made. During the site preparation phase, they agreed on expedited removal actions to mitigate the slow dispersal of contaminants off site and to protect on-site workers from various hazardous materials.

### 1.6 Prior Remedial Activities

Work at the quarry was performed in two phases. Phase 1 was the bulk waste excavation phase during which the contaminated material was removed from the quarry under Quarry Bulk Waste Operable Unit. Phase 2 was the Quarry Residuals Operable Unit (QROU), which addressed the remaining soil and groundwater contamination both inside and outside the quarry proper. Remedial activities under the Quarry Bulk Waste Operable Unit were performed under the *Record of Decision for Management of Bulk Wastes at the Weldon Spring Quarry* (Bulk Waste ROD) (Ref. 2). The Bulk Waste ROD was signed by the EPA on September 28, 1990 and by the DOE on March 7, 1991. The primary activities established were to:

1. Excavate and remove bulk waste using conventional methods (i.e. structural debris, drummed and unconfirmed waste, process equipment, sludge, and soil).

2. Transport the waste along a dedicated haul road to the temporary storage area (TSA), which is located within the boundary of the Chemical Plant Operable Unit.

3. Stage bulk wastes at the TSA for ultimate disposal in the on-site disposal cell.

The removal of the bulk waste was performed in a multi-tiered process similar to the one used at the chemical plant. In the first tier, the quarry water treatment plant, which was designed to treat contaminated water from the quarry sump, was constructed. In the second tier, the basic infrastructure, including decontamination facilities, a haul road, and the utilities needed to excavate and transport the waste from the quarry to the chemical plant, was built. In the final tier, the waste was excavated.

The waste was removed with conventional equipment and excavation techniques and placed in covered trucks that hauled it via the haul road to the TSA at the chemical plant. The waste was retained in this temporary facility until it could be placed in the disposal cell. From May of 1993 to October of 1995, approximately 110,000 $m^3$ (144,000 $yd^3$) of soil and waste material were removed from the quarry, transported to the chemical plant area, and placed in the TSA. The temporary storage area was an 11-acre structure near the southwest corner of the chemical plant area surrounded by a 4ft to 6 ft dike. It was designed and constructed to meet the substantive requirements for a *Resource Conservation Recovery Act* (RCRA) waste pile. To prevent the migration of contaminants, the compacted clay bottom was covered by a high density polyethylene geomembrane to form a composite liner. Drainage over this liner was ensured by a layer of coarse sand and a surface layer of gravel separated from the sand by a geotextile. Fine grain soils made up the main pile on the northern half of the facility; the pile was mostly surrounded by rubble, and there was a smaller pile of nitroaromatic contaminated soil adjacent to the south. The temporary storage area retention basin was midway on the west side, and there were also nitroaromatic soils and rubble in the center. Structural debris and equipment were placed at the southwest corner of the facility. A double-lined retention basin collected rainfall runoff and leachate generated from the stored wastes. This water was treated by the site water treatment plant. The capacity of the surface impoundment was 1.1 million gallons. All of the wastes were directly placed or treated and placed in the disposal cell by March of 1999.

Bulk waste excavation was carried out in conjunction with a removal action to pump, treat, and discharge contaminated water from the quarry sump. The Quarry Water Treatment Plant (QWTP), which was authorized under the *Engineering Evaluation/Cost Analysis for the Proposed Management of Contaminated Water in the Weldon Spring Quarry* (Ref. 41), was constructed to treat the contaminated water. Construction of the plant began in May of 1990 and was completed by February of 1992. The system consisted of an equalization basin, a treatment plant, and two effluent ponds. The QWTP used a batch system consisting of 6 major sequential steps: lime mix, clarification, multi-media filter, activated alumina, activated carbon, and ion exchange. Each batch of water was sampled and analyzed prior to discharge to ensure compliance with the NPDES permit. From October of 1993 to February of 2001, approximately

63.4 million gallons of contaminated water were treated in the QWTP. After February 2001, two portable water treatment units (Train 3 & RBIX unit) were used at the quarry to treat the

remaining contaminated water including water generated by the quarry interceptor trench system. On June 27, 2002, the treatment of contaminated water was completed. A total of 68.3 million gallons of water had been treated at the quarry and the treated water were discharged to the Missouri River.

## 2. OPERABLE UNIT BACKGROUND

The Quarry Residuals Operable Unit (QROU) was the second of two operable units established for the quarry area of the Weldon Spring site. A remedial investigation/feasibility study (RI/FS) process was conducted for the QROU in accordance with the requirements of *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA), as amended, to document the proposed management of the quarry proper, the Femme Osage Slough and nearby creeks, and groundwater north of the Femme Osage Slough. Documents developed during the RI/FS process included the:

1. *Remedial Investigation for the Quarry Residuals Operable Unit of the Weldon Spring Site, Weldon Spring, Missouri* (Ref. 3)

2. *Baseline Risk Assessment for the Quarry Residuals Operable Unit of the Weldon Spring Site, Weldon Spring, Missouri* (Ref. 4)

3. *Feasibility Study for Remedial Action for the Quarry Residuals Operable Unit at the Weldon Spring Site, Weldon Spring, Missouri* (Ref. 5)

4. *Proposed Plan for Remedial Action at the Quarry Residuals Operable Unit of the Weldon Spring Site* (Ref. 6)

These documents incorporate the values of the *National Environmental Policy Act* (NEPA), and represent a level of analysis consistent with an *Environmental Impact Statement* (EIS). The *Record of Decision for Remedial Action for the Quarry Residuals Operable Unit at the Weldon Spring Site, Weldon Spring Missouri* (ROD) (Ref. 7) was issued in September 1998. Together, the remedial investigation, baseline risk assessment, feasibility study, proposed plan and ROD are the required primary documents consistent with the provisions of the *Federal Facility Agreement* (Ref. 42) entered into between the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA).

According to the ROD, long-term monitoring was the selected remedial action and consisted of the following components to be implemented:

1. Long-term groundwater monitoring to confirm significant impacts to the Missouri River alluvial aquifer will not occur.

2. Institutional controls that would prevent use of the property that would result in unacceptable exposure to groundwater or adversely affect contaminant migration.

3. Construction of a small-scale interceptor trench to be used as a pilot study to determine the need for and effectiveness of groundwater remediation.

4. Hydrologic and geochemical sampling within the area of uranium impact to support the conceptual model that the attenuation of uranium is by sorption and precipitation.

5. Soil sampling at the quarry proper to delineate the full extent of radiological contamination at the northeast slope and ditch area within the quarry proper. Evaluation of the samples consistent with the chemical plant cleanup criteria and possible removal of soil in these areas.

Reclamation of the quarry was not considered a component of the remedial action for the QROU. However it was discussed in the ROD as a component to attain final closure of the quarry area. Activities to be performed were:

1. Restoration of the quarry proper through backfilling with soil to reduce fall hazards, stabilize highwalls, eliminate ponding of surface water, and minimize infiltration of surface water through the inner quarry area to the groundwater.

2. Dismantlement of facilities utilized during bulk waste removal including the QWTP and associated basins.

## 2.1 Summary of Remedial Design

To provide a transition from the environmental documentation phase (QROU) to the implementation of the selected remedial action, the *Remedial Design/Remedial Action Work Plan for the Quarry Residuals Operable Unit* (RD/RA) was generated (Ref. 8). This work plan was the primary document used in defining the design and implementation of the selected remedial action for the QROU and was prepared in accordance with the FFA and CERCLA requirements. It provided the design strategy, implementation approach, overall schedule, general cost estimates, and the major deliverables associated with the selected remedial activities. The EPA allowed for the combination of the remedial design and the remedial action work plans for this operable unit to expedite field work.

### 2.1.1 Long-Term Groundwater Monitoring

Under the RD/RA, long-term groundwater monitoring consists of two separate programs. The first program details the monitoring of uranium and 2,4-DNT levels south of the slough to ensure the levels remain protective of human health and the environment. The second program consists of monitoring groundwater contaminant levels within the area north of the slough until they attain a predetermined target level indicating negligible potential to impact the groundwater south of the slough.

Groundwater monitoring is prudent to ensure the uranium-contaminated groundwater has a negligible potential to impact the well field. Under the current conditions, the groundwater north of the slough poses no imminent risk to human health from water obtained from the St. Charles County well field. A target level of 300 pCi/l for uranium was established in the *RD/RA Work Plan* to represent significant reduction in the contaminant levels north of the slough. The target level for 2,4-DNT in groundwater north of the slough has been set at 0.11 ug/l, the Missouri water quality standard. Upon attainment of these target levels, it will be determined that the goal for the monitoring program has been met and the long-term monitoring activities for this operable unit be concluded. Following attainment of the long-term monitoring target levels in groundwater north of the slough, an assessment of the residual risks based on actual groundwater concentrations will be performed to determine the need for future institutional controls.

Currently, uranium levels in monitoring wells south of the slough and at the production wells in St. Charles County well field have been, and remain, within background ranges. Nitroaromatic compounds have not been detected in groundwater south of the slough. The vulnerability of the St. Charles County well field from contaminated groundwater originating from the quarry has been the focus of several studies (Ref. 3 and Ref. 9). It was determined from these studies that recharge from the area of impact accounts for less than 1% of the total flow through the St. Charles County well field, therefore, if natural attenuation of uranium were to cease after attainment of the 300 pCi/l target concentration, the increase in uranium in the well field would be 3 pCi/l. A target level of 30 pCi/l for uranium and 0.11 ug/l for 2,4-DNT was established in the *RD/RA Work Plan* (Ref. 8) to identify any significant change in the alluvial aquifer. If groundwater south of the slough were ever to meet or exceed these contamination levels, actions outlined in the *Long-Term Surveillance and Maintenance Plan* (Ref. 12) would be evaluated. The uranium target level was revised to 20 pCi/l during the 5-year review to reflect the new MCL at the recommendation of the EPA. Data from south of the slough will continue to be evaluated and trended to establish that uranium and 2,4-DNT levels are not increasing.

### 2.1.2 Field Studies in Support of the Selected Remedy

The selected remedy in the QROU ROD outlined the performance of two field studies to support the decision for long-term monitoring of groundwater. These field studies consisted of the installation and operation of an interceptor trench and hydrologic/geochemical sampling within the area of uranium impact. The results of the studies were to be used to evaluate the effectiveness and benefits of removing the uranium from the groundwater north of the slough.

#### 2.1.2.1 Quarry Interceptor Trench Field Study

Under the *RD/RA Work Plan* (Ref. 8), design criteria for the construction of the interceptor trench were given. The trench used in the field study was a scaled down version of the interceptor trench presented in Alternative 6 of the *Proposed Plan* (Ref. 6). The trench would be constructed to represent a cross section of alluvial material and would be optimally

located to extract groundwater in the areas with high uranium concentrations. The trench was to be approximately 550 ft. in length and water produced from the trench would be routed underground to the quarry water treatment plant. The system was to be evaluated and monitored for up to two years to confirm model predictions. If the results of the uranium removal indicated that 10% or less of the total uranium in the area was removed, further evaluation of groundwater remediation would not be necessary. If the uranium removal results were greater than 10%, the need for and effectiveness of groundwater extraction would be reevaluated.

#### 2.1.2.2 Geochemical Field Study

The determination to perform an additional geochemical field study in the area north of the slough was made given the reliance on natural systems to limit potential migration of uranium south of the slough to groundwater. Over a short distance north of the slough, there is a notable decrease in concentration of uranium in the groundwater. This indicates that dilution and dispersion are not the major attenuation processes and reduction of uranium was likely from sorption and/or reduction (precipitation) of uranium from the groundwater. Sample results from the geochemical field study were to fulfill four objectives:

1. Evaluate the groundwater geochemistry north of the Femme Osage Slough, emphasizing factors that influence the attenuation of uranium in groundwater.
2. Estimate the uranium distribution coefficients for the alluvial aquifer and bedrock aquifer materials north of the slough.
3. Characterize the oxidation state of groundwater throughout the alluvial aquifer and define the boundary of the reducing zone north of the slough.
4. Determine the distribution of precipitated uranium across the reducing front.

### 2.1.3 Soil Characterization within the Quarry Proper

The ROD identified the need to define the extent of radiological soil contamination at two locations in the Quarry proper. Based on the review of characterization data removal of existing soil was recommended in the *RD/RA Work Plan* at 3 locations (the northeast slope, the ditch near the transfer station, and the snake pit). Remediation was not mandated based on the requirements outlined in the ROD. However, since the removal of contaminated material would be performed during the early stages of quarry restoration, it was included into the quarry restoration work package for three primary reasons:

- It would provide a reduction in already low risk levels.
- It would reduce potential disposal costs if future remediation was required because, at the time, these areas were readily accessible and the on-site disposal cell was still available.
- It would facilitate the release of the quarry proper as surplus property.

Cleanup criteria for the quarry proper soils were taken from the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 11). This criteria

was developed from the results of the site-specific risk assessment for a residential scenario. Based on previous characterization activities, only radiological contaminants of concern would be targeted. Cleanup criteria was applicable to both surface soils and subsurface soils (greater than 2' below ground surface). The cleanup criteria is detailed in Table 2-1.

Table 2-1 Radionuclide Contaminant Soil Cleanup Criteria

| Radionuclide (pCi/g) | SURFACE Criteria | SUBSURFACE Criteria |
|---|---|---|
| Radium-226 | 6.2 | 16.2 |
| Radium-228 | 6.2 | 16.2 |
| Thorium-230 | 6.2 | 16.2 |
| Thorium-232 | 6.2 | 16.2 |
| Uranium-238 | 120 | 120 |

### 2.1.4 Quarry Restoration

Since the implementation of quarry restoration was necessary to attain final closure of the quarry and has impact on the final configuration of the quarry, it was integrated into the RD/RA Work Plan. After contaminated soil was removed, quarry restoration would begin. The quarry proper would be restored through backfilling with soil to meet the following goals:

- Minimize long-term physical hazards associated with the quarry highwalls.
- Eliminate ponding of surface water in the quarry.
- Reduce recharge to the groundwater within the quarry.

The most significant hazard associated with the quarry proper was the presence of the highwalls along the north, east, and south sides of the quarry proper. Elevation differences along the highwalls range from 440 ft. to 552 ft. above mean sea level prior to backfilling. An evaluation of the stability of the quarry highwalls was performed to assess (1) the height of backfill placement, (2) the potential for slope failures or rock fall hazards after restoration if complete, and (3) the application of protective measures to minimize physical hazards during and after restoration. Based on observations made during the evaluation, most of the quarry highwalls appear to be in a stable condition,; therefore, an extensive rock stabilization program was not required.

Backfill was selected and placed in a manner to:

- Minimize settling.
- Minimize the flow of groundwater through the quarry proper.
- Minimize infiltration of precipitation.
- Promote sheet-flow of surface runoff over the top of the backfill.

The quarry was backfilled with a soil material with a lower permeability than surrounding bedrock to promote regional horizontal groundwater flow around the quarry proper. This lower permeability material was placed to an elevation of 468 ft MSL, which is the modeled high static water level in the quarry. Above this elevation, a common fill material was used to attain the desired fill elections. A lower permeability cap, approximately 2 ft thick, was placed over the backfill material to minimize infiltration of precipitation and promote sheet flow.

Several large aperture fractures were present on the floor and benches of the quarry floor. These large fractures were filled to reduce the possibility of soil piping and ultimately settlement of the final graded soil surface. Lower permeability clay materials and/or grout were used to backfill fractures. Some large vertical fractures were present in the north highwall that will require treatment to reduce soil piping and settlement. These fractures were filled with concrete.

In addition to backfilling of the quarry proper, development of a borrow area and removal of existing structures, utilities, and features located within the quarry area were outlined in the RD/RA. The development of a borrow area was necessary to obtain soil for backfilling of the quarry proper while removal of the existing structures, utilities, and features would facilitate release of the surrounding areas back to the original property owner (MDC).

Final grades within the quarry proper slope from the northeast corner to the Little Femme Osage Creek, with minimal grade changes in the flow path. Placement of materials and final grading prevents ponding on the final graded surface. The area was seeded to prevent erosion of the backfill surface and to promote the growth of natural vegetation.

### 2.1.5 Institutional Controls

As presented in the *RD/RA Work Plan* (Ref. 8) and the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri,* Site (Draft) (Ref. 12), DOE will restrict the quarry property to ensure that positive surface drainage is maintained to prevent ponding and infiltration of water in order to prevent potential mobilization of residual contaminants in bedrock fractures. DOE will establish institutional controls to prohibit use of contaminated groundwater for irrigation, consumption, or as a surface water source. Other uses inconsistent with a recreational user exposure scenario will also be restricted. DOE will also establish institutional controls to prevent disturbance of the uranium reduction zone between the Katy Trail and Femme Osage Slough, and to restrict groundwater use south of Femme Osage Slough that may result in intercepting contaminated groundwater north of the slough.

## 2.2 ROD Changes

There were no amendments, non-significant or significant differences, or changes to the Quarry Residuals ROD.

## 2.3 QROU Planning Reports

Quarterly reports were prepared in response to the reporting requirements of the FFA and summarized the actions performed by the WSSRAP. The reports provided the EPA the status of project activities, efforts towards project completion, studies, sampling activities, and planning dates.

# 3. CONSTRUCTION ACTIVITIES

At the Weldon Spring Site Remedial Action Project (WSSRAP), construction activities were summarized and implemented as individual work packages. The work packages contained all of the specifications, construction drawings, and quality control guidance for the implementation of each project. Safe work plans, bonding, insurance, a substance abuse program, subcontractor quality assurance/quality control programs, work sequence forecasting, and a complete schedule were required as initial submittals to the Project Management Contractor (PMC) prior to the subcontractor being given notice to proceed with the work.

Construction activities under the Quarry Residuals Operable Unit (QROU) began in January of 2000 and were completed by September of 2002. The actions described below are those performed to accomplish the remedial action as outlined in the *Quarry Residuals Record of Decision* (ROD) and *Remedial Design/Remedial Action* (RD/RA) *Work Plan*. The construction activities are summarized in Table 3-1.

Table 3-1 QROU Construction Activity Summary

| QROU Construction Activity | Work Package Number | Work Package Title | Performance Period |
|---|---|---|---|
| Interceptor Trench Construction | WP-515 | Quarry Area Interceptor Trench Construction and Startup | 27-Jan-00 to 05-May-00 |
| Contaminated Material Removal | WP-505X | Quarry Residual Contaminated Material Removal | 08-May-00 to 15-Sep-00 |
| Well Installation and Abandonment | WP-487A | Well Installation and Abandonment | 09-Feb-00 to 29-Mar-01 |
| Quarry Water Treatment Plant Dismantlement | WP-551D & | Quarry Equalization Basin Liner Removal | 13-Oct-00 to 14-Nov-00 |
| | WP-553A | Quarry Water Treatment Plant and Facilities Demolition | 04-Apr-01 to 20-Jun-01 |
| Quarry Restoration Phase I | WP-551A | Quarry Restoration | 20-Nov-00 to 17-Aug-01 |
| Geochemical Characterization | WP-533 | Subsurface Drilling Services | 18-Oct-01 to 18-Jan-01 |
| Quarry Restoration Phase II | WP-529B | Quarry Restoration Phase II | 24-Apr-02 to 06-Sep-02 |

## 3.1 Interceptor Trench Construction

The construction of the pilot study interceptor trench was accomplished under Work Package 515 (WP-515) and labeled the Quarry Area Interceptor Trench Construction and Startup project. The scope of work for this subcontract consisted of:

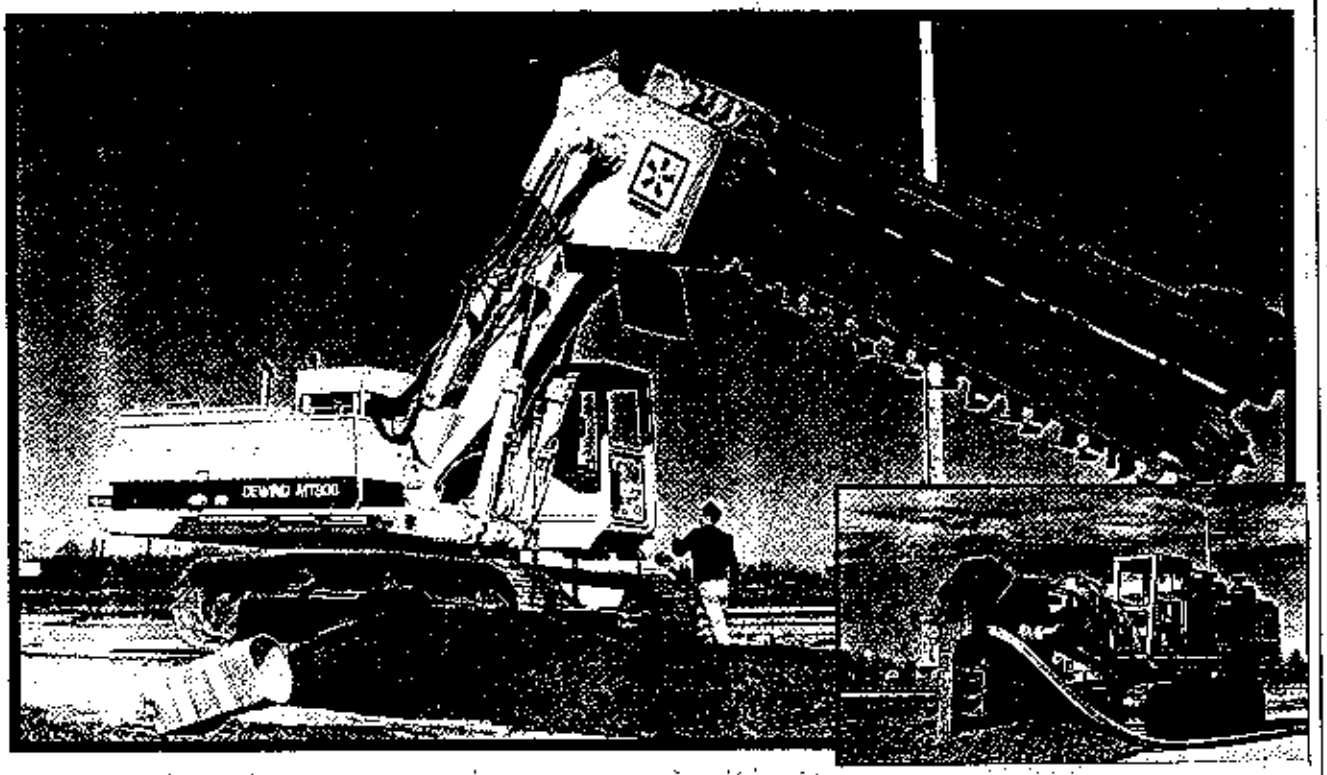
1. Conducting a topographic base survey.
2. Installation of the groundwater interceptor trench, extraction wells, and all related equipment, pumps, piping, and electrical wiring required to operate the system

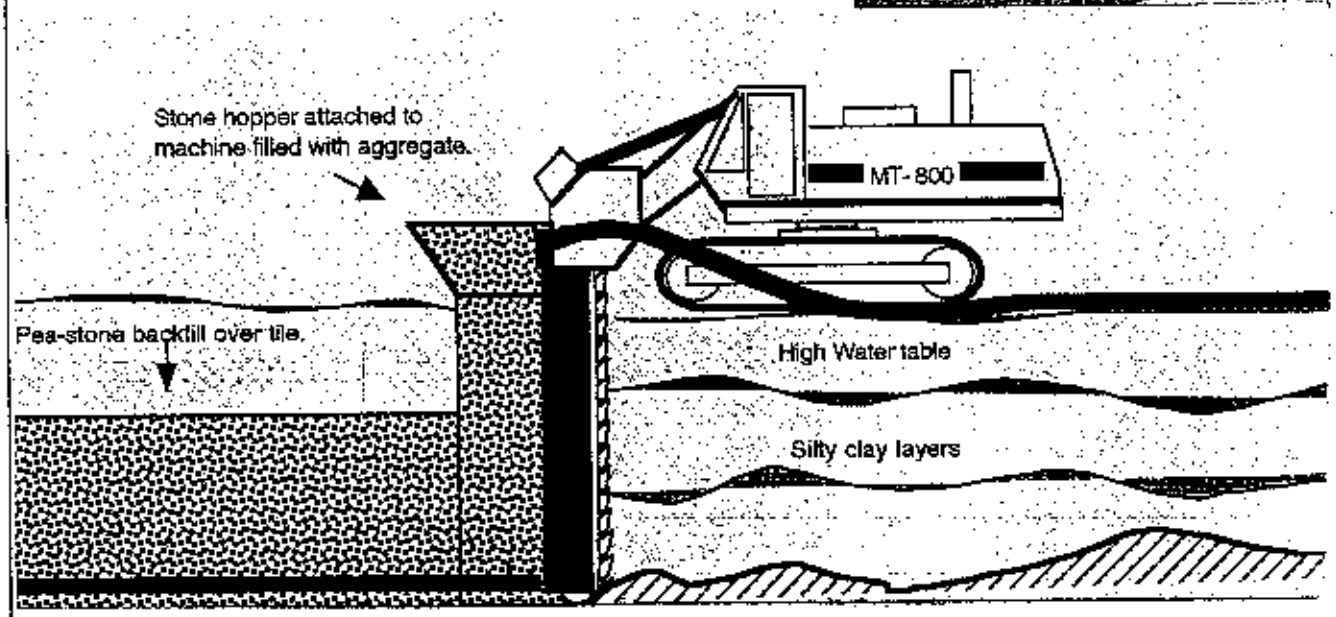
and transport the extracted groundwater to the existing Quarry Water Treatment Plant (QWTP) equalization basin and/or effluent pond 2.

3. Operating the constructed system during the startup phase and turning over the system to the Contractor after satisfactory performance.
4. Restoration of all disturbed areas (final grade/seed/mulch)
5. Collecting, containing, and discharging all groundwater generated during the trench installation into the QWTP equalization basin.
6. Regulating traffic at the interceptor trench site, along dedicated access/haul roads, and the Katy Trail State Park.
7. Storm water runoff control.
8. Cleaning/decontaminating equipment used.
9. Transportation and disposal of uncontaminated waste to a sanitary landfill.

The activities began on January 27, 2000, and were completed by May 5, 2000. Per the subcontract specifications, the area where the interceptor trench was to be located was topographically surveyed. After the layout of the trench was marked, the area was cleared, grubbed, and graded so that trenching equipment could access and install the interceptor trench. On February 15, 2000, an "all-in-one" trencher (MT 800) was mobilized at the Quarry by Dewind Dewatering Inc. The trencher was used to excavate to the top of bedrock, place 3 in. high density polyethylene (HDPE) dewatering pipe, and backfill the interceptor trench all in one pass (Figure 3-1). Pea gravel was used as the backfill material and the trench was backfilled within 3 ft. of the ground surface. To ensure that the subcontract specified drainage pipe depth was maintained, a laser guide mounted on the MT 800 was used. Within three days, the MT 800 was able to install and backfill 550 ft. of drainage pipe.

After the trencher was demobilized, four extraction wells were drilled through the trench and 1-ft into the underlying bedrock and four pitless unit pumps were installed. A utility trench 42 in. in depth was excavated adjacent to the interceptor trench. Process water lines from the pitless units and electrical conduit were placed in the trench. The process water lines ran into an underground valve vault (south valve vault) and merged into one double-walled HDPE pipe (2 in./4 in.). The double-walled HDPE pipe was pressure tested prior to backfill. The double-walled pipe ran from the south valve vault to another valve vault (north valve vault) located east of the QWTP effluent pond #2 (Figure 3-2). Leak detection ports were installed in the double-walled pipe to detect any potential leak of contaminated groundwater.

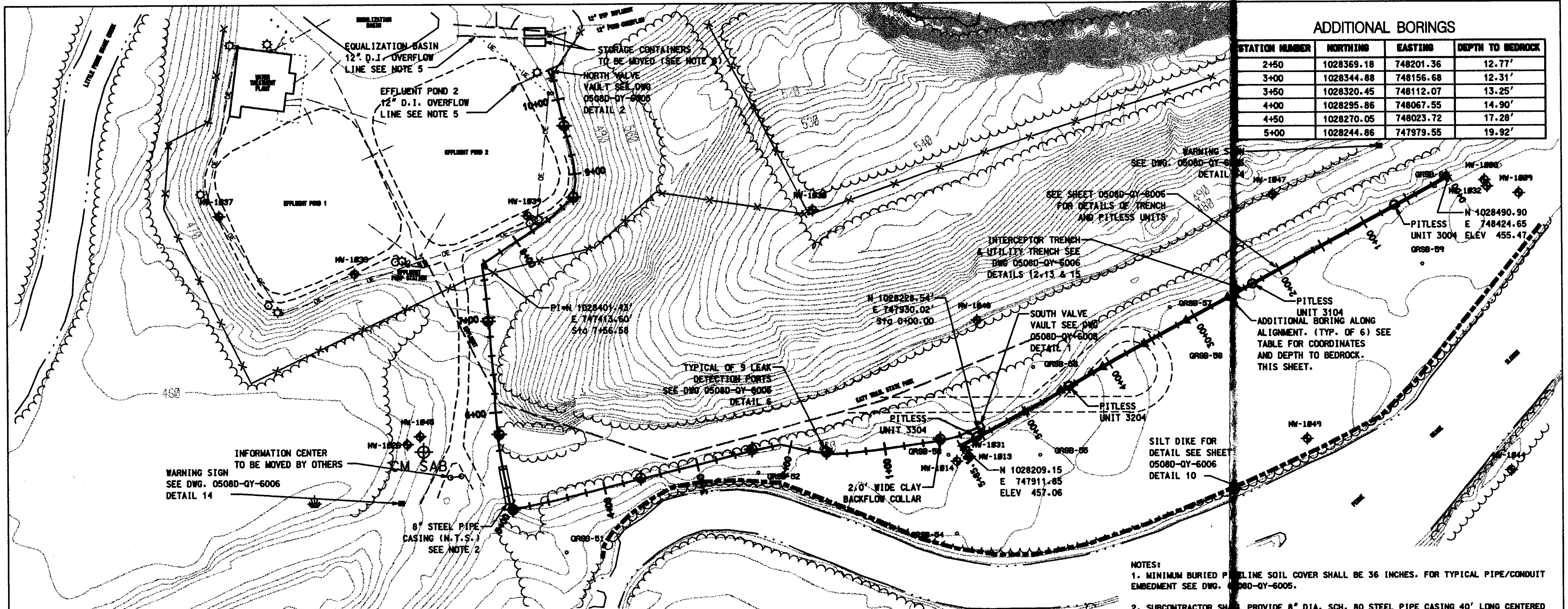





MT800 TRENCHER

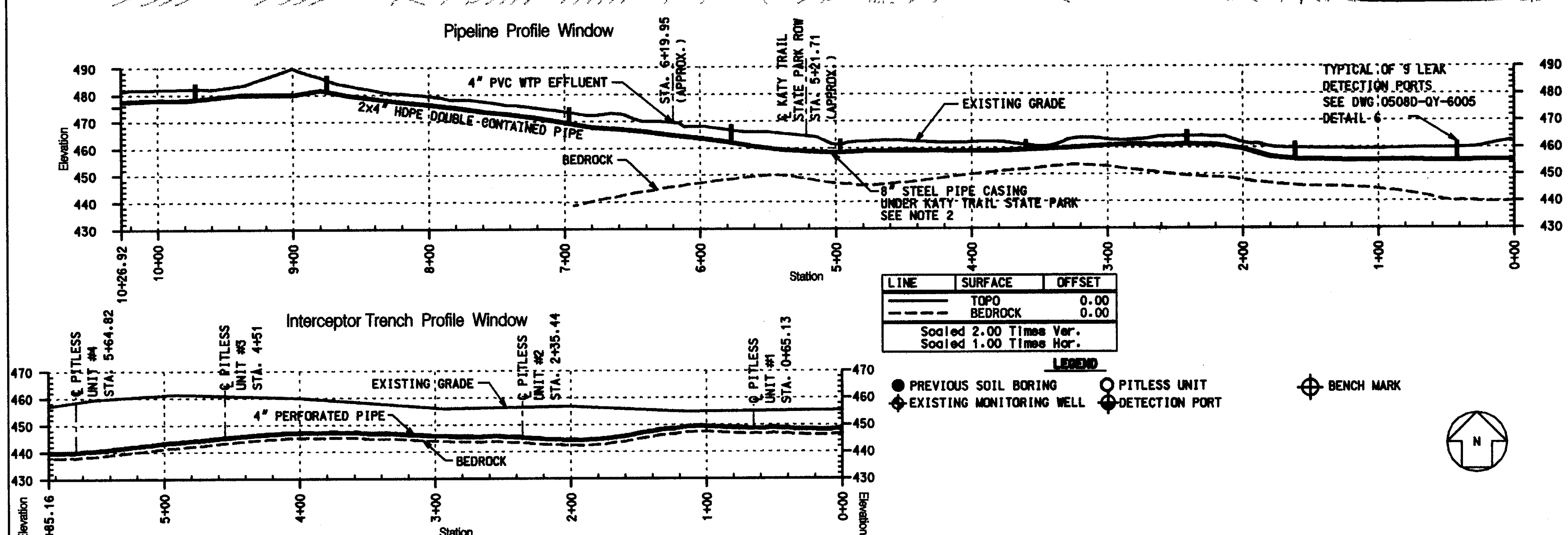
FIGURE 3-1

| | | |
|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | EXHIBIT NO.: | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 10/28/02 |




## ADDITIONAL BORINGS

| STATION NUMBER | NORTHING | EASTING | DEPTH TO BEDROCK |
|---|---|---|---|
| 2+50 | 1028369.18 | 748201.36 | 12.77' |
| 3+00 | 1028344.88 | 748156.68 | 12.31' |
| 3+50 | 1028320.45 | 748112.07 | 13.25' |
| 4+00 | 1028295.86 | 748067.55 | 14.90' |
| 4+50 | 1028270.05 | 748023.72 | 17.28' |
| 5+00 | 1028244.86 | 747979.55 | 19.92' |




| LINE | SURFACE | OFFSET |
|---|---|---|
| ——— | TOPO | 0.00 |
| – – – | BEDROCK | 0.00 |

Scaled 2.00 Times Ver.
Scaled 1.00 Times Hor.

**LEGEND**

- ● PREVIOUS SOIL BORING
- EXISTING MONITORING WELL
- PITLESS UNIT
- DETECTION PORT
- BENCH MARK

N

NOT TO SCALE

NOTES:

1. MINIMUM BURIED PIPELINE SOIL COVER SHALL BE 36 INCHES. FOR TYPICAL PIPE/CONDUIT EMBEDMENT SEE DWG. 0508D-QY-6005.

2. SUBCONTRACTOR SHALL PROVIDE 8" DIA. SCH. 80 STEEL PIPE CASING 40' LONG CENTERED ON KATY TRAIL. SEE SHEET 0508D-QY-6005 DETAIL 5. SUBCONTRACTOR SHALL LOCATE TOP OF 8" CASING PIPE A MIN. 5'-6" BELOW KATY TRAIL.

3. LOCATION OF EXISTING 4" EFFLUENT PIPELINE IS APPROXIMATE AND SHALL BE FIELD VERIFIED FOR LOCATION AND DEPTH BY HAND EXCAVATING WHEN WITHIN 2' OF LINE. SUBCONTRACTOR SHALL LOCATE NEW PIPE UNDER EXISTING EFFLUENT LINE.

4. SUBCONTRACTOR SHALL PROTECT ALL PERMANENT STRUCTURES, i.e. MONITORING WELLS, MONUMENTS, ETC.

5. SUBCONTRACTOR SHALL FIELD VERIFY LOCATION OF OVERFLOW LINES. CUT THE OVERFLOW LINES SO THAT THE NEW 2x4" HDPE DOUBLE CONTAINED PIPE CAN BE ROUTED THRU THE REMAINING LINES WHEN SEALED PROPERLY. DOWNSTREAM END OF OVERFLOW LINES SHALL BE SEALED ALSO. SEE DWG. 0508D-QY-6005 DETAIL 4.

6. SUBCONTRACTOR SHALL MOVE THE STORAGE CONTAINERS AS DIRECTED BY CONTRACTOR.

8. LOCATION OF PITLESS UNITS ARE SUBJECT TO CHANGE BASED ON FIELD CONDITIONS.

# INTERCEPTOR TRENCH

## FIGURE 3-2

| REPORT NO.: DOE/GJ/79491-927 | EXHIBIT NO.: B/QY/039/1102 | |
|---|---|---|
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/24/03 |

Within the north valve vault, the double-walled pipe made individual runs into either the QWTP equalization basin or the QWTP effluent pond 2. Upon installation of utilities into the utility trench, both the utility trench and the remaining section of the interceptor trench were backfilled with low permeable soil. The soil was graded to prevent surface water infiltration. Upon successful startup and operation of the interceptor trench, the system was turned over to the PMC. On April 27, 2000, the interceptor trench was placed into operation. The WP-515 subcontractor completed restoration (grading/seeding/strawing) of all disturbed areas and demobilized from the Quarry by May 5, 2000.

### 3.2 Quarry Interceptor Trench Operation

Operation of the Quarry interceptor trench started on April 27, 2000, and was concluded on April 26, 2002. Sampling of the trench and nearby monitoring wells was performed as outlined in the *Sampling Plan for the QROU Interceptor Trench Field Study* (Ref. 13). As of April 26, 2002, a total of 1,666,234 gallons of water was pumped from the interceptor trench to the Quarry, treated, and discharged. A summary of the production from each sump is detailed in Table 3-2.

Table 3-2 Two Year Summary of Quarry Interceptor Trench Production

| Sump | Production (gallons) | Days of Operation | Total Mass of Uranium Removed (grams) |
|---|---|---|---|
| 3004 | 257 | 3 | 2 |
| 3104 | 108,712 | 47 | 1,400 |
| 3204 | 158,277 | 59 | 1,635 |
| 3304 | 1,398,988 | 559 | 10,974 |
| Total | 1,666,234 | 567 | 14,011 |

The efficiency of the interceptor trench system was defined as the ratio of the cumulative mass of uranium removed to the initial mass of uranium present within the capture zone of the trench. The total mass of uranium within the average capture zone of the trench was estimated at 791 kg (22 kg dissolved and 769 kg sorbed). By the end of the two-year study period, the interceptor trench had removed 14.0 kg of uranium. This accounted for 1.8% of the mass available to the interceptor trench. A performance goal of 10% was specified in the QROU ROD. The 1.8% performance of the removal system was significantly below the 10% specified performance goal and in accordance with the QROU ROD, it was determined that further evaluation of the groundwater was not warranted. The results of the interceptor trench field study are documented in *Evaluation of the Performance of the Interceptor Trench Field Study* (Ref. 14).

## 3.3 Contaminated Material Removal

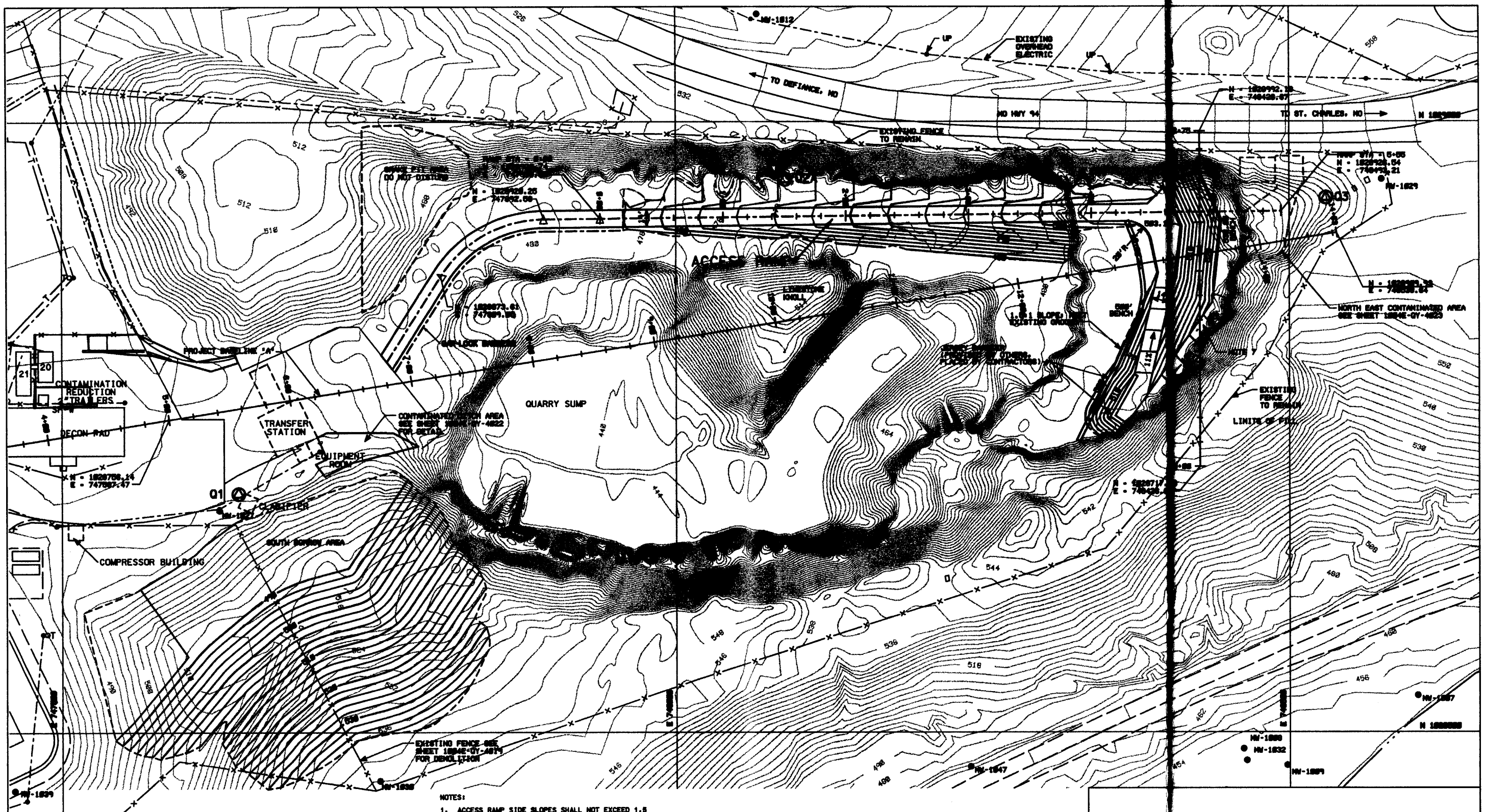
The removal of residual contaminated material from the Weldon Spring Quarry was incorporated into the scope of work for Work Package 505 Task X (WP-505X) scope of work. WP-505X was labeled the Quarry Residual Contaminated Material Removal project and consisted of the following tasks:

1. Preparation of a borrow area for transport and placement of soil into the Quarry proper.
2. Installation of ramps to provide access to the 500-ft quarry bench and northeast rim.
3. Excavation of contaminated material, transporting the material on the Quarry haul road to the Chemical Plant area, and placement of the material in the disposal cell.
4. Backfill of the excavated area after successful confirmation verification.
5. Maintenance of the Quarry haul road.
6. Stabilization of specific Quarry highwall areas and treatment of fractures.
7. Removal of utilities and physical structures within the project area.

Remediation of the Quarry residual contaminated material began on May 8, 2000 and was completed on September 15, 2000. Work began with the clearing and grubbing of the borrow area to be used for construction of a ramp to the northeast corner (Figure 3-3). Trees and other vegetation were cut off flush with or below the original ground surface. Stumps and roots were removed to a depth of not less than 10 in. below the original surface level. Depressions created from the grubbing were filled with suitable material and compacted to make the surface conform with the original ground surface. The access ramp was constructed of common fill placed in eight to twelve in. lifts and compacted to 90% of the maximum density. The ramp was constructed at a 6.5% slope with minimum 14 ft wide drive lanes. Concrete "jersey" barriers were placed 10 ft. from the edge of the 500 ft. bench to provide safe access.

As the access ramp was being constructed, multiple fractures in the Quarry floor and highwall were sealed with clay backfill, shotcrete, or concrete. These fractures were designated by the numbers 66 through 89 and are detailed in Figure 3-4. Fractures on the floor were filled with clay and compacted with a vibratory plate attached to a Caterpillar 322B excavator. Attempts at using shotcrete (concrete applied by spraying) to seal the vertical fractures on the Quarry highwall were, for the most part, unsuccessful. The shotcrete would adhere to the highwall until it became too thick and then fall to the ground. The subcontract specifications were changed so that the vertical fractures would be blocked with plywood and sealed with concrete. The plywood prevented the concrete from running out of the fracture and provided more efficient sealing of the fracture. Five fractures on the north side of the quarry were deleted from this package because they were to high in elevation to use plywood forms rather than shotcrete. These fractures were later added to WP-551A (Section 3.6).

Once access to the northeast slope was established, contaminated soil was removed in accordance with engineering design. Radiological surveys obtained during excavation of the




NOTES:

1. ACCESS RAMP SIDE SLOPES SHALL NOT EXCEED 1.5 HORIZONTAL TO 1 VERTICAL.
2. RAMP SHALL BE CONSTRUCTED WITH MATERIAL SUITABLE FOR COMMON FILL AND COMPACTED TO THE COMPACTION REQUIREMENTS FOR THE SAME.
3. THE SUBCONTRACTOR SHOULD TREAT ALL FRACTURES IN THE VICINITY OF THE ACCESS RAMP PRIOR TO ANY EARTH WORK ACTIVITIES. THESE FRACTURES SHALL BE REPAIRED/TREATED IN ACCORDANCE WITH THE FRACTURE SEALING PLANS SHEETS 1004E-GY-4024 THROUGH 4030 AND SPECIFICATIONS.
4. STOCK PILE TOPSOIL AS DIRECTED BY THE CONTRACTOR.
5. SEED DISTURBED AREAS AFTER EXCAVATION AND EARTHWORK OPERATIONS ARE COMPLETE.
6. PROVIDE 14' WIDE MINIMUM DRIVE LANES.
7. INSTALL "JERSEY" TYPE CONCRETE BARRIERS 10' MINIMUM FROM EDGE OF 500' BENCH AND AS SHOWN.
8. THE SUBCONTRACTOR SHALL DISSEMBLE DECONTAMINATE AND STORE SCAFFOLDIND AS DIRECTED BY THE CONTRACTOR.

[ ] - REMOVED FOUNDATION

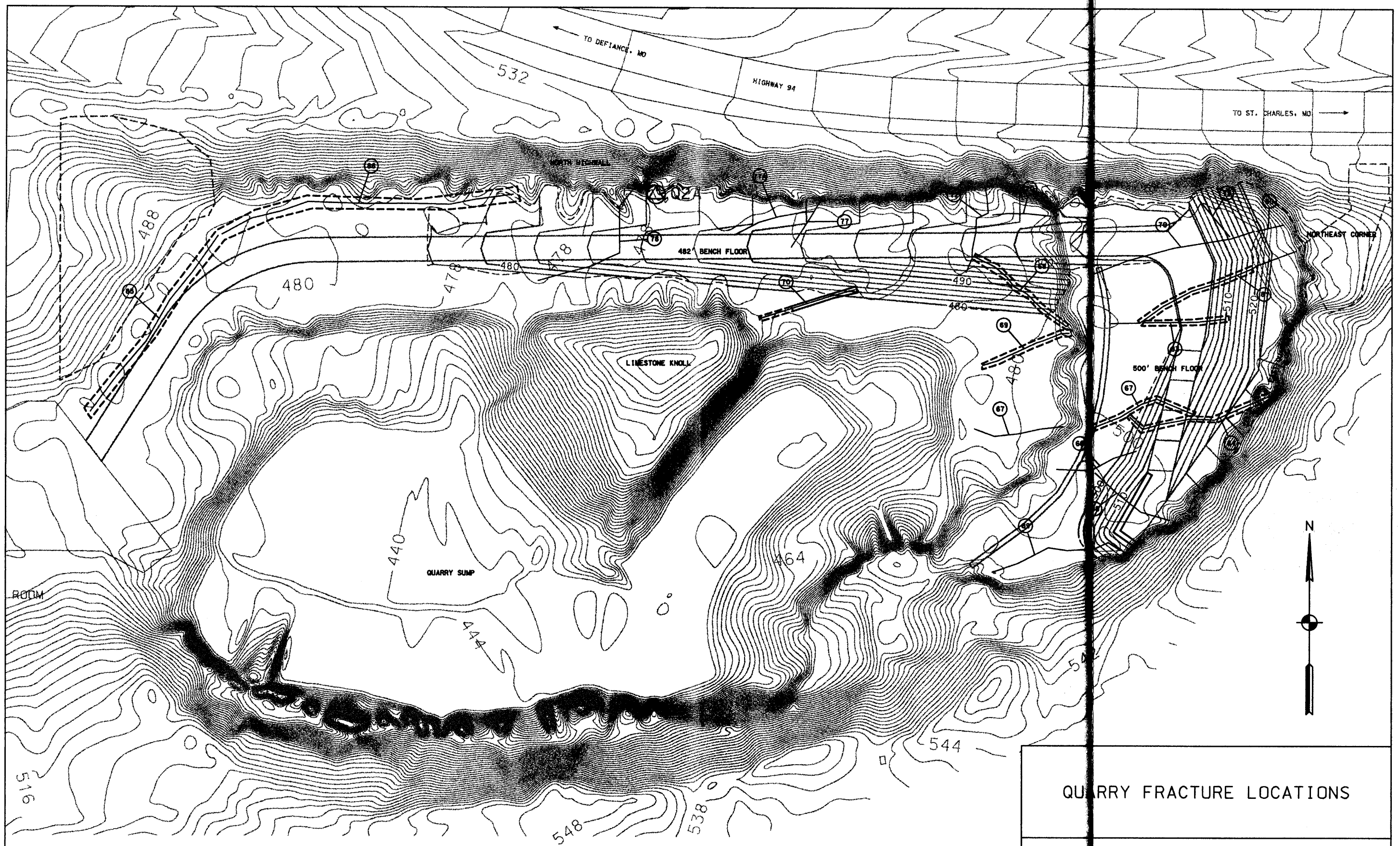
40 0 40 80
1"=40'-0"

N

ACCESS RAMP TO THE NORTHEAST SLOPE

FIGURE 3-3

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/016/0802 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/15/02 | |




QUARRY FRACTURE LOCATIONS

FIGURE 3-4

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/017/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/15/02 | |

northeast slope revealed additional contaminated areas requiring removal. The original area was excavated deeper in addition to extending the excavation both east and west of the original design. Contaminated material removed increased from an estimate of 210 $yd^3$ to approximately 764 $yd^3$. Following the soil removal activities, additional walkover surveys were conducted and soil confirmation samples were collected to ensure the contaminated materials had been removed to specified concentrations. Upon successful completion of the confirmation sampling, the excavation was backfilled and sloped to near original grade.

The removal of contaminated soil in the Snake Pit and the Ditch area commenced after the remediation of the Quarry northeast slope. During the remediation of both areas, the volume of contaminated material removed increased based on walk-over surveys or confirmation sampling results. The Snake Pit area increased from approximately 245 $yd^3$ to 322 $yd^3$ and the volume of contaminated material removed from the Ditch area increased from approximately 286.8 $yd^3$ to 441.2 $yd^3$. Following the soil removal activities, additional walkover surveys were conducted and soil confirmation samples were collected to ensure the contaminated materials had been removed (section 3.9).

Remediation of additional contaminated materials consisted of demolition of the contamination reduction trailer, transfer station, clarifier structure, concrete/asphalt, and underground utilities. All items were demolished, sized, and transported from the Quarry to the disposal cell. Soil confirmation sampling was performed beneath approximately 480 linear feet of contaminated underground piping upon completion of piping removal. Following the confirmation sampling, the area was backfilled with clean soil and graded to the original elevation. Variances in the estimated volume of contaminated material to be removed under WP-505X and the actual quantities are detailed in Table 3-3.

Table 3-3 Summary of WP-505X Contaminated Material Removed

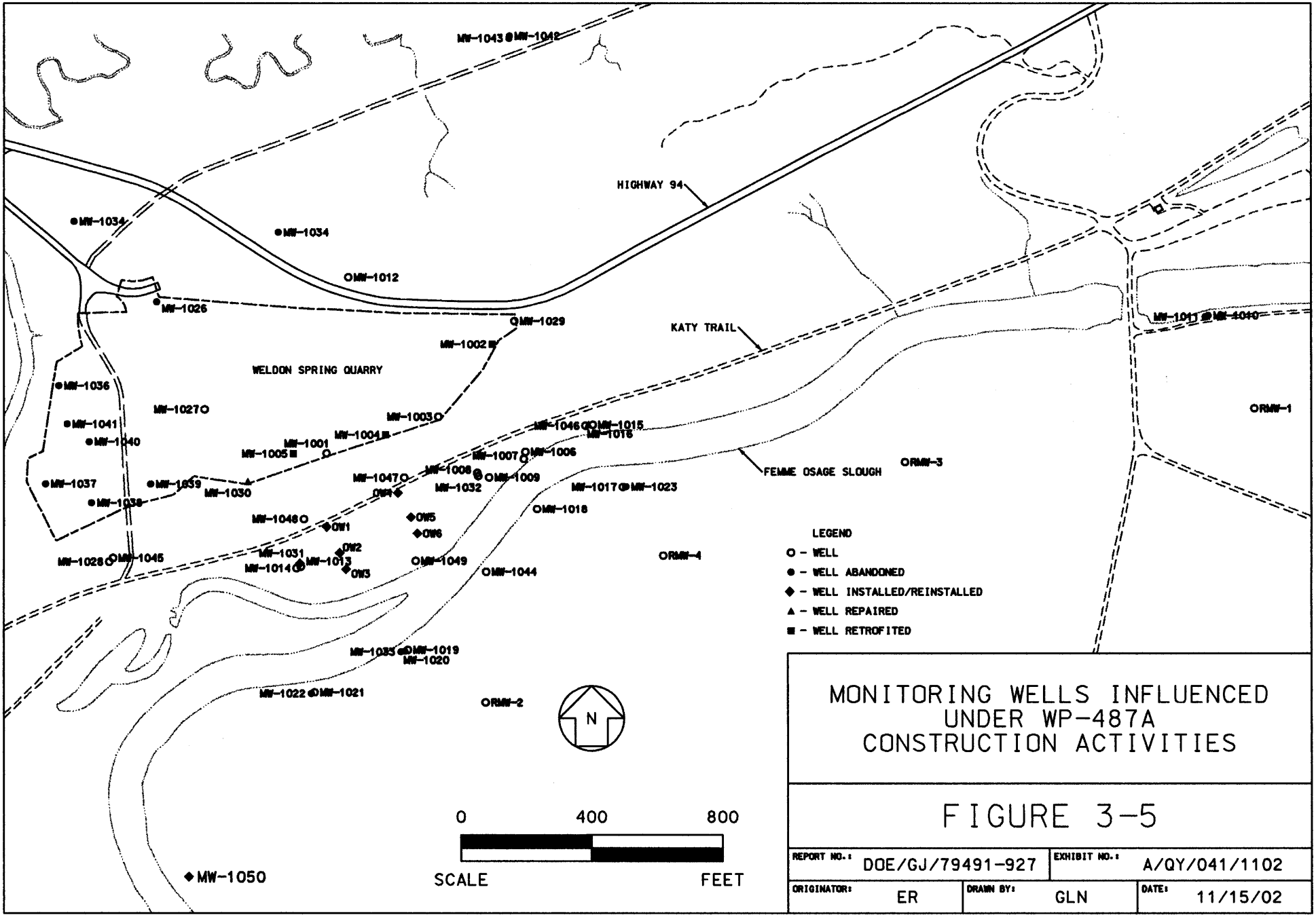
| Quarry Area | Engineering Estimate ($yd^3$) | Volume of Contaminated Material Removed ($yd^3$) |
|---|---|---|
| Northeast Slope | 210 | 764 |
| Snake Pit | 245 | 322 |
| Clarifier Ditch | 287 | 488 (a) |
| Underground Piping | 4 | 4 |
| Soil Envelope around Underground Piping | 293 | 293 |
| Transfer Station | 238 | 337 |
| Decon Pad | 28 | 28 |
| Walk Way | 48 | 48 |
| Contamination Reduction Trailer | 36 | 3614 |

| Quarry Area | Engineering Estimate ($yd^3$) | Volume of Contaminated Material Removed ($yd^3$) |
|---|---|---|
| Clarifier – Structure | 14 | 14 |
| Clarifier Concrete Pad | 14 | 14 |
| Total Quantities | 1417 | 2348 |

(a) – includes soil beneath clarifier pad.

### 3.4 Well Installation and Abandonment

The installation of new monitoring/observation wells and the abandonment of existing monitoring wells not utilized for the QROU long-term groundwater monitoring program were performed under Work Package 487A, Well Installation and Abandonment (WP-487A). The construction activities were performed under four individual tasks (Task 5, 6, 7, and 9). All work performed under the four tasks was in accordance with State of Missouri Geologist Registration Act (4 CSR 145) and the State of Missouri Monitoring Well Construction Rules (10 CSR 23). WP-487A construction activities, the timeframe of the work performed, and monitoring wells influenced within the QROU are detailed in Table 3-4 and Figure 3-5. Several wells that are not part of the long-term monitoring of the quarry were not abandoned during this period. Abandonment of MW-1024, MW-1029, OW-1, OW-2, OW-4, and OW-5 will be done at a later date possibly in coordination with the final groundwater operable unit remedy implementation. Drilling derived wastes generated from the well installation and abandonment activities were characterized and disposed of in accordance with the specifications. Contaminated well casings, covers, and pads were disposed of in the on-site disposal cell. Contaminated purge water and development water were transported to the QWTP for treatment.




MONITORING WELLS INFLUENCED UNDER WP-487A CONSTRUCTION ACTIVITIES

FIGURE 3-5

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/041/1102 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/15/02 | |

Table 3-4 WP487A QROU Construction Activities

| WP-487A Scope of Work | Performance Period |
|---|---|
| **Task 5** | |
| Abandonment of MW-1042 & 1043 | 09-Feb-00 through 21-Feb-00 |
| **Task 6** | |
| Installation of OW-1 through OW-6 (6 wells) | 29-Mar-00 through 25-Apr-00 |
| Re-installation of MW-1031 | 26-Apr-00 through 04-May-00 |
| Abandonment of MW-1010, MW-1011, & MW-1034 | 04-May-00 through 12-May-00 |
| Repair of MW-1016 | 10-May-00 |
| **Task 7** | |
| Installation of MW-1050 | 10-Aug-00 through 18-Aug-00 |
| Abandonment of MW-1001, MW-1003, MW-1020, MW-1022, MW-1023, MW-1026, & MW-1033 | 23-Aug-00 through 01-Dec-00 |
| Repair of MW-1030 | 21-Aug-00 through 22-Aug-00 |
| Retrofit of MW-1002, MW-1004, & MW-1005 | 17-Oct-01 through 08-Nov-01 |
| **Task 9** | |
| Abandonment of MW-1035, MW-1036, MW-1037, MW-1038, MW-1039, MW-1040, & MW-1041 | 15-Mar-01 through 29-Mar-01 |

## 3.5 Quarry Water Treatment Plant Dismantlement

With the completion of WP-505X (Contaminated Material Removal), the volume of contaminated water that required treatment at the quarry was significantly reduced. It was determined that effluent pond 2 had sufficient capacity to store contaminated water and effluent pond 1 was sufficient for storing treated water prior to discharge. The removal of the equalization basin would not effect the ability to treat contaminated water at the Quarry. Also, removal of these structures at this time would allow for placement in the on-site disposal cell rather than off-site shipment to a licensed disposal facility. The approval of the mobile Train 3 treatment process allowed for early dismantlement of the QWTP and placement of the building and equipment in the on-site disposal cell.

The dismantlement of the QWTP was separated into two individual work packages. The first work package detailed the removal of the equalization basin. The second focused on the removal of the QWTP. The work performed under these two work packages is summarized in the following sections.

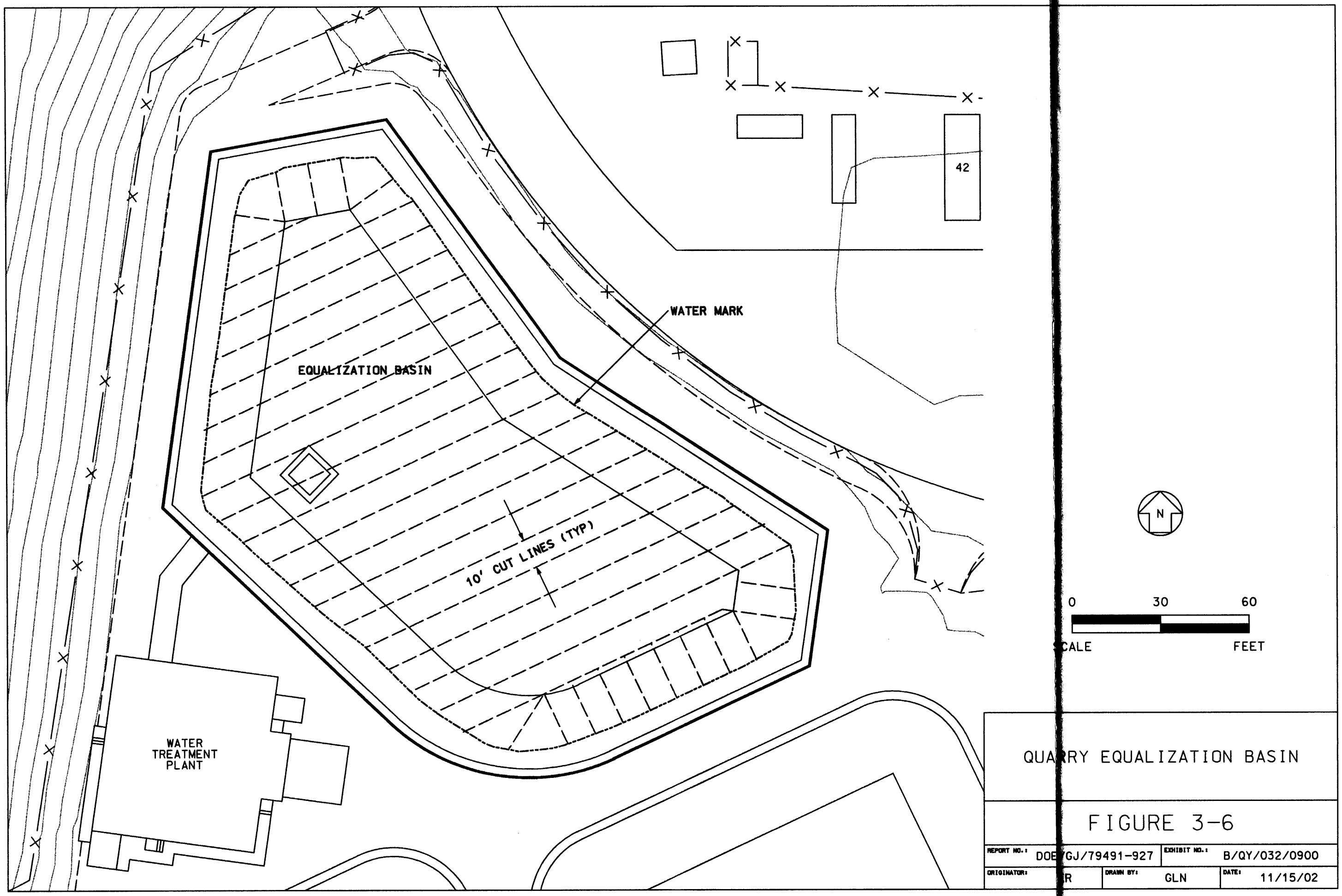
### 3.5.1 Work Package 551, Task D

Work Package 551, Task D (WP-551D) was labeled the Quarry Equalization Basin Liner Removal project and consisted of cutting, sizing, packaging, and removing three layers of 60-mil HDPE liner and two layers of geogrid from the QWTP Equalization Basin. Additional scope of work for the subcontract task consisted of:

1. Plugging of all piping going into the Equalization Basin.
2. Removal of fencing, handrails, and jersey barriers surrounding the Equalization Basin.
3. Transport and placement of sized/segregated material to the designated staging area next to the quarry decontamination pad.
4. Transport of uncontaminated waste to a licensed landfill for proper disposal.

Removal of the Equalization Basin liner began on October 13, 2000, and was completed by November 14, 2000. Accumulated sediment in the Equalization Basin was removed and temporarily stored in containers. It was later mixed with soil and transported to the disposal cell. After removal of the sediment the first layer of liner was marked into 10' wide sections with spray paint (Figure 3-6). All HDPE liner and geogrid material above the designated water mark was determined to be at background and designated for disposal in a licensed landfill. The remaining liner/geogrid was designated as contaminated above background based on surveys, and targeted for disposal in the Chemical Plant disposal cell.

A Caterpillar 322 excavator with an extended boom and cutter attachment was mobilized by the subcontractor to remove the contaminated liner. The excavator was used to cut through the layers of liners and geogrid in one pass. After the liners/geogrid were cut, laborers using hand cutters, sized and packaged the material. The liner was packaged in bales using plywood and banding materials. The geogrid was rolled up and later unrolled in the disposal cell. The packages were lifted out of the basin with the excavator and transported to the staging area next to the quarry decontamination pad. Approximately 175 $yd^3$ of geogrid and 30 $yd^3$ of HDPE liner were staged for and disposed in the Chemical Plant disposal cell.




QUARRY EQUALIZATION BASIN

FIGURE 3-6

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/032/0900 | |
| ORIGINATOR: | | DRAWN BY: GLN | DATE: 11/15/02 |

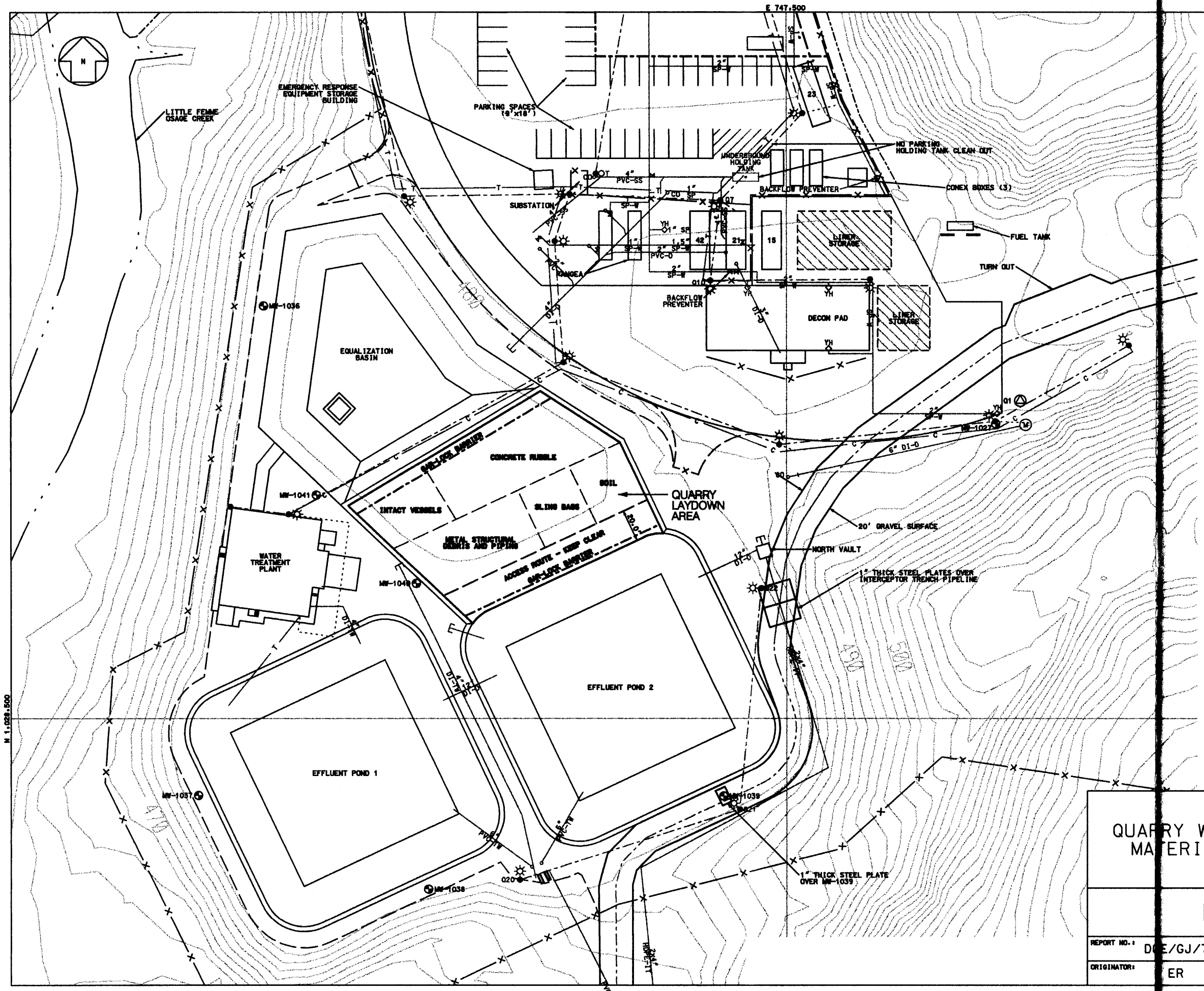
To remove the uncontaminated liner, the subcontractor mobilized a Caterpillar 446 backhoe. The liners/geogrid at the top of the Equalization Basin (anchor trench) were excavated and the material transported to a licensed landfill. Approximately 85 $yd^3$ of material was transported from the Quarry to the Milam landfill located in St. Clair County, Illinois, for disposal.

### 3.5.2 Work Package 553, Task A

With the construction of the dimple in the Chemical Plant disposal cell, it was determined that there would be adequate capacity for waste that would be generated from the demolition of the QWTP. Work Package 553, Task A (WP-553A) was created for this purpose and labeled the Quarry Water Treatment Plant and Facilities Demolition project. The scope of work for this subcontract task consisted of:

1. Demolition of the QWTP and all associated facilities/piping, including but not limited to the treatment units, the treatment plant building, the decontamination pad, and the QWTP foundation.
2. Excavation of contaminated soil beneath structures/utilities.
3. Backfill of the excavated area after successful confirmation verification.
4. Sorting and segregating demolition waste and excavated material.
5. Transport and placement of sized/segregated material to the designated staging area.
6. Transport of uncontaminated waste to a licensed landfill.
7. Construction of a temporary decontamination pad to be used for decontaminating haul trucks and equipment utilized during contaminated demolition activities.
8. Removal of miscellaneous utilities and physical structures within the project area.

Remediation activities began on April 4, 2001 and were completed by June 20, 2001. The work zone was enclosed with construction fencing and the southern berm of the laydown yard re-worked so that any precipitation runoff would flow directly into EP-2. Waste generated by the demolition activities was segregated in the laydown yard according to 6 individual waste streams. These waste streams were: concrete rubble, soil, sling bags of media from the QWTP process and EP-2 sediment, structural metal/piping, wood, and intact vessels (Figure 3-7). Concrete rubble was sized so that no pieces were larger than 18 in. in any dimension. Structural metal/piping was sized into pieces that did not exceed 10 ft. in length, 18 in. in height, and 4 ft. in width. Intact vessels consisted of process tanks from the QWTP and these items were directly placed in the laydown yard.




**SEGREGATION OF MATERIALS**

1. CONCRETE
2. PIPE
3. METAL STRUCTURAL DEBRIS
4. SOILS AND SEDIMENT
5. INTACT VESSELS
6. SLING BAGS (NOT IN SCOPE)

**SEQUENCE OF REMOVAL BASED ON C.I.D. 305**

1. CONCRETE RUBBLE
2. INTACT VESSELS
3. METAL STRUCTURAL DEBRIS, PIPE, SOIL
4. SLING BAGS

**LEGEND**

- CAP
- FENCE
- MONITORING WELL
- OVERHEAD ELCETRIC
- TELEPONE LINE
- CONTROL CABLE
- CO - CLEAN OUT
- XX-SS - SANITARY SEWER
- XX-D - DRAIN LINE
- XX-T - TREATED WATER LINE
- XX-IT - INTERCEPTOR TRENCH
- Q20 - POWER POLE AND NUMBER

0 60 120
SCALE FEET

# QUARRY WATER TREATMENT PLANT MATERIAL SEGREGATION PLAN

## FIGURE 3-7

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/021/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/15/02 | |

Demolition activities began with the removal of the quarry decontamination pad and associated piping (Figure 3-8). The subcontractor then demolished the QWTP building from east to west and from north to south. All contaminated material was segregated according to its waste type and placed appropriately in the laydown yard. The concrete foundation and underground piping were excavated, sized, and staged. A one-foot envelope of soil was removed from below and from the sides of contaminated underground piping during the excavation of the pipe to ensure removal of contaminated soil if a pipe had leaked. After all of the concrete had been staged, a concrete processor was brought in to pulverize the concrete for volume reduction purposes. Following the completion of the demolition and excavation activities, walkover surveys were conducted and soil confirmation samples were collected from within the QWTP footprint and along pipe trenches to ensure the contaminated materials had been removed. Upon successful completion of the confirmation sampling, the areas were backfilled and released for use (Section 3.9). Demolition and backfill activities under WP-553A were completed by May 10, 2001. From May 10, 2001 to June 20, 2001, the subcontractor decontaminated equipment and completed demobilization.

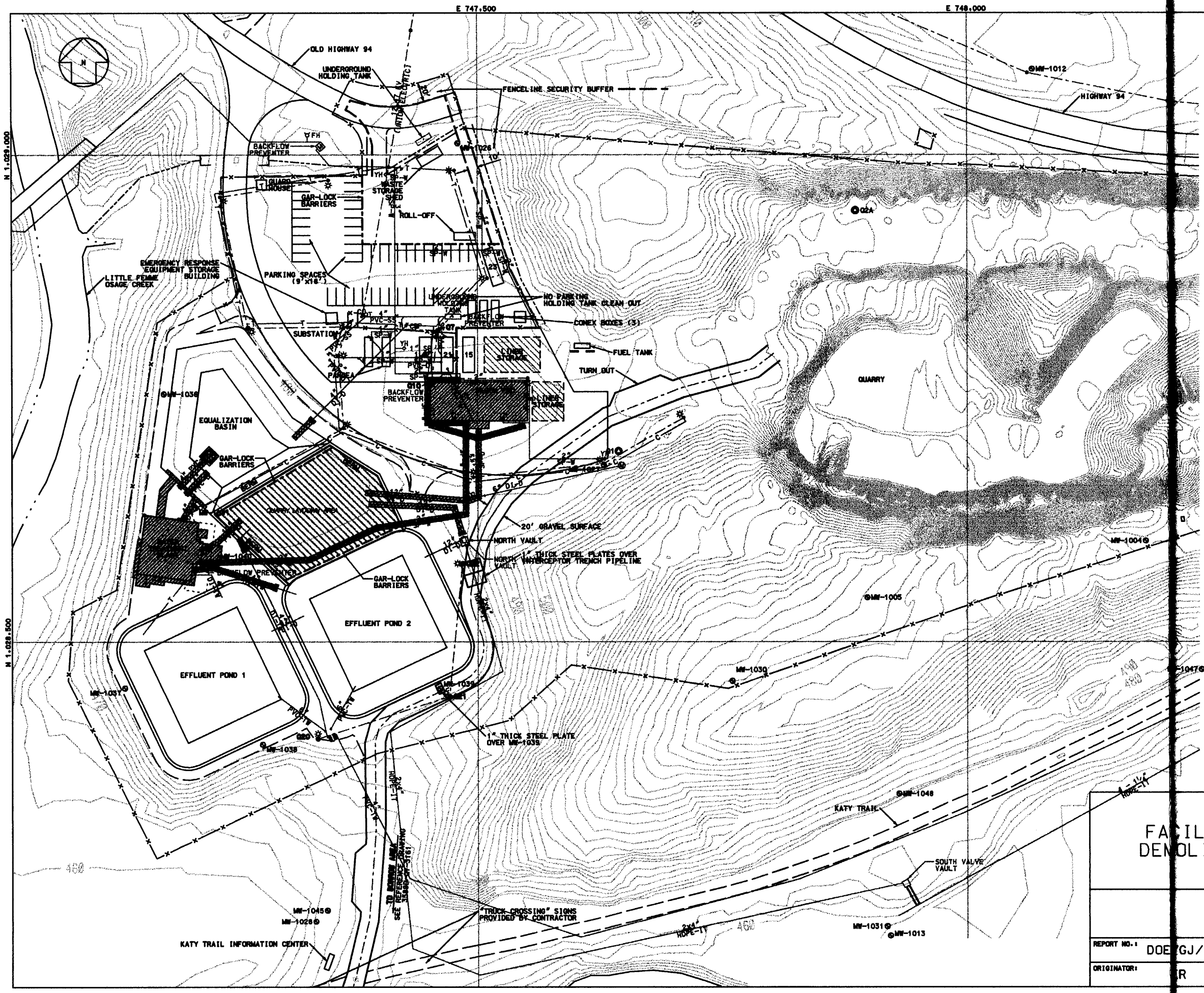
Wastes generated under WP-553A and WP-551D were temporarily staged at the quarry. From May 16 to May 23, 2001, the "direct hire organization" (DHO) transported and disposed of the quarry waste in the chemical plant disposal cell under work package 437 (WP-437). The vessels and equipment were placed and grouted in the cell to eliminate void spaces. Waste quantities are detailed in Table 3-5.

Table 3-5 Quarry Waste Streams Placed in the Disposal Cell Dimple

| Waste Type | Volume of Contaminated Material Removed ($yd^3$) |
|---|---|
| Concrete rubble | 304 |
| Soil | 1675 |
| Sling bags of media/sediment | 200 |
| Structural metal/piping | 534 |
| Intact vessels | 36 |
| Wood and railroad ties | 20 |
| WP-551D liner and geonet | 205 |
| Total Volume of WP-551D and WP-553A Waste | 2974 |

## 3.6 Quarry Restoration Phase I

Because of both the availability of funding and the necessity for treatment of water generated from the interceptor trench, the restoration of the Weldon Spring Quarry was divided




**NOTE:**

1. DEPTH OF UNDERGROUND PIPE CAN BE FOUND ON REFERENCE DRAWING.
2. GRADE WESTERN SIDE OF WATER TREATMENT PLANT EXCAVATION FOLLOWING CONFIRMATION TO DRAIN TOWARD LITTLE FEMME OSAGE CREEK.

**LEGEND**

- CAP LINE CLEAN
- NIS - NOT IN SCOPE
- REMOVE CLEAN
- REMOVE CONTAMINATED (PIPE DEPTHS CAN BE FOUND ON REFERENCE DRAWINGS)
- FENCE
- MONITORING WELL
- OVERHEAD ELCETRIC
- TELEPONE LINE
- CONTROL CABLE
- CO - CLEAN OUT
- XX-SS - SANITARY SEWER
- XX-D - DRAIN LINE
- XX-T - TREATED WATER LINE
- XX-IT - INTERCEPTOR TRENCH
- 020 - POWER POLE AND NUMBER

0 100 200
SCALE FEET

FACILITIES TARGETED FOR DEMOLITION UNDER WP-553A

FIGURE 3-8

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/022/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/15/02 | |

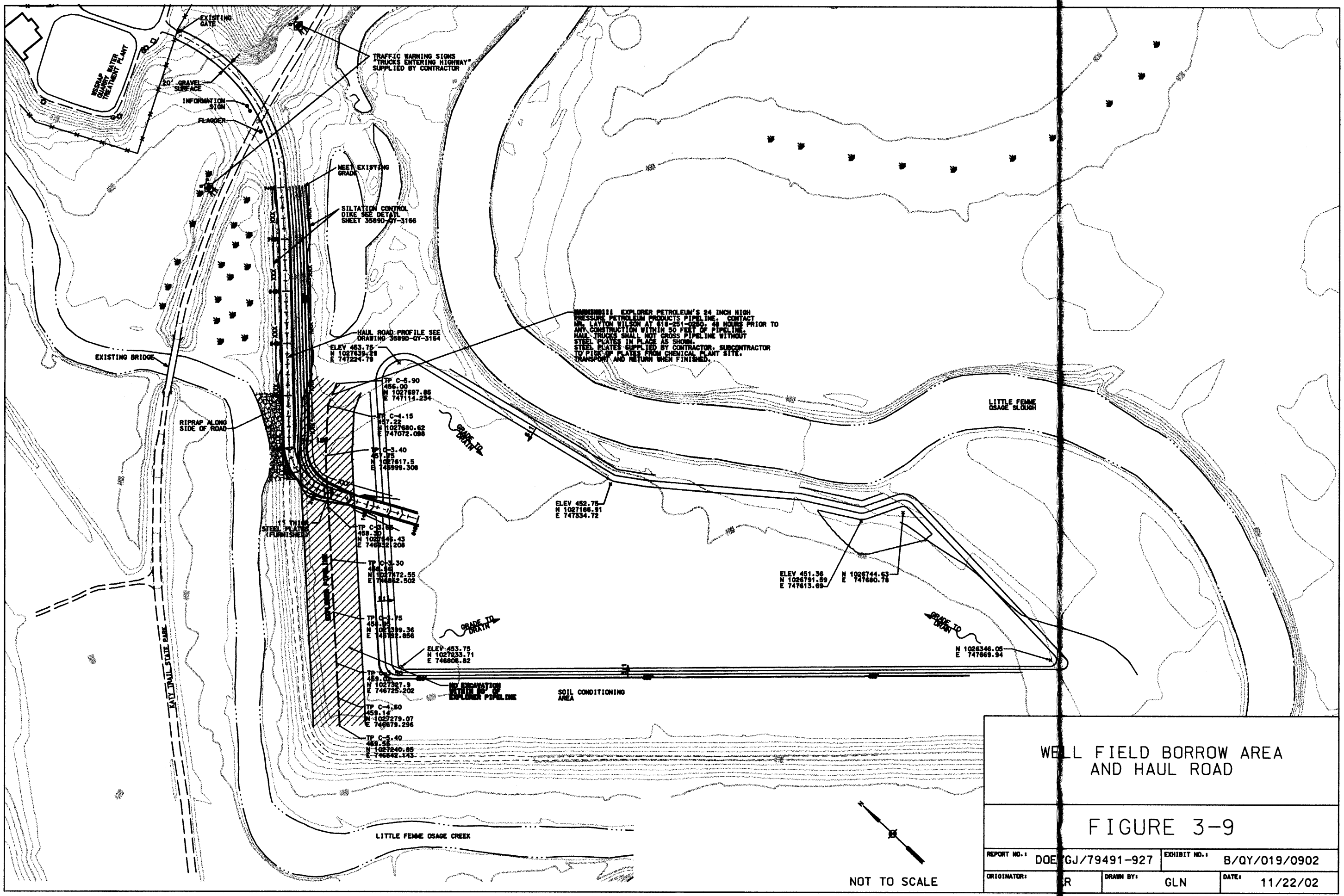
into two phases. The first phase was labeled the Quarry Restoration Phase I and performed as task A under Work Package number 551, (WP-551A) and consisted of the following tasks:

1. Removal of the "Claymax" liner from the Quarry Equalization Basin and disposal in a municipal landfill.
2. Backfill half of the Quarry Equalization Basin to construct a laydown area.
3. Preparation of designated borrow areas, excavation of fill (low permeability, common, and top soil), and transportation of fill to the quarry.
4. Construction and maintenance of a borrow area haul road.
5. Placement and compaction of fill in the quarry.
6. Removal of designated utilities and physical structures.
7. Sealing of specified fractures with concrete.
8. Seeding, mulching, and fertilizing of all disturbed areas following completion of excavation activities.

Remediation activities for WP-551A began on November 20, 2000, and started with the construction of a haul road leading from the quarry to the borrow area located in the wellfield south of the quarry. The haul road exited the Quarry from the south and ran on top of the levee along the Little Femme Osage Creek (Figure 3-9). It was constructed of 6 in. Missouri Department of Transportation (MoDOT) Type 5 aggregate. A ramp was constructed from the top of the levee into the borrow area so that the borrow area could be accessed. Steel plates were placed over the area where the Explorer pipeline ran beneath the levee to prevent potential damage to the pipeline from haul truck traffic.

The designated borrow area consisted of approximately 17 acres of land on Missouri Department of Conservation property (Figure 3-9). Trees, brush, and other vegetation were cleared from the area and the stumps and roots removed. After the area was scarified, a sump was excavated in the northeast corner to prevent sediment bearing water runoff from entering the Femme Osage Slough or Little Femme Osage Creek. On December 6, 2000, it was discovered that the fill material in the borrow was too wet to meet the backfill requirements within the Quarry. It was decided to have the subcontractor transport the soil out of the wellfield into a stockpiling area on the Quarry ramp where the soil could then be conditioned to meet moisture requirements and be used as fill. Approximately 6,535 $yd^3$ of soil was transported to the stockpiling area in the Quarry from January 16, 2001 to January 25, 2001. Due to excessive moisture in the fill material, inclement weather, and extensive soil conditioning, the transporting of soil from the borrow area was temporarily suspended.

A modification to the WP-551A subcontract was created to remove the "Claymax" liner from the Quarry Equalization Basin and construct a laydown area in a section of the basin. The removal of the "Claymax" liner from the Quarry Equalization Basin began on February 5, 2001 and was completed by February 8, 2001. The liner was removed using a Caterpillar 345B excavator. The liner was determined to be at background levels based on sampling results and targeted for disposal in a municipal landfill. Approximately 60 tons of




WELL FIELD BORROW AREA AND HAUL ROAD

FIGURE 3-9

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/019/0902 | |
| ORIGINATOR: R | DRAWN BY: GLN | DATE: 11/22/02 | |

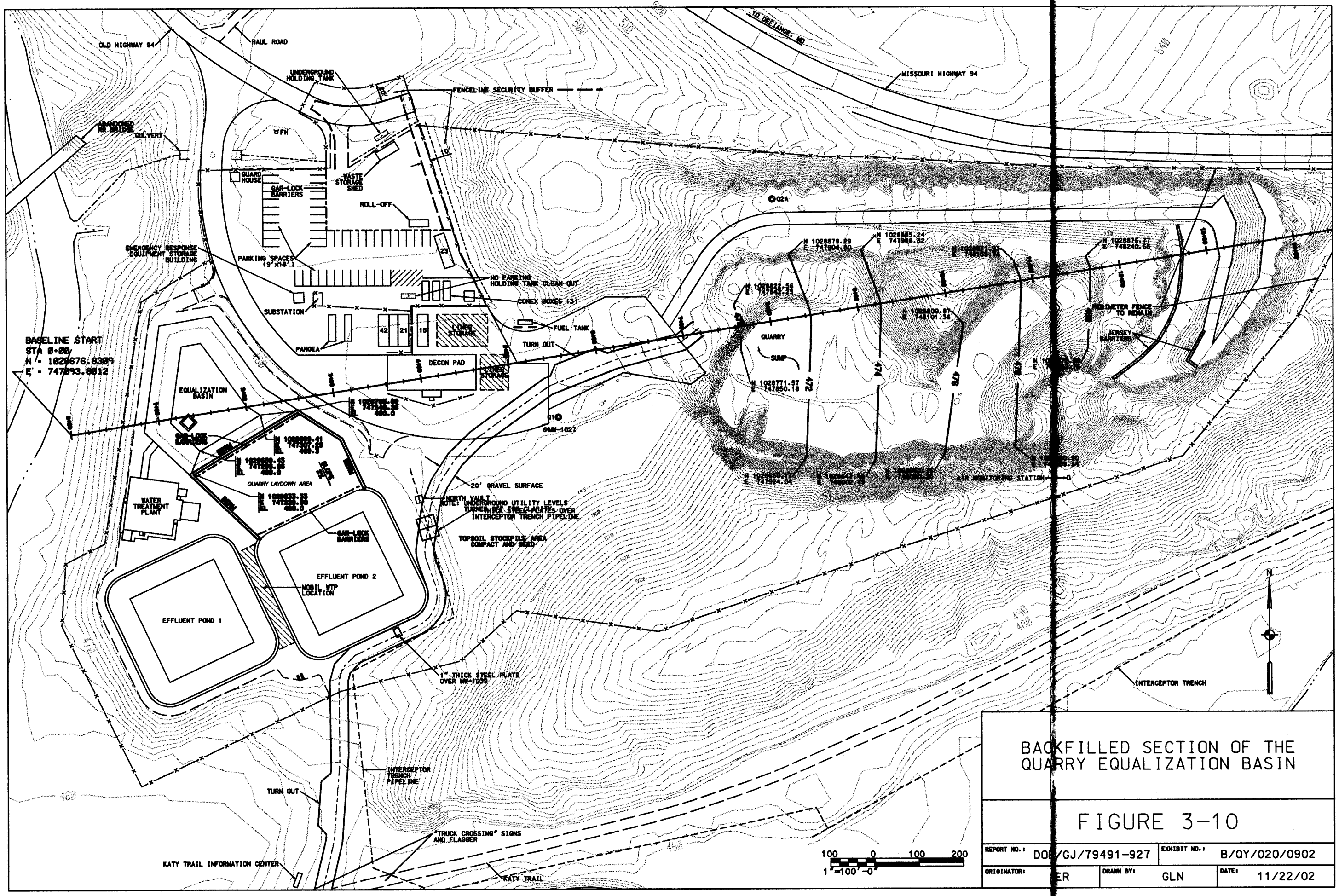
material were transported off-site and disposed of at the Milam landfill in Milam, Illinois. After the liner was removed, walkover surveys were conducted and soil confirmation samples collected.

Upon successful completion of confirmation sampling and unrestricted release of the area, half of the Equalization Basin was backfilled (Section 3.9). The backfilled area was to be used as a staging area for the demolition of the QWTP (Section 3.5.2). Approximately 3,550 $yd^3$ of clean common fill was transported from the stockpiling area within the Quarry into the southern half of the Equalization Basin (Figure 3-10). The placed soil was compacted with a Caterpillar D-6 dozer to meet established compaction requirements and a 6 in. berm was constructed around the area to eliminate concerns about potential contaminated surface water runoff concerns. With the completion of the constructed laydown area, WP-551A was temporarily suspended and a re-start date of April 16, 2001 was scheduled.

Because of QWTP demolition activities (WP-553A), WP-551A did not resume until May 14, 2001. Work activities resumed with de-watering the inner quarry sump and conditioning soil in the borrow area. The water in the quarry sump was pumped into Effluent Pond #2 for treatment. During pumping activities, it was discovered groundwater was seeping into the quarry sump in three distinct locations along the south highwall. The rate of the seepage was estimated at approximately 250 gallons per hour based on pumping data. It was determined that a "quick set" concrete would be used to seal the seepage points. Using borrow area material, a ramp was constructed into the quarry sump. After all of the water had been pumped from the sump area, approximately 60 $yd^3$ of concrete was used to seal the three seepage points. The concrete was allowed to set up and then two 18-in. lifts of clayey soil were compacted on top of the concrete. After the completion of the sealing activity, all seepage into the quarry sump was eliminated.

Prior to backfilling the quarry sump, sediment at the bottom of the sump was pumped to the 480 ft. bench and stabilized. Approximately 60 tons of pelletized lime was used to condition the sediment and reduce its moisture content. The lime was mixed into the sediment using a Caterpillar 325 excavator. After the sediment had been thoroughly mixed and the appropriate moisture percentage achieved, the material was left in place and compacted.

From May 30, 2001, to August 5, 2001, approximately 69,888 $yd^3$ of fill material was transported from the borrow area to the quarry sump, placed, and compacted. Fill material was excavated from the borrow area and placed in a designated area for moisture conditioning. A Rome disk was used to aerate the fill material in order to meet the subcontract established moisture requirements. After the material met established moisture requirements, it was pushed to the stockpile area where the material was then loaded into articulated haul trucks and transported to the inner quarry. Upon placement of the material in the quarry sump, the fill was compacted with a Caterpillar 815 "Sheepsfoot" roller to meet subcontract established compaction requirements. Throughout the excavation, placement, and compaction activities, moisture and compaction samples were generated to verify compliance with ASTM D-2216, D-




BACKFILLED SECTION OF THE QUARRY EQUALIZATION BASIN

FIGURE 3-10

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/020/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/22/02 | |

4643, and D-698 (Ref. 15, 16, 17) standard test methods established in the subcontract requirements. A summary of the moisture and compaction testing results for WP-551A are summarized in Appendix A.

Under WP-551A (Quarry Restoration), five fractures on the north end of the quarry were sealed with 30 $yd^3$ of concrete. These fractures had been deleted from WP-505X (Contaminated Soil Removal) because of the ineffectiveness of the shotcrete and the current elevation at the time (section 3.3). With the increased elevation created under WP-551A, these fractures were now able to be formed in with plywood and sealed with concrete.

Upon completion of backfill activities, final grading and seeding were performed on both the borrow area and inner quarry. Grass seed and fertilizer were mixed with water and hydraulically applied to excavated areas using a hydroseeder. The grass seed consisted of native grass seeds derived directly from native, wild stock and complying with the Association of Official Seed Analysts' purity and germination tolerances. The subcontractor had completed remediation activities and was demobilized by August 17, 2001.

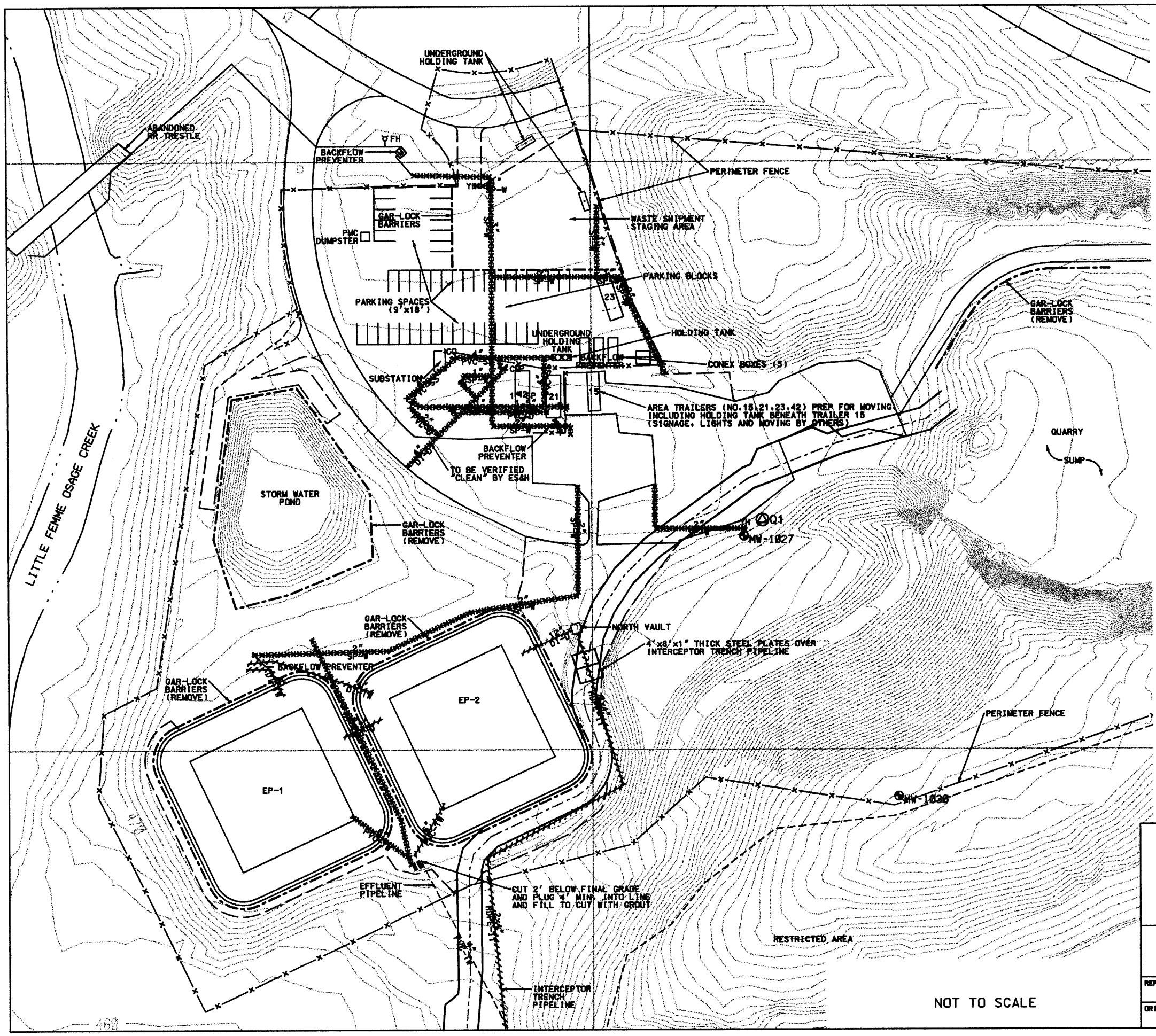
### 3.7 Quarry Restoration Phase II

Work Package 529, Task B (WP-529B) was the second phase of restoring the quarry and was labeled Quarry Restoration Phase II. The WP-529B subcontract consisted of the following tasks:

1. Demolition of both contaminated and uncontaminated sections of the Quarry Interceptor Trench.
2. Mixing of contaminated sediment in EP-2 with absorbent material and placing the mixture into contractor provided shipping containers.
3. Removal and disposal of contaminated and uncontaminated sections of HDPE liner from EP-1 and EP-2.
4. Demolition of the effluent pipeline pumps, pedestals, electrical control boards, and outfall structure at the Missouri River. Grouting of the effluent pipeline at the Quarry input and at the output ends.
5. Removal and disposal of all underground piping, utilities, tanks and overhead electrical utilities.
6. Milling, hauling, and stockpiling of the Quarry asphalt.
7. Removal of the Quarry well field borrow area access ramp.
8. Removal of designated equipment as surplus property and transport of the equipment to the GFE yard.
9. Preparation of conex boxes and trailers 42, 21, 23 and 15 for re-location from the job-site.
10. Excavation, conditioning, hauling, placing, compacting and testing of soils from the western section of the Quarry to the inner Quarry.
11. Final grading and seeding of all excavated areas.

12. Construction of a section of the Hamburg trail through the quarry area.

Remediation activities began on April 24, 2002 and were completed by September 6, 2002. Trailers 42, 23, 15, and 21 were all prepared for re-location. Trailers 42 and 23 were moved to the old Highway 94 asphalt on the north end of the quarry and were used as office/break trailers during WP-529B (Quarry Restoration Phase II) remediation activities. Trailers 15 and 21 were re-located to the Chemical plant site. The trailers were moved so that the area could be used as a borrow source for the backfilling of the inner quarry. All underground utilities, storage tanks, and aboveground structures associated with prior quarry operations were either salvaged or disposed (Figure 3-11).




NOTES

1. CONTAMINATED OR SUSPECT MATERIALS SHALL BE TRANSPORTED SEPARATELY FROM UNCONTAMINATED MATERIALS.
2. "CLEAN" UNDERGROUND UTILITIES MAY LIE WITHIN THE "AFFECTED" ENVELOPE OF CONTAMINATED UTILITIES. "CLEAN" UTILITIES IN THIS VICINITY SHALL BE CONSIDERED SUSPECT.
3. "CLEAN" DEMOLITION WASTE SHALL BE DISPOSED OF IN A LICENSED LANDFILL APPROPRIATE FOR THE TYPE OF WASTE TO BE DISPOSED OF.
4. SEE GENERAL NOTES AND ABBREVIATIONS ON SHEET 3089E-QY-3198.
5. PROTECT ALL MONITORING WELLS AND BENCH MARKS DURING CONSTRUCTION AND DEMOLITION.

LEGEND

- XXXXX - REMOVE CLEAN
- ///// - REMOVE CONTAMINATED (PIPE DEPTHS CAN BE FOUND ON REFERENCE DRAWINGS)
- -x— - FENCE
- ⊗ - MONITORING WELL
- - - — - OVERHEAD ELCETRIC
- —T— - TELEPONE LINE
- —C— - CONTROL CABLE
- CO • - CLEAN OUT
- XX-SS - SANITARY SEWER
- XX-D - DRAIN LINE
- XX-T - TREATED WATER LINE
- XX-IT - INTERCEPTOR TRENCH

N

# WP-529B STRUCTURES & UNDERGROUND UTILITIES DEMOLITION

## FIGURE 3-11

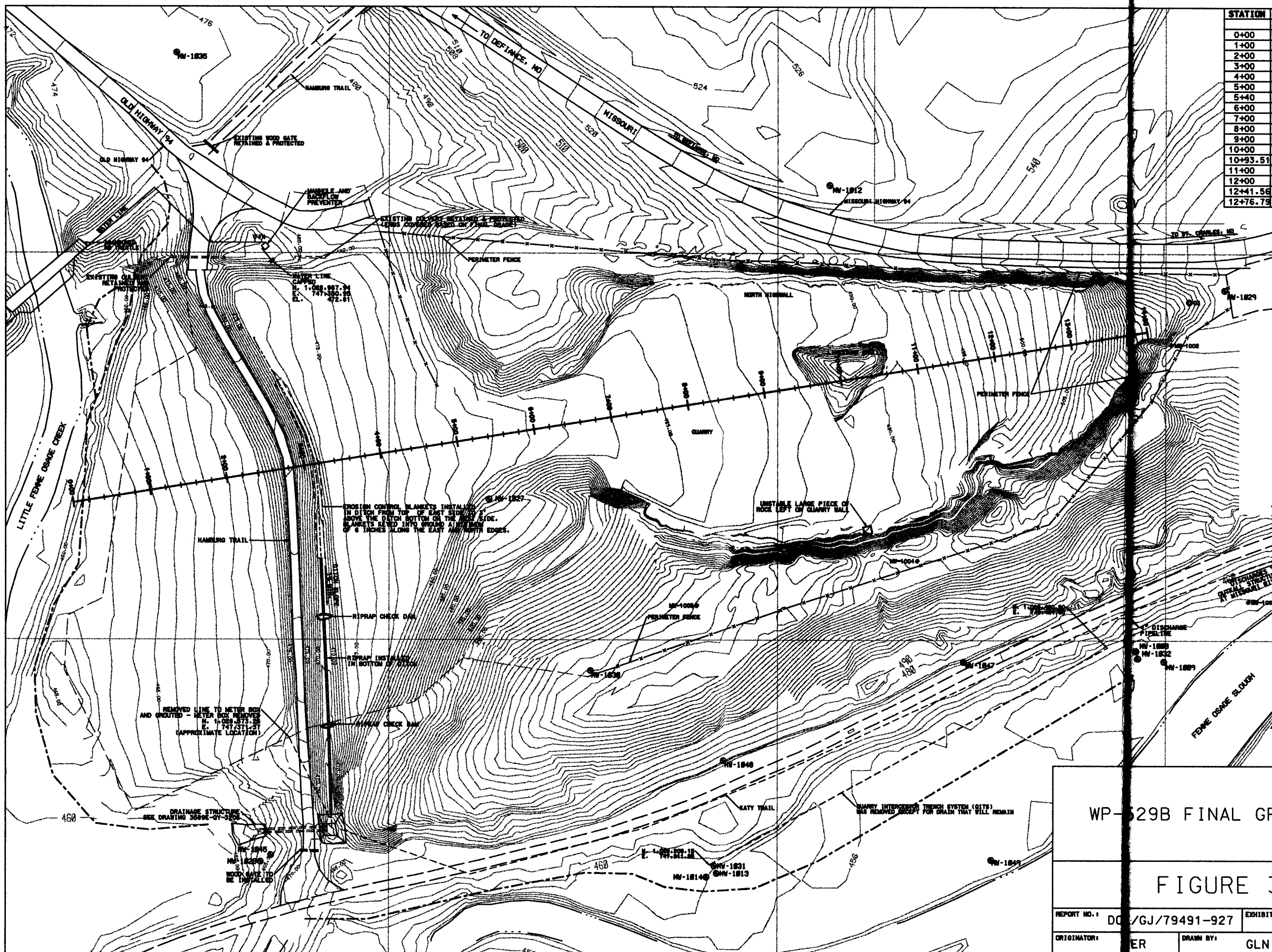
| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/023/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/22/02 | |

Upon completion of the trailer re-location, the access ramp into the well field borrow area was removed. This access ramp was constructed under WP-551A (Quarry Restoration) and kept in place at the request of the Missouri Department of Conservation. The aggregate surface of the access ramp was graded into the eastern side of the Little Femme Osage Creek levee. Soil beneath the aggregate was used to cover the rock and graded to blend in with the existing levee. The steel plates placed over the Explorer pipeline were removed and transported to the surplus material staging area at the Chemical plant. After the access ramp had been restored, the subcontractor proceeded to mill uncontaminated asphalt leading from the Quarry parking lot gate to the inner quarry. Approximately 700 $yd^3$ of milled asphalt was transported up Highway 94 to a designated staging area at the chemical plant borrow area.

Prior to the backfilling of the inner quarry, accumulated storm water was pumped out of both the inner quarry sump and effluent pond 2. As the water was being removed, the western perimeter fence was taken down and the area from the fence to the Little Femme Osage Creek was cleared and grubbed. Erosion control measures were initiated and maintained until completion of the fieldwork. Hauling activities began on May 30, 2002, and were completed on August 20, 2002. As shown on Figure 3-12, a majority of the area west of station 6+53.26 was designated as borrow material. Soil in this area was excavated with Caterpillar 95E Challengers pulling dual 15 $yd^3$ scraper pans. The excavated material was transported into the inner quarry and compacted beginning at station 12+41.56. The subcontractor worked their way westward as the subcontract-specified elevation was achieved. Approximately 62,000 $yd^3$ of fill material was excavated from the designated quarry cut areas, transported to the inner quarry, placed and compacted. Upon completion of the cut/fill activities, the area was hydroseeded and mulched with straw.

During soil placement activities, soil testing was performed by the subcontractor to determine soil compaction and moisture results. All testing performed during backfill activities conformed with ASTM D-4643, D-698, D-3017, and D-2216 testing methods. Quality assurance test results for WP-529B indicated that the soil placement met the established subcontract requirements. A summary of the testing results is provided in Appendix B.

On April 26, 2002, the Quarry Interceptor Trench Field study was completed. With the completion of the study, the need for the treatment of contaminated water at the quarry was eliminated. All remaining water in EP-2 was pumped out of the pond, treated, placed in EP-1, and then discharged to the Missouri River after testing. Prior analysis of the sediment on the bottom of EP-2 had shown it to exceed background levels for radioactivity. Per Missouri Department of Natural Resource regulation 10 CSR 80-3.010(3)(A)2.B, the sediment could not be disposed of in a Missouri sanitary landfill and was targeted for disposal at U.S. Ecology near Grand View, Idaho.




| STATION | GRADE ELEVATION | | |
|---|---|---|---|
| | EXISTING | FINAL | CUT/FILL |
| 0+00 | 460.00 | 459.37 | CUT |
| 1+00 | 473.54 | 464.88 | CUT |
| 2+00 | 472.46 | 469.07 | CUT |
| 3+00 | 482.90 | 474.70 | CUT |
| 4+00 | 482.00 | 476.96 | CUT |
| 5+00 | 482.00 | 480.09 | CUT |
| 5+40 | 482.42 | 480.91 | CUT |
| 6+00 | 483.21 | 482.21 | CUT |
| 7+00 | 480.09 | 483.99 | FILL |
| 8+00 | 471.69 | 485.52 | FILL |
| 9+00 | 474.00 | 487.17 | FILL |
| 10+00 | 509.88 | 489.58 | FILL |
| 10+93.51 | 479.88 | 491.34 | FILL |
| 11+00 | 479.98 | 491.58 | FILL |
| 12+00 | 486.02 | 497.35 | FILL |
| 12+41.56 | 497.21 | 500.16 | FILL |
| 12+76.79 | 502.00 | 502.27 | FILL |

LEGEND
N.I.S. - NOT IN SCOPE
- - - - - SILT FENCE (TO REMAIN AFTER CONTRACT)

WP-529B FINAL GRADING PLAN

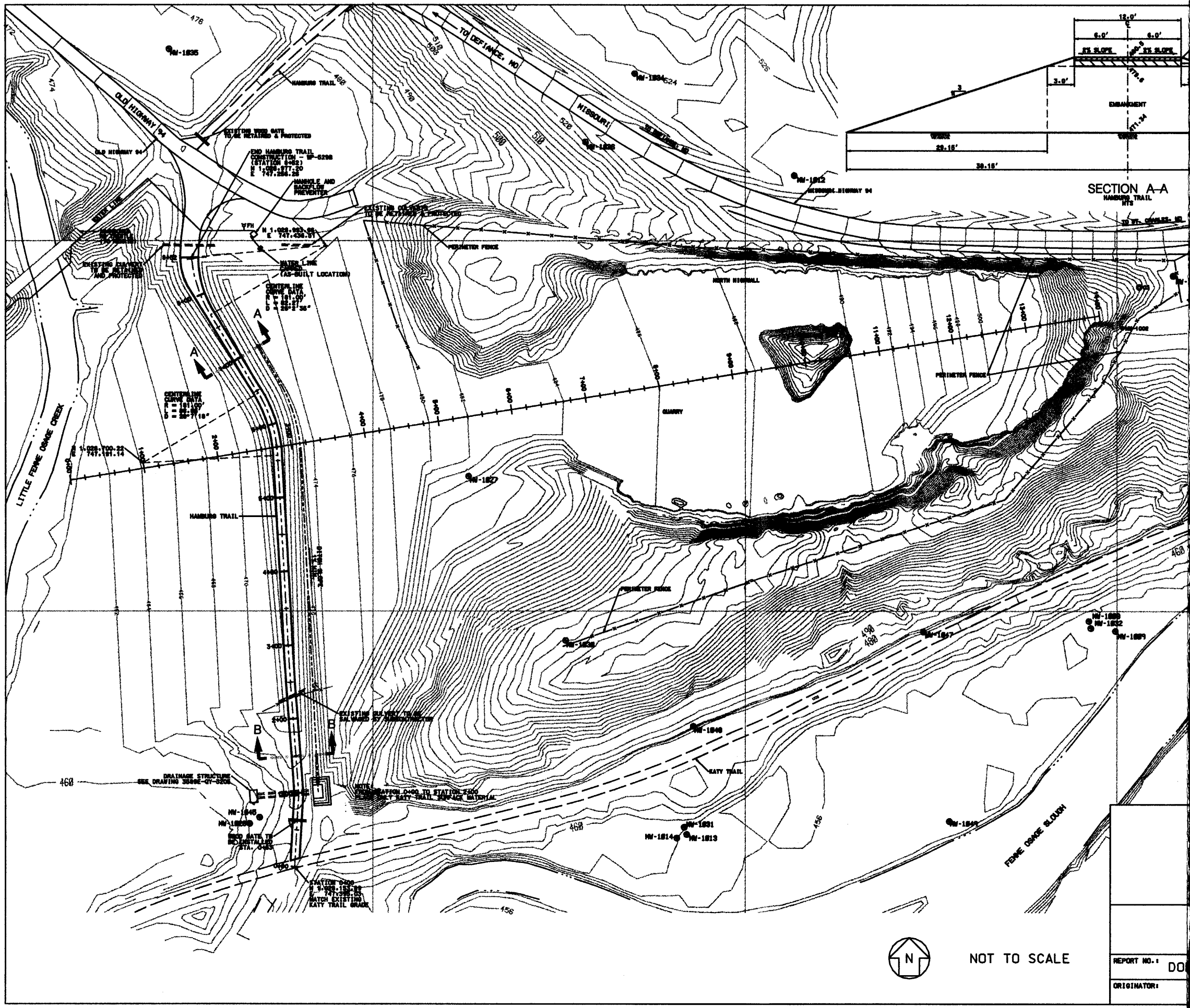
FIGURE 3-12

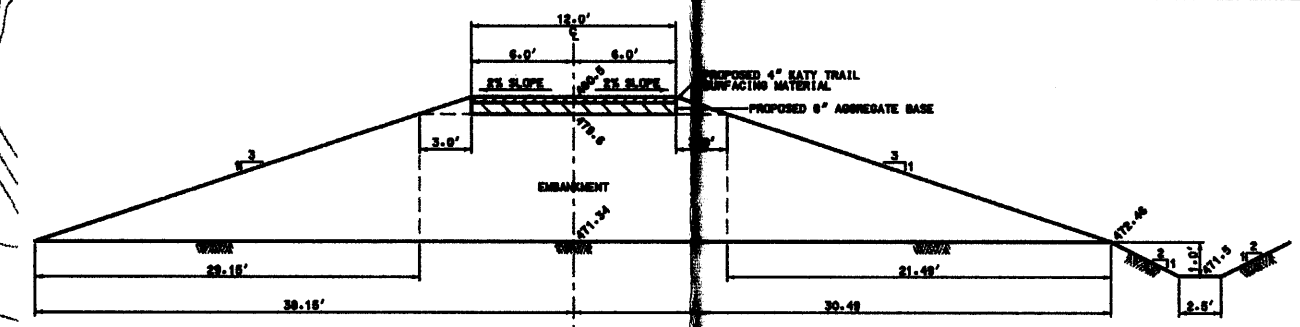
| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/024/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

After the water had been removed from EP-2, the WP-529B subcontractor began solidifying the sediment with the subcontract required "Waterworks" absorbent. Enough absorbent material was added to the sediment so that the mixture passed the EPA SW-846 Method 9095A Paint Filter Test ensuring no free liquids. The material was then loaded into 24 $yd^3$ intermodal containers and staged for transport. Upon completion of the sediment solidification, the 60-mil HDPE liner was removed from EP-2. The liner material that was determined to be at background levels was disposed of in a sanitary landfill and liner material exceeding background levels was shipped to U.S. Ecology. Approximately 91 $yd^3$ of EP-2 sediment and 20 $yd^3$ of HDPE liner were transported to U.S. Ecology for disposal. In contrast, the majority of EP-1 liner was determined to be at background levels and was disposed of in a sanitary landfill. Less than 1 $yd^3$ of EP-1 liner was above background and transported to U.S. Ecology for disposal. Walkover surveys and confirmation sampling were performed on EP-2 after the liner had been removed. Once it was determined that the soil beneath EP-2 met criteria for release (Section 3.9), the soil was excavated, transported to the inner quarry, and compacted as fill material.

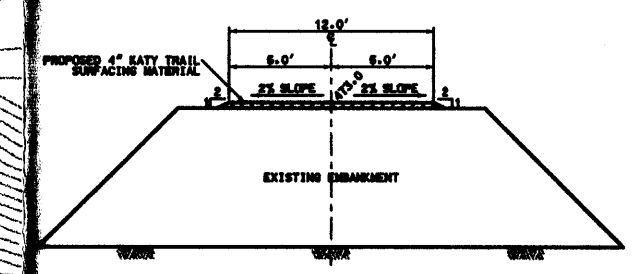
The demolition of the Quarry Interceptor Trench (QITS) began on May 13, 2002, and was completed by July 3, 2002. Approximately 1060 linear ft. of double-walled HDPE piping (2 in./4 in.) and 925 linear ft. of 1 ¼ in. HDPE piping was excavated, sized, and transported to U.S. Ecology for disposal. Additional QITS contaminated waste disposed under WP-529B included: QITS pumps (4), well casings, and sections of the north and south valve vaults. QITS waste at background levels and disposed of in a sanitary landfill included: QITS electrical control panels, wiring/conduit, bollards, and sections of the north and south valve vaults. Upon removal of the 1 ¼ in. QITS piping, walkover surveys were conducted on soil beneath the piping. All survey results were at background levels. No confirmation sampling was performed and the trenches were backfilled after completion of the walkover surveys. No confirmation sampling was performed beneath the double-walled HDPE piping because the piping leak detection ports had never shown evidence of a leak, the piping passed an integrity test after operations, and the piping was flushed prior to demolition.

On August 4, 1999, the construction of a trail connecting the historic Katy Trail to the August A. Busch Memorial Conservation Area was agreed upon in a proclamation letter signed by the Department of Energy, Missouri Department of Conservation, and Missouri Department of Natural Resources. The trail was named the Hamburg Trail and the construction of the trail from the Katy Trail to the beginning of the old Quarry Haul Road was included into the WP-529B subcontract (Figure 3-13). Construction on the WP-529B section of trail began on July 17, 2002 and was completed by August 30, 2002. Fill material was used in sections of the trail to bring the base up to the required elevation. After the required elevation of the base was achieved, 8 in. of compacted ¾ in. clean rock was placed as the sub-base. Four inches of compacted 3/8 in. pug material was then used for the Hamburg Trail surface. A drainage ditch along the eastern end of the Hamburg Trail and two 24 in. steel culverts in the southern section of the trail were installed for surface water drainage purposes.




SECTION A–A
HAMBURG TRAIL
NTS




SECTION B–B
HAMBURG TRAIL
NTS

NOTES

1. THE PROPOSED 24" CMP HAS 2.0% SLOPE.
2. UNSUITABLE/WET SUPERFICIAL MATERIAL SHALL BE REMOVED TO MINIMUM DEPTH OF 6-INCHES IN THE BOTTOM OF THE PIPES AND AREA MUST BE REPLACED BY SUITABLE MATERIAL COMPACTED TO 90% OF THE MAXIMUM DENSITY OBTAINED BY ASTM D-698 AT MOISTURE CONTENT OF -2% TO +4% OPTIMUM MOISTURE.
3. ALL WORK ON THAT PORTION OF SUBGRADE (FILL AREA), ON WHICH THE BASE IS TO BE CONSTRUCTED SHALL BE COMPACTED TO NOT LESS THAN 90% OF STANDARD MAXIMUM DENSITY OBTAINED BY ASTM D-698 AT MOISTURE CONTENT OF -2% TO +4% OPTIMUM MOISTURE.
4. THE MAXIMUM COMPACTED THICKNESS OF ANY LAYER (AGGREGATE BASE, SURFACING) SHALL NOT EXCEED 6-INCHES WITH A MINIMUM OF 4-PASSES COVERAGE OF SMOOTH-DRUM, WITH A MINIMUM OPERATING WEIGHT OF 10-TONS AND A SPEED NOT TO EXCEED 5 MILES PER HOUR.
5. AGGREGATE BASE SHALL MEET THE FOLLOWING GRADIATION ACCORDING TO ASTM D-422.

| U.S. STANDARD SIEVE SIZE (SQUARE OPENINGS) | PERCENT PASSING (BY WEIGHT) |
|---|---|
| ¾ in | 100 |
| ⅜ in | 30-60 |
| ⅜ in | 5-10 |

6. AGGREGATE BASE AND AGGREGATE SURFACE SHALL BE PLACED TO LINE AND GRADE. (SEE THE PROFILE AND CROSS-SECTION FOR MORE DETAILS).
7. THE DESIGNED DITCH SHALL BE STARTED AT STA. 7+00 ALONG THE HAMBURG TRAIL WITH 1% SLOPE TO CARRY THE WATER FLOW TO THE CULVERTS AT STA. 1+00.
8. THE DESIGNED DITCH AT STA. 7+00 HAS A WIDTH OF 2.5', DEPTH OF 1.0', AND SIDE SLOPE OF 2:1. (SEE THE CROSS-SECTION FOR MORE DETAILS).
9. WOOD GATE SHALL BE INSTALLED AT STA. 0+63. (SEE THE DRAWING FOR MORE DETILS).
10. ALL THE SIDE SLOPES FOR THE EMBANKMENT AND THE DITCH, INCLUDING THE BOTTOM OF THE DITCH, SHALL BE SEEDED IN ACCORDANCE WITH SPECIFICATION 0250 – SECTION 02480.
11. WOOD TRAIL GATE AT STA. 0+63 TO BE PROVIDED BY CONTRACTOR.

WP-529B SECTION OF HAMBURG TRAIL

FIGURE 3-13

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: B/QY/025/0902 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

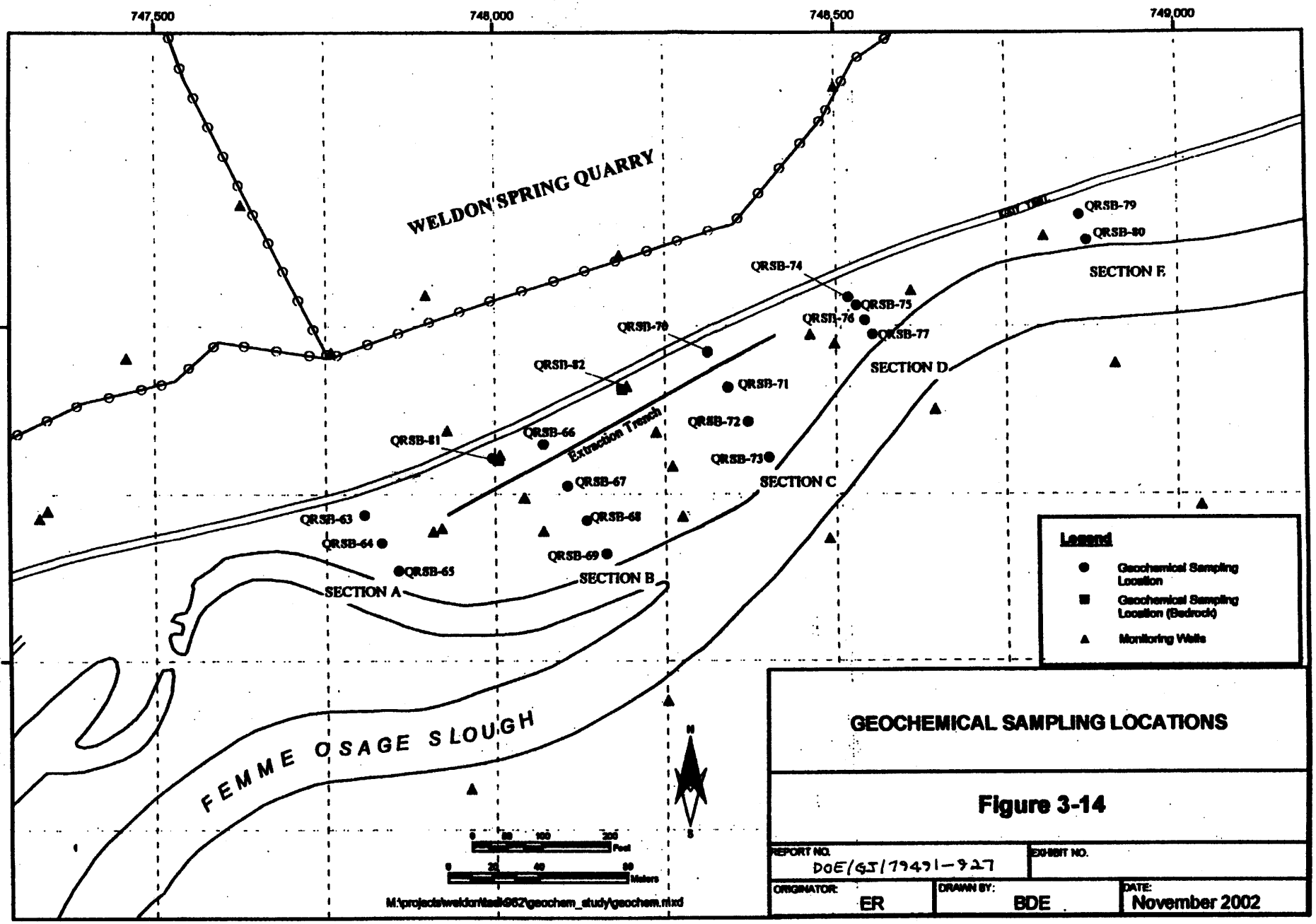
## 3.8 Geochemical Characterization Field Study in Support of the QROU ROD

Drilling, temporary well installation, and soil and groundwater testing were conducted in the area of uranium impact north of the Femme Osage Slough from October 25, 2001 through November 21, 2001. Sampling activities were performed under WP-533, Subsurface Drilling Services. Soil sampling was conducted at 17 borehole locations, and 21 temporary wells were installed, tested, and sampled during that period (Figure 3-14). Drilling and testing were performed to meet the following objectives.

- Evaluate the groundwater geochemistry north of the Femme Osage Slough, emphasizing factors that influence the attenuation of uranium in groundwater.
- Estimate the uranium distribution coefficients for the alluvial and bedrock aquifer materials north of the slough.
- Characterize the oxidation state of groundwater throughout the alluvial aquifer and define the boundary of the reducing zone north of the slough.
- Determine the distribution of precipitated uranium across the reducing front.

The study achieved the objective of determining and quantifying the mechanisms attenuating uranium in the groundwater north of the slough. Oxidation state and redox-sensitive parameter data defined the oxidizing and reducing zones of alluvial aquifer and the boundary between them. Distribution coefficients were determined from depth-discrete sampling data to determine the sorption/desorption capacity of the bedrock and soil aquifer materials. The distribution of uranium in soil across the reducing front was quantified where uranium was concentrated in a narrow band beneath the oxidized/reduced contact.

The results of the geochemical characterization provided a better understanding of the natural geochemistry of the alluvial aquifer north of the Femme Osage Slough and its impact on the fate of uranium contamination in groundwater. The area contains a naturally occurring oxidation/reduction front, which acts as a barrier to the migration of dissolved uranium by inducing its precipitation. These results confirm that the geochemical parameters measured in both the field and laboratory support the interpretations made during previous investigations. The physical and chemical parameters measured in groundwater samples were successfully correlated with the physical properties of the aquifer material and support the conceptual fate and transport model presented in the *QROU Remedial Investigation* (Ref. 2). Specific details of this geochemical characterization can be found in the *Completion Report for the Geochemical Characterization Performed in Support of the QROU Field Studies* (Ref. 18).




GEOCHEMICAL SAMPLING LOCATIONS

Figure 3-14

| REPORT NO. | EXHIBIT NO. | |
|---|---|---|
| DOE/GJ/79491-927 | | |
| ORIGINATOR: ER | DRAWN BY: BDE | DATE: November 2002 |

## 3.9 Post Remediation Sampling Results

The Quarry was broken down into two remedial units for soil confirmation activities. The first remedial unit encompassed the QWTP Equalization Basin and was designated as Remedial Unit 26 (RU026), Confirmation Unit 397 (CU397). Confirmation walkover surveys and soil sampling were conducted in accordance with the *Confirmation Sampling Plan Details for the Quarry Water Treatment Plant Equalization Basin* (Ref. 19). This plan was developed to ensure that goals established by the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 20) and the *RCRA Closure Plan* (Ref. 21) were accomplished, and to ensure that remediation requirements of the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Chemical Plant ROD) (Ref. 11) were met. Technically, the equalization basin was remediated under the Chemical Plant ROD but is discussed here for completeness.

The second remedial unit of the Quarry was designated as Remedial Unit 27 (RU027) and encompassed numerous small, noncontiguous confirmation units. Confirmation walkover surveys and soil sampling were conducted in accordance with the *Quarry Proper Confirmation Plan* (Ref. 22). Cleanup criteria detailed in the Chemical Plant ROD were specified in the QROU ROD and used in the *Quarry Proper Confirmation Plan* to ensure remaining soil concentrations met the applicable excavation design goals. Post-remedial sampling in the Quarry is summarized in Table 3-6 and the location of the confirmation units is illustrated in Figure 3-15.

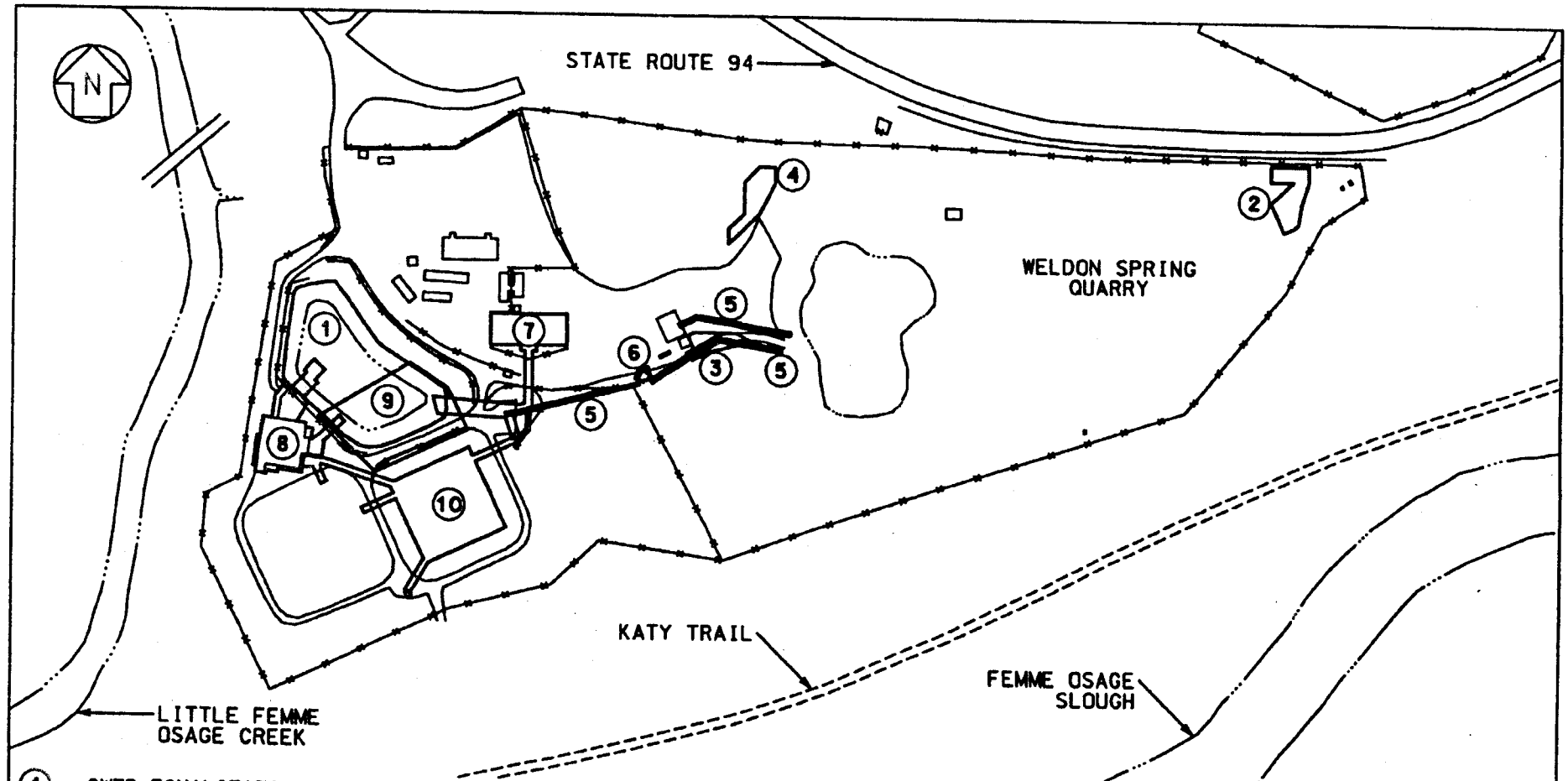
Table 3-6 Summary of Quarry Confirmation Units

| Quarry Area | Remedial Unit | Confirmation Unit Designation | Approximate Area ($m^2$) | Approximate Area ($ft.^2$) |
|---|---|---|---|---|
| QWTP Equalization Basin | RU026 | CU397 | 2,426.44 | 26,118.79 |
| Northeast Slope | RU027 | CU411 | 265.18 | 2,854.5 |
| Ditch Area | RU027 | CU412 | 150.57 | 1,620.77 |
| Snake Pit Area | RU027 | CU413 | 223.49 | 2,405.72 |
| Quarry Utility Trenches | RU027 | CU416 | 248.13 | 2,670.92 |
| Clarifier Pad Area | RU027 | CU417 | 24.57 | 264.46 |
| Decon Pad and Piping | RU027 | CU418 | 678.30 | 7,301.4 |
| QWTP Foundation and Piping | RU027 | CU419 | 691.61 | 7,444.62 |
| Laydown Area | RU027 | CU420 | 1,367.00 | 14,714.75 |
| Effluent Pond 2 and Piping | RU027 | CU421 | 1,415.06 | 15,232.06 |

After walkover surveys verified the entire CU to be less than 1.5 times background gamma radioactivity level, confirmation sampling locations were surveyed and identified with

pin flags. Sample locations were selected by superimposing a predetermined grid across the work zone. All grid intersections (nodes) and some center points that lie within the area targeted for contaminated soil removal were selected in order to obtain a sufficient sampling density in accordance with the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 20) for radiologic contaminants. Confirmation sampling was performed by collecting soil from the remediation cut surface to a depth of 6 in. for laboratory analysis.

The criteria for release of the CUs included specific not-to-exceed target levels, hot-spot evaluation procedures, average data target levels, and cumulative data goals. If both Ra-226 and Ra-228 parameters are present in the soil sample, the sum of the concentrations must be compared to the cleanup criteria level. Confirmation results and additional specific confirmation information are detailed in the *Post-Remedial Action Report for the Quarry Water Treatment Plant Equalization Basin (RU026)* (Ref. 23) and the *Post-Remedial Action Report for the Quarry Proper Area* (RU027) (Ref. 24).




(1) - QWTP EQUALIZATION BASIN (RU026; CU397)
(2) - NORTHEAST SLOPE (RU027; CU411)
(3) - DITCH AREA (RU027; CU412)
(4) - SNAKE PIT AREA (RU027; CU413)
(5) - UTILITY TRENCHES (RU027; CU416)
(6) - CLARIFIER PAD (RU027; CU417)
(7) - DECON PAD AND PIPING (RU027; CU418)
(8) - QWTP FOUNDATION AND PIPING (RU027; CU419)
(9) - LAYDOWN AREA (RU027; CU420)
(10) - EP2 AND PIPING (RU027; CU421)

0 200 400
SCALE FEET

CONFIRMATION SAMPLING LOCATIONS AT THE WELDON SPRING QUARRY

FIGURE 3-15

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/035/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

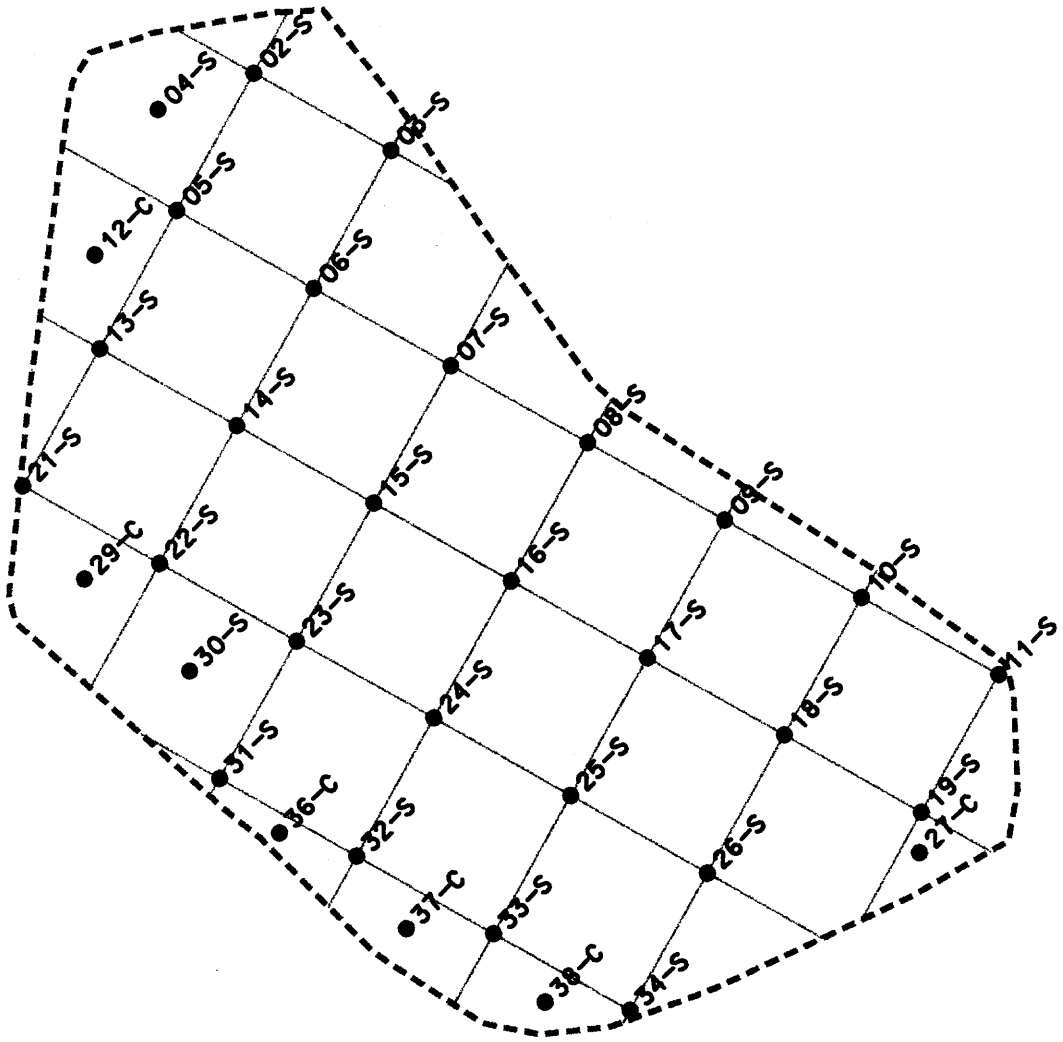
### 3.9.1 QWTP Equalization Basin Cleanup Confirmation

Based upon the review of contaminants identified during water treatment activities and those required in the *RCRA Closure Document* (Ref. 21), specific contaminants were selected for confirmation sampling. The contaminants identified for the QWTP Equalization Basin included: arsenic, chromium, lead, 2,4,6-trinitrotoluene (2,4,6-TNT), 2,4-dinitrotoluene (2,4-DNT), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), Uranium-238 (U-238), Radium-226 (Ra-226), Radium-228 (Ra-228), Thorium-230, (Th-230), and Thorium-232 (Th-232). Sample locations for the confirmation unit are detailed in Figure 3-16. As summarized in Table 3-7, all average parameter concentrations were below the ALARA goal concentration and no single sample data point exceeded cleanup criteria concentration for any of the parameters. The entire confirmation unit was released for unrestricted use on February 21, 2001 (Ref. 23).

Table 3-7 QWTP Equalization Basin Analytical Results Summary (CU397)

| Contaminant of Concern | Concentration Range | Concentration Average | Surface ALARA Goal Concentration | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > ALARA |
|---|---|---|---|---|---|---|
| Arsenic (mg/kg) | 5.8 – 22.1 | 9.58 | 45 | 22.1 | 75 | 0 |
| Chromium (mg/kg) | 12.7 – 21.1 | 16.77 | 90 | 21.1 | 100 | 0 |
| Lead (mg/kg) | 11.6 – 20.3 | 14.67 | 240 | 20.3 | 450 | 0 |
| 2,4,6-TNT (mg/kg) | Results < D.L. | N/A | 14 | N/A | 140 | 0 |
| 2,4-DNT (mg/kg) | Results < D.L. | N/A | 7.5 | N/A | 55 | 0 |
| PAHs (mg/kg) | 0 – 0.040 | 0.001 | 0.44 | 0.040 | 6.5 | 0 |
| PCBs (mg/kg) | 0 – 0.072 | 0.002 | 0.65 | 0.072 | 8 | 0 |
| Ra-226 (pCi/g) | 0.85 – 1.25 | 1.06 | 5.0 | 1.25 | 6.2 | 0 |
| Ra-228 (pCi/g) | 0.40 – 1.48 | 1.11 | 5.0 | 1.48 | 6.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 1.36 – 2.53 | 2.16 | 5.0 | 2.53 | 6.2 | 0 |
| Th-230 (pCi/g) | 1.09 – 2.02 | 1.48 | 5.0 | 2.02 | 6.2 | 0 |
| Th-232 (pCi/g) | 0.41 – 1.52 | 1.14 | 5.0 | 1.52 | 6.2 | 0 |
| U-238 (pCi/g) | 1.04 – 2.46 | 1.22 | 30 | 2.46 | 120 | 0 |

D.L. = Detection Limit




N

● - SAMPLE POINT

0 40 80

SCALE FEET

CONFIRMATION SAMPLING LOCATIONS AT THE EQUALIZATION BASIN (RU026; CU397)

FIGURE 3-16

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/028/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

### 3.9.2 Northeast Slope

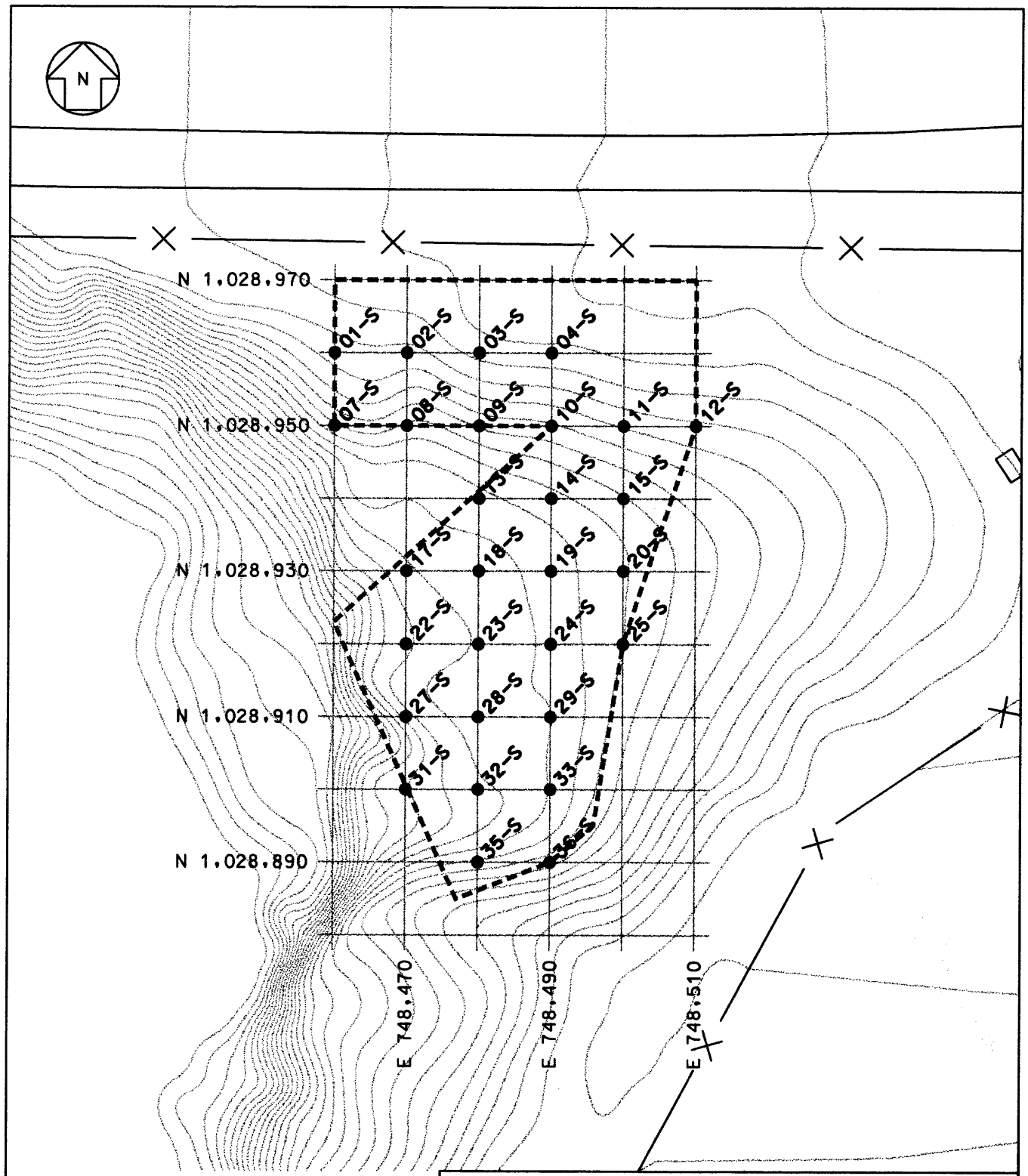
Prior characterization activities had limited the contaminants for the Quarry Northeast Slope (CU 411) to Ra-226, Ra-228, Th-230, and U-238. A total of 29 samples were taken from the Northeast Slope and are illustrated in Figure 3-17. Surface cleanup criteria were used for the northeast slope area because of the greater potential for erosion that could cause soils to be exposed after restoration was completed. As detailed in Table 3-8, the area did not satisfy confirmation unrestricted release criteria. The area contained more than 5 hotspots and 2 of the hotspots exceeded three times cleanup criteria. Additional excavation could not be performed; however, because the hotspots were located on bedrock and not soil. The samples had been collected by removing soil from crevices and picking up dirt clods within an approximate 3 ft. radius of the sample location. The ALARA committee met to discuss remediation options including vacuuming or pressure washing the crevices. In accordance with the principles established in the *Chemical Plant Area Cleanup Attainment Confirmation Plan*, the committee agreed that while the cleanup concentrations were not obtained, the ALARA principle had been met. A unanimous decision was made by the committee that no further remedial action was required and the area could be backfilled (Appendix C). The confirmation unit (CU411) was released on August 24, 2000.

Table 3-8 Northeast Slope Analytical Results Summary (CU411)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.59 – 12.67 | 1.89 | 12.67 | 6.2 | 1 |
| Ra-228 (pCi/g) | 0.91 – 9.87 | 1.85 | 9.87 | 6.2 | 1 |
| Combined Ra-226 & Ra-228 (pCi/g) | 2.00 – 22.54 | 3.74 | 22.54 | 6.2 | 3 |
| Th-230 (pCi/g) | 1.27 – 77.9 | 8.93 | 77.9 | 6.2 | 6 |
| U-238 (pCi/g) | 0.28 – 3.91 | 1.67 | 3.91 | 120 | 0 |

### 3.9.3 Quarry Ditch Area

Contaminants targeted within the Quarry Ditch area (CU412) were: Ra-226, Ra-228, Th-230, and U-238. Subsurface cleanup criteria were used because the area would be backfilled with more than 2 ft of backfill after the confirmation unit was released. A total of 25 samples were taken within CU412 and the sample locations are illustrated in Figure 3-18. As detailed in Table 3-9, no single sample data point exceeded cleanup criteria concentration for any of the parameters. The confirmation unit (CU412) was released for unrestricted use on August 16, 2000.




CONFIRMATION SAMPLING LOCATIONS
AT THE NORTHEAST SLOPE
(RU027; CU411)

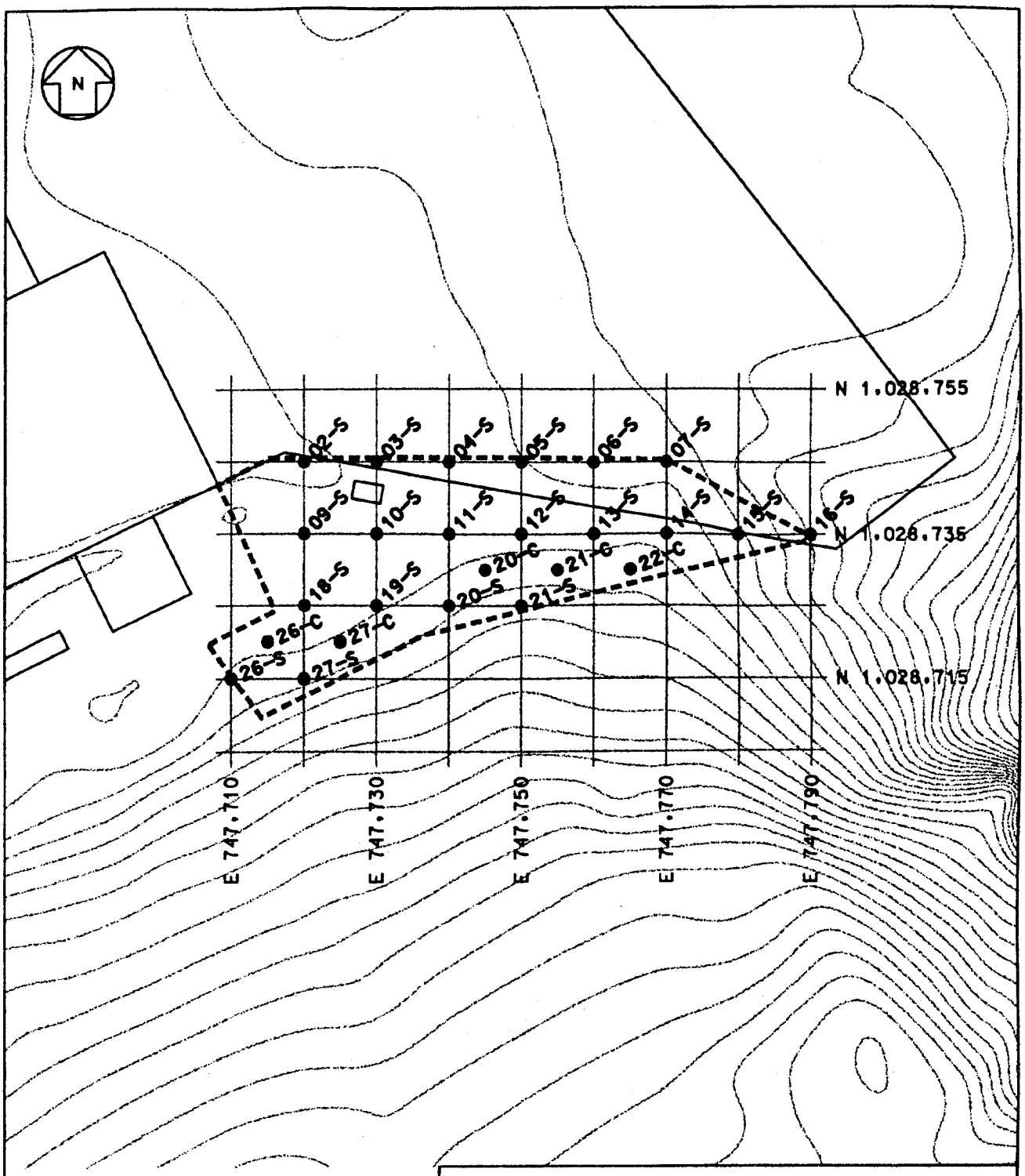
● - SAMPLE POINT

0 20 40

SCALE FEET

FIGURE 3-17

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/029/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/27/02 | |




● - SAMPLE POINT

0 20 40

SCALE FEET

CONFIRMATION SAMPLING LOCATIONS
AT THE DITCH AREA
(RU027; CU412)

FIGURE 3-18

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/030/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

Table 3-9 Quarry Ditch Area Analytical Results Summary (CU412)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Subsurface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.87 – 7.91 | 1.89 | 7.91 | 16.2 | 0 |
| Ra-228 (pCi/g) | 0.29 – 2.77 | 1.00 | 2.77 | 16.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 1.37 – 8.83 | 2.88 | 8.83 | 16.2 | 0 |
| Th-230 (pCi/g) | 1.59 – 13.2 | 4.84 | 13.2 | 16.2 | 0 |
| U-238 (pCi/g) | 0.50 – 10.10 | 3.91 | 10.10 | 120 | 0 |

### 3.9.4 Snake Pit Area

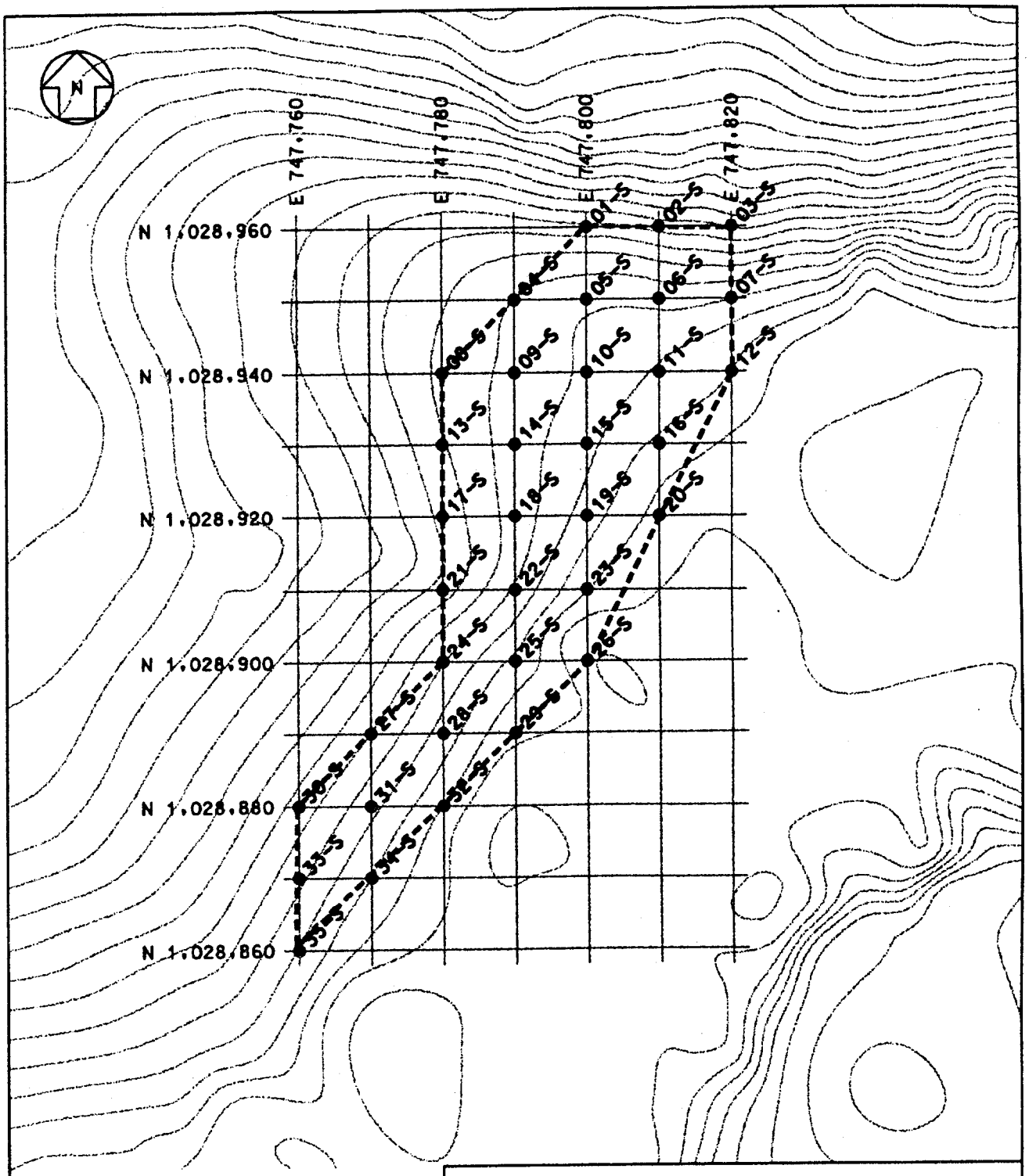
Prior characterization activities of the Snake Pit area had determined the contaminants to be: Ra-226, Ra-228, Th-230, and U-238. Because the area would be backfilled with more than 2 ft of soil upon release, subsurface cleanup criteria were used. A total of 35 samples were taken of the Snake Pit area and are illustrated in Figure 3-19. As summarized in Table 3-10, two of the 35 sample locations exceeded the subsurface cleanup criteria for Th-230 (16.2 pCi/g). According to the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 20), no radiological hot spot can be greater than 25 $m^2$ in surface area and must be less than three times the cleanup criteria level for that parameter. Both hot spots were estimated to be approximately 4.6 $m^2$ in area and were less than three-times the cleanup criteria. In accordance with the cleanup attainment guidelines, the confirmation unit (CU413) was released on July 31, 2000.

Table 3-10 Snake Pit Analytical Results Summary (CU413)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Subsurface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.24 – 1.43 | 0.70 | 1.43 | 16.2 | 0 |
| Ra-228 (pCi/g) | 0.32 – 1.19 | 0.61 | 1.19 | 16.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 0.57 – 2.30 | 1.31 | 2.30 | 16.2 | 0 |
| Th-230 (pCi/g) | 0.78 – 17.74 | 2.80 | 17.74 | 16.2 | 2 |
| U-238 (pCi/g) | 0.85 – 1.49 | 1.05 | 1.49 | 120 | 0 |

### 3.9.5 Quarry Utility Trenches

Contaminants targeted within the Utility Trench area (CU416) were: Ra-226, Ra-228, Th-230, and U-238. Subsurface cleanup criteria were used because the trenches would be greater than 2 ft below the ground surface upon completion of quarry restoration. A total of 32 samples were to be taken within CU416. During remediation activities, it was discovered




● - SAMPLE POINT

0 20 40

SCALE FEET

CONFIRMATION SAMPLING LOCATIONS
AT THE SNAKE PIT AREA
(RU027; CU413)

FIGURE 3-19

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/031/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

that contaminated lines leading into the Quarry sump were in bedrock trenches. Soil was not present in the bottom of the trenches nor the sidewalls. Sample locations 26 through 32 were deleted from the confirmation unit and a total of 25 locations were sampled. Under WP-505X, sections of CU416 were partially released on August 5th and 16th, 2000. The entire confirmation unit was released on April 24, 2001 under WP-553A. Sample locations and the analytical data are summarized in Figure 3-20 and Table 3-11.

Table 3-11 Quarry Utility Trenches Analytical Results Summary (CU416)

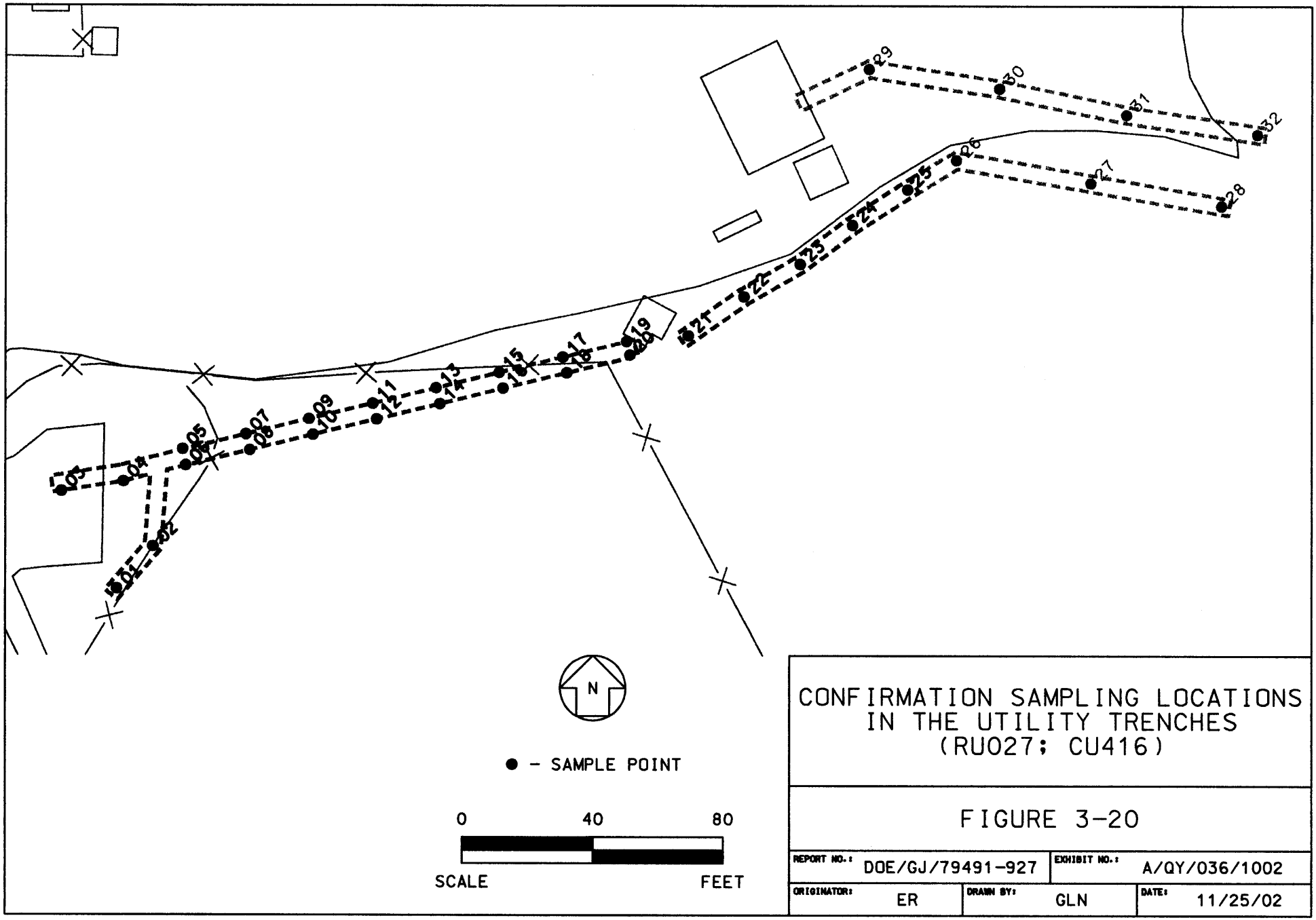
| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Subsurface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.64 – 1.54 | 0.97 | 1.54 | 16.2 | 0 |
| Ra-228 (pCi/g) | 0.39 – 1.93 | 1.11 | 1.93 | 16.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 1.38 – 3.26 | 2.08 | 3.26 | 16.2 | 0 |
| Th-230 (pCi/g) | 1.02 – 5.48 | 2.22 | 5.48 | 16.2 | 0 |
| U-238 (pCi/g) | 0.07 – 2.56 | 1.43 | 2.56 | 120 | 0 |

### 3.9.6 Clarifier Pad Area

During WP-505X remediation activities, the concrete clarifier pad was removed as contaminated material. Walkover surveys performed after removal of the pad identified two areas exceeding 1.5 times site-specific background levels. It was determined that Ra-226, Ra-228, Th-230, and U-238 were the contaminants selected for confirmation. Subsurface criteria was selected because the area was to be backfilled with more than two feet of clean soil upon release. The area was designated as confirmation unit 417 (CU417) and a total of 25 samples were taken as illustrated in Figure 3-21. As shown in Table 3-12, no single sample data point exceeded cleanup criteria concentration for any of the parameters. The confirmation unit was released on August 2, 2000.

Table 3-12 Clarifier Pad Analytical Results Summary (CU417)

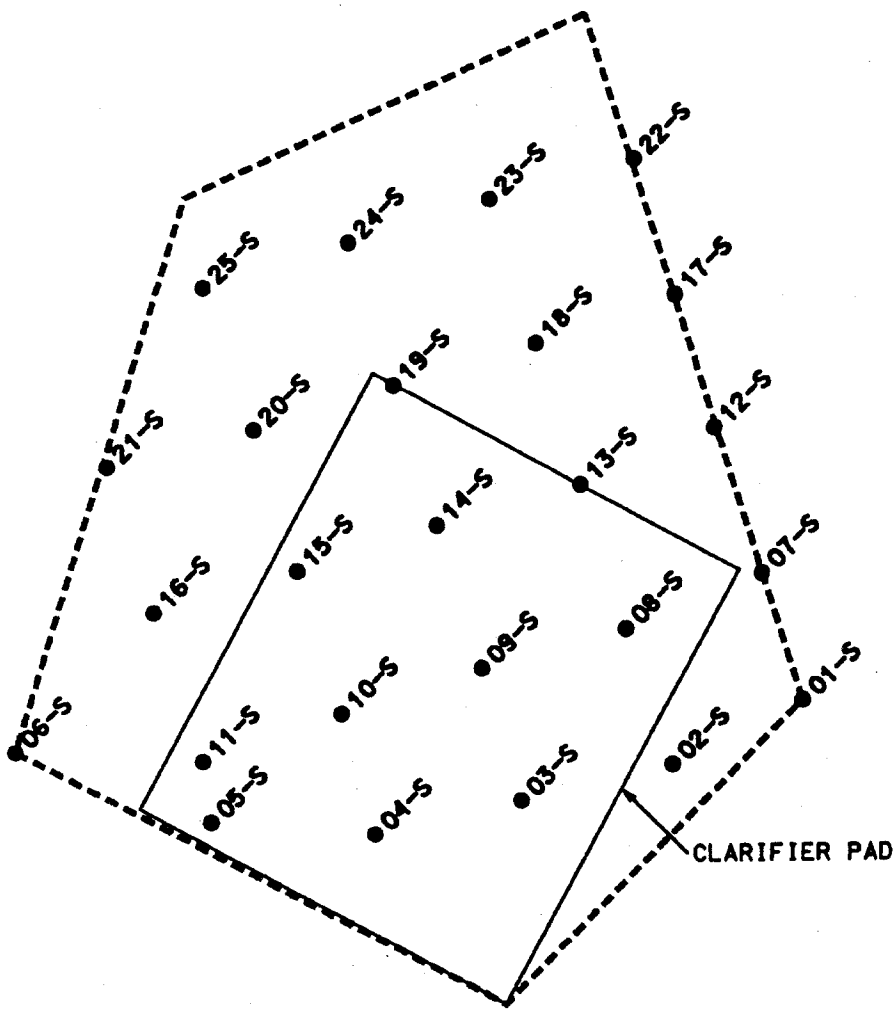
| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Subsurface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.47 – 1.48 | 0.80 | 1.48 | 16.2 | 0 |
| Ra-228 (pCi/g) | 0.44 – 1.76 | 0.83 | 1.76 | 16.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 0.92 – 3.18 | 1.63 | 3.18 | 16.2 | 0 |
| Th-230 (pCi/g) | 0.86 – 3.09 | 1.73 | 3.09 | 16.2 | 0 |
| U-238 (pCi/g) | 0.47 – 4.29 | 1.72 | 4.29 | 120 | 0 |




CONFIRMATION SAMPLING LOCATIONS
IN THE UTILITY TRENCHES
(RU027; CU416)

FIGURE 3-20

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/036/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |




N

● - SAMPLE POINT

0 5 10

SCALE FEET

CONFIRMATION SAMPLING LOCATIONS IN THE CLARIFIER PAD AREA (RU027; CU417)

FIGURE 3-21

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/037/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

### 3.9.7 Decontamination Pad and Piping

Based on the sampling results of the quarry decontamination pad, the contaminants selected for confirmation purposes were: Ra-226, Ra-228, Th-230, and U-238. Because the area (CU418) was to be more than 2 ft below ground surface upon completion of quarry restoration, subsurface cleanup criteria were used. A total of 27 samples were taken after the decontamination pad and its associated piping was removed (Figure 3-22). As detailed in Table 3-13, no single sample data point exceeded cleanup criteria concentration for any of the parameters. The confirmation unit (CU418) was released on May 1, 2001.

Table 3-13 Decontamination Pad/Piping Analytical Results Summary (CU418)

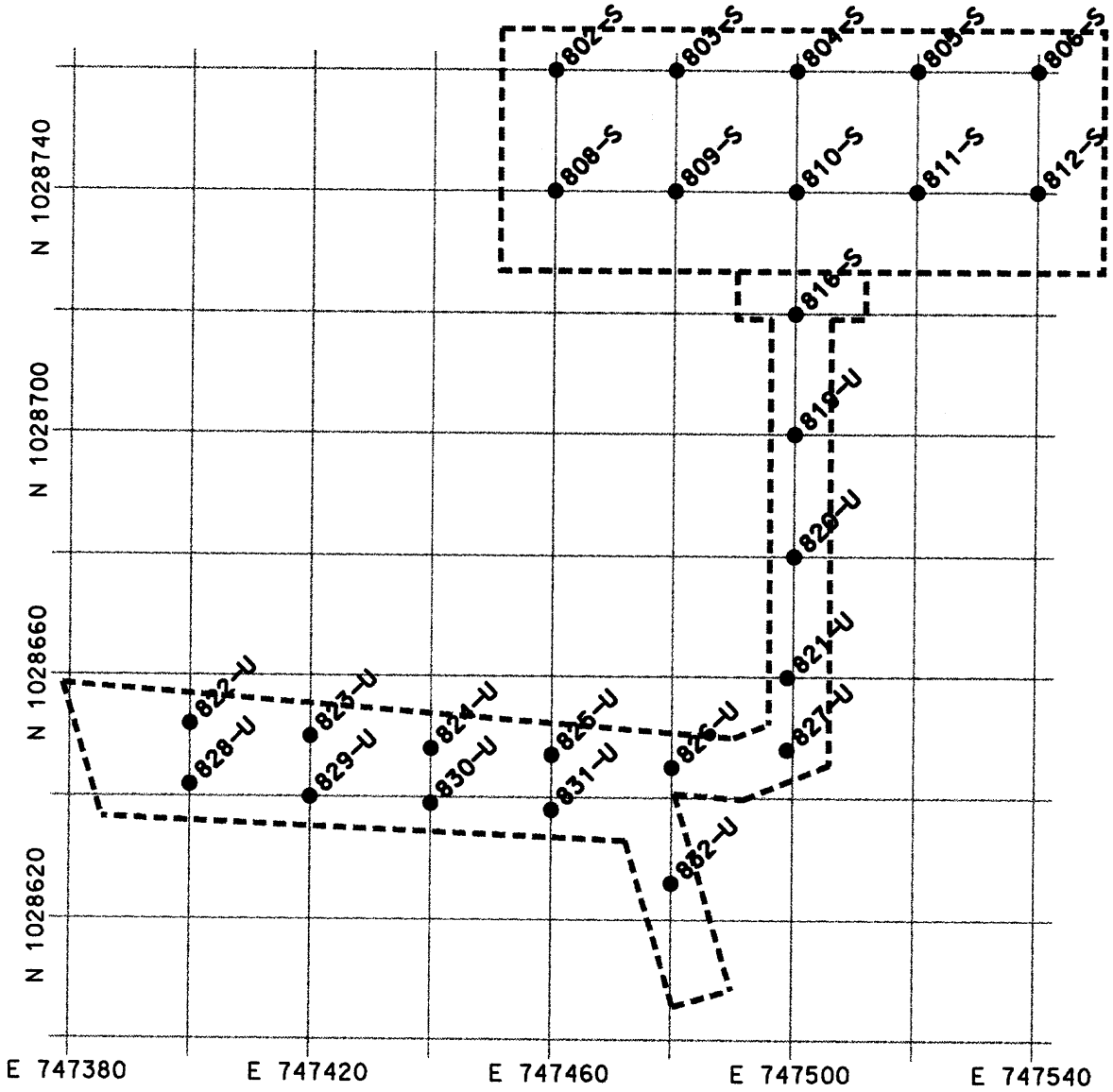
| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Subsurface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.64 – 1.32 | 0.89 | 1.32 | 16.2 | 0 |
| Ra-228 (pCi/g) | 0.26 – 1.74 | 1.10 | 1.74 | 16.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 1.12 – 3.06 | 1.99 | 3.06 | 16.2 | 0 |
| Th-230 (pCi/g) | 0.60 – 2.75 | 1.29 | 2.75 | 16.2 | 0 |
| U-238 (pCi/g) | 0.96 – 3.12 | 1.79 | 3.12 | 120 | 0 |

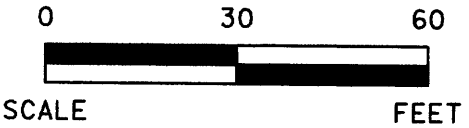
### 3.9.8 Quarry Water Treatment Plant and Underground Piping

Contaminants identified for the confirmation sampling of the QWTP were Ra-226, Ra-228, Th-230, and U-238. Although chemically contaminated soil may have been present, it was considered that these contaminants would be comingled with radiological contaminants. Therefore, both would be removed based on verification of radiological contaminants. If the area failed the initial confirmation sampling, additional soil would be excavated and the area re-sampled this time including chemical contaminants of concern in addition to radiological contaminants of concern. A total of 25 samples were taken beneath the QWTP and contaminated underground piping (Figure 3-23). Surface cleanup criteria were used because that area would be used as fill under WP-529B and only uncontaminated soil could be used as backfill. As shown in Table 3-14, no single sample data point exceeded cleanup criteria concentration for any of the parameters. Since the analytical results showed no radiological contamination, no chemical analysis was conducted.

Table 3-14 QWTP and Underground Piping Analytical Results Summary (CU419)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.48 – 1.59 | 0.88 | 1.59 | 6.2 | 0 |
| Ra-228 (pCi/g) | 0.48 – 1.59 | 1.00 | 1.59 | 6.2 | 0 |

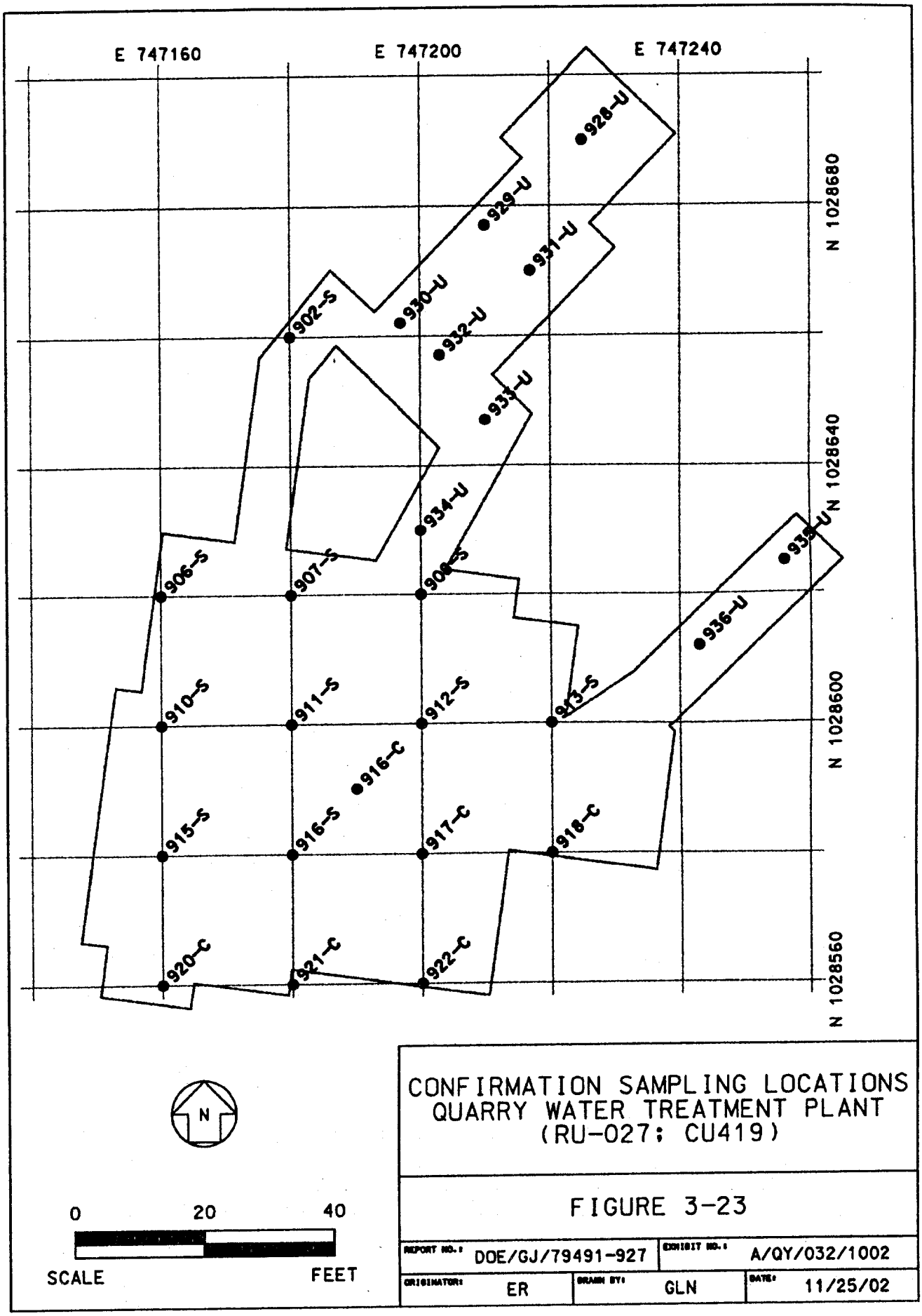





CONFIRMATION SAMPLING LOCATIONS
AT THE DECONTAMINATION PAD
(RU-027; CU418)

FIGURE 3-22

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/038/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |




CONFIRMATION SAMPLING LOCATIONS
QUARRY WATER TREATMENT PLANT
(RU-027; CU419)

FIGURE 3-23

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/032/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

Table 3-14 QWTP and Underground Piping Analytical Results Summary (CU419) (Continued)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Combined Ra-226 & Ra-228 (pCi/g) | 0.96 – 3.18 | 1.98 | 3.18 | 6.2 | 0 |
| Th-230 (pCi/g) | 0.16 – 2.70 | 1.27 | 2.70 | 6.2 | 0 |
| U-238 (pCi/g) | 0.56 – 3.87 | 1.80 | 3.87 | 120 | 0 |

### 3.9.9 Quarry Laydown Area

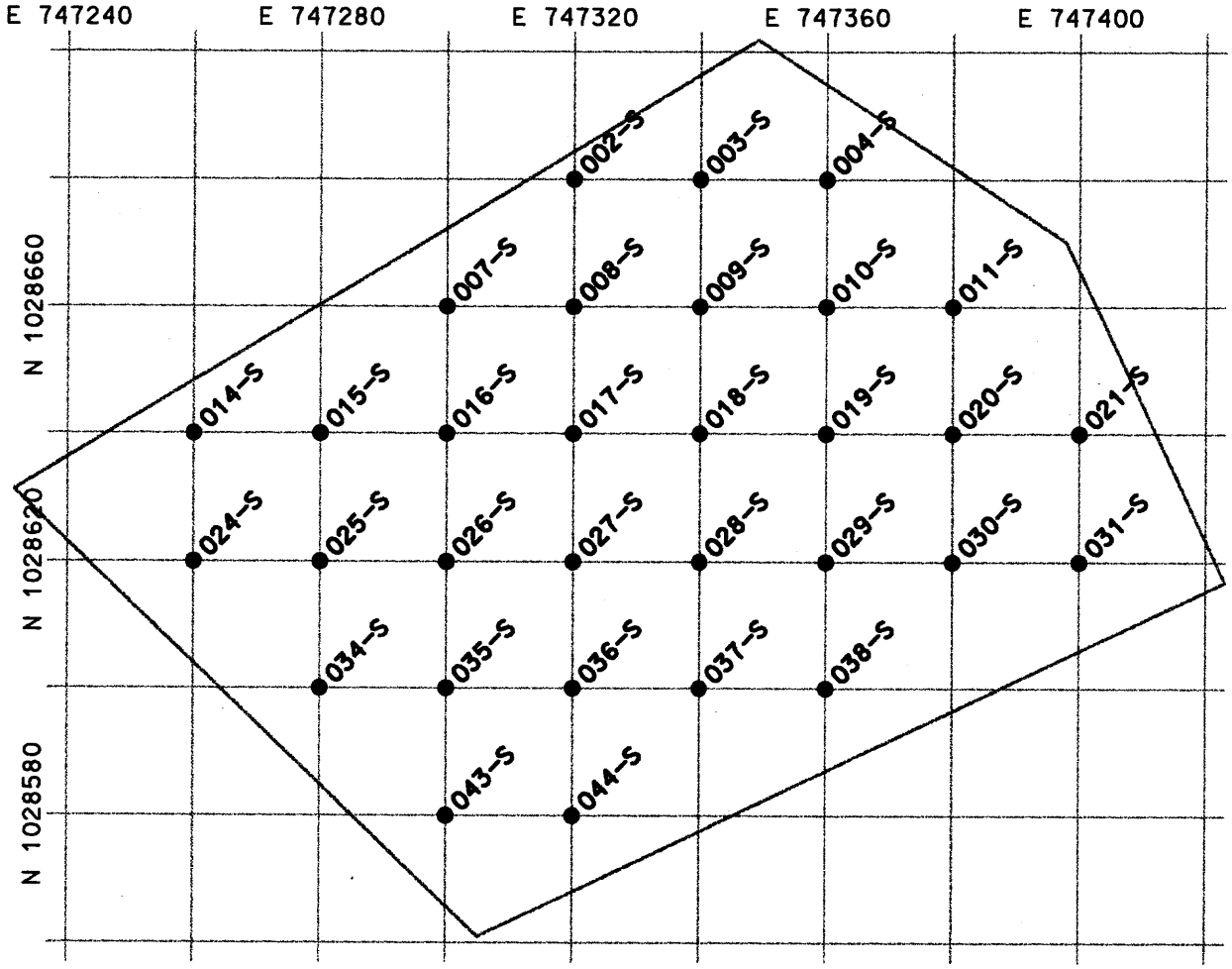
After the QWTP waste was transported from the Quarry Laydown area to the disposal cell, approximately 6 in. of soil and the surrounding berm were removed and transported to the disposal cell. Confirmation sampling was performed on the laydown area to ensure that the soil beneath the waste had not become contaminated by the wastes placed for temporary storage. The contaminants were determined to be: Ra-226, Ra-228, Th-230, and U-238 and based on the co-mingling theory, no chemical parameters were analyzed. The laydown area soil was to be used as fill material under WP-529B; hence, surface cleanup criteria were used for confirmation purposes. A total of 31 samples were taken of confirmation unit 420 (CU420) and the sample locations are illustrated in Figure 3-24. No single sample data point exceeded cleanup criteria concentration for any of the parameters (Table 3-15). The confirmation unit was released for unrestricted use on June 11, 2001.

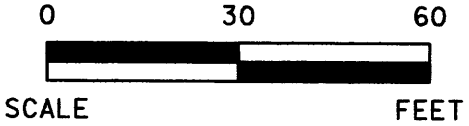
Table 3-15 Quarry Laydown Area Analytical Results Summary (CU420)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.41 – 1.11 | 0.80 | 1.11 | 6.2 | 0 |
| Ra-228 (pCi/g) | 0.40 – 1.38 | 1.02 | 1.38 | 6.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 0.99 – 2.40 | 1.82 | 2.40 | 6.2 | 0 |
| Th-230 (pCi/g) | 0.14 – 3.53 | 1.32 | 3.53 | 6.2 | 0 |
| U-238 (pCi/g) | 0.83 – 7.79 | 2.10 | 7.79 | 120 | 0 |

### 3.9.10 Effluent Pond 2 and Piping

Contaminants targeted within Effluent Pond 2 and its associated piping were: Ra-226, Ra-228, Th-230, and U-238. Surface cleanup criteria were used because the area was to be used as fill for WP-529B after the confirmation unit (CU421) was released. A total of 25 samples were taken within CU421 and the sample locations are illustrated in Figure 3-25. Sections of CU421 were partially released on June 28 and July 8, 2002. The entire confirmation unit was released on July 22, 2002. No single sample data point exceeded cleanup criteria concentration for any of the parameters (Table 3-16).

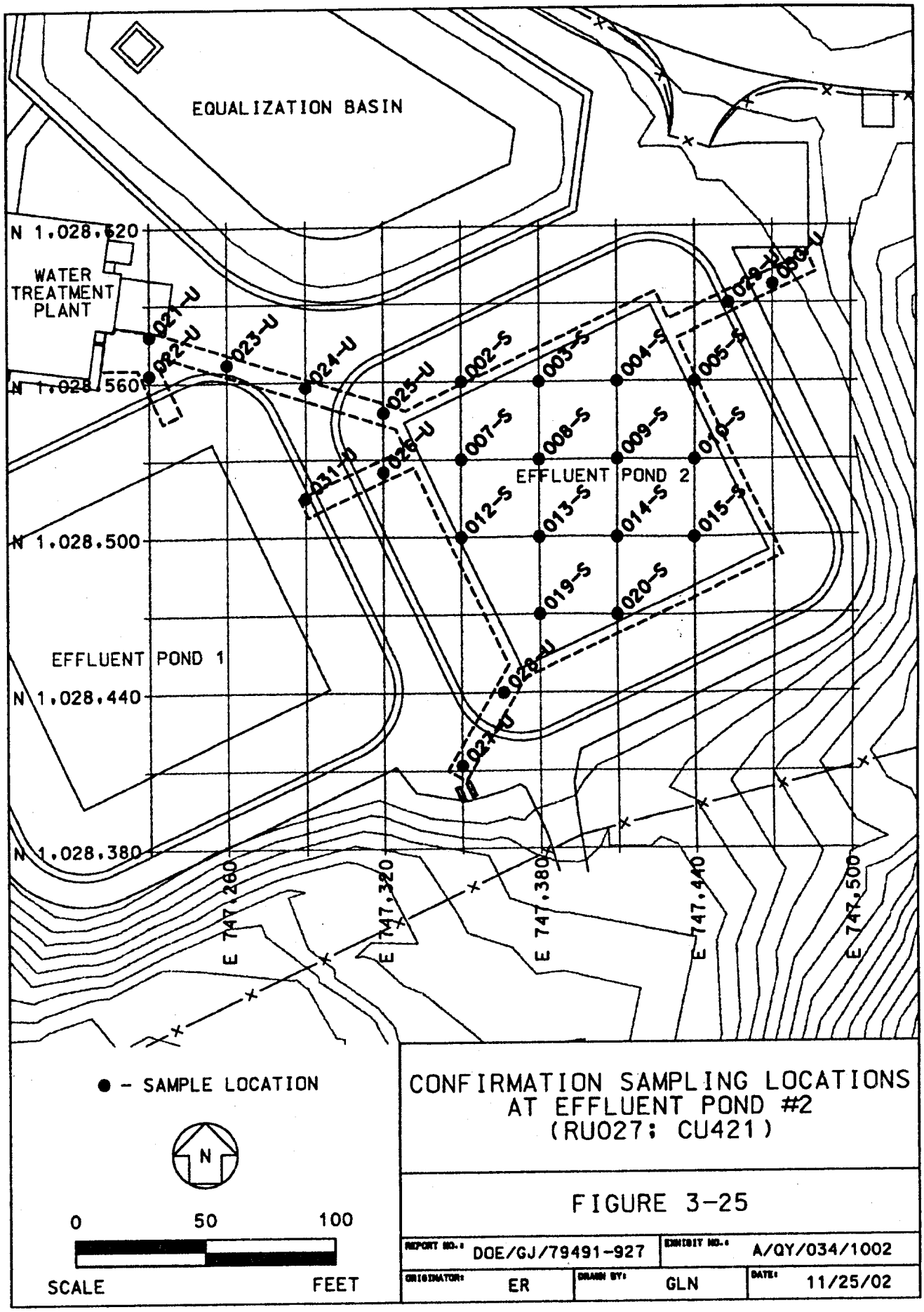





CONFIRMATION SAMPLING LOCATIONS
QUARRY LAYDOWN AREA
(RU-027; CU420)

FIGURE 3-24

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/033/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |




CONFIRMATION SAMPLING LOCATIONS AT EFFLUENT POND #2 (RU027: CU421)

FIGURE 3-25

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/GJ/79491-927 | | EXHIBIT NO.: A/QY/034/1002 | |
| ORIGINATOR: ER | DRAWN BY: GLN | DATE: 11/25/02 | |

Table 3-16 Effluent Pond 2 and Piping Analytical Results Summary (CU421)

| Contaminant of Concern | Concentration Range | Concentration Average | Maximum Concentration | Surface Cleanup Criteria | Number of Samples > Criteria |
|---|---|---|---|---|---|
| Ra-226 (pCi/g) | 0.38 – 1.28 | 0.87 | 1.28 | 6.2 | 0 |
| Ra-228 (pCi/g) | 0.75 – 1.56 | 1.09 | 1.56 | 6.2 | 0 |
| Combined Ra-226 & Ra-228 (pCi/g) | 1.47 – 2.81 | 1.96 | 2.81 | 6.2 | 0 |
| Th-230 (pCi/g) | 0.19 – 2.76 | 0.59 | 2.76 | 6.2 | 0 |
| Th-232 (pCi/g) | 0.32 – 1.05 | 0.60 | 1.05 | 6.2 | 0 |
| U-238 (pCi/g) | 0.34 – 2.52 | 1.43 | 2.52 | 120 | 0 |

### 3.9.11 ORISE Verification

The Oak Ridge Institute for Science and Education (ORISE) was contracted by the DOE to audit the confirmation soil sampling at the Weldon Spring site. ORISE conducted a verification survey at the Quarry on February 21, 2001. The survey was conducted within the QWTP Equalization Basin (RU026; CU397) after the removal of the liner under WP-551D. The audit consisted of walkover radiological surveys and independent collection and analysis of soil samples to verify proper disposition of the confirmation unit. The surveys and sampling were conducted in accordance with ORISE's *Final Verification Survey Plan for the Chemical Plant Area* (Ref. 25). A letter report verifying the PMC's findings that remedial action objectives for the QWTP Equalization Basin were met was sent on March 15, 2001. No audits by ORISE were conducted on any of the other Quarry confirmation units.

# 4. EXISTING SITE CONDITIONS

## 4.1 Groundwater

Uranium and nitroaromatic compounds leached from the wastes in the quarry proper and contaminated groundwater beneath the site. Uranium concentrations in groundwater have decreased in the area north of Femme Osage Slough by adsorption onto aquifer materials and precipitation by a naturally occurring chemical reduction process. The reduction zone is located north of Femme Osage Slough and extends south of the slough (Ref. 18). The greatest effect is observed north of the slough where geochemical conditions change from oxidizing to reducing.

The highest uranium concentrations in groundwater occur in the bedrock downgradient from the quarry and in the alluvial material north of Femme Osage Slough. The groundwater standard of 20 pCi/L was exceeded at 13 locations in 2002, all located north of Femme Osage Slough (Figure 4-1). The standard, although used as a reference level, is not applicable to groundwater north of the slough because this area is not considered a usable groundwater source due to low yield (Ref. 7).

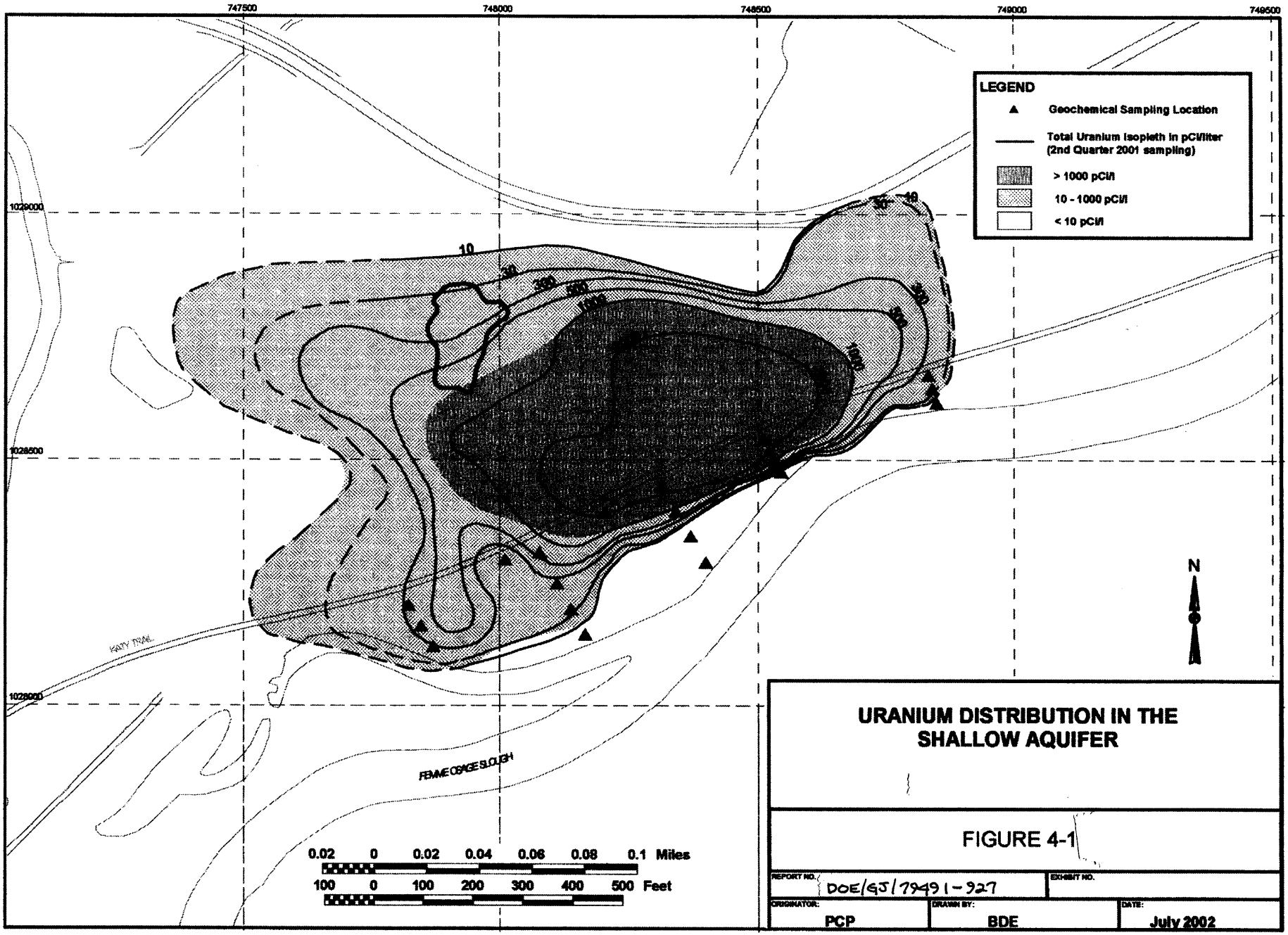
Nitroaromatic compounds in groundwater occur in the bedrock and alluvium downgradient of the quarry and north of Femme Osage Slough. All concentrations were below detection limits in samples from locations south of Femme Osage Slough. The average 2,4 DNT concentration for location MW-1027 remained above the Missouri drinking water standard of 0.11 ug/L in 2002.

## 4.2 Surface Water

Surface water bodies in the quarry area are Femme Osage Slough, Little Femme Osage Creek, and Femme Osage Creek. These water bodies did not receive direct runoff from the quarry but were sampled to monitor water quality due to possible movement of contaminated grouindwater from the fractured bedrock of the quarry through fine-grained alluvial materials. Femme Osage Slough is directly south of the quarry and is known to receive contaminated groundwater through subsurface recharge. The slough continues to show declining uranium levels (Ref. 45). Uranium concentrations in the slough do not pose a risk to recreational users or to the aquatic and terrestrial life associated with the slough.

## 4.3 Sediments

Sediments in the Femme Osage Slough and nearby creeks were characterized during the RI (Ref. 3). The 95-percent upper confidence limit background value for uanium in the creek and slough sediment is 4.35 pCi/g. Sediments in the creeks and lower portion of the slough have uranium levels similar to background. The upper portion of the slough, directly south of the quarry, has uranium levels slightly greater than background (5.41 pCi/g). These levels pose no human health or ecological risks under a recreational scenario.




**URANIUM DISTRIBUTION IN THE SHALLOW AQUIFER**

FIGURE 4-1

| REPORT NO. | EXHIBIT NO. | |
|---|---|---|
| DOE/GJ/79491-927 | | |
| ORIGINATOR: PCP | DRAWN BY: BDE | DATE: July 2002 |

## 4.4 Soil in the Quarry Proper

Some areas of residual radioactive contamination remain in the quarry proper. These areas were not trageted for removal because risk levels are within the acceptable range for a recreational visitor, and the areas were not easily accessible during contaminated soil removal activities (i.e., limited access for equipment, or soil in creacks and fissures).

The locations within the quarry proper that still have residual radioactive soil include the southeast slope, the knoll, wall and floor fractures, and the northeast slope. All of these locations are covered by backfill. A summary of the levels of contamination is presented in Table 4-1.

Table 4-1 Maximum Radionuclide Concentrations in Soil at Areas in the Weldon Spring Quarry

| Location | Radium 226[a] | Radium 228[a] | Thorium 230[a] | Uranium 238[a] | Notes |
|---|---|---|---|---|---|
| Northeast Slope | 12.7 | 9.87 | 77.9 | 3.91 | (1) |
| Southeast Slope | 8.20 | 2.79 | 42.0 | 35.1 | (2) |
| Knoll | 1.70 | 1.39 | 12.9 | 2.33 | (1) |
| Wall Fractures | 7.07 | 8.77 | 81.1 | 32.7 | (1) |
| Floor Fractures | 9.44 | 7.53 | 396 | 202 | (1) |

[a]All concentration in pCi/g.
Notes: (1) Below Soil Backfill > 2 feet.
(2) Below Soil Backfill <1 foot.

## 4.5 Residual Risk for the QROU

The *Baseline Risk Assessment for the Quarry Residuals Operable Unit* was performed in 1997 (Ref. 4). This assessment focussed primarily on the expected land-use for the quarry vicinity, which is recreational. The residual risk, both for recreational and residential scenarios, for various areas that comprise the QROU were evaluated based on site conditions after completion of activities associated with quarry restoration (Ref. 44). These areas are: (1) the Femme Osage Slough (including the creeks), (2) the quarry proper (cracks/fissures and soils), the groundwater north of the slough.

The results of the re-evaluation indicate that the concentrations in the surface water and sediments in the vicinity of the quarry would not pose a risk to a recreational user or, if the area were to become residential, a resident. Also the soils within the quarry proper do not pose a risk to recreational users. Groundwater north of the Femme Osage Slough would pose a risk to a resident if the groundwater were used. For a recreational user the concentrations in groundwater does not pose a risk because the groundwater cannot be accessed.

# 5. CHRONOLOGY OF EVENTS

The following is a chronology of the Quarry Residuals Operable Unit of the Weldon Spring Site Remedial Action Project.

Table 5-1 Quarry Residuals Operable Unit

| EVENT | WORK PACKAGE | DATE |
|---|---|---|
| DOE designates the Weldon Spring Site Remedial Action Project as a Major Project | | 01-Jan-85 |
| The Project Management Contractor (PMC) is selected | | 01-Feb-86 |
| DOE and PMC establish a Site Office | | 01-Jul-86 |
| PMC assumes site control | | 01-Oct-86 |
| Weldon Spring Quarry placed on the National Priorities List (NPL) | | 22-Jul-87 |
| WSSRAP designated as a Major Systems Acquisition | | 01-May-88 |
| Quarry Bulk Waste Record of Decision finalized | | 07-Mar-91 |
| Begin Bulk Waste removal and TSA operations | 186 | 31-May-93 |
| Complete Quarry Bulk Waste removal | 186 | 27-Oct-95 |
| Remedial Investigation for the QROU issued | | 02-Mar-98 |
| Baseline Risk Assessment for the QROU issued | | Feb 98 |
| Feasibility Study for Remedial Action for the QROU issued | | 17-Mar-98 |
| Proposed Plan for Remedial Action at the QROU issued | | Mar 98 |
| DOE Headquarters Milestone: Issue QROU ROD to EPA and MDNR | | 05-Jun-98 |
| QROU Record of Decision finalized | | 02-Sep-98 |
| Additional characterization of the Quarry Ditch Area | | May 1999 |
| DOE Headquarters Milestone: Complete Quarry Restoration Design | | 29-Jul-99 |
| Additional characterization of the Quarry Northeast Slope | | Oct 1999 |
| Remedial Design/Remedial Action Work Plan for the QROU issued | | 19-Jan-00 |
| Quarry Interceptor Trench construction subcontract began | 515 | 27-Jan-00 |
| Additional characterization of the Quarry Snake Pit Area | | Feb 2000 |
| Installation, repair, and abandonment of Quarry monitoring wells began (Task 5) | 487A | 09-Feb-00 |
| Installation, repair, and abandonment of Quarry monitoring wells completed (Task 5) | 487A | 21-Feb-00 |
| Installation, repair, and abandonment of Quarry monitoring wells began (Task 6) | 487A | 27-Mar-00 |
| Quarry Residual Contamination subcontract began | 505X | 04-Apr-00 |
| DOE Headquarters Milestone: Complete Quarry Interceptor Trench Construction | 515 | 21-Apr-00 |
| Start of the Quarry Interceptor Trench Operation | 515 | 26-Apr-00 |
| Quarry Interceptor Trench contract completed | 525 | 15-May-00 |
| Installation, repair, and abandonment of Quarry monitoring wells completed (Task 6) | 487A | Jul 2000 |
| Installation, retrofitting, and abandonment of Quarry monitoring wells began (Task 7) | 487A | 31-Jul-00 |
| Quarry Residual Contamination subcontract completed | 505X | 15-Sep-00 |
| Quarry Equalization Basin Liner Demolition subcontract began | 551D | 13-Oct-00 |
| Quarry Equalization Basin Liner Demolition subcontract completed | 551D | 14-Nov-00 |
| Quarry Restoration Phase I subcontract began | 551A | 20-Nov-00 |
| Installation, retrofitting, and abandonment of Quarry monitoring wells completed (Task 7) | 487A | 01-Dec-00 |
| DOE Headquarters Milestone: Start Quarry Water Treatment Plant decommissioning | 485 | 04-Jan-01 |
| Partial backfill of the Quarry Equalization Basin began | 551A | 05-Feb-01 |
| Quarry Restoration Phase I temporarily suspended | 551A | 14-Feb-01 |
| Quarry Water Treatment Plant decommissioning completed | 517 | 23-Feb-01 |
| Partial backfill of the Quarry Equalization Basin completed | 551A | 27-Feb-01 |
| Abandonment of Quarry monitoring wells subcontract began (Task 9) | 487A | 15-Mar-01 |
| Quarry Water Treatment Plant demolition subcontract began | 553A | 19-Mar-01 |
| Abandonment of Quarry monitoring wells subcontract completed (Task 9) | 487A | 29-Mar-01 |
| Quarry Restoration Phase I subcontract resumed operations | 551A | 14-May-01 |

Table 5-1 Quarry Residuals Operable Unit (Continued)

| EVENT | WORK PACKAGE | DATE |
|---|---|---|
| DOE Headquarters Milestone: Complete Quarry Backfill | 551A | 31-May-01 |
| Quarry Water Treatment Plant demolition subcontract completed | 553A | 20-Jun-01 |
| Quarry Restoration Phase I subcontract completed | 551A | 17-Aug-01 |
| Subsurface Drilling Insitu Groundwater Sampling subcontract began | 533 | 18-Oct-01 |
| Subsurface Drilling Insitu Groundwater Sampling subcontract completed | 533 | 18-Jan-02 |
| Quarry Restoration Phase II subcontract began | 529B | 24-Apr-02 |
| DOE Headquarters Milestone: Complete Quarry Interceptor Trench Study | 485 | 26-Apr-02 |
| DOE Headquarters Milestone: Complete Quarry Final Restoration | 529B | 06-Sep-02 |
| Quarry Restoration Phase II subcontract completed | 529B | 06-Sep-02 |

# 6. PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

## 6.1 Performance Standards

A summary of the remedial objectives described in *the Remedial Design/Remedial Action Work Plan* (Ref. 8) and a comparison to how these were performed is presented in Table 6-1. All of the componennts of the Quarry Residuals Operable Unit (QROU) have been completed with the exception of long-term groundwater monitoring and implementation of institutional controls.

Table 6-1 Performance Results Compared with Remedial Objectives

| Component | Remedial Objective | Performance Result |
|---|---|---|
| Long-Term Groundwater Monitoring | 90th percentile of the uranium data collected in the area of impact is less than 300 pCi/l for a monitoring year | Long-term groundwater monitoring was initiated in October 2002. Data for this 12-month monitoring period does not satisfy the remedial objectives. Data verifies that the groundwater quality south of the Femme Osage Slough has not been impacted by contaminated groundwater north of the slough. Monitoring will continue. |
| | No upward trends in uranium concentrations are identified at any monitoring location in the area of impact | |
| | 90th percentile of the 2,4-DNT data collected in the area of impact is less than 300 pCi/l for a monitoring year | |
| | No upward trends in 2,4-DNT concentrations are identified at any monitoring location in the area of impact | |
| | Uranium concentrations remain below 20 pCi/l in groundwater south of the Femme Osage Slough | |
| | No upward trends in uranium concentrations are identified at any monitoring location south of the Femme Osage Slough | |
| Institutional Controls | Prevent groundwater usage in the area of groundwater impact for consumption or uses that would adversely affect contaminant migration | Evaluation of the risks from contaminated groundwater below and south of the quarry proper indicates that this groundwater could not be used for unrestricted use. Use of groundwater beneath and adjacent to the quarry proper and within a surrounding buffer zone will be restricted. DOE will implement a real estate restrictive easement with the necessary landowners. |
| | Evaluate residual risks from quarry proper soils after completion of reclamation project and establish controls, if necessary | Evaluation of the residual risks from contaminant concentrations present in the surface soils indicates that these quarry proper could used for unrestricted use; however, due to subsurface contamination, residential land use of the quarry proper will be restricted. DOE will place a notation of land records for continuing control of land use through Federal ownership. |

| Component | Remedial Objective | Performance Result |
|---|---|---|
| | Evaluate residual risks from sediments and surface water in the quarry area and establish controls, if necessary | Evaluation of the residual risks from contaminant concentrations present in the sediment and surface water indicates that these areas can be used for unrestricted use. No institutional controls are necessary. |
| | **Quarry Interceptor Trench Field Study** Evaluate effectiveness of pilot scale trench for removal of uranium from the alluvial aquifer north of the Femme Osage Slough. If results indicate that 10% or less of the total uranium mass present in the area of influence can be removed over the 2-year operational period, additional evaluation of groundwater remediation is not warranted. | By the end of the 2-year study period, 14.0 kg of uranium had been removed that accounted for 1.5% of the mass available to the interceptor trench. The percent removed was significantly below the predicted performance of the trench and constitutes only a small reduction of the total uranium contamination present, which would not provide a measurable increase in the protection of the groundwater south of the slough. Combined with the results from the other field studies it can be concluded that active remediation of the uranium impacted groundwater north of the slough is not necessary. |
| | **Hydrological and Geochemical Studies** Assess natural attenuation of uranium in the aquifer north of the Femme Osage Slough and provide additional supporting evidence to identify the attenuation mechanisms | Results of the investigations provided a better understanding of the natural geochemistry of the alluvial aquifer north of the slough. The physical and chemical parameters measured in groundwater samples were successfully correlated with the physical properties of the aquifer material and support the conceptual fate and transport model presented in the Remedial Investigation. It can be concluded that the natural system present in the groundwater north of the slough provides adequate protection of the groundwater south of the slough. |

| Component | Remedial Objective | Performance Result |
|---|---|---|
| Quarry Proper Soils | Perform additional characterization of northeast slope and ditch areas to determine natural and extent of known soil contamination areas. Evaluate data consistent with the Baseline Risk Assessment to determine if soil removal is warranted. | Review of additional characterization data indicated no increase in the risk levels within the quarry proper. Removal of some soil from these areas was included in the restoration project because removal would be performed during the early states of quarry restoration. Excavation limits were based on the cleanup criteria for radionuclides presented in the *Chemical Plant ROD* and verified as outlined in the *Quarry Proper Confirmation Plan*. All confirmation units met the criteria established in that plan. |
| Quarry Reclamation | **Restoration of the Quarry Proper** Backfill the quarry proper with soil to reduce fall hazards, to stabilize the highwalls, and eliminate ponding of surface water. Backfilling would reduce the potential for mobilization of any potential residual contaminants into the groundwater, force groundwater flow around the inner quarry area, and reduce infiltration of precipitation through the quarry proper | The quarry proper was backfilled with soil acquired from an off-site borrow area and uncontaminated soils from within the quarry ad the quarry staging area. The quarry was backfilled with a low permeability material to the specified height to promote groundwater flow around the quarry and to reduce infiltration through the quarry proper. The total height of backfill was sufficient to prevent ponding of water on the ground surface and to promote sheet flow toward the Little Femme Osage Creek. |
| | **Removal of Bulk Waste and Quarry Water Treatment Plant Facilities** Dismantlement of facilities utilized to support bulk waste removal activities and restoration of the haul road. | All facilities were removed and contaminated soils were removed as outlined in the appropriate specifications and was verified as outlined in the *Quarry Proper Confirmation Plan*. All confirmation units met the criteria established in that plan. Restoration of the quarry haul road was not performed because it was agreed upon with the MDC to keep the haul road in place for future use as a hike and bike trail. |
| | **Removal of the Quarry Interceptor Trench and Reclamation of the Quarry Area** Dismantlement of the QITs facilities and final grading of the quarry area to near-natural conditions | All facilities were removed and contaminated soils were removed as outlined in the appropriate specifications and was verified as outlined in the *Quarry Proper Confirmation Plan*. All confirmation units met the criteria established in that plan. |

## 6.2 Construction Quality Assurance/Quality Control

All construction activities were performed by the Project Management Contractor (PMC). Work activities performed by the PMC during the Weldon Spring Remedial Action Project (WSSRAP) were required to be performed under an established quality program. The PMC established a *Quality Assurance Program Plan* (QAPP) in 1987, which complied with the criteria of *American National Standards Institute/American Society of Mechanical Engineers Nuclear Quality Assurance Program* (ANSI/ASME NQA-1 1986) and Department of Energy Order 5700.6A *Quality Assurance* (Ref. 26). The QAPP was used as a generic working document to control and document the quality of work at the WSSRAP. The document required

that specific procedures and plans be generated to address quality related work and inspection activities.

As the project progressed the *Quality Assurance Program Plan* (QAPP) was superseded in 1992 by the *Project Management Contractor Quality Assurance Program* (QAP) (Ref. 27). The QAP has been reviewed annually and revised as necessary to comply with the current Department of Energy orders and contract requirements. The *Quality Assurance Program* satisfies the requirements of DOE Order 414.1A – *Quality Assurance* (Ref. 28), (which superseded DOE Order 5700,.6A) 10 CFR Part 830.120 – *Quality Assurance* and associated reference documents identified in the QAP.

At the WSSRAP, *Quality Assurance Program* requirements and procedural controls were applied selectively utilizing the graded approach. The requirements selected, and the degree of their application to each item and activity, are commensurate with the following factors, as applicable:

- The relative importance to safety, safeguards, and security;
- The magnitude of any hazard involved;
- The life cycle stage of a facility;
- The programmatic mission of a facility;
- The particular characteristics of a facility; and
- Any other relevant factors.

The design activities for the QROU were performed in accordance with the PMC *Quality Assurance Program* and specific engineering Standard Operating Procedures. The *Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 29) described the methods by which the QROU construction activities would be tested and inspected. The remedial action inspection and test plan in conjunction with the PMC quality assurance plan ensured that the work performed within the QROU conformed to the design specifications. This conformation included documented observations, inspections, tests and measurements performed by qualified PMC personnel. Quality Assurance and Quality Control personnel were trained and certified in the discipline that was to be their area of responsibility in accordance with site quality procedures.

The Engineering Department, assisted by the responsible design organization, described in appropriate design documents (drawings, specifications, plans, procedures, etc.) those factors that contribute to the assurance of quality. Quality factors are identified by establishing quality levels that are related to the appropriate major structures, systems, components, materials activities, services, etc., within each activity. These quality levels take into account the relative degree of environmental, safety, programmatic, and economic impact and risk that could result should an item, activity, or service fail or fail to meet the specified quality requirements. The quality levels are used to determine the extent of quality assurance activities that need to be imposed to provide evidence of quality achievement. During QROU construction activities,

there was no quality "Stop Work Orders" nor outstanding quality deficiencies issued at any time for subcontractor work performed.

## 6.3 Environmental Quality Assurance/Control

### 6.3.1 Characterization and Environmental Monitoring Activities

Certain environmental compliance issues were addressed in 1988 by the *Remedial Investigation Quality Assurance Plan* (RIQAPP). The RIQAPP addressed the specific EPA/QAMS 005-80 requirements for the characterization of the Weldon Spring Quarry. The RIQAPP was superseded in 1991 by the *Environmental Quality Assurance Program Plan* (EQAPP). The EQAPP focused on the U.S. Environmental Protection Agency (EPA) requirements under Comprehensive Environmental Response and Liability Act (CERCLA). The EQAPP met the requirements of applicable EPA guidance documents, including Part 1 of Region VII's *Quality Assurance Program Plan* (EPA 1986a) (Ref. 30) and U.S. EPA's *Interim Guidelines and Specifications for the Preparation of Quality Assurance Project Plans* (EPA 1980) (Ref. 31). The EQAPP and QAPP programs fulfilled the DOE's requirements under the Federal Facilities Agreement between DOE and EPA for the Weldon Spring site.

As site activities progressed the *Environmental Quality Assurance Program Plan* (EQAPP) was replaced by the *Environmental Quality Assurance Project Plan* (EQAPjP) (Ref. 32) in 1992. The EQAPjP focused on the U.S. Environmental Protection Agency requirements under the Comprehensive Environmental Response and Liability Act (CERCLA) and met the applicable requirements of EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans for Environmental Operations* (Ref. 33). The document primarily specified the quality assurance requirements for WSSRAP environmental data operations and supports the PMC *Quality Assurance Program.* The environmental data operations referred to activities involving the acquisition, analysis, and evaluation of environmental data which included all work performed to obtain, use or report information pertaining to environmental processes and conditions. The *Sample Management Guide* (Ref. 34), PMC standard operating procedures (SOPs), departmental instructions, the WSSRAP health and safety program, and work plans written for specific environmental tasks, supported the EQAPjP.

Subcontracted off-site laboratories that performed analysis used *Contract Laboratory Program* (CLP) methodologies when applicable. Each of the subcontracted off-site laboratories was required to submit a site-specific Quality Assurance Project Plan (QAPjP) and controlled copies of their SOPs. The QAPjPs and SOPs were reviewed and approved by the PMC before any samples would be shipped to the laboratory. Changes to the standard analytical protocols or methodology are documented in the controlled SOPs. Quality assurance assessments were performed routinely to inspect the laboratory facilities and operations, to ensure that the laboratories are performing analyses as specified in their contracts, and to check that WSSRAP data documentation and records are being properly maintained.

Data verification was performed on all analytical data received from laboratories performing analysis on environmental, waste management, health physics and geochemical samples in accordance with WSSRAP Procedure ES&H 4.9.1 *Environmental Monitoring Data Verification* (Ref. 35). Data verification included nonanalytical processing and review of analytical laboratory data and associated documentation to ensure that samples are collected, shipped, maintained, and analyzed in accordance with established data quality requirements and standard operating procedures.

Data validation was performed on analytical data received from laboratories performing analysis for the site as required under DOE Order 5400.1 (Ref. 36) in accordance with WSSRAP Procedure ES&H 4.9.2 *Environmental Monitoring Data Validation* (Ref. 37). At a minimum the WSSRAP Data Validation Group determined the analytical accuracy, precision, and completeness of 10% of the environmental data collected. The data validation review was performed by using analysis-specific checklists, which followed the U.S. EPA Functional Guidelines for Inorganics and Organics and SAIC Guidelines for Radionuclides.

### 6.3.2 Long-Term Monitoring Activities

Beginning in October 2003, monitoring activities were managed by S.M. Stoller Inc. (Stoller) from the Grand Junction Office (GJO). Sampling , analysis, and data management are performed in accordance with the *Sampling and Analysis Plan for GJO Projects* (Ref. 43). This plan incorporates DOE-GJO standard operating procedures (SOPs) into ground water and surface-water sampling activities. This document provides detailed procedures so that samples are collected in a consistent and technically sound manner.

DOE-GJO SOPs are contained in the *GJO Environmental Procedures Catalog*, (GJO 6) (DOE continually updated), which incorporates DOE and U.S. Environmental Protection Agency (EPA) guidance. The procedures in the *GJO Environmental Procedures Catalog* are intended as general guidance and require additional detail from project planning documents in order to be complete. Sampling for the QROU will be performed as outline in the LTS&M Plan for the WSSRAP.

All water samples will be analyzed by the GJO Analytical Chemistry Laboratory or an approved sub-contracted laboratory. GJO laboratory quality control will be performed in accordance with the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (DOE 2001). This manual defines the non-technical policies and procedures necessary to ensure the laboratory will provide high quality analytical data and maintain customer confidentiality. It provides a framework for performing, controlling, documenting, and reporting analyses and related laboratory activities. GJO laboratory analytical methods used for ground water and surface water analyses are detailed in *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures* (DOE continually updated). This

manual contains detailed procedures used for each analytical method and includes specific requirements for reagents and standards, detection limits, quality control, calculations, and data

reporting. In addition, interferences associated with each analytical method are listed in each section.

Environmental data management activities performed for the Weldon Spring Site are detailed in the *Sampling and Analysis Plan for GJO Projects* (Ref. 43). The Sampling and Analysis Plan for GJO Projects directs data management activities, and data validation requirements. This plan and the associated data validation requirements have been adopted for the monitoring program at the Weldon Spring Site. The primary activities associated with data management and data quality are field documentation, sample management, data validation, data review, and database maintenance. These programs ensure that analytical data generated by laboratories for samples collected at the Weldon Spring Site are reviewed and qualified prior to release for general usage.

Data validation is the process of reviewing the sampling documentation and analytical data to ensure that adequate documentation was maintained and that results are qualified in compliance with established reporting requirements. Data generated during sampling activities and by analytical laboratories for the Weldon Spring Site monitoring programs are validated.

The validation process consists of reviewing data for transcription errors, reviewing sampling documentation and chain-of-custody documentation, and comparing actual holding times to the method specified holding times. During validation, personnel determine whether the laboratory records document the established quality control criteria for the analytical methodology utilized at the laboratory. This is to ensure the analytical procedures were followed, quality control samples are within their respective acceptance limits, and that adequate documentation is available to support the validity of the data.

Also, during the validation process, the data are reviewed and qualified by the data reviewer for comparability with historical results and for statistical and compliance evaluations.

Upon completion of data validation, data are flagged with appropriate final data qualifiers and are then available for general use. All databases containing final validated data are backed up regularly. To maintain the integrity of the computer files, access to edit the database is extensively restricted.

# 7. FINAL INSPECTION AND CERTIFICATIONS

## 7.1 Pre-Final Inspection

A remedial action completion inspection of the Quarry Residuals Operable Unit (QROU) was performed on December 6, 2002, with the Environmental Protection Agency (EPA), Missouri Department of Natural Resources (MDNR), Department of Energy (DOE) and Project Management Contractor (PMC) personnel. This inspection included a review of the restoration/reclamation activities, review of the results of field studies performed in support of the Record of Decision, and visual inspections of the quarry proper, interceptor trench area, and the quarry borrow area.

## 7.2 Health and Safety

Health and safety requirements for all field activities were specified in the *Weldon Spring Site Remedial Action Project Health & Safety Plan* (HASP) (Ref. 38). The HASP was an integral component of the contract documents for every subcontract work package at the WSSRAP. The HASP included information and requirements on the following topics:

- Contaminant and hazard description
- Work practices and engineering controls
- Personal protective equipment (PEP)
- Monitoring for radiological and industrial hygiene related hazards
- Construction and industrial safety
- Medical surveillance
- Training and qualifications
- Site access control and security
- Decontamination
- Emergency response.

Hazard assessment and abatement was communicated and managed at the worker level through the use of Safe Work Plans and Task-Specific Safety Assessments (TaSSAs). These work control documents, required for every field activity, identified: the work to be performed; the associated work hazards (i.e. radiological, chemical, biological, construction & industrial safety); and necessary work controls to minimize identified hazards (i.e. engineering and administrative controls, PEP, training, monitoring, decontamination). Applicable HASP requirements were incorporated into all Safe Work Plans and TaSSAs.

Overall adherence to health and safety requirements at the WSSRAP was excellent. The WSSRAP employed an extensive staff of field-oriented health & safety professionals to help identify hazards and prescribe appropriate controls for all field activities. This staff routinely monitored all daily work activities to ensure compliance. However one of the most effective means of ensuring health and safety requirements implementation was the Time Out for Safety

Program. This program allowed and encouraged anyone to stop any work activity which they felt was not being performed in a safe manner. Once a Time Out was taken, employees from all appropriate entities got together to evaluate the situation and make any necessary changes to ensure the work would be performed safely. Workers were recognized in a positive manner and rewarded for taking Time Outs. This resulted in extensive worker buy-in to the health and safety program.

The WSSRAP was formally recognized in outstanding safety and health performance by becoming the first DOE hazardous waste remediation site to receive the DOE Voluntary Protection Program (DOE-VPP) Gold Star. The DOE-VPP provides public recognition to sites whose health and safety programs go beyond DOE and OSHA standards to protect workers more effectively. The Gold Star is the highest available award in the DOE-VPP.

# 8. OPERATION AND MAINTENANCE ACTIVITIES

The details for the QROU post-construction operation and maintenance activities such as surveillance and maintenance, long-term monitoring, institutional controls and other post-closure activities can be found in the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring Site* (LTS&M Plan) (Ref. 12). The Plan is currently in draft form and will be finalized upon completion of the Groundwater Operable Unit ROD. The information in this section provides a summary of the current information in the Plan.

DOE will maintain protectiveness at the Weldon Spring Quarry through a combination of federal ownership, maintaining a local presence, conducting regular inspections, conducting environmental sampling, institutional controls, and regulatory compliance.

## 8.1 Routine Site Inspections

DOE will inspect the Weldon Spring Quarry area annually in accordance with the LTS&M Plan to confirm that institutional controls remain effective and to determine if maintenance or additional monitoring are needed. Inspectors will note changes to the Quarry and the surrounding area. Significant changes within an area could include new development that may result in changes to the surface grading, groundwater system, and evidence of inappropriate groundwater extraction. Inspectors will also look for evidence of settling, ponding water, backfill erosion, and highwall instability. Specific inspection criteria and a checklist are included in the LTS&M Plan.

## 8.2 Reports

DOE will prepare an annual report which will include the results of the annual site inspection. The report will be submitted to EPA, MDNR, and stakeholders. The report will also be posted on the LTSM Program Internet site (www.gjo.doe.gov/programs/ltsm). In the report, DOE will also address maintenance and surveillance and monitoring results for the previous 12 months. The DOE will also prepare a CERCLA 5-year review report in accordance with current EPA guidance for 5-year reviews. The purpose of the 5-year review is to ensure that the remedies remain protective of human health and the environment. The next five year review report will be released in 2006.

## 8.3 Routine Site Maintenance and Operations

During the routine site inspection, DOE will inspect all site monitoring wells and arrange for maintenance or repairs, as necessary. Groundwater samplers also will note maintenance needs and ensure the wells are kept secured and in good repair. Monitoring personnel will maintain access to sample locations, which may include maintenance of access routes and vegetation control. Such maintenance on off-site locations will be conducted in accordance with access agreements.

## 8.4 Long Term Monitoring

The remedial design/remedial action work plan for the Quarry Residuals Operable Unit (QROU) specifies the long-term monitoring of groundwater, which is implemented through the LTS&M Plan (Ref. 12). Results will be reported annually and summarized in the 5-year review report.

The quarry monitoring program has two primary objectives:

- Monitor uranium concentrations in groundwater south of the Femme Osage Slough to verify that the groundwater is not impacted.

- Monitor contaminant concentrations (uranium and 2,4-DNT) within the area of affected groundwater north of the slough until they attain target concentrations, indicating negligible potential to degrade groundwater south of the slough.

Data from wells north of the slough are analyzed to monitor contaminated behavior and to demonstrate that the target concentration for uranium (300 pCi/l) and the regulatory limit for 2,4 DNT (0.11 ug/l) are attained. Cleanup objectives are met when the $90^{th}$ percentile of the data for each parameter in a 12 month monitoring period does not exceed traget concentrations, and analysis indicates that contaminant levels are decreasing.

No surface water monitoring is required as part of the remedy for the QROU; however DOE will monitor four locations along the slough. These locations are in the upper portion of the slough that is adjacent to the area of groundwater impact. During high groundwater levels, this part of the slough is recharged by groundwater.

## 8.5 Institutional Controls

Institutional control at the Weldon Spring Site are grouped into three main categories. The first category is nonengineering measures (primary legal controls) that serve to limit activities in order to prevent or reduce exposure to hazardous substances. Institutional controls can also be defined as real estate agreements that are entered into between landowners for the purpose of maintaining monitoring programs or site integrity. The third type of institutional control involves ongoing education of the public such as through the Weldon Spring Site Interpretive Center.

Institutional controls are applied to prevent inadvertent exposure to contaminated media and residual contaminants as required under site Records of Decision. DOE must ensure that future land use is consistent with the exposure scenarios found to be protective for the selected remedies. Institutional controls may include restrictions placed on the deeds to the properties, including property currently in federal ownership.

Restrictive easements and other realty documents will be recorded in the records of St. Charles County under the system mandated by its regulations. These projective controls will remain with the land through any subsequent transfer or conveyance of the property. The institutional controls will identify appropriate authorities to enforce restrictions.

The institutional controls, which are further discussed in the draft *Long-Term Surveillance and Maintenance Plan* (Ref. 12), for the Weldon Spring Quarry are summarized in Table 8.1.

Table 8-1 A Summary of Institutional Controls for the Weldon Spring – Quarry

| DESCRIPTION | METHOD OF IMPLEMENTATION | PARTIES TO DOCUMENT | DURATION |
|---|---|---|---|
| Restrict residential land use and all shallow groundwater use on quarry property | Notation on land records for continuing control of land use through Federal ownership | DOE | Indefinite term. |
| Restrict land use to prevent physical disturbance of the quarry area reduction zone | Real Estate Restrictive Easement | MDC to DOE | Indefinite term easement. |
| Restrict all groundwater use adjacent to DOE's quarry property in the area of contamination and surrounding buffer zone | Real Estate Restrictive Easement | MDC to DOE, MDNR to DOE | Until groundwater standards are met. Indefinite term easement. |

# 9. SUMMARY OF PROJECT COSTS

A summary of the costs for major elements of the Quarry Residuals Operable Unit (QROU) and a comparison of the actual project costs with the estimates provided in the *Record of Decision* (Ref. 7) and the *Remedial Design/Remedial Action Work Plan* (Ref. 8) is provided in Table 9-1. The actual project costs for those elements that have not been completed (long-term groundwater monitoring and institutional controls) will be finalized upon finalization of this report at a future date. The costs presented are final as of the end of fiscal year 2003. The costs presented in the table are primarily subcontract costs for performance of fieldwork. A more detailed breakdown of the costs is provided in Appendix D. Oversight costs for the project management contractors are not included; however, these costs were not included in the estimates provided in the *ROD* and the *RD/RA Work Plan*.

Table 9-1 QROU Cost Summary

| COST ITEM | ROD ESTIMATE (1998) | RD/RA ESTIMATE (2000) | ACTUAL COSTS |
|---|---|---|---|
| Geochemical and Hydrologic Data Needs | $ 0.4 M | $ 0.31 M | $ 0.32 M |
| Quarry Interceptor Trench Field Study (Construction, operation, and water treatment) | $ 2.5 M | $ 1.9 M | $ 1.2 M |
| Long-Term Groundwater Monitoring (Annual Costs) | $ 0.6 M | $ 0.11 M | $ 0.2 M |
| Long-Term Groundwater Monitoring (Capitol Costs) | $ 0.15 M | $ 0.17 M | $ 0.3 M (c) |
| Quarry Reclamation | --- (a) | $ 6.2 M | $ 9.6 M |
| Institutional Controls | --- (b) | --- (b) | TBD |

a Costs were not supplied because reclamation of the quarry was not considered a component of the remedial action for the quarry, although it was discussed as a component to attain final closure of the quarry area.

b Costs for implementing institutional controls were not supplied because it was unknown at that time the area extent controls would be required.

c Costs do not include abandonment of 4 wells that will occur at a future date.

# 10. OBSERVATIONS AND LESSONS LEARNED

A number of DOE Orders, rules, and requirements refer to Lessons Learned. Many require that Lessons-Learned be identified, evaluated, shared, and incorporated into projects, programs, or operations. WSSRAP used the Oak Ridge Implementation Guidance to define and assign responsibilities on-site. On March 16, 1994, Rev. 0 of Site Quality Procedure 25-Lessons Learned – was implemented.

The Lessons Learned program at WSSRAP was developed as a method to communicate continuous improvement in Safety, Quality, Productivity, and Efficiency. The Lessons Learned could be initiated by anyone on site and were ranked by four levels depending on the level of importance:

- Red Alert – Immediate dissemination. It describes any problem or issue with major environmental, safety, health or quality implications.
- Yellow Alert – A negative lesson learned that might require management action
- Blue Alert – A positive lesson learned that might require management action
- Green Alert – Positive or negative experiences of a non-critical nature.

As stated in section 2.1.4, cleanup criteria for soil remediation under the Quarry Residuals Operable Unit were taken from the Chemical Plant ROD. One lesson learned was attributed to work within the Quarry Residuals Operable Unit. This lesson learned was carried over from work within the Chemical Plant Operable Unit.

**Lessons-Learned WSSRAP –1997-009 Green**
**Cleanup Criteria for Contaminants of Concern**

No single cleanup criteria was established in the *Record of Decision at the Chemical Plant Area of the Weldon Spring Site* (Ref. 39) for individual contaminants-of-concern. Instead of deriving a single concentration cleanup criteria for the chemical and radiological COCs in the soils at the Chemical Plant, the ROD established cleanup values for both surface and subsurface (deeper than 6"); in addition, an As-Low-As-Reasonably-Achievable (ALARA) goal concentration, which the ROD stated would be met in most cases, was established for each of the COCs. Because this resulted in up to three different target levels for each of the contaminants, it was unclear when adequate cleanup would be achieved.

The *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 20) presented the protocol used to determine when the cleanup requirements of the ROD had been attained. The site was divided into discrete areas for which a decision was made as to whether or not the remediation was completed based on data collected via implementation of the Plan. The Plan stated that the more stringent ALARA numbers were only goals and remediation was deemed complete either when the data indicated that the ALARA goal concentrations had been met or it was determined that the ALARA principle had been met even though the actual goal

concentrations had not. A committee consisting of PMC management and a DOE representative was formed to make these decisions. This committee was responsible for ensuring that contaminant levels remaining in the soil across the site after remediation range between the cleanup criteria and the ALARA goals, reaching the goals in most cases. In all cases, the protective cleanup criteria were met to the statistical confidence specified in the Plan. Where the final grade had been reached during excavation or the soils would potentially be used for fill, surface cleanup levels were achieved. Where fill would be placed over the grade attained during excavation, subsurface criteria were identified as the cleanup levels.

Several innovative designs and best management practices were incorporated into the activities performed for the Quarry Residuals Operable Unit, which reduced construction times and costs and in some cases increased worker safety. These include:

- Quarry Restoration Borrow Source - Cooperation between U.S. Department of Energy and the Missouri Department of Conservation regarding obtaining a borrow source resulted in developing a borrow source within close proximity to the quarry proper and establishing a wetland area for future recreational use in the Weldon Spring Conservation Area.
- Quarry Interceptor Trench Field Study - Utilizing an innovative trenching machine allowed the interceptor trench to be constructed with simultaneous placement of collection pipe and gravel materials. Employment of this method reduced installation time and increased worker safety.
- Quarry Interceptor Trench Field Study - Establishing a well-defined performance standard for the interceptor trench provided a clear measurement upon which to evaluate field data and conclude the field study.
- Quarry Restoration - Innovative use of a skid-mounted water treatment facilities allowed for early decommissioning and demolition of the Quarry Water Treatment Plant QWTP. The contaminated portions of the QWTP were disposed of in the on-site cell rather than being shipping it off-site to a disposal facility. This resulted in a reduction in costs and acceleration of the project schedule.
- Quarry Restoration - Use of plywood forms and concrete to seal wall fractures within the quarry proper rather than using shotcrete, which was unsuccessful due to thickness and amount of shotcrete required. It was also demonstrated that grouting of wall fractures was unnecessary due to quantity, permeability, and elevation of soil backfill.

# 11. OPERABLE UNIT CONTACT INFORMATION

Department of Energy contact:

U.S. Department of Energy
Weldon Spring Site Remedial Action Project Office
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The Project Management Contractor (PMC) was Washington Group International, formerly MK-Ferguson, Inc. in association with Jacobs Engineering Group. The contract number was DE-AC05-86OR21548.

PMC Contacts:

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The Technical Assistance Contractor (TAC) is:

S.M. Stoller, Inc. The Contract number is
DE-AC13-02GJ79491.
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Missouri Department of Natural Resources Contact:

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Jefferson City, MO 65102
Phone Number: 573-751-3907

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# APPENDIX A
# WP-551A QUALITY ASSURANCE RECORDS

# Appendix A

## CONSTRUCTION QUALITY ASSURANCE AND CONTROL
## Work Package WP-551A

Quarry Clean Material Backfill Restoration

The subcontractor, Pangea, was required under WP-551A to have an approved quality assurance program and a designated quality control representative to perform first line inspections. The construction material testing was performed by the PMC. An on-site testing laboratory was established to perform the testing. The *Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 1) described the methods by which the construction activities were required to be tested and inspected to verify compliance with the specification requirements.

Prior to the start of quarry restoration the PMC investigated potential borrow sources for backfill materials. The selected borrow source was identified in the Work Package WP-551 specification documents for use by the Subcontractor Pangea. The low permeability and common fill for the quarry restoration was obtained from an offsite borrow area identified as the Quarry Well Field located southeast of the quarry footprint and from sources within the quarry. The off-site borrow area was qualified under WSSRAP-Quarry Restoration Borrow Investigation Report Technical Memorandum No. 3840TM-3032-01. The material in the Well Field was found to be suitable as low permeability backfill or common fill based upon the investigation report test results.

Prior to starting any backfill activities, additional soil testing was performed to verify that the borrow area materials would meet the low permeability requirement being classified as CL or CH in accordance with ASTM D-2487, *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)* (Ref. 2). All the material tested met the CL or CH classification, inorganic clay of low to medium plasticity and inorganic clay of high plasticity, respectively. After the low permeability material passed classification, moisture/density relationship testing was performed in accordance with ASTM D-698, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard and Effort* (12,400 ft-lbf/ft$^3$ (600 KN-m/m$^3$)) (Ref. 3).

Moisture and density control requirements for the earthwork was identified in the contract specifications and the *Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 1). The results of the optimum moisture-density curve obtained from each type of borrow material was the basis of control for compaction determinations. Moisture testing was performed in accordance with ASTM D-2216, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock Mass* (Ref. 4); ASTM D-3017,

*Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)* (Ref. 5); or ASTM D-4623, *Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method* (Ref. 6), as applicable. Density testing was performed in accordance with ASTM D-1556, *Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method* (Ref. 7) or ASTM D-2922, *Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)* (Ref. 8).

Although the designated borrow area met the classification requirements for low permeability and common fill material, the insitu moisture content was above the requirements for placement. In addition to the borrow area, the quarry stockpiles designated as fill materials had moisture levels above the requirements for placement. Due to this excessive moisture content, conditioning at the borrow area and quarry stockpiles was required. The conditioning consisted of stockpiling, disking, and/or blending with drier material to achieve the allowable moisture content for placement.

To facilitate the conditioning of the materials to ensure that both the low permeability and common fill material were acceptable for placement, PMC quality personnel performed extensive moisture and moisture/density relationship testing. There were 225 informational moisture tests performed on the various materials. These tests were used to determine insitu moisture content, progress of conditioning and/or acceptability for placement as backfill. To determine the acceptable moisture ranges for fill placement, 38 moisture/density relationship tests were performed in accordance with ASTM D-698 (Ref. 3). Record moisture tests were performed on both the low permeability and common fill to ensure the specification requirements were met for all placed material. For the low permeability materials, 66 record moisture tests were performed and 46 record moisture tests were performed for the common fill material.

The low permeability was placed directly on top of the bedrock or on top of prepared track-walked finished subgrade. The low permeability material was required to be placed with a maximum loose lift thickness of 12 inches. Continuous monitoring was performed during material placement to ensure that the first four lifts of material were spread and compacted as required. In addition, the low permeability placement was verified as being placed in horizontal lifts with at least a two-percent slope to facilitate drainage. Visual inspections were performed to ensure that not more than 10% of organic materials or deleterious substances were in the low permeability soil.

The required test frequency for performing moisture/density relationship tests in accordance with ASTM D-698 (Ref. 3) is one test prior to placement with two supplemental tests performed for the first four lifts. As indicated above, due to the excessive moisture content of the designated backfill materials, 38 moisture/density relationship tests were performed.

The *Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 1) required density testing on the initial four lifts of low permeability material.

Two density tests per lift were to be performed following four passes of the compaction equipment. A total of 11 density tests were performed on the first four lifts of the low permeability material. Four tests were performed on the first lift, two tests on the second lift, three tests on the third lift and two tests on the fourth lift. With acceptable compaction results achieved in the first four lifts, the remaining lifts were placed with a minimum number of roller passes per lift.

All testing and observations were documented via daily reports completed by the PMC quality representative. One surveillance was performed for WP-551A to verify the current status of controlled documents. The action identified in the surveillance for Pangea was corrected immediately.

Testing Summary for WP-551A:

Moisture Tests per ASTM D-2216 (Ref. 4), ASTM D-4623 (Ref. 6):

| No. of Tests | Type of Test |
|---|---|
| 225 | Information only test for low permeability/common fill material |
| 66 | Record test for low permeability material |
| 46 | Record test for common fill material |

Moisture/Density Relationship Tests per ASTM D-698 (Ref. 3):

| No. of Tests | Type of Test |
|---|---|
| 38 | Test for low permeability/common fill material |

Density Tests per ASTM D-1556, ASTM D-2922 (Ref. 8):

| No. of Tests | Type of Test |
|---|---|
| 11 | Test for low permeability material |
| 8 | Test for common fill material |

References:

1. Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities.

2. ASTM D-2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

3. ASTM D-698: Standard Test Methods for Laboratory Compaction Characteristic of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 KN-m/m3)).

4. ASTM D-2216: Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

5. ASTM D-3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

6. ASTM D-4643: Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.

7. ASTM D-1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

8. ASTM D-2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

# APPENDIX B
# WP-529B QUALITY ASSURANCE RECORD

# Appendix B

## CONSTRUCTION QUALITY ASSURANCE AND CONTROL
## Work Package WP-529B

Quarry Restoration Phase II

The subcontractor, Pangea, was required under WP-529B to have an approved quality assurance program, a designated quality control representative to perform first line inspections and an approved material testing laboratory. Pangea set up an on-site laboratory to perform moisture tests and subcontracted the field density and standard proctor (moisture/density relationship) testing to Geotechnology, Inc. Pangea later obtained, and submitted for approval, equipment to perform standard proctor (moisture/density relationship) tests on-site. Pangea submitted for approval calibration and certification reports for all testing equipment used. The PMC Project Quality Department assigned a representative to the work package to provide oversight of the subcontractor's activities. The *Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 1) described the methods by which the construction activities would be tested and inspected to verify compliance with the specification requirements.

The common fill borrow material was obtained from the sources within the quarry delineated on the contract drawings. After initial site clearing, Pangea obtained material samples for moisture/density relationship testing per ASTM D-698, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 KN-m/m$^3$))* (Ref. 2). These samples were taken at various elevations from excavations dug for the specific purpose of sampling. Additional moisture/density relationship testing was performed as different materials were exposed and used for the backfill activities. The moisture/density relationship testing was used to determine the acceptable criteria of –2% to +4% of optimum moisture for the common fill backfill material as placed. A total of 12 ASTM D-698 (Ref. 2) Moisture Density/Relationship tests were performed by the subcontractor.

The contract specifications and *Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities* (Ref. 1) required density testing on the initial four lifts of common fill material. Two density tests per lift were to be conducted following four passes of the compaction equipment. If the test results indicated that acceptable compaction had been achieved following four passes, the next lift could be placed. Pangea performed 6-information only density tests on uncompacted lifts in the lower quarry area. This testing was used by Pangea to determine the compaction effort needed to obtain the required 90% of maximum density obtainable by ASTM D-698 (Ref. 2). It was determined from the informational testing and subsequent record tests that the required 90% of maximum density could be obtained

through a minimum of four passes with a compactor, provided the moisture requirements were met.

Pangea elected to perform density testing through the entire backfill operations. A total of 36, nuclear method ASTM D-2922 (Ref. 3), field density tests were performed. Two tests resulted in failures. One test did not meet the moisture requirements and the other did not meet the compaction requirement. Both test areas were reworked and the retest recorded acceptable results.

Moisture content of the common fill materials was measured on a daily basis during placement. Representative samples were taken from a depth of 2-6 inches and tested for moisture content using ASTM D-4643 (Ref. 4) methods. Microwave test results were correlated against a standard convection oven at an approximate ratio of 10 microwave tests per oven test correlation. A total of 56 moisture tests were taken for the common fill backfill operations.

The Hamburg Extension for the Katy Trail required aggregate base and surface materials to be placed on compacted subgrade. The subcontractor submitted gradation test reports for the proposed aggregate materials prior to placement. The proposed base material did not meet the specification gradation requirements. The proposed base material was evaluated by the Engineering Department for compatibility with the surface aggregate. The Engineering Department determined that the proposed base material was compatible with the surface aggregate and revised the specifications. No testing was required for the aggregate materials placed for the Hamburg Trail. The lift thickness and number of roller passes was monitored for compliance to the specification requirements.

The PMC Project Quality Department assigned a representative to perform oversight of the subcontractor's activities and to ensure that the quality control testing and observations of the work activities were being performed. Daily reports were completed to document the oversight activities.

The subcontractor, Pangea, submitted a Final Quality Assurance Report that summarized Pangea's quality activities and stated that the soil placement met project requirements. The submitted report was reviewed and accepted by the PMC.

Testing Summary for WP-529B:

Moisture Test per ASTM D-4623 (Ref. 4):

| No. of Tests | Type of Test |
|---|---|
| 56 | Test for common fill material |

Moisture/Density Relationship Tests per ASTM D-698 (Ref. 2):

| No. of Tests | Type of Test |
|---|---|

| | |
|---|---|
| 12 | Test for common fill material |

Density Tests per ASTM D-1556, ASTM D-2922 (Ref. 3):

| No. of Tests | Type of Test |
|---|---|
| 36 | Test for common fill material |

References

1. Remedial Action Inspection and Test Plan for Quarry Restoration Earthwork Activities.

2. ASTM D-698: Standard Test Methods for Laboratory Compaction Characteristic of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 KN-m/m$^3$)).

3. ASTM D-2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D-4643: Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.

# APPENDIX C
# Northeast Slope ALARA Committee Documentation

# ALARA Committee Meeting
## August 23, 2000

| | | | |
|---|---|---|---|
| Attendees: | Dave Hixson* | Ken Greenwell* | Tom Pauling* (DOE) |
| | Steve Warren* | Melissa Lutz* | Yvonne Deyo |
| | Becky Cato | Linda Broody | Eric Ripp |

* ALARA committee member

Topic: Quarry - NE Slope

Background – The Northeast slope of the quarry is being remediated under provisions of the Quarry Residuals ROD. The ROD indicated that further characterization of the area would be performed and then, based upon how the new data affected the prior risk evaluation for a recreational visitor, remediation may be undertaken. If remediation was to be conducted, the Chemical Plant ROD cleanup criteria for radionuclides would be applied. Although the further characterization did not appear to affect the overall risk to the recreational visitor, DOE decided to proceed with remediation of this area and to apply not only the Chemical Plant cleanup criteria, but also the concepts of the cleanup attainment plan. The surface cleanup criteria were applied at the northeast corner, despite the plan to backfill, because the slope of the area could result in future erosion. A detailed *Quarry Proper Confirmation Plan* was written to implement the cleanup attainment plan.

The ALARA committee met to review and discuss the NE Slope sample results. This area does not meet confirmation release criteria since it contains more than 5 hotspots and 2 of these hotspots exceed three times criteria. Based upon this information alone, additional excavation would be required. The area has a Th-230 average (8.08 pCi/g) exceeding the ALARA goal.

All of the hotspots are located on bedrock, where no additional soil excavation is possible. The samples had been collected by removing soil from crevices and picking up dirt clods within an approximate 3 ft radius of the sampling location, rather than the normal 6 inch sample depth. A visit was made to the NE Slope by the committee to view the excavation and hear an account of the field activities that had occurred (provided by Eric Ripp). Attachment 1 identifies the hotspot locations and concentrations exceeding criteria.

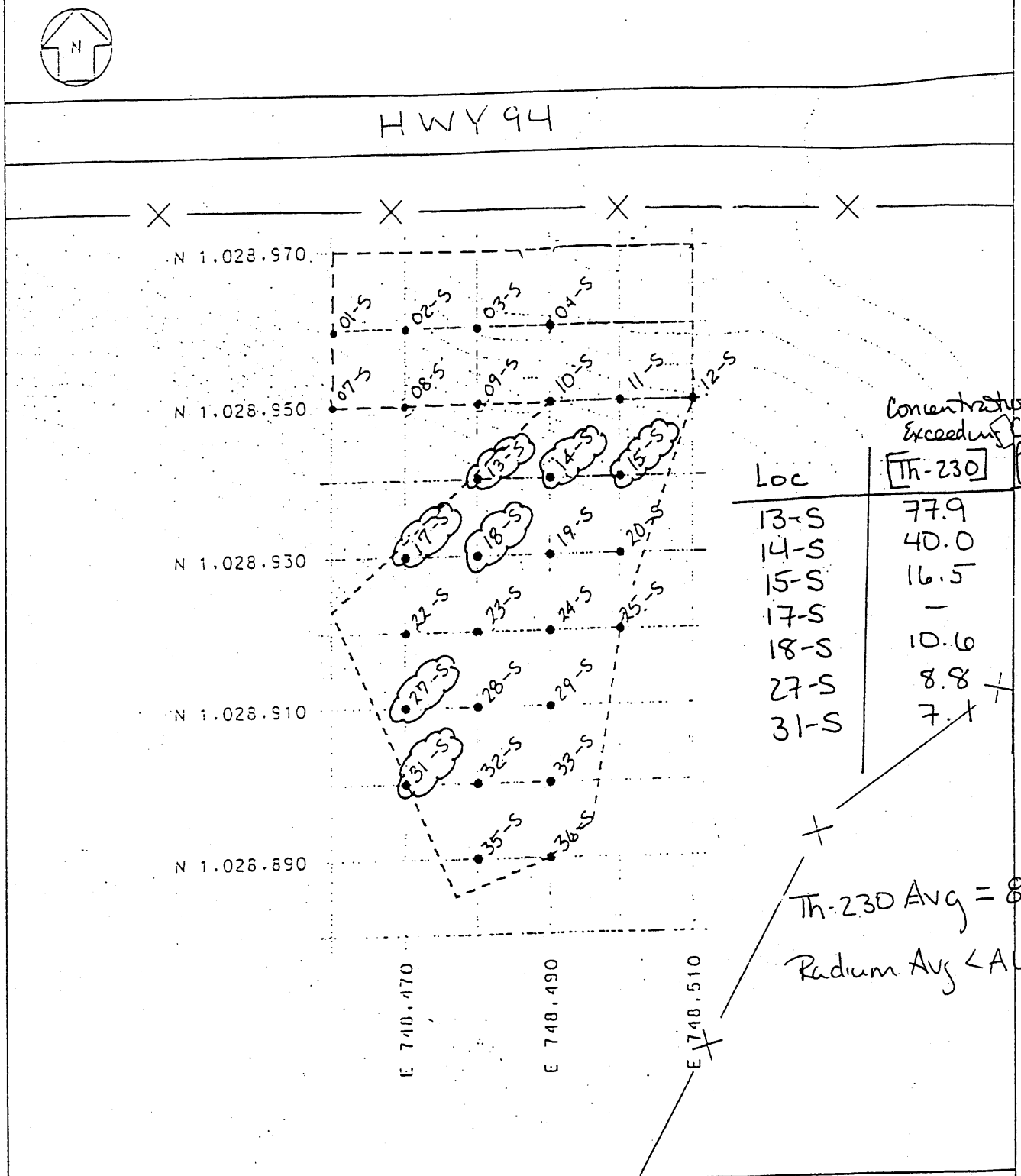
The committee members discussed options that included vacuuming or spraying down the floor of the excavation where bedrock was exposed to clean out the crevices and remove what soil remained on the floor. The committee agreed that this level of effort would result in little benefit gained since minimal additional soil volume could be removed and other areas are remaining in the quarry with similar levels. Everyone felt that reasonable efforts in design and in field implementation to try to achieve cleanup goals had been put forth. In accordance with the principles established in the *Chemical Plant Area Cleanup Attainment Confirmation Plan*, the committee also agreed that while the cleanup concentrations were not obtained, the ALARA principle has been met. Additional details on the ALARA concept are discussed in Section 1.4 of the Attainment Plan.

The unanimous decision was that no further remedial action was required and that the area should be backfilled. The committee requested that Tom Pauling discuss the committee's decision with Steve McCracken. The approval to backfill the NE Slope would not be given to the subcontractor until Steve McCracken had been briefed and the committee's decision approved.

Follow-up Tom Pauling spoke with Steve McCracken, who agreed with the ALARA committee decision. Photographs will be taken of the surface prior to backfilling in order to further document the physical constraint to further excavation.

cc: G. Valett A. Pickett (DOE) J. Meier B. Moore (MDNR)

ALARA Committee Meeting
08·23·00




Concentrations Exceeding Criteria

| Loc | Th-230 | Radium |
|---|---|---|
| 13-S | 77.9 | 22.5 |
| 14-S | 40.0 | 6.3 |
| 15-S | 16.5 | — |
| 17-S | — | 7.3 |
| 18-S | 10.6 | — |
| 27-S | 8.8 | — |
| 31-S | 7.1 | — |

Th-230 Avg = 8.08 pCi/g

Radium Avg < ALARA

TOTAL # OF SAMPLES: 29

● – SAMPLE POINT

0 20 40

SCALE FEET

CONFIRMATION SAMPLING LOCATIONS AT THE NORTHEAST SLOPE (RU027CU411)

FIGURE 3-1

| | | | |
|---|---|---|---|
| REPORT NO.: DOE/OR/21548-866 | | EXHIBIT NO.: A/QY/026/0700 | |
| ORIGINATOR: RC | DRAWN BY: GLN | DATE: 7/12/00 | |

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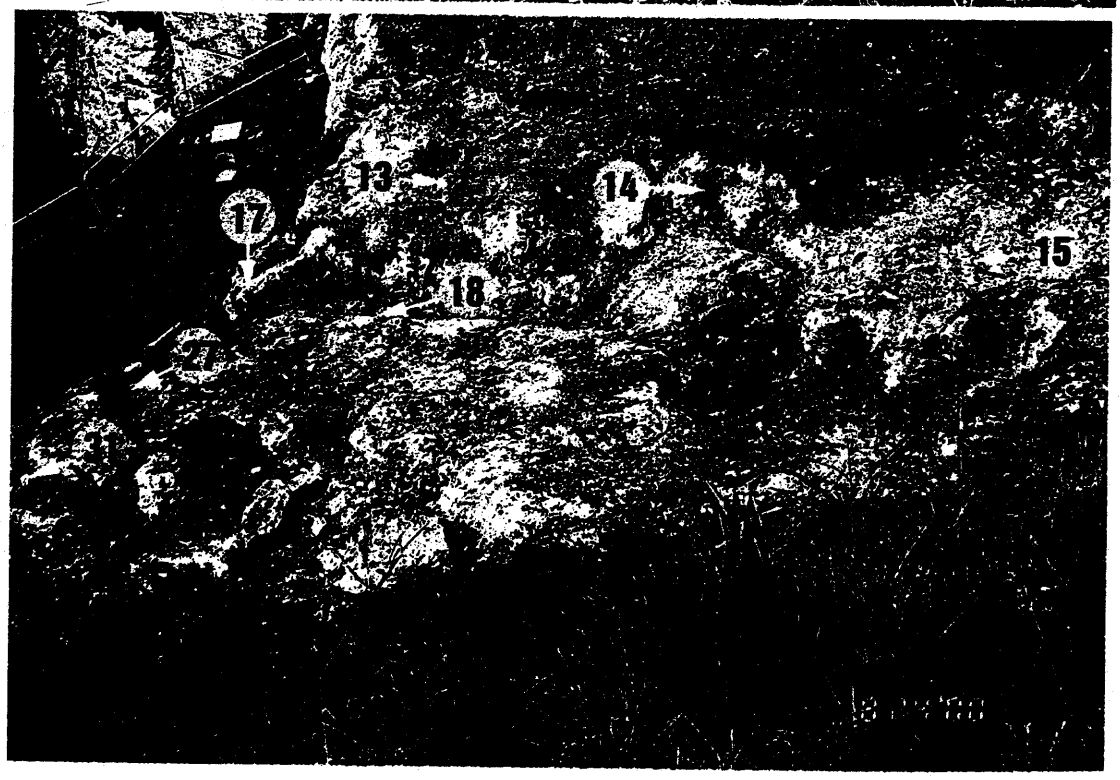
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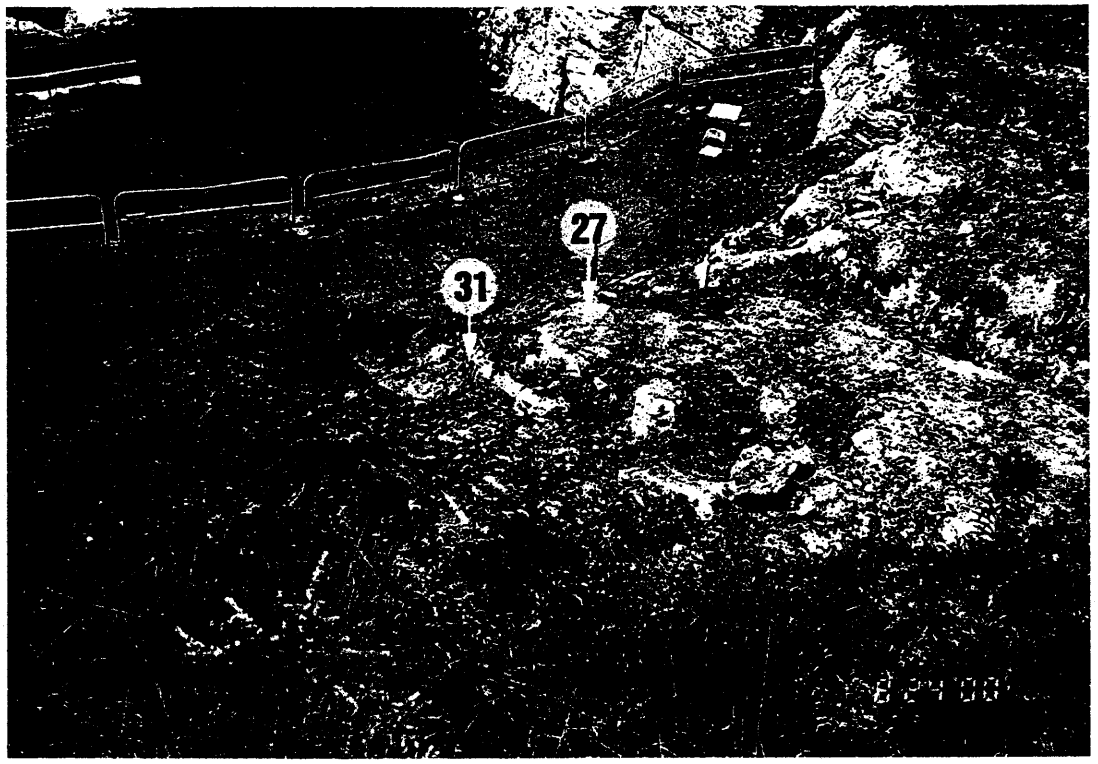
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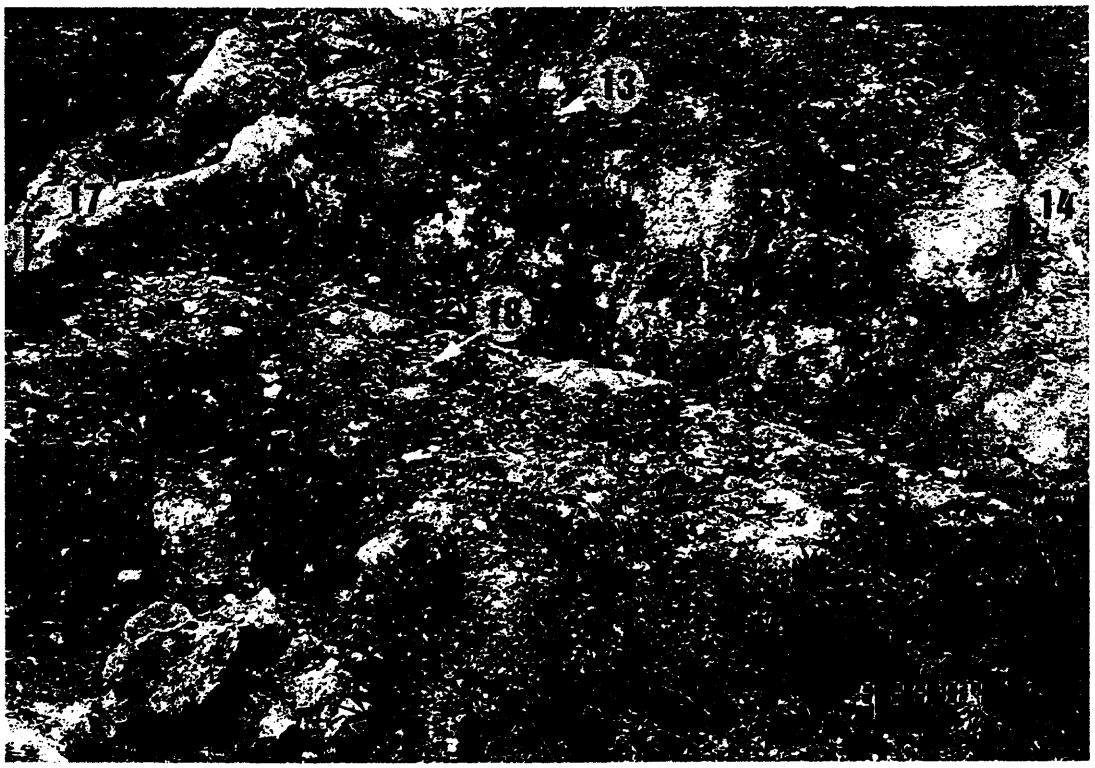
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# APPENDIX D
## Breakdown of QROU Project Costs

The WSSRAP cost management system is designed around the work breakdown structure (WBS) framework for organization and management. This structure includes all work on the project and is product oriented. The WBS structure provides a structure to roll up cost from lower levels to higher summary levels. The WBS was established at the beginning of the project and was not revised to reflect the four operable units at WSSRAP.

Conceptual designs and cost estimates were used for requesting project funds in accordance with the project schedule. The planning and sequencing of project work activities for all four operable units used defined cost estimates after the design was completed. As the DOE and Army funding was allocated annually, work was scheduled and contracted.

The actual costs included in this QROU Interim Remedial Action reflect WBS Level IV cost accounts specific to the Quarry Residuals Operable Unit. The costs were identified from the total costs of the WSSRAP and are summarized in Table D-1. Cost associated with the sampling and analysis of confirmation units within the QROU were placed within general accounts and specific costs were not able to be identified.

Table D-1 Summary of Project Costs

| WBS Level 4 | Cost Code | Cost Code Title | Amount ($) | Comments |
|---|---|---|---|---|
| 2.1.6 | P754-21601 | DOD-OSC Off-site Waste Disposal | 342,760 | WP-529B EP-2 Sediment/Liner |
| 2.1.6 | S071-21602 | Subsurface Drilling Services: WP385 | 283,514 | QRSB borings |
| 2.1.6 | S071-21602 | Subsurface Drilling Services: WP533 | 34,238 | Geochemical field study |
| 2.1.6 | S071-21603 | Well Installation & Abandonment:WP-487A | 149,959 | WP-487A Tasks 5, 6, 7, & 9 |
| 2.3.2 | G071-23202 | QY, CP & Site Containers | 12,720 | FY1999 through FY2003 |
| 3.3.1 | G071-33101 | QWTP Supplies & Equipment | 108,398 | FY1999 through FY2002 |
| 3.3.1 | S071-33102 | QWTP Operation: WP485 | 521,840 | FY1999 through FY2001 |
| 3.3.1 | S071-33102 | Train 3 Construction: WP505AC | 15,047 | |
| 3.3.1 | L382-33104 | JEG-QY WTP Eng. Assistance | 7,221 | FY 1999 only |
| 3.3.1 | S071-33110 | QWTP System Calibration/Maintenance | 4,836 | FY1999 & FY2000 only |
| 3.3.1 | S071-33111 | QWTP Maintenance Agreements | 21,046 | FY1999-FY2001 only |
| 3.3.1 | G071-33112 | Quarry: Train 3 & RBIX (Jan '01 and out) | 22,921 | |
| 3.3.1 | S071-33112 | Quarry: Train 3 & RBIX (Jan '01 and out) | 369,579 | |
| 3.5.1 | L382-35101 | A&E QITS-Construction Support | 10,195 | |
| 3.5.1 | L393-35101 | MKES-ENG QY Restoration Support | 63,888 | Tasks 371 & 372 |
| 3.5.1 | S071-35101 | QY Interceptor Trench Design | 96,703 | |

| WBS Level 4 | Cost Code | Cost Code Title | Amount ($) | Comments |
|---|---|---|---|---|
| 3.5.1 | S082-35101 | Quarry Residual Remediation | 4,523 | |
| 3.5.1 | S071-35102 | QY Wellfield Interceptor Trench: WP-515 | 652,115 | WP-515 |
| 3.5.1 | S071-35104 | QY Ramp/Remove Contam. Material: WP-505X | 1,236,698 | WP-505X |
| 3.5.1 | S077-35105 | DHO Quarry Waste Placement | 874,509 | Placement of QWTP into Cell |
| 3.6.1 | L382-36101 | A&E QY Restoration-Construction Support | 8,865 | |
| 3.6.1 | L393-36101 | Restoration Engineering: Task 324 | 108,196 | |
| 3.6.1 | L382-36102 | A&E QY Restoration Design Task 301 | 810 | |
| 3.6.1 | S071-36102 | Quarry Restoration Support | 12,033 | |
| 3.6.1 | S071-36103 | Qy Restoration Design | 386,026 | |
| 3.6.1 | S082-36103 | Quarry Restoration-Construction Support | 29,938 | |
| 3.6.1 | S071-36104 | Quarry Restoration: WP551D | 266,596 | WP-551D |
| 3.6.1 | S071-36105 | QY Clean Material Backfill Restoration: WP-551A | 3,136,342 | WP-551A |
| 3.6.1 | S071-36107 | QITS/QY Reclamation: WP-529B | 2,469,118 | WP-529B |
| 3.6.1 | S071-36108 | QWTP & Facility Demo: WP-553A | 680,555 | WP-553A |
| 8.3.7 | L393-83701 | MK-QY Residuals RD/RA: Task 962 | 152,573 | |
| | | **Total:** | **17,063,580** | |

**Responses to MDNR Comments on QROU Interim RA Report (Rev. A)**

Comment 1 – Figure 2-1, Suggest supplying a better reproduction of this map in the final report.

Response 1 – DOE agrees that Figure 2-1 should be reproduced to better convey the uranium distribution.

Comment 2 – Section 8.0, Summary of Project Costs, Page 78, This section is incomplete. The summary does not include the cost of Institutional Controls (ICs). Institutional Controls are a component of the remedy as specified in the Record of Decision.

Response 2 – DOE agrees that QROU costs presented in this table do not capture potential future costs such as those described by MDNR. We will revise this table to better reflect costs for this Operable Unit through September 2003. Since it is an interim report, future costs will be updated when the remedial action is complete.

Comment 3 – Section 9.0, Observations and Lessons Learned, Page 80, This section refers to lessons leaned and observations. Although there is only one official lessons learned for this operable unit, many observations could be noted in this section. Observations such as the difficulty encountered during Gunnite application to quarry wall fractures and the difficulty defining the mass of uranium in groundwater could be mentioned.

Response 3 - DOE agrees that additional information may be appropriate for this section. The draft final version will expand in this area.