074754

0052130

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

NOV 23 1999

Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

DEC 1999
RECEIVED
EDMC

Dear Ms. Hedges:

LACK OF FUNDING FOR MILESTONE M-24 (RESOURCE CONSERVATION AND RECOVERY ACT [RCRA] GROUNDWATER MONITORING WELL INSTALLATION) AND SITEWIDE WELL DECOMMISSIONING

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to Richard Holten from you, same subject as above, dated September 27, 1999. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-24 addresses the necessity to fund the work scope in Fiscal Year 2000. The work scope that was deemed higher priority than construction of additional RCRA wells and well decommissioning already exceeds the Fiscal Year 2000 budget. The site allocates funds through the planning process via the Integrated Priority List. This sitewide prioritization process included input from Ecology and the U.S. Environmental Protection Agency but did not rank M-24 work scope and well decommissioning sufficiently high to receive funding under the Fiscal Year 2000 appropriations provided to the site. In our meeting with you held on October 19, 1999, these issues were discussed. 51911

We believe a constructive path forward may be to re-evaluate the existing milestone activities and deadlines. A Tri-Party Agreement approach to seek cost efficiencies and flexible deadlines would enable the maintenance of the program goals. A number of changes within the work scope and schedule of M-24 are possible. This approach assures that priorities for funding to support the cleanup along the Columbia River corridor do not lose sight of the activities necessary to cleanup the Central Plateau.

Additional resources to support well installation and decommissioning could be achieved through implementing proposed efficiencies in the groundwater monitoring operation. Attached please find the "Hanford Site Groundwater Monitoring Strategy." This strategy proposes several approaches to improve the efficiency and effectiveness of groundwater monitoring. In an effort to identify funding to provide for installation of high-priority wells, the U.S. Department of Energy (DOE) would like to renew discussions with Ecology regarding alternative groundwater monitoring approaches. We expect implementation of these approaches would result in cost savings. Many of these alternative approaches have been discussed with Ecology staff and may include final-status monitoring approaches such as

control charts that utilize within-well comparisons or monitoring specific hazardous constituents rather than indicator parameters. Other approaches such as grouping waste sites may also be considered.

An estimate of more than $200K in cost savings could be achieved by the end of Fiscal Year 2000, if alternative approaches are implemented early in Fiscal Year 2000. For example, the 300 Area Process Trenches (APT) currently are monitored semi-annually using four independent samples; this results in eight sets of samples collected each year for the constituents of concern identified for this site. However, the current statistical method is appropriate for sites that are in "compliance monitoring" status and if the goal is to evaluate whether the groundwater protection standard is being exceeded. Given that the 300 APT is in corrective action, we believe it would be more appropriate to move to the alternate approach. Our proposed approach utilizes an alternative statistical approach (i.e., the combined Shewhart-CUSUM control chart approach) for intra-well comparison of analyte concentrations over time and it does not require an upgradient well. This statistical methodology has been endorsed by the Washington State University statisticians (consultants hired by Ecology). Under this alternative approach it requires of only two sets of individual samples each year yet provides for comparable or better statistical power under different contamination scenarios. The sampling and analysis cost savings at the 300 APT using the proposed approach alone will be approximately $35,000 per year. In addition, this intra-well comparison approach is broadly applicable to RCRA Treatment, Storage, and/or Disposal (TSD) where there is no clearly defined upgradient location (i.e., the B Pond System), the groundwater flow direction is changing (e.g., other 200 Area East sites), the groundwater flow rate is slow (e.g., 200 Area West sites), or where a high degree of spatial variability exists in parameter concentrations.

Ecology is asked to reconsider the approaches that have been proposed previously for specific facilities, to review alternative approaches for additional RCRA facilities, and to approve those which can technically meet the objectives of groundwater monitoring. An initial meeting in November 1999 is proposed to review the alternate approaches, the status of proposals that are currently "on the table" and facilities that could benefit from alternate approaches. The next step will be to hold meetings for specific facilities to come to agreement on the alternate approaches that could be applied. An objective of these meetings is for decisions on moving to these approaches with formal documentation to follow.

DOE will direct cost savings from monitoring efficiencies to priorities identified with Ecology, including installation of new wells to maintain adequate spatial coverage due to declining water tables, or to improve current understanding on the nature and extent of groundwater contamination in the vicinity of tank farms. Demonstrating these efficiencies will be influential in adjusting Fiscal Year 2000 budget priorities to identify additional resources in support of M-24.

