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Hanford Facility RCRA Permit Condition II.U.1 Report for Mapping and Marking of Dangerous Waste Underground Pipelines

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1.0 INTRODUCTION

The purpose of this report is to fulfill Condition II.U.1. of the Hanford Facility (HF) *Resource Conservation and Recovery Act* (RCRA) Permit. The HF RCRA Permit, Number WA7890008967, became effective on September 28, 1994 (Ecology 1994). Permit Conditions II.U. (mapping) and II.V. (marking) of the HF RCRA Permit, Dangerous Waste (DW) Portion, require the mapping and marking of dangerous waste underground pipelines subject to the provisions of the Washington Administrative Code (WAC) Chapter 173-303. Permit Condition II.U.1. requires the submittal of a report describing the methodology used to generate pipeline maps and to assure their quality. Though not required by the Permit, this report also documents the approach used for the field marking of dangerous waste underground pipelines (Permit Condition II.V.).

During negotiations conducted before issuance of the HF RCRA Permit, mapping and marking of dangerous waste underground pipelines were discussed with the Washington State Department of Ecology (Ecology), the results of which are reflected in Permit Conditions II.U. and II.V. Because of the potential magnitude, scope, and cost of the mapping and marking permit conditions, a functional analysis workshop and a value engineering workshop were conducted during fiscal year 1995. Both workshops were attended by representatives from the Hanford Facility Permittees and Ecology. Based on the results from these workshops, terms were defined to assist in communication (Appendix A), and the general work scope was clarified (to the extent possible). This report includes a discussion of the agreements made during the workshops, which serve as the basis for the outlined mapping approach and description.

This report is organized around a simplified logic diagram of the mapping and marking process shown in Figure 1. The general flow of work progresses from left to right on Figure 1. As diagramed, the mapping and marking process consists of four elements. These elements make up the major sections of this report as follows:

- Permit Conditions (Section 2.0)
- Functional Analysis and Value Engineering Workshops (Section 3.0)
- Major Activities (Section 4.0)
- Deliverables (Section 5.0).

Included within a discussion of the four elements is information on the following:

- Description of the mapping and marking permit conditions (Section 2.0)
- Description of specific functional analysis and value engineering workshop agreements (Section 3.0)
- Description of the estimated accuracy of the pipeline information (Section 3.1.2 and 4.1)

- 1 • Description of the methods used to retrieve pipeline information
2 (Section 3.2 and 4.1)
- 3
- 4 • The quality assurance and quality control techniques employed to
5 support information (Sections 4.2 and 4.4)
- 6
- 7 • Examples of the mapping deliverables (Appendix D)
- 8
- 9 • Example of pipeline markers (Appendix E).
- 10

11 Figure 2 provides a more detailed flow diagram of the various mapping
12 activities discussed in Section 4.0.

13
14 The pipeline maps will provide general information on the location and
15 attributes of dangerous waste underground pipelines as required by the
16 HF RCRA Permit, DW Portion. More detailed drawings will be needed when
17 pipeline information is required to support compliance activities,
18 construction activities, and/or obtain excavation permits.

19
20 The Hanford Facility Dangerous Waste Permit Application, General
21 Information Portion, provides a glossary (DOE/RL-91-28).

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

2.0 HANFORD FACILITY RCRA PERMIT CONDITIONS

A copy of the actual mapping and marking Permit Conditions is provided in
Appendix B. Permit Conditions II.U. and II.V. are summarized as follows.

Permit Condition II.U.1.: By September 28, 1996, issue a report
describing the methods to be used to map the dangerous waste
underground pipelines.

Permit Condition II.U.2.: By September 28, 1997, issue initial
submittal of maps showing the applicable dangerous waste underground
pipelines that are located outside of the fences enclosing the
200 East, 200 West, 300, 400, 100N, and 100K Areas.

Permit Condition II.U.3.: By September 28, 1998, issue initial
submittal of pipeline schematics showing dangerous waste underground
pipelines within the 200 East, 200 West, 300, 400, 100N, and
100K Areas.

Permit Condition II.U.4.: By September 28, 1998, issue initial
submittal of maps showing the applicable dangerous waste underground
pipelines within the 200 East, 200 West, 300, 400, 100N, and 100K
Areas.

Permit Condition II.V.: By September 28, 1997, mark the dangerous
waste underground pipelines identified in Permit Condition II.U.2.

1 Much of the individual Hanford Facility treatment, storage, and/or
2 disposal (TSD) Part B permit application documentation is not scheduled for
3 incorporation into the HF RCRA Permit for several years. Even though existing
4 construction drawings are archived onsite, Ecology determined that the mapping
5 and marking Permit condition would provide interim information required to
6 locate dangerous waste underground pipelines. According to the Permit
7 Applicability Matrix (Attachment 3 of the HF RCRA Permit, DW Portion), Permit
8 Conditions II.U. and II.V. apply to interim status TSD units, TSD units
9 undergoing closure (Part V of the HF RCRA Permit), and operating TSD units
10 (Part III of the HF RCRA Permit). A list (current as of May 1996) of these
11 TSD units is provided in Appendix C. All TSD units will not be included in
12 this mapping effort as not all units have dangerous waste underground
13 pipelines subject to the provisions of the WAC.
14
15

16 3.0 FUNCTIONAL ANALYSIS AND VALUE ENGINEERING WORKSHOPS 17 18

19 As a means of defining the mapping and marking process, functional
20 analysis and value engineering workshops were conducted. This section
21 discusses the bases and agreements reached at these workshops. These bases
22 and agreements will be used to prepare the maps and post the signs to satisfy
23 the HF RCRA Permit conditions.
24

25 The primary objective of the functional analysis workshop was to discuss
26 and reach agreement on a mapping and marking functional approach. The results
27 from the functional analysis workshop provided an approach to be used to
28 secure, authenticate, and document the needed information. During the value
29 engineering workshop, the mapping and marking process strategy was refined and
30 details clarified to provide a more efficient approach.
31

32 Both the functional analysis and value engineering workshops were
33 convened during the early stages of the program to ensure that the mapping and
34 marking process was both well conceived and that functional analysis and value
35 engineering participants had an active role in defining and shaping the
36 mapping strategy.
37
38

39 3.1 FUNCTIONAL APPROACH 40

41 Overall functional activities that would be necessary to satisfy the
42 HF RCRA Permit conditions were consolidated into those that pertain to the
43 collection of applicable pipeline data, provide an accuracy level of these
44 data, and document these data.
45

46 The primary agreements from the functional analysis workshop include a
47 consensus on the use of: (1) the data sources available on the Hanford
48 Facility, (2) existing excavation information to address pipeline data
49 accuracy, and (3) a computer automated mapping system.
50
51
52

1 **3.1.1 Data Sources**
2

3 Several of the data sources necessary to generate the pipeline maps were
4 identified by the functional analysis workshop participants. It was
5 determined that these data were available from existing onsite sources.
6 Therefore, the workshop participants agreed that only onsite sources that
7 would be readily accessible would be researched to obtain the required
8 pipeline information. The most pertinent data sources are presented in
9 Section 4.1.
10

11
12 **3.1.2 Data Accuracy**
13

14 One of the intents of this report, as required by Permit Condition
15 II.U.1., is to address the "estimated accuracy of the data provided" and to
16 describe the "techniques to be employed including field verification
17 activities (i.e., surveying, ground-penetrating radar, excavations, etc.) to
18 support information gathered from existing drawings." During the functional
19 analysis workshop, a session was held with onsite construction personnel to
20 evaluate the accuracy of the existing construction drawings. The existing
21 drawing system was critiqued, as this system would be the primary source of
22 dangerous waste underground pipeline information. The critique was based on
23 reviewing available past excavation information as a method of comparing the
24 documented and actual location of underground pipelines.
25

26 Three onsite cathodic protection upgrades, conducted during 1985 through
27 1995, were evaluated. Of the 328 excavations performed in the 200 East and
28 200 West Areas, all were 100 percent successful in locating the designated
29 underground pipelines. These existing field verification data support the
30 general accuracy of the existing drawings and are used to justify the
31 assertion that the estimated accuracy of the data provided generally is good.
32

33 These excavation data also are used as the field verification activities
34 to support information gathered from existing drawings. Therefore, no further
35 field verification activities will be performed before the initial map
36 submittals required by Permit Conditions II.U.2. and II.U.4. If sufficient
37 information does not exist on the drawing, field walkdowns will be performed
38 to provide field data coordinates [taken at locations where the pipeline exits
39 the ground (risers, wall penetrations, etc.)] and pipeline components
40 (diversion boxes, valve pits, etc).
41

42 Subsequent data accuracy agreements made during the value engineering
43 workshop can be found in Section 3.2, Agreement 7.
44
45

46 **3.1.3 Mapping System**
47

48 The existing onsite Computer Automated Mapping Information System (CAMIS)
49 was introduced to the functional analysis workshop participants as a system
50 for use in generating the HF RCRA Permit pipeline maps. With certain
51 upgrades, this system, or others like it, was determined to provide the best

1 method of compiling the applicable pipeline information as well as providing
2 storage for future map updates.
3

4 The CAMIS provides an effective way to handle and process spatial
5 information. The CAMIS can be used to extract data from a common base map
6 pool, to generate both maps and pipeline information lists (the pipeline
7 information lists are referred to as "map attachments"), to store mapping
8 information for future use, and to furnish consistent sets of data repeatedly.
9 A customized "toolbox" (user menu) could be created for use in CAMIS that
10 specifically supports this mapping project. The toolbox increases
11 productivity and improves data quality and consistency. A dedicated file
12 could be created for handling data and updating maps associated with each
13 TSD unit.
14

15 The CAMIS is not the only computer automated mapping system that could be
16 used. Whatever computer automated mapping system is used, the system must be
17 able to process and store the pipeline information required by the
18 HF RCRA Permit. Multiple mapping systems, if used, must produce map
19 deliverables with a uniform appearance (i.e., maps that edgematch so that
20 pipelines can be followed as they continue from one map to another, have the
21 same symbology, have consistent features, etc.) and must conform to a single
22 format.
23
24

25 3.2 IMPLEMENTATION APPROACH

26

27 The objective of the value engineering workshop was to evaluate and
28 improve the mapping and marking process to sufficiently satisfy the
29 HF RCRA Permit mapping and marking requirements. To that end, definitions for
30 certain terms were established (Appendix A). The value engineering workshop
31 participants also identified the following agreements that would be
32 implemented and documented in this report.
33

34 Agreement 1: HF RCRA Permit Condition II.U.1 Report

35 The methodology report, required by Permit Condition II.U.1., also will
36 be used to document functional analysis and value engineering workshop
37 agreements that described how the mapping and marking will be
38 accomplished.
39

40 It is not required that this report be certified. Rather, the maps will
41 receive approval signatures indicating that they meet the description
42 provided in this report (refer to Section 4.2).
43
44

45 Agreement 2: Data Questionnaire

46

47 Data questionnaires will be used to assist in collecting pipeline
48 information for each TSD unit. Questionnaires will be issued to the
49 applicable TSD unit manager, environmental compliance officer (ECO), or
50 designated cognizant individual (hereafter referred to as the "cognizant
51 individual"). These questionnaires will require pipeline information
52 (e.g., pipeline origin, destination, size, depth, material type, specific

1 in-line features, age, existing marker, data sources, etc.) input from
2 the TSD unit cognizant individual. The questionnaires also will require
3 the cognizant individual to provide a set of existing drawings and
4 engineering change notices that pertain to that TSD unit's dangerous
5 waste underground pipelines. These questionnaires will be used to
6 generate the TSD unit maps as described in Section 4.0.

7
8 Once returned to the mapping and marking sitewide coordinator, the
9 questionnaire responses are expected to manifest the following:

- 10
11 • Current and reliable TSD unit dangerous waste underground pipeline
12 information
13
14 • Data sources for this information
15
16 • Information formatted such that the information easily can be entered
17 into a computer automated mapping system.
18

19 **Agreement 3: Schematics Incorporation**

20
21 Submittals of schematics and maps originally were planned to be performed
22 at separate times. Current wording of the HF RCRA Permit requires that
23 the schematics and maps be submitted at the same time. Participants
24 agreed that any additional information required on the schematic
25 submittals, including direction of flow and pipeline status (active,
26 inactive, or abandoned), be included on the map submittals. This
27 approach eliminates the need for separate schematic submittals while
28 still meeting the Permit Condition.
29

30 **Agreement 4: Pipeline Attributes**

31
32 Each submittal will provide specific pipeline information as required by
33 the HF RCRA Permit. Listing these pipeline attributes (e.g., size,
34 depth, material, and status) on an attachment to the maps will ease
35 reporting changes during the annual updates should updated information be
36 available. Further details on the map and map attachment features can be
37 found in Section 4.3. A map submittal is understood to include the map
38 attachment.
39

40 **Agreement 5: Depth of Pipeline**

41
42 The HF RCRA Permit requires that the depth of the pipelines be
43 identified, but does not specify details as to how, nor at what
44 locations, the pipeline depth is to be reported. Participants agreed
45 that the depth of the pipeline will be reported as elevations at key
46 points along the pipeline route. Existing reference drawings that
47 provide further elevational information will be listed on the map
48 attachments.
49
50

1
2 **Agreement 6: Approval of Map Submittals**
3

4 During the value engineering workshop, approval requirements were agreed
5 upon for the map submittals (refer to Section 3.2, Agreement 1, and
6 Section 4.2). All map submittals, including map attachments, will
7 receive approval signatures indicating that they meet the description set
8 forth in this report (refer to Section 4.2).
9

10 **Agreement 7: Quality/Accuracy Description**
11

12 The HF RCRA Permit Conditions II.U.2., II.U.3., and II.U.4. require that
13 map submittals be accompanied by a description of the quality assurance
14 and quality control measures used to compile the maps. As a result of
15 the value engineering workshop, participants agreed that these quality
16 assurance and quality control measures (refer to Sections 4.2 and 4.4)
17 would be described once in this report and that each map submittal would
18 meet these measures.
19

20 Also, in response to both the quality assurance/quality control measures
21 and the estimated data accuracy requirements of Permit Condition II.U.1.,
22 participants agreed that the most common data sources for the map
23 submittals, along with a description of data sources, be provided in this
24 report (refer to Section 4.1). The data source description is provided
25 so that the quality and accuracy of the data source, and therefore the
26 map data, can be determined by the map users. This approach eliminates
27 the need to resubmit this information annually and provides further
28 information on the map data accuracy.
29

30 **Agreement 8: Treatment, Storage, and/or Disposal Unit Complex Perimeters**
31

32 From discussions among the value engineering workshop participants,
33 pipelines within the immediate vicinity of a TSD unit, defined as the
34 "TSD Complex Perimeter" (Figure 3), were determined to be sufficiently
35 mapped by the existing construction drawings. Therefore, these pipelines
36 would not need to be included on the HF RCRA Permit maps as long as the
37 reference drawings are provided, i.e., dangerous waste underground
38 pipelines completely within the TSD Complex Perimeter will not be mapped.
39 Reference drawings for these pipelines either will be provided on the
40 maps or be listed on the map attachments, whichever is most appropriate.
41 The concept of a "TSD Complex Perimeter" is defined as follows (Figure 3)
42 and will be shown for each individual TSD unit on applicable maps:
43

- 44 • Could include various buildings associated with the TSD unit
- 45
- 46 • Will not have dangerous waste underground pipelines mapped
- 47
- 48 • Could or could not follow the TSD unit boundary as defined in that
- 49 TSD unit's Part A, Form 3
- 50
- 51 • Could or could not follow a TSD unit fence line
- 52

- Will be used to clarify which dangerous waste underground pipelines will be mapped and have reference drawings identified
- Will only be used for HF RCRA Permit Condition II.U. purposes.

Dangerous waste underground pipelines that exit a TSD Complex Perimeter will be mapped. These pipelines will be mapped from the point where a pipeline leaves the TSD unit (building wall) to the building wall of the facility where a pipeline is being routed to or from.

Tank farms are excluded from this agreement, as dangerous waste underground pipelines within a fenced tank farm will not be included in the HF RCRA Permit maps. Dangerous waste underground pipelines between fenced tank farms will be mapped.

4.0 MAJOR ACTIVITIES

This section provides a description of the methods used to collect, verify, present, and control the dangerous waste underground pipeline information required by the HF RCRA Permit Conditions as outlined in the process flow diagram shown on Figure 2. The discussion provided in this section follows the sequence of the flow diagram.

4.1 DATA COLLECTION

Several informational sources will be used to retrieve dangerous waste underground pipeline data to support the mapping process. This data search will be limited to onsite sources and will cover dangerous waste underground pipelines which contain or contained dangerous waste as of January 1, 1980 (see Section 5.2 for annual update schedule). The January 1, 1980 date was agreed to during the value engineering workshop to provide a mutually acceptable date to all parties involved and only is used for Permit Conditions II.U. and II.V.

Data questionnaires will be sent to TSD units. By responding to these questionnaires, the cognizant individuals from the TSD units will provide information required for preparation of the map submittals. Possible sources of data that could be used in responding to the data questionnaires include, but are not limited to, the following.

- Construction Specifications--These documents provide pipeline construction instructions (e.g., pipeline material, size, etc.) and are used in conjunction with construction drawings during the construction and inspection phases of a project. Construction specifications are controlled documents that require changes to the document be made through an engineering change notice (ECN) process or a design change notice (DCN) process.

- 1 • Existing Drawings--These are existing drawings (on mylar, vellum, or
2 electronic form, etc.) that are used, along with construction
3 specifications, to construct, modify, or convey information concerning
4 buildings, structures, and systems. Drawings bearing "H-Series"
5 identification numbers are subject to standardized document control.
6 Changes to these existing drawings are made through an ECN or DCN
7 process.
8
- 9 • Field Verification--This information includes those field activities
10 used to locate buildings, structures, and systems. Field activities
11 can include field walkdowns, surveying, ground-penetrating radar, and
12 excavations. As sufficient excavation data exists (refer to
13 Section 3.1.2), only field walkdowns will be performed should
14 additional information be necessary.
15
- 16 • Cognizant Individuals--This source includes information that is
17 obtained from personnel interviews, historical documents, and process
18 knowledge, as identified by the individual TSD unit manager or ECO.
19

20 These data sources are described in this report so that the accuracy of
21 the data used to compile the maps can be determined as agreed to by the value
22 engineering workshop participants (Section 3.2, Agreement 7). Responses to
23 the questionnaires could include additional sources of information unique to
24 the individual TSD unit.
25

26 4.2 DATA QUALITY

27
28
29 Data provided to compile the maps will be verified through the methods
30 used in obtaining and correlating the pipeline information gathered by the
31 questionnaires.
32

33 First, data obtained via the questionnaires will be furnished and
34 approved by the individual TSD unit's cognizant individual. Second, the data
35 questionnaire will be checked for completeness by the mapping service
36 organization (i.e., the organization[s] that actually draws the maps) before
37 processing any information into the computer automated mapping system.
38 Questionnaires that are not complete will be returned to the TSD unit's
39 cognizant individual for additional information. The accuracy of the
40 information gathered will be substantiated through random evaluations (spot
41 checking) of the data questionnaires for data consistency. These random
42 evaluations will be performed by the mapping and marking sitewide coordinator
43 (i.e., this is the person tasked with coordinating the sitewide mapping and
44 marking efforts). Finally, the mapping service organization will correlate
45 the data with information submitted by other TSD units.
46

47 In addition to the verification of data gathered by the questionnaires,
48 the following quality checks will be conducted by the mapping service
49 organization during the map preparation process to ensure a quality product.
50

- 51 • Data Research--Existing drawings submitted with the data
52 questionnaires will be reviewed to determine if references listed on

1 the drawings can provide additional information. Any pertinent
2 references, such as additional existing drawings and/or outstanding
3 ECNs or DCNs will be added to the set of drawings submitted by the TSD
4 unit. This quality check will identify and locate additional
5 drawings, ECNs, and DCNs that might not have been included as part of
6 that TSD unit's questionnaire and will ensure drawing lineage
7 traceability.
8

- 9
- 10 • Attributes--After consolidation of each TSD unit's pipeline attributes
11 and features, a second individual (not the same person that
12 consolidated the attributes/features) from the mapping service
13 organization will scrutinize the data to verify all required pipeline
14 attributes have been captured and to ensure the dangerous waste
15 underground pipeline components are uniquely identified, coded, and
16 annotated.
- 17 • Checking--After preparation of a map, a second individual (not the
18 same person as the map preparer) from the mapping service organization
19 also will review the data transferred from the questionnaire and the
20 existing drawing set to confirm that applicable pipeline attributes
21 have been transferred reliably and in accordance with this report.
22 For the initial map submittals for Permit Conditions II.U.2. and
23 II.U.4., the mapping and marking sitewide coordinator will spot check
24 the maps against the description given in this report to ensure
25 agreement between this report and the maps.
26
- 27 • Approvals--Once any inconsistencies and errors have been resolved, the
28 maps will be submitted to the individual TSD unit's cognizant
29 individual for review. Changes to the maps resulting from this review
30 again will go through the "checking" process. Once the maps
31 (generated for the permit conditions) meet the final approval of the
32 checker, the maps will receive an approval signature from the mapping
33 service organization manager indicating that the maps meet the
34 description set forth in this report and from the individual TSD unit
35 manager indicating that the information provided is complete and
36 accurate to the best of their knowledge.
37

38 39 4.3 DATA PRESENTATION 40

41 Some of the information required by the HF RCRA Permit mapping conditions
42 will be shown on the maps while the rest of the information will be found on
43 the map attachments (refer to Section 3.2, Agreement 4). This method of
44 presenting information will facilitate future updates. The distinction
45 between information shown on the maps and attachments is as follows.
46

Shown on Maps

Listed on Map Attachments

- Pipeline locations
- Pipeline origin
- Pipeline destination
- Diversion boxes*
- Valve pits*
- Seal pots*
- Catch tanks*
- Receiver tanks*
- Pumps
- Pipeline direction of flow
- Map scale
- Pipeline designator (name)
- Coordinates (at key locations)
- Pipeline depth (given as elevations at key locations)
- TSD Complex Perimeter pipeline reference drawings (if easily listed on the map)

- Pipeline material (type)
- Pipeline status
- Pipeline age
- Pipeline depth (list reference drawings)
- Estimates (if used)
- Pipeline size
- Data sources
- Coordinates (if deemed necessary to add coordinates not already listed on map)
- TSD Complex Perimeter pipeline reference drawings (if not already listed on map)

Additional map features not required by the HF RCRA Permit, but included for clarity, are the location of improved roads, major area fences, fenced tank farms, and TSD units. The TSD units, and items indicated previously by an asterisk (*), also will be labeled on the maps. Maps, and map attachments, submitted to satisfy Permit Condition II.U. must all have a uniform appearance (edgemark across map sheet boundaries, same map symbology, consistent map and map attachment format and features, etc.) even if different or multiple mapping systems are used. Refer to Appendix D for map and map attachment examples.

All maps and map attachments will bear the following statement:

"This document has been prepared to satisfy the Hanford Facility RCRA Permit (#WA7890008967) Condition II.U. (Dangerous Waste Portion) and is updated annually, as required by the Permit Condition. Changes to this document are to be made only in support of Permit Condition II.U. Also, refer to the Hanford Facility RCRA Permit Condition II.U.1. Report for Mapping and Marking of Dangerous Waste Underground Pipelines (DOE/RL-96-50). This document should not be used as the sole source for regulatory compliance, construction, or excavation purposes."

Each map will identify the scale used (typically 1 centimeter equals 20 meters). All locational information will use the Washington State Plane Coordinate System (NAD 83 [91]), and elevations will use the North American Vertical Datum of 1988 (NAVD 88).

4.4 DATA CONTROL

As the HF RCRA Permit maps will be updated annually, the aspect of reproducibility introduces a required degree of standardization to ensure

1 consistency and configuration control. The following approach will be
2 implemented to control the mapping data and the quality of the deliverable.
3

- 4 • As applicable dangerous waste underground pipeline data are collected,
5 the data and data sources will be organized into TSD unit-specific
6 dangerous waste underground pipeline data sets such that pipeline
7 information can be verified and ensured to meet mapping requirements
8 as described in this report. This approach will improve user
9 confidence in the mapped data by ensuring consistency of the data from
10 the point of beginning to the point of termination for each dangerous
11 waste underground pipeline and by ensuring the data are traceable.
12 This approach also will ensure future system and data maintainability
13 and repeatability.
- 14 • All maps and map attachments will conform to a single format with a
15 uniform appearance. This will ensure that the mapping deliverables
16 will be repeatable, i.e., updated maps will be produced for the same
17 areas with the same background contents on a consistent basis. This
18 also will ensure that the map deliverables submitted from different or
19 multiple mapping systems will look alike and be consistent with each
20 other.
- 21 • All maps will be released through a formal document control process.
22 This will ensure that each time a map and its map attachment are
23 generated/updated, the data set used to produce these, along with the
24 defining parameters (i.e., database queries, plot definitions, etc.)
25 will be captured and stored for future use. This approach also will
26 ensure that changes are controlled.

27
28
29 The pipeline maps and all supporting data sets, graphics data, database
30 attribute data, package documentation, etc., will be archived into the CAMIS
31 repository or equivalent computer-aided design and drafting dataset management
32 system. These data also will be stored on magnetic tape media as a secondary
33 backup. This will ensure that the Permit Condition II.U. mapping data always
34 can be retrieved.
35

36
37 To ensure effective preservation of the Permit Condition II.U. mapping
38 data, the data will be copied onto a new disk at least every 7 years as
39 necessary. As media technology changes, the format (devices) of archived
40 media will be upgraded as necessary.
41

42 5.0 DELIVERABLES

43
44
45 As technology and management approaches improve, this report could be
46 revised. Therefore, changes to the agreements or methods discussed, where
47 appropriate, could be replaced with equivalent or better approaches that meet
48 HF RCRA Permit Conditions. The new approaches, and any revisions, will be
49 implemented and documented in the HF Operating Record, General Information
50 File.
51
52

1 **5.1 MAP SUBMITTALS**
2

3 The initial pipeline maps will be submitted on aperture cards.
4 Thereafter, letter notifications of updated map completion will be submitted
5 rather than drawings or aperture cards. The current version of the maps will
6 be available on the Hanford Facility by accessing the HF Operating Record,
7 General Information File.
8
9

10 **5.2 MAP UPDATES**
11

12 Permit Condition II.U. requires that annual map updates be provided based
13 on Hanford Facility activities that could change previously submitted
14 information. This updated information includes new construction (the adding
15 or removing of dangerous waste underground pipelines) and any new information
16 found in the field.
17

18 This updated information will include *Hanford Federal Facility Agreement*
19 *and Consent Order* (Tri-Party Agreement) milestones that necessitate new
20 construction projects and any new information found as a result of Tri-Party
21 Agreement TSD closure work. As separate schematics will not be submitted,
22 changes in the information required by Permit Condition II.U.3. will be
23 reflected in updates to the maps of Permit Condition II.U.4.
24

25 The updates will incorporate information available 6 months before the
26 next scheduled submittal date. Therefore, annual updates will be as shown in
27 Table 1.
28
29
30

31 Table 1. Schedule for the Provision of Map Input.

32 Submittal dates	Required activity
33 September of each year	Maps are submitted as required.
34 6 months after map submittal 35 (by March of each year)	The latest information is gathered from TSDs, ECNs, DCNs, Tri-Party Agreement, etc.
36 6 months before next map submittal 37 (March through September)	The latest information is used to prepare updated maps.

38
39
40 **5.3 MARKING**
41

42 Permit Condition II.V. requires the posting of signs over the pipelines
43 mapped in Permit Condition II.U. These pipelines are to "be marked at the
44 point they pass beneath a fence at their origin and destination, at any point
45 they cross an improved road, and every 100 meters along the pipeline corridor
46 where practicable." Therefore, if a post already exists over a dangerous
47 waste underground pipeline that is subject to the marking Permit Condition,
48 the existing post will be used. If the existing post already is marked with a
49 sign that identifies the existence of a dangerous waste underground pipeline

1 (radiological posting), that sign will be sufficient to satisfy Permit
2 Condition II.V.

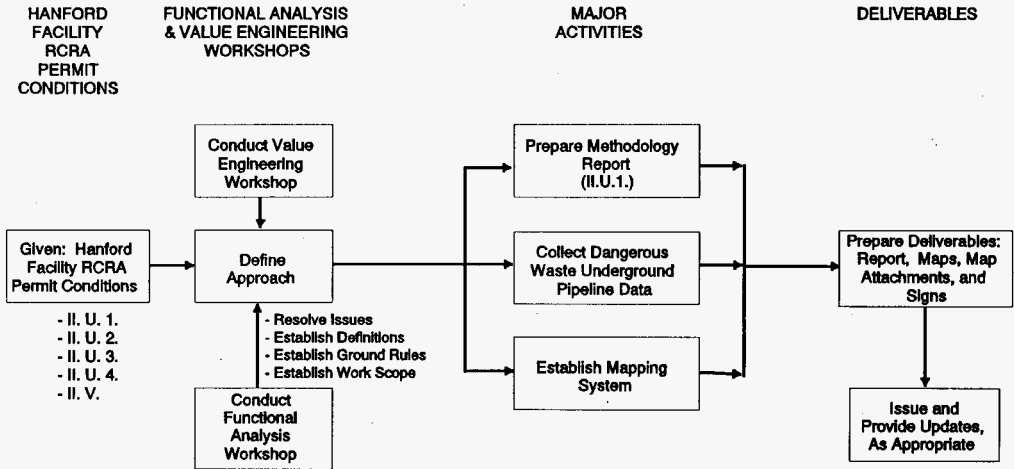
3

4 Sign posting will be updated annually along with updated map submittals.
5 Refer to Appendix E for marker examples.

6.0 REFERENCES

- 1
2
3
4 DOE/RL-91-28, *Hanford Facility Dangerous Waste Permit Application, General*
5 *Information*, DOE/RL-91-28, Rev. 1, U.S. Department of Energy, Richland
6 Operations Office, Richland, Washington.
7
8 Ecology 1994, *Dangerous Waste Portion of the Resource Conservation and*
9 *Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous*
10 *Waste*, dated September 28, 1994, Permit Number WA7890008967, Olympia,
11 Washington.
12
13 *Hanford Federal Facility Agreement and Consent Order* 1996, Washington State
14 Department of Ecology, U.S. Environmental Protection Agency,
15 U.S. Department of Energy, Richland Operations Office.

Figure 1. Permit Condition II.U. and II.V. Process Flow Diagram.



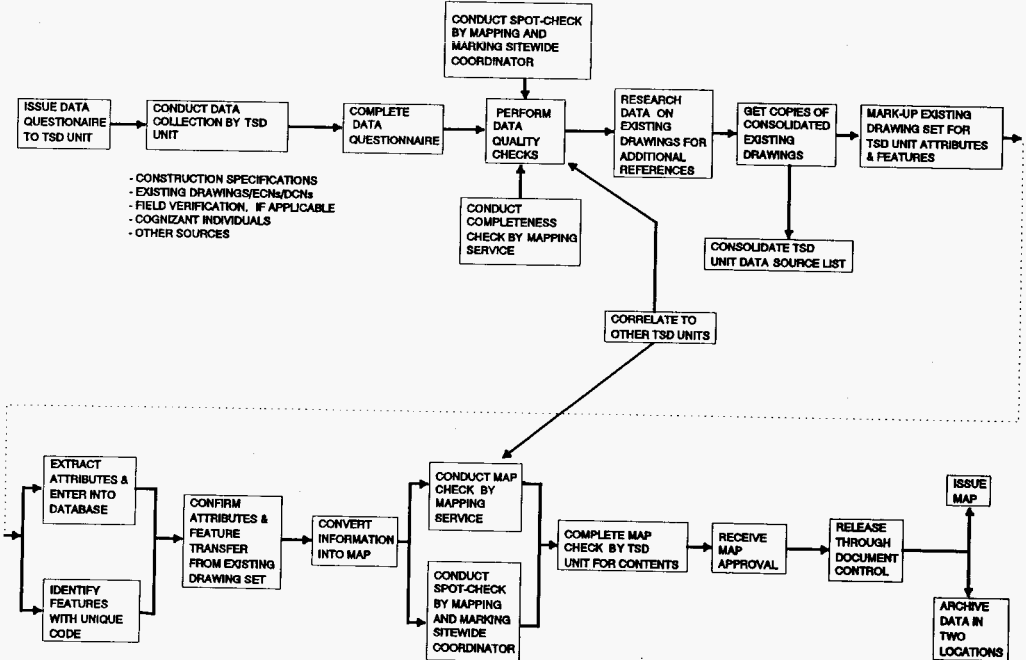
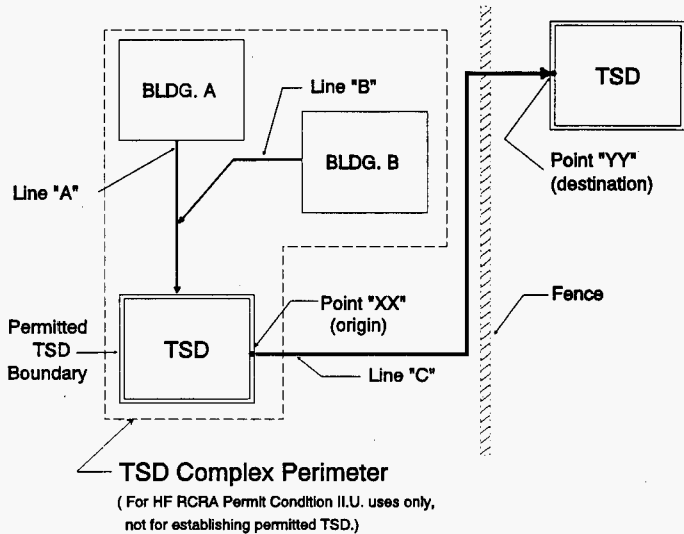


Figure 2. Permit Condition II.U. Detailed Mapping Activity Flow Diagram.



Line to be Mapped	Lines not Mapped
Line "C" from Point "XX" (origin) to Point "YY" (destination).	Lines "A" and "B." Provide reference drawings only.

Figure 3. Example of a "TSD Complex Perimeter."

APPENDIX A

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VALUE ENGINEERING WORKSHOP DEFINITIONS

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Value Engineering Workshop Definitions

3 Key word/phrase	Definition	Comments
4 Abandoned 5 pipeline	Underground pipelines (does not include pipelines within or under a building/structure) as required by the HF RCRA Permit, which, since January 1, 1980, were used to conduct dangerous waste but now are out of service (pipelines that physically or administratively have been isolated from active use).	Isolated means cut, capped, valved-off, etc.
6 Access to mapping 7 information	For the initial submittal, a set (hard copy) of the maps will be delivered to the regulators. For annual updates, notification (letter) that the updates have been done and that the regulators have access to the updated maps will be provided.	The initial map submittals will be transmitted on aperture cards.*
8 Active pipeline	Underground pipelines (does not include pipelines within or under a building/structure) as required in the HF RCRA Permit that are being used to conduct dangerous waste.	
9 Building/ 10 Structure	A building, diversion box, valve pit, transfer box, pipeline trench, catch station, vault, double-contained receiver tank, TSD Complex, etc.	
11 Catch tanks	Underground dangerous waste tanks as required by the HF RCRA Permit that function as secondary containment for a diversion box, valve pit, or transfer box.	
12 Coordinates	Washington State Plane Coordinates NAD 83(91)	II.U.1 report will describe to what extent coordinates will be given.
13 Dangerous waste	As defined in WAC 173-303-040	
14 Depth	Elevation will be reported at key points. These key points will be outlined in the II.U.1. report. Existing reference drawings will be listed and provided with the map submittals.	The II.U.1. report simply identifies that elevations will be provided at key points.*

App A-1

Value Engineering Workshop Definitions

	Key word/phrase	Definition	Comments
1	Destination	<p>For Permit Condition II.U.2: Where the pipeline crosses an area fence as dangerous waste is routed to that area via an underground pipeline.</p> <p>For Permit Condition II.U.4: The TSD unit's building wall (or disposal unit) where the dangerous waste is traveling to via an underground pipeline. For tank farms, the "destination" is where the underground dangerous waste line crosses and/or enters a fenced tank farm (where it crosses the fence). (Does not include pipelines within or under a building/structure.)</p>	
2	Diversion box	Concrete building/structure housing jumpers, pipelines, valves, or pumps (includes transfer boxes) used to conduct or transfer dangerous waste as defined in the HF RCRA Permit. Pipelines within the building/structure will not be mapped.	
3	Existing drawing	Refers to a drawing that exists and was generated for purposes other than for the mapping and marking conditions.	
4	Field verification	Methods used to establish quality of information.	May include existing verification information, surveying, random spot checks, ground-penetrating radar, etc.
5			
6	Improved road	A road that has been paved.	
7	"In accordance with the FFAO milestone schedule"	Means that new underground dangerous waste pipeline information as required by the HF RCRA Permit that is made available as Tri-Party Agreement milestones are met will be used to update maps annually.	Comment deleted.*
8			
9			
10			

Value Engineering Workshop Definitions

Key word/phrase	Definition	Comments
1 Inactive pipeline	Underground pipelines (does not include pipelines within or under a building/structure) as required by the HF RCRA Permit, which, since January 1, 1980 were used to conduct dangerous waste and still retain the <i>capability</i> (have not been cut, capped, nor abandoned) for future use.	Capability means the ability and intent for future use. Installed spares may be included.
2 Information available	Information reasonable available only on the Hanford Facility.	
4 Initial update 5 revision cutoff 6 date for maps 7 "outside fences" 8 (Permit Condition 9 II.U.2)	March 19, 1997.	
10 Mapped pipelines	Underground dangerous waste pipelines to be mapped are those lines as required by the HF RCRA Permit conditions that are connected to a TSD Complex (does not include pipelines completely within a TSD Complex). When an underground dangerous waste pipeline leaves a TSD Complex, it is to be mapped from the building wall (within the TSD Complex) to the building wall of the TSD unit to which the pipeline is routed. Tank farm underground dangerous waste pipelines will be mapped between tank farms but not within the fenced tank farms.	Existing drawings locating underground dangerous waste pipelines (does not include pipelines within a building structure) within a TSD Complex's perimeter will be listed and provided along with the map submittals. Pipelines within fenced tank farms will not be referenced.
11 Map scale	2.5 centimeters equal to but not more than 61.0 meters (1 inch equal to but not more than 200 feet) WAC 173-303-806(a)(xviii)	Typically: 1 centimeter = 20 meters
12 Map size	"F" size	"F" size dimensions are 28"x40"*

Value Engineering Workshop Definitions

Key word/phrase	Definition	Comments
1 Origin	<p>For Permit Condition II.U.2: Where the pipeline crosses an area fence as dangerous waste is routed from that area via an underground pipeline.</p> <p>For Permit Condition II.U.4: The building wall of a TSD unit (even though the wall is within the TSD Complex perimeter) where an underground dangerous waste pipeline comes from is the origin, as long as the pipeline crosses the TSD Complex perimeter. For tank farms, the "origin" is where the underground dangerous waste pipeline leaves a fenced tank farm (where the pipeline crosses the fence). (Does not include pipelines within or under a building/structure.)</p>	
2 Pipeline 3 schematics	The map submittals for Permit Condition II.U.4 meets the requirements of both Permit Conditions II.U.3 and II.U.4. Therefore, separate schematics will not be submitted.	Add to the maps of Permit Condition II.U.4: direction of flow and the pipeline status (active, inactive, or abandoned).
4 Pipeline trenches	Underground pipeline trenches with dangerous waste pipelines subject to the HF RCRA Permit will be included in mapping and marking efforts as appropriate (does not include pipeline trenches within or under a building/structure).	The pipeline trenches will be mapped, but the pipelines within the trenches are not required to be mapped.
5 Pump	A device that raises, transfers, or compresses fluids by suction or pressure.	
6 Receiver tank	Dangerous waste tanks as required by the HF RCRA Permit that function as primary containment located within a concrete vault (includes catch stations like 244-S). Usually referred to as a double-contained receiver tank.	
7 Seal pots	Inline underground drain traps (does not include seal pots within or under a building/structure).	

Value Engineering Workshop Definitions

Key word/phrase	Definition	Comments
1 Signs	If sign posts exist over an underground dangerous waste pipeline subject to the HF RCRA Permit (marking) Condition II.V., placards will be added to the existing posts to ensure that the words "buried dangerous waste pipe" are included on the existing placard.	The words "buried dangerous waste pipe" (or an equivalent warning) will be used. Existing placards that identify the existence of an underground pipeline carrying radioactive material will be sufficient to satisfy Permit Condition II.V.*
2 Treatment, storage, and/or disposal (TSD) unit	The TSD unit will be defined as a "TSD Complex." The "TSD Complex" perimeter could include various buildings/structures, could or could not be a facility's fence, could or could not be a permitted TSD unit boundary, and will be used in clarifying which underground dangerous waste pipelines are mapped. The TSD Complex will be used only for mapping and marking efforts.	The TSD Complex will be defined in the Permit Condition II.U.1. report.
6 Threshold date	January 1, 1980 will be the date used when underground dangerous waste pipelines are included in implementation efforts for the Permit Conditions II.U. and II.V.	This date is used for mapping and marking purposes only and does not reflect when the state received authority on mixed waste nor when the pipelines became "subject to the provisions of Chapter 173-303 WAC."
7 Tolerance for pipeline/equipment locations	As shown on the existing drawings.	+/- 1.5 meters can be used when needed.
11 Valve pit	Concrete building/structure housing pipelines and valves used to conduct dangerous waste as defined in the HF RCRA Permit. Pipelines within the building/structure will not be mapped.	

* Text has been added or modified following the value engineering workshop.

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APPENDIX B

HANFORD FACILITY RCRA PERMIT CONDITIONS II.U. AND II.V.
(from the HF RCRA Permit, Rev. 2)

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1 **II.U. MAPPING OF UNDERGROUND PIPING**
2

3 **II.U.1.** Within 24 months of the effective date of the Permit, the Permittees
4 shall submit a report to the Department which describes the
5 procedures proposed to be used to compile the information required by
6 Conditions II.U.2., II.U.3., and II.U.4. The report shall describe
7 the methods which will be used to retrieve the piping information,
8 the estimated accuracy of the data to be provided, quality assurance
9 and/or quality control techniques to be employed including field
10 verification activities (i.e., surveying, ground penetrating radar,
11 etc.) to support information gathered from existing drawings, and
12 conceptual examples of the product which will be submitted.
13

14 **II.U.2.** Within 36 months of the effective date of this Permit, the Permittees
15 shall make an initial submittal to the Department of maps showing the
16 location of dangerous waste underground pipelines (including active,
17 inactive, and abandoned pipelines which contain or contained
18 dangerous waste subject to the provisions of Chapter 173-303 WAC) on
19 the Facility which are located outside of the fences enclosing the
20 200 East, 200 West, 300, 400, 100N, and 100K Areas. These maps shall
21 identify the origin, destination, size, depth and type (i.e.,
22 reinforced concrete, stainless steel, cast iron, etc.) of each pipe
23 and the location of their diversion boxes, valve pits, seal pots,
24 catch tanks, receiver tanks, and pumps, utilizing Washington State
25 Plane Coordinates, NAD 83(91), meters. If the type of pipe material
26 is not documented on existing drawings, the most probable material
27 type shall be provided. These maps shall be accompanied by a
28 description of the quality assurance and quality control measures
29 used to compile the maps.
30

31 The age of all pipes required to be identified pursuant to this
32 Condition shall be documented in an attachment to the submittal. If
33 the age cannot be documented, an estimate of the age of the pipe
34 shall be provided based upon best engineering judgement.
35

36 These maps, and any attachments, shall be maintained in the Facility
37 Operating Record and updated annually after the initial submittal
38 with new or revised information. Each map submittal required by this
39 Condition shall incorporate information available six months before
40 the scheduled submittal date.
41

42 **II.U.3.** Within 48 months of the effective date of this Permit, the Permittees
43 shall make an initial submittal to the Department of piping
44 schematics for dangerous waste underground pipelines (including
45 active, inactive, and abandoned pipelines which contain or contained
46 dangerous waste subject to the provisions of Chapter 173-303 WAC)
47 within the 200 East, 200 West, 300, 400, 100N, and 100K Areas. The
48 piping schematics shall identify the origin, destination, and
49 direction of flow for each pipe, as well as whether the pipe is
50 active, inactive, or abandoned. These schematics need not include
51 the pipes within a fenced tank farm or within a building/structure.
52 These schematics shall be accompanied by a description of the quality

1 assurance and quality control measures used to compile the maps.
2 These schematics and any attachments, shall be maintained in the
3 Facility Operating Record and updated annually after the initial
4 submittal with new or revised information. Each map submittal
5 required by this Condition shall incorporate information available
6 six months before the scheduled submittal date.
7

8 II.U.4. Within 48 months of the effective date of this Permit, the Permittees
9 shall make an initial submittal to the Department of maps showing the
10 location of dangerous waste underground pipelines (including active,
11 inactive, and abandoned pipelines which contain or contained
12 dangerous waste subject to the provisions of Chapter 173-303 WAC)
13 within the 200 East, 200 West, 300, 400, 100N, and 100K Areas. These
14 maps will incorporate information available six months prior to the
15 scheduled submittal date. Thereafter, the maps will be updated on an
16 annual basis to incorporate additional information, as such
17 information becomes available in accordance with the FFACO milestone
18 schedule. A schedule for the provision of map input shall be
19 included in the report specified in Condition II.U.1.
20

21 The maps shall identify the origin, destination, size, depth and type
22 (i.e., reinforced concrete, stainless steel, cast iron, etc.) of each
23 pipe and the location of their diversion boxes, valve pits, seal
24 pots, catch tanks, receiver tanks, and pumps, and utilize Washington
25 State Plan Coordinates, NAD 83(91), meters. If the type of pipe
26 material is not documented on existing drawings, the most probable
27 material type shall be provided. These maps need not include the
28 pipes within a fenced tank farm or within a building/structure.
29 These maps shall be accompanied by a description of the quality
30 assurance/quality control used to compile the maps.
31

32 The age of all pipes required to be identified pursuant to this
33 Condition shall be documented in an attachment to the submittal. If
34 the age cannot be documented, an estimate of the age of the pipe
35 shall be provided based upon best engineering judgement.
36

37 These maps, and any attachments, shall be maintained in the Facility
38 Wide Operating Record and updated annually after the initial
39 submittal with new or revised information.
40

41 II.V. MARKING OF UNDERGROUND PIPING

42
43 Within 36 months of the effective date of this Permit, the Permittees
44 shall mark the underground pipelines identified in Condition II.U.2.
45 These pipelines shall be marked at the point they pass beneath a
46 fence enclosing the 200 East, 200 West, 300, 400, 100N or 100K Areas,
47 at their origin and destination, at any point they cross an improved
48 road and every 100 meters along the pipeline corridor where
49 practicable. The markers shall be labeled with a sign that reads
50 "Buried Dangerous Waste Pipe" and shall be visible from a distance of
51 15 meters.

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APPENDIX C

TREATMENT, STORAGE, AND/OR DISPOSAL UNIT LISTING

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Treatment, Storage, and/or Disposal Unit Listing

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TSD unit	Location	Operable unit	Mapping per Permit Condition II.U. required?
Double-Shell Tank System	200EW	200-PO-3 200-PO-4 200-IU-6 200-TP-5 200-BP-7 200-UP-3 200-RO-2	Yes
204-AR Waste Unloading Station	200E	200-PO-3	Yes
242-A Evaporator	200E	200-PO-3	Yes
222-S Laboratory Complex	200W	200-RO-3	Yes
200 Area Effluent Treatment Facility	200E	200-BP-11	Yes
Liquid Effluent Retention Facility	200E	200-BP-11	Yes
Central Waste Complex	200W	200-ZP-3	No
Waste Receiving and Processing 1	200W	200-ZP-3	No
Low-Level Burial Grounds	200EW	200-BP-10 200-PO-6 200-ZP-3	Yes
224-T Transuranic Waste Storage and Assay Facility	200W	200-TP-4	No
T Plant Complex	200W	200-TP-4	Yes
616 Nonradioactive Dangerous Waste Storage Facility	600	200-IU-6	No
PUREX Storage Tunnels	200E	200-PO-2	No
325 Hazardous Waste Treatment Units	300	300-FF-2	Yes
305-B Storage Facility	300	300-FF-2	No
207-A South Retention Basin	200E	200-PO-5	Yes
216-B-3 Expansion Ponds	200E	200-BP-11	Yes
216-B-63 Trench	200E	200-BP-8	Yes
Single-Shell Tank System	200EW	200-BP-7 200-PO-3 200-RO-4 200-TP-5 200-TP-6 200-UP-3	Yes

Treatment, Storage, and/or Disposal Unit Listing

	TSD unit	Location	Operable unit	Mapping per Permit Condition II.U. required?
1	200 West Area Ash Pit Demolition Site	200W	200-SS-2	No
2	218-E-8 Borrow Pit Demolition Site	200E	200-RO-2	No
3	Hanford Patrol Academy Demolition Sites	600	1100-EM-1	No
4	2727-S Storage Facility	200W	200-RO-3	No
5	4843 Alkali Metal Storage Facility	400	300-FF-2	No
6	105-DR Large Sodium Fire Facility	100	100-DR-1	No
7	3718-F Alkali Metal Treatment and Storage Area	300	300-FF-2	Yes
8				
9	304 Concretion Facility	300	300-FF-2	Yes
10	300 Area Solvent Evaporator	300	300-FF-2	No
11	300 Area Waste Acid Treatment System	300	300-FF-2	Yes
12	303-M Oxide Facility	300	300-FF-2	No
13	303-K Storage Unit	300	300-FF-2	Yes
14	2101-M Pond	200E	200-SS-1	No
15	Hexone Storage and Treatment Facility	200W	200-RO-2	Yes
16	241-CX Tank System	200E	200-SO-1	Yes
17	183-H Solar Evaporation Basins	100	100-HR-1	No
18	1324-N Surface Impoundment	100	100-NR-1	Yes
19	1301-N Liquid Waste Disposal Facility	100	100-NR-1	Yes
20	1325-N Liquid Waste Disposal Facility	100	100-NR-1	Yes
21	1324-NA Percolation Pond	100	100-NR-1	Yes
22	100-D Ponds	100	100-DP-1	Yes
23	216-S-10 Pond and Ditch	200W	200-RO-1	Yes
24	216-A-29 Ditch	200E	200-PO-5	Yes
25	216-B-3 Main Pond	200E	200-BP-11	Yes
26	216-A-10 Crib	200E	200-PO-2	Yes
27	216-U-12 Crib	200W	200-UP-2	Yes
28	216-A-36B Crib	200E	200-PO-2	Yes
29	216-A-37-1 Crib	200E	200-PO-4	Yes

Treatment, Storage, and/or Disposal Unit Listing

	TSD unit	Location	Operable unit	Mapping per Permit Condition II.U. required?
1	300 Area Process Trenches	300	200-FF-1	Yes
2	Nonradioactive Dangerous Waste Landfill	600	200-IU-3	No
3	Simulated High-Level Waste Slurry Treatment/Storage	3000	1100-EM-3	No
4				
5	PUREX Plant	200E	200-PO-1	Yes
6	241-Z Treatment and Storage Tanks	200W	200-ZP-1	Yes
7	B Plant Complex	200E	200-BP-6	Yes
8	1706-KE Waste Treatment System	100	100-KR-2	No
9	221-T Containment Systems Test Facility	200W	220-TP-4	Yes
10	2727-WA Sodium Reactor Experiment Sodium Storage Building	200W	200-UP-2	No
11				
12	437 Maintenance and Storage Facility	400	300-FF-2	No
13	324 Sodium Removal Pilot Plant	300	300-FF-2	No
14	Biological Treatment Test Facilities	300	300-FF-2	No
15	Physical and Chemical Treatment Facilities	300	300-FF-2	No
16	Thermal Treatment Test Facilities	300	300-FF-2	No
17	332 Storage Facility	300	300-FF-2	No
18	Sodium Storage Facility and Sodium Reaction Facility	400	300-FF-2	No
19				
20	600 Area Purgewater Storage and Treatment Facility	600	200-BP-11	No
21				
22	Grout Treatment Facility	200E	200-PO-3	Yes
23	Hanford Waste Vitrification Plant	200E	200-BP-9	No
24				

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APPENDIX D

MAP AND MAP ATTACHMENT EXAMPLES

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The initial submittal of pipeline maps will be on aperture cards.

MAP ATTACHMENT REPORT - HANFORD FACILITY RCRA PERMIT CONDITION II.U.

MAP DWG. NO.: H-13-12345, Rev. 0

TSD NAME: 123A Storage Unit

"This document has been prepared to satisfy the Hanford Facility RCRA Permit (#WA7890008967) Condition II.U. (Dangerous Waste Portion) and is updated annually, as required by the Permit Condition. Changes to this document are to be made only in support of Permit Condition II.U. Also, refer to the Hanford Facility RCRA Permit Condition II.U.1. Report for Mapping and Marking of Dangerous Waste Underground Pipelines (DOE/RL-96-50). This document should not be used as the sole source for regulatory compliance, construction, or excavation purposes."

TSD PERIMETER PIPELINE REF. DWGS.: H-2-33984, Rev. 0 H-2-85858, Rev. 0
 H-2-36637, Rev. 0 H-2-99903, Rev. 0
 H-2-78459, Rev. 0
 H-2-83474, Rev. 0

PIPELINE NAME	SEGMENT ID #	ORIGIN (POINT)	DESTINATION (POINT)	SIZE	STATUS	MATERIAL TYPE	AGE	DEPTH (REF. DWGS.)	DATA SOURCES
V-404	12010101	N34355,W73626	N83737,W88484	4"	ABAN	PVC	1957	(START) H-2-64544, Rev. 0	H-2-14666 Sht. 1, Rev. 3
	12010102	N73632,W93873	N37363,W83737	4"		PVC	1957		H-2-14666, Sht. 1, Rev. 3
	12010103	N83727,W93737	N37366,W63536	6"		ST. STL.	1969		H-2-14668, Rev. 0
	12010104	N83837,W78377	N73737,W38388	6"		ST. STL.	1969	(END) H-2-89444, Rev. 0	H-2-14668, Rev. 0
V-405	12010201	N83736,W32323	N93838,W93838	3"	ACT	CLAY	1944	S H-2-33833, Rev. 0	H-2-34724, Sht. 1, Rev. 0
	12010202	N12221,W88885	N48983,W93483	4"		PVC	1978		H-2-69033, Rev. 0
	12010203	N38283,W98998	N23020,W98998	4"		PVC	1994	E H-2-75777, Rev. 0	H-2-99374, Rev. 0
V-406	12010301	N98999,W98989	N87876,W21888	2 3/8"	INACT	ST. STL.	1974	S H-2-94944, Rev. 0	H-2-90443, Rev. 3
	12010302	N98878,W23536	N45455,W10989	2 3/8"		ST. STL.	1974	E H-2-34455, Rev. 0	H-2-90443, Rev. 3

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APPENDIX E

MARKER EXAMPLES

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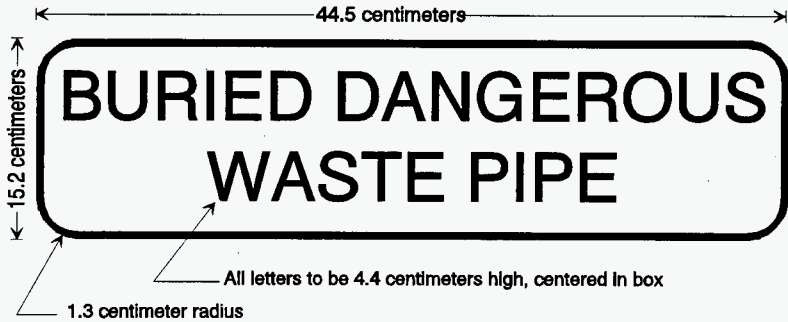


Figure E-1: Example of New Mapping and Marking Sign

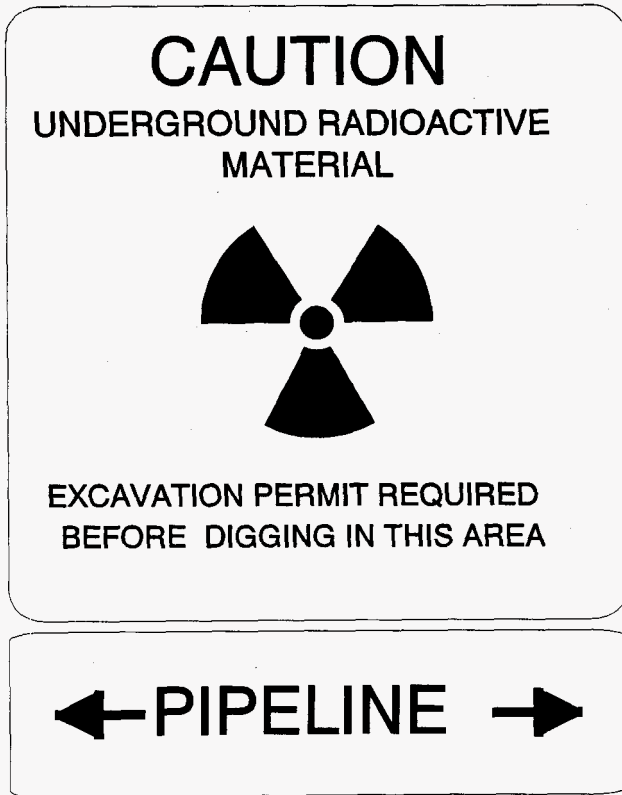


Figure E-2: Example of Existing Signs

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