The Tri-Party Agreement agencies need to work together to develop a long-range master plan which identifies groundwater monitoring needs at TSD units covered by M-24 and for well decommissioning. Such a plan should include a well decommissioning component and adding this to the milestone should be considered. However, such an approach needs to encompass Tri-Party Agreement and regulatory procedures within the federal appropriations process. DOE's ability to procure funding is limited to requesting funding for cleanup activities at Hanford. Article XLVIII of the Tri-Party Agreement provides for the agencies to adjust work scope or milestones to be consistent with funding appropriations. In cases such as this, it is paramount to strive to maintain the work scope commitment, even when funding appropriations are inadequate to meet schedule requirements.

Please consider this new approach to maintaining the goals of M-24 within the DOE procurement constraints. If you have any questions, please contact me on 376-6888, or K. Michael Thompson on 373-0750.

Sincerely,

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

074754
NOV 23 1999

Subject Code: OU/TPA/8960
Written Response Required: NO
Closes CCN: 072892
OU: Groundwater
TSD: N/A
ERA: N/A
Project: YES

The Tri-Party Agreement agencies need to work together to develop a long-range master plan which identifies groundwater monitoring needs at TSD units covered by M-24 and for well decommissioning. Such a plan should include a well decommissioning component and adding this to the milestone should be considered. However, such an approach needs to encompass Tri-Party Agreement and regulatory procedures within the federal appropriations process. DOE's ability to procure funding is limited to requesting funding for cleanup activities at Hanford. Article XLVIII of the Tri-Party Agreement provides for the agencies to adjust work scope or milestones to be consistent with funding appropriations. In cases such as this, it is paramount to strive to maintain the work scope commitment, even when funding appropriations are inadequate to meet schedule requirements.

Please consider this new approach to maintaining the goals of M-24 within the DOE procurement constraints. If you have any questions, please contact me on 376-6888, or K. Michael Thompson on 373-0750.

Sincerely,

ORIGINAL SIGNED BY:

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

RECEIVED
NOV 23 1999
DOE-RL/DIS

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

bcc: OFF File
GW/VZ Rdg File
WW Ballard, A5-12
KM Thompson, GW/VZ
ORL Rdg File, A5-15

Record Note: None.

RECORD-COPY

MIKE.T\M24RSP-KMT.DOC

Office >	GW/VZ	GW/VZ	OCC	ORL	BJJD	
Surname >	THOMPSON	FURMAN	CAROSINO	SANDERS GHS	NELSON	
Date >	P. Concurred	P. Concurred	P. Concurred	11/22/99	P. Concurred	

(Please return to Cindy Anderson 6-6553 A5-12/FED, Room 598B, FAX 2-2610)

Document No. 15833

Subject Code: OU/TPA/8960
Written Response Required: NO
Closes CCN: 072892
OU: Groundwater
TSD: N/A
ERA: N/A
Project: YES

074754

DOE requests that Ecology provide specific and appropriate input in how best to maintain the goals of M-24 within procurement constraints that Hanford cleanup must occur. If you have any questions, please contact George Sanders at 376-6888, or K. Michael Thompson at 373-0750.

Sincerely,

K. Michael Thompson, Acting Team Lead
Groundwater/Vadose Zone

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

bcc: OFF File
GW/VZ Rdg File
WW Ballard, A5-12
KM Thompson, GW/VZ
ORL Rdg File, A5-15

Record Note: None.

MIKE.T\M24RSP-KMT.DOC

Office >	GWVZ	GWVZ	OCC	ORL	BUD	GW/VZ
Surname >	THOMPSON	FURMAN	CAROSINO	SANDERS	NELSON	THOMPSON
Date >	P. Concurred	P. Concurred	P. Concurred	11/19/99	P. Concurred	

(Please return to Cindy Anderson, 6-6559 HO-12/3350/GWW/2D54 FAX 6-4360)

Document No. 15833

Subject Code: OU/TPA/8960
Written Response Required: NO
Closes CCN: 072892
OU: Groundwater
TSD: N/A
ERA: N/A
Project: YES

DOE requests that Ecology provide specific and appropriate input in how best to maintain the goals of M-24 within procurement constraints that Hanford cleanup must occur. If you have any questions, please contact Mr. George Sanders at 376-6888, or Mr. K. Michael Thompson at 373-0750.

Sincerely,

K. Michael Thompson, Acting Team Lead
Groundwater/Vadose Zone

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

bcc: OFF File
GW/VZ Rdg File
WW Ballard, A5-12
KM Thompson, GW/VZ
ORL Rdg File, A5-15
JM Nelson, BUD HO-12 (w/o att)

Record Note: None.

MIKE.T\M24RSP-KMT.DOC

Office >	GWVZ	GWVZ	OCC BLW for	ORL	BUD	GW/VZ
Surname >	PREVIOUSLY CONCURRED	PREVIOUSLY CONCURRED	CAROSINO	SANDERS	NELSON	THOMPSON
Date >			11/17/99		11/16/99	

(Please return to Cindy Anderson 6-6339 HO-12/3350GWW/2D54 FAX 6-4360)

Document No. 15833

Subject Code: OU/TPA/8960
Written Response Required: NO
Closes CCN: 072892
OU: Groundwater
TSD: N/A
ERA: N/A
Project: YES

DOE requests that Ecology provide specific and appropriate input in how to best maintain the goals of M-24 within procurement constraints that Hanford cleanup must occur. If you have any questions, please contact Mr. George Sanders at 376-6888, or Mr. K. Michael Thompson at 373-0750.

Sincerely,

K. Michael Thompson, Acting Team Lead
Groundwater/Vadose Zone

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

bcc: OFF File
GW/VZ Rdg File
WW Ballard, A5-12
KM Thompson, GW/VZ
ORL Rdg File, A5-15

Record Note: None.

MIKE.T\M24RSP-KMT.DOC

Office >	GWVZ	GWVZ	OCC	ORL	GWVZ	BUO
Surname >	THOMPSON	FURMAN	CAROSINO	SANDERS	THOMPSON	NELSON
Date >	11/01/99	11/4/99				

(Please return to Cindy Anderson 6-6559 HO-12/3350GWW/2D54 FAX 6-4360)

Document No. 15833

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

074754

Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Dear Ms. Hedges:

LACK OF FUNDING FOR MILESTONE M-24 (RESOURCE CONSERVATION AND RECOVERY ACT [RCRA] GROUNDWATER MONITORING WELL INSTALLATION) AND SITEWIDE WELL DECOMMISSIONING

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to Mr. Richard Holten from you, same subject as above, dated September 27, 1999. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-24 addresses the necessity to fund the work scope in Fiscal Year 2000. The work scope that was deemed higher priority than construction of additional RCRA wells and well decommissioning already exceeds the Fiscal Year 2000 budget. The site allocates funds through the planning process via the Integrated Priority List. This sitewide prioritization process included input from Ecology and the U.S. Environmental Protection Agency but did not rank M-24 work scope and well decommissioning sufficiently high to receive funding under the Fiscal Year 2000 appropriations provided to the site. In our meeting with you held on October 19, 1999, these issues were discussed.

The U.S. Department of Energy (DOE), Richland Operations Office, Manager, Mr. Keith Klein has provided the site with a new vision of cleanup at Hanford. That vision, which serves as the basis for funding priorities, focuses on three key elements. The first priority is the cleanup along the Columbia River corridor. This vision is key to gaining successful reduction of risks to the river and showing progress in those areas where near term cleanup can be most readily achieved. The goal is to reduce the overall footprint of the site to the smallest possible area. The second priority will be cleanup and risk reduction on the Hanford Central Plateau area. The third priority is Mr. Klein's vision of transition of the site's assets to other productive uses. DOE believes that the M-24 milestone work scope and well decommissioning generally supports the second vision area.

DOE has considered

Three possible paths forward ~~are open to resolve the Fiscal Year 2000 M-24 funding issue.~~ First, DOE will continue to seek efficiencies within its current year budget to free more funds toward those items that now fall below the prioritization line. If sufficient savings are achieved, then some M-24 scope could be funded. This may still be contingent on full funding for cleanup work ~~along the Columbia River corridor. Work on M-24 may also be constrained by contractual and~~ logistical

?

capabilities at the time that funds might become available. An option within this pathway would be to adjust the site funding priorities. DOE would appreciate Ecology's input regarding which priorities should be adjusted to fund M-24. A careful examination of any proposals to change river corridor priorities would be necessary.

6 Insert

A second option that has been discussed is to request capital ~~expense~~ line item funding for this work scope in future appropriations requests. ~~Past years' funding for M-24 capital expense~~ was ~~from this type of appropriation~~. However, this type of request was originally rejected because of the three-year lead-time ~~for this type of appropriation, and funding~~ would ~~therefore~~ not be available in time to continue without interruption. There is however, a more important consideration in the evaluation of this option. Funds requested from Congress utilizing this option will not result in additional financial allocations to Hanford. It is still a "zero-sum game."

The third pathway is to re-evaluate the existing milestone activities and deadlines. A Tri-Party Agreement approach to seek cost efficiencies and flexible deadlines would enable the maintenance of the program goals. A number of changes within the work scope and schedule of M-24 are possible. This approach assures that priorities for funding to support the vision of cleanup along the Columbia River corridor do not lose sight of the activities necessary to reach the second vision of cleanup of the Central Plateau.

Additional resources to support well installation and decommissioning could be achieved through implementing proposed efficiencies in the groundwater monitoring operation. Attached please find the "Hanford Site Groundwater Monitoring Strategy." This strategy proposes several approaches to improve the efficiency and effectiveness of groundwater monitoring. In an effort to identify funding to provide for installation of high-priority wells, the DOE would like to renew discussions with Ecology regarding alternative groundwater monitoring approaches. We expect implementation of these approaches would result in cost savings. Many of these alternative approaches have been discussed with Ecology staff and may include final-status monitoring approaches such as control charts that utilize within-well comparisons or monitoring specific hazardous constituents rather than indicator parameters. Other approaches such as grouping waste sites may also be considered.

An estimate of more than $200K in cost savings could be achieved by the end of Fiscal Year 2000, if alternative approaches are implemented early in Fiscal Year 2000. For example, the 300 Area Process Trenches (APT) currently are monitored semi-annually using four independent samples; this results in eight sets of samples collected each year for the constituents of concern identified for this site. However, the current statistical method is appropriate for sites that are in "compliance monitoring" status and if the goal is to evaluate whether the groundwater protection standard is being exceeded. Given that the 300 APT is in corrective action, we believe it would be more appropriate to move to the alternate approach. Our proposed approach utilizes an alternative statistical approach (i.e., the combined Shewhart-CUSUM control chart approach) for intra-well comparison of analyte concentrations over time and it does not require an upgradient well. This statistical methodology has been endorsed by the Washington State University statisticians (consultants hired by Ecology). Under this alternative approach it

INSERT

074754

A second option that has been discussed is to request capital line item funding in future budget requests. M-24 well installations had previously been accomplished using a line item that originated in FY 1993. A follow-on capital line item approach was rejected because of the three-year lead-time before DOE could receive Congressional approval of a budget request and continue with well installations. Additionally, DOE would be hard-pressed to explain asking for line item funding within the Environmental Restoration (ER) program which was designed to utilize operating expense funding exclusively (the original line item had been requested when M-24 wells were managed by the RL waste management organization; all groundwater activities were consolidated within ER in FY 1997). Lastly, and perhaps more importantly, funds requested utilizing this option would not result in additional funding for the Hanford Site. Total Hanford funding is a "zero-sum game." Final budget decisions are not affected by types of funding (i.e., operating versus capital line item).

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

074754

Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Dear Ms. Hedges:

LACK OF FUNDING FOR MILESTONE M-24 (RESOURCE CONSERVATION AND RECOVERY ACT [RCRA] GROUNDWATER MONITORING WELL INSTALLATION) AND SITEWIDE WELL DECOMMISSIONING

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to Mr. Richard Holten from you, same subject as above, dated September 27, 1999, on the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-24 ~~regarding~~ ADDRESSES the necessity to fund the work scope in ~~the~~ Fiscal Year 2000. The work scope that was deemed higher priority than construction of additional RCRA wells and well decommissioning already exceeds the Fiscal Year 2000 budget. The site allocates funds through the planning process via the Integrated Priority List. This sitewide prioritization process included input from Ecology and the U.S. Environmental Protection Agency but did not rank M-24 work scope and well decommissioning sufficiently high to receive funding under the Fiscal Year 2000 appropriations provided to the site. In our meeting with you held on October 19, 1999, these issues were discussed.

The U.S. Department of Energy (DOE), Richland Operations Office, Manager, Mr. Keith Klein has provided the site with a new vision of cleanup at Hanford. That vision, which serves as the basis for funding priorities, focuses on three key elements. The first priority is the cleanup along the Columbia River corridor. This vision is key to gaining successful reduction of risks to the river and showing progress in those areas where near term cleanup can be most readily achieved. The goal is to reduce the overall footprint of the site to the smallest possible area. The second priority will be cleanup and risk reduction on the Hanford Central Plateau area. The third priority is Mr. Klein's vision of transition of the site's assets to other productive uses. DOE believes that the M-24 milestone work scope and well decommissioning generally supports the second vision area.

Three possible paths forward are open to resolve the Fiscal Year 2000 M-24 funding issue. First, DOE will continue to seek efficiencies within its current year budget to free more funds toward those items that now fall below the prioritization line. If sufficient savings are achieved, then some M-24 scope could be funded. This may still be contingent on full funding for cleanup work along the Columbia River corridor. Work on M-24 may also be constrained by contractual and logistical

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

074754

Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Dear Ms. Hedges:

LACK OF FUNDING FOR MILESTONE M-24 (RESOURCE CONSERVATION AND RECOVERY ACT [RCRA] GROUNDWATER MONITORING WELL INSTALLATION) AND SITEWIDE WELL DECOMMISSIONING

and well decommissioning

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to Mr. Richard Holten from you, same subject as above, dated September 27, 1999, on the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-24 regarding the necessity to fund the work scope in the Fiscal Year 2000. The work scope deemed higher priority than construction of additional RCRA wells already exceeds the Fiscal Year 2000 budget. The site allocates funds through the planning process via the Integrated Priority List. This sitewide prioritization process included input from Ecology and the U.S. Environmental Protection Agency but did not rank M-24 work scope sufficiently high to receive funding under the Fiscal Year 2000 appropriations provided to the site. In our meeting with you held on October 19, 1999, these issues were discussed.

and well decommissioning

The U.S. Department of Energy (DOE), Richland Operations Office, Manager, Mr. Keith Klein has provided the site with a new vision of cleanup at Hanford. That vision, which serves as the basis for funding priorities, focuses on three key elements. The first priority is the cleanup along the Columbia River corridor. This vision is key to gaining successful reduction of risks to the river and showing progress in those areas where near term cleanup can be most readily achieved. The goal is to reduce the overall footprint of the site to the smallest possible area. The second priority will be cleanup and risk reduction on the Hanford Central Plateau area. The third priority is Mr. Klein's vision of transition of the site's assets to other productive uses. DOE believes that the M-24 milestone work scope supports the second vision area.

and well decommissioning generally

Three possible paths forward are open to resolve the Fiscal Year 2000 M-24 funding issue. First, DOE will continue to seek efficiencies within its current year budget to free more funds toward those items that now fall below the prioritization line. If sufficient savings are achieved, then some M-24 scope could be funded. This may still be contingent on full funding for cleanup work along the Columbia River corridor. Work on M-24 may also be constrained by contractual and logistical

capabilities at the time that funds might become available. An option within this pathway would be to adjust the site funding priorities. DOE would appreciate Ecology's input regarding which priorities should be adjusted to fund M-24. A careful examination of any proposals to change river corridor priorities would be necessary.

There is, however, a more important consideration in the evaluation of this option. Funds requested from Congress utilizing this option will not result in additional financial allocations to Hanford. It is still a "zero-sum game".

A second option that has been ~~considered~~ discussed is to request capital expense line item funding for this work scope in future appropriations requests. Past years' funding for M-24 capital expense was from this type of appropriation. However, this type of request was originally rejected because of the three-year lead-time for this type of appropriation, and funding would therefore not be available in time to continue without interruption. ~~DOE would gladly work with Ecology to determine the appropriate level of funding and schedule adjustments necessary to request and implement a capital expense line item approach to M-24 for out-year work scope~~.

The third pathway is to re-evaluate the existing milestone activities and deadlines. A Tri-Party Agreement approach to seek cost efficiencies and flexible deadlines would enable the maintenance of the program goals. A number of changes within the work scope and schedule of M-24 are possible. This approach assures that priorities for funding to support the vision of cleanup along the Columbia River corridor do not lose sight of the activities necessary to reach the second vision of cleanup of the Central Plateau.

Additional resources to support well installation and decommissioning could be achieved through implementing proposed efficiencies in the groundwater monitoring operation. In an effort to identify funding to provide for installation of high-priority wells, the DOE would like to renew discussions with Ecology regarding alternative groundwater monitoring approaches. We expect implementation of these approaches would result in cost savings. Many of these alternative approaches have been discussed with Ecology staff and may include final-status monitoring approaches such as control charts that utilize within-well comparisons or monitoring specific hazardous constituents rather than indicator parameters. Other approaches such as grouping waste sites may also be considered.

Although we fund the Hanford Site Groundwater Monitoring Strategy, this strategy proposes several approaches to improve the efficiency and effectiveness of groundwater monitoring

An estimate of more than $200K in cost savings could be achieved by the end of Fiscal Year 2000, if alternative approaches are implemented early in Fiscal Year 2000. For example, the 300 Area Process Trenches (APT) currently are monitored semi-annually using four independent samples; this results in eight sets of samples collected each year for the constituents of concern identified for this site. However, the current statistical method is appropriate for sites that are in "compliance monitoring" status and if the goal is to evaluate whether the groundwater protection standard is being exceeded. Given that the 300 APT is in corrective action, we believe it would be more appropriate to move to the alternate approach. Our proposed approach utilizes an alternative statistical approach (i.e., the combined Shewhart-CUSUM control chart approach) for intra-well comparison of analyte concentrations over time and it does not require an upgradient well. This statistical methodology has been endorsed by the Washington State University statisticians (consultants hired by Ecology). Under this alternative approach it

requires of only two sets of individual samples each year yet provides for comparable or better statistical power under different contamination scenarios. The sampling and analysis cost savings at the 300 APT using the proposed approach alone will be approximately $35,000 per year. In addition, this intra-well comparison approach is broadly applicable to RCRA Treatment, Storage, and/or Disposal (TSD) where there is no clearly defined upgradient location (i.e., the B Pond System), the groundwater flow direction is changing (e.g., other 200 Area East sites), the groundwater flow rate is slow (e.g., 200 Area West sites), or where a high degree of spatial variability exists in parameter concentrations.

Ecology is asked to reconsider the approaches that have been proposed previously for specific facilities, to review alternative approaches for additional RCRA facilities, and to approve those which can technically meet the objectives of groundwater monitoring. An initial meeting in November 1999 is proposed to review the alternate approaches, the status of proposals that are currently "on the table" and facilities that could benefit from alternate approaches. The next step will be to hold meetings for specific facilities to come to agreement on the alternate approaches that could be applied. An objective of these meetings is for decisions on moving to these approaches with formal documentation to follow.

DOE will direct cost savings from monitoring efficiencies to priorities identified with Ecology, including installation of new wells to maintain adequate spatial coverage due to declining water tables, or to improve current understanding on the nature and extent of groundwater contamination in the vicinity of tank farms. Demonstrating these efficiencies will be influential in adjusting Fiscal Year 2000 budget priorities to identify additional resources in support of M-24.

Additional meetings with Ecology will address monitoring plans and priorities for the next several years, with an anticipated outcome of agreements on the placement of wells in the future. This also will be documented upon DOE and Ecology agreement.

and for well decommissioning

DOE agrees that the Tri-Party Agreement agencies need to work together to develop a long-range master plan which identifies groundwater monitoring needs at TSD units covered by M-24. DOE also agrees that such a plan should include a well decommissioning component and adding this to the milestone should be considered. However, such an approach needs to encompass Tri-Party Agreement and regulatory procedures within the federal appropriations process. DOE's ability to procure funding is limited to requesting funding for cleanup activities at Hanford. Article XLVIII of the Tri-Party Agreement provides for the agencies to adjust work scope or milestones to be consistent with funding appropriations. In cases such as this, DOE believes it is paramount to strive to maintain the work scope commitment, even when funding appropriations are inadequate to meet schedule requirements.

Paintite

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

DRAFT

Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 4
To [redacted]	From [redacted]
Co. Cindy Baldwin	Co. KM
Dept.	Phone #
Fax # 376-4360	Fax #

Dear Ms. Hedges:

LACK OF FUNDING FOR MILESTONE M-24 (RESOURCE CONSERVATION AND RECOVERY ACT [RCRA] GROUNDWATER MONITORING WELL INSTALLATION) AND SITEWIDE WELL DECOMMISSIONING

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to Mr. Richard Holten from you, same subject as above, dated September 27, 1999. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-24 addresses the necessity to fund the work scope in Fiscal Year 2000. The work scope that was deemed higher priority than construction of additional RCRA wells and well decommissioning already exceeds the Fiscal Year 2000 budget. The site allocates funds through the planning process via the Integrated Priority List. This sitewide prioritization process included input from Ecology and the U.S. Environmental Protection Agency but did not rank M-24 work scope and well decommissioning sufficiently high to receive funding under the Fiscal Year 2000 appropriations provided to the site. In our meeting with you held on October 19, 1999, these issues were discussed.

The U.S. Department of Energy (DOE), Richland Operations Office (RL), Manager, Mr. Keith Klein has provided the site with a new vision of cleanup at Hanford. That vision, which serves as the basis for funding priorities, focuses on three key elements. The first priority is the cleanup along the Columbia River corridor. This vision is key to gaining successful reduction of risks to the river and showing progress in those areas where near term cleanup can be most readily achieved. The goal is to reduce the overall footprint of the site to the smallest possible area. The second priority will be cleanup and risk reduction on the Hanford Central Plateau area. The third priority is Mr. Klein's vision of transition of the site's assets to other productive uses. DOE believes that the M-24 milestone work scope and well decommissioning generally supports the second vision area.

DOE has considered three possible paths forward. First, DOE will continue to seek efficiencies within its current year budget to free more funds toward those items that now fall below the prioritization line. If sufficient savings are achieved, then some M-24 scope could be funded. This may still be contingent on full funding for cleanup work along the Columbia River corridor. Work on M-24 may also be constrained by contractual and logistical capabilities at the time that

DRAFT

DRAFT

funds might become available. An option within this pathway would be to adjust the site funding priorities. DOE would appreciate Ecology's input regarding which priorities should be adjusted to fund M-24. A careful examination of any proposals to change river corridor priorities would be necessary.

A second option that has been discussed is to request capital line item funding in future budget requests. M-24 well installations had previously been accomplished using a line item that originated in Fiscal Year 1993. A follow-on capital line item approach was rejected because of the three-year lead-time before DOE could receive congressional approval of a budget request and continue with well installations. Additionally, DOE would be hard pressed to explain asking for line item funding within the Environmental Restoration (ER) Program which was designed to utilize operating expense funding exclusively (the original line item had been requested when M-24 wells were managed by the RL Waste Management organization; all groundwater activities were consolidated within ER in Fiscal Year 1997). Lastly and perhaps more importantly, funds requested utilizing this option would not result in additional funding for the Hanford Site. Total Hanford funding is a "zero-sum game." Final budget decisions are not affected by types of funding (i.e., operating versus capital line item).

We believe a constructive path forward may be ~~The third pathway is~~ to re-evaluate the existing milestone activities and deadlines. A Tri-Party Agreement approach to seek cost efficiencies and flexible deadlines would enable the maintenance of the program goals. A number of changes within the work scope and schedule of M-24 are possible. This approach assures that priorities for funding to support the ~~vision of~~ cleanup along the Columbia River corridor do not lose sight of the activities necessary to ~~reach the second vision of~~ cleanup of the Central Plateau.

Additional resources to support well installation and decommissioning could be achieved through implementing proposed efficiencies in the groundwater monitoring operation. Attached please find the "Hanford Site Groundwater Monitoring Strategy." This strategy proposes several approaches to improve the efficiency and effectiveness of groundwater monitoring. In an effort to identify funding to provide for installation of high-priority wells, the DOE would like to renew discussions with Ecology regarding alternative groundwater monitoring approaches. We expect implementation of these approaches would result in cost savings. Many of these alternative approaches have been discussed with Ecology staff and may include final-status monitoring approaches such as control charts that utilize within-well comparisons or monitoring specific hazardous constituents rather than indicator parameters. Other approaches such as grouping waste sites may also be considered.

An estimate of more than $200K in cost savings could be achieved by the end of Fiscal Year 2000, if alternative approaches are implemented early in Fiscal Year 2000. For example, the 300 Area Process Trenches (APT) currently are monitored semi-annually using four independent samples; this results in eight sets of samples collected each year for the constituents of concern identified for this site. However, the current statistical method is appropriate for sites that are in "compliance monitoring" status and if the goal is to evaluate whether the groundwater protection standard is being exceeded. Given that the 300 APT is in corrective action, we believe

DRAFT

DRAFT

it would be more appropriate to move to the alternate approach. Our proposed approach utilizes an alternative statistical approach (i.e., the combined Shewhart-CUSUM control chart approach) for intra-well comparison of analyte concentrations over time and it does not require an upgradient well. This statistical methodology has been endorsed by the Washington State University statisticians (consultants hired by Ecology). Under this alternative approach it requires of only two sets of individual samples each year yet provides for comparable or better statistical power under different contamination scenarios. The sampling and analysis cost savings at the 300 APT using the proposed approach alone will be approximately $35,000 per year. In addition, this intra-well comparison approach is broadly applicable to RCRA Treatment, Storage, and/or Disposal (TSD) where there is no clearly defined upgradient location (i.e., the B Pond System), the groundwater flow direction is changing (e.g., other 200 Area East sites), the groundwater flow rate is slow (e.g., 200 Area West sites), or where a high degree of spatial variability exists in parameter concentrations.

Ecology is asked to reconsider the approaches that have been proposed previously for specific facilities, to review alternative approaches for additional RCRA facilities, and to approve those which can technically meet the objectives of groundwater monitoring. An initial meeting in November 1999 is proposed to review the alternate approaches, the status of proposals that are currently "on the table" and facilities that could benefit from alternate approaches. The next step will be to hold meetings for specific facilities to come to agreement on the alternate approaches that could be applied. An objective of these meetings is for decisions on moving to these approaches with formal documentation to follow.

DOE will direct cost savings from monitoring efficiencies to priorities identified with Ecology, including installation of new wells to maintain adequate spatial coverage due to declining water tables, or to improve current understanding on the nature and extent of groundwater contamination in the vicinity of tank farms. Demonstrating these efficiencies will be influential in adjusting Fiscal Year 2000 budget priorities to identify additional resources in support of M-24.

Additional meetings with Ecology will address monitoring plans and priorities for the next several years, with an anticipated outcome of agreements on the placement of wells ~~in the future~~. This also will be documented upon DOE and Ecology agreement.

~~DOE agrees that~~ The Tri-Party Agreement agencies need to work together to develop a long-range master plan which identifies groundwater monitoring needs at TSD units covered by M-24 and for well decommissioning. ~~DOE also agrees that~~ Such a plan should include a well decommissioning component and adding this to the milestone should be considered. However, such an approach needs to encompass Tri-Party Agreement and regulatory procedures within the federal appropriations process. DOE's ability to procure funding is limited to requesting funding for cleanup activities at Hanford. Article XLVIII of the Tri-Party Agreement provides for the agencies to adjust work scope or milestones to be consistent with funding appropriations. In cases such as this, ~~DOE believes~~ it is paramount to strive to maintain the work scope commitment, even when funding appropriations are inadequate to meet schedule requirements.

DRAFT

DRAFT

please consider this new approach ~~and other~~ to maintaining ~~DOE requests that Ecology provide specific and appropriate input in how best to maintain~~ the goals of M-24 within procurement constraints ~~that Hanford cleanup must occur~~. If you have any questions, please contact Mr. George Sanders at 376-6888, or Mr. K. Michael Thompson at 373-0750.

the DOE

I suggest we [illegible]

Sincerely,

K. Michael Thompson, Acting Team Lead
Groundwater/Vadose Zone

George H. Sanders, Program Manager
Office of Regulatory Liaison

GW/VZ:KMT

Attachment

cc w/attach:
J. S. Hertzel, FDH
O. S. Kramer, FDH
D. R. Sherwood, EPA
R. F. Stanley, Ecology

cc w/o attach:
G. L. Black, BHI
M. L. Blazek, OOE
R. Jim, YN
P. Sobotta, NPT
M. B. Reeves, HAB
J. R. Wilkinson, CTUIR

DRAFT

DOE/RL-99-XX

Hanford Site Groundwater Monitoring Strategy

United States
Department of Energy
Richland, Washington

DOE/RL-99-XX

Hanford Site Groundwater Monitoring Strategy

Date Published
August 1999

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Executive Summary

This document supports the *Hanford Site Ground-Water Protection Management Plan* (DOE 1995) by describing the groundwater-monitoring strategy for the U.S. Department of Energy (DOE) Hanford Site located in southeastern Washington State. This strategy provides the basis for integrated monitoring that meets all of the regulatory requirements and considers needs for groundwater-monitoring data that may not be specifically defined in the regulations. A technically defensible monitoring system is needed for cost-effective protection of human health and the environment. In developing this strategy, the data quality objectives (DQO) process was used to help balance the requirements of the different regulations and the need for technically effective monitoring. Issues relating to regulatory overlap and conflict were considered in developing the groundwater-monitoring strategy. Regulators, DOE, contractors, and tribal representatives participated in the DQO process. The DQO process is designed to ensure that data collection is focused on making specific decisions which are critical to the Site mission.

A decision logic diagram was developed to illustrate how groundwater data are expected to be used in the decision-making processes on the Site. This logic incorporates the monitoring needs for all objectives and regulatory requirements. Specific groundwater-monitoring strategies were developed for decisions related to conceptual model development, background data needs, groundwater-plume tracking, detection and assessment of new groundwater impacts, and monitoring endpoints. Strategies for the effective use of groundwater-monitoring data in remediation decisions were deferred to project-specific decisions for remediation projects. Key elements of the strategy are listed below:

- The groundwater-monitoring plans will emphasize a technically sound groundwater-monitoring system. Waivers will be sought to deviate from default regulatory requirements or guidance when the specified regulatory methods are deemed to be less effective due to Site conditions.

- Groundwater-monitoring systems will be based on a suitable conceptual model of contaminant release and transport, hydrologic conditions, and geology. If data are insufficient to develop a detailed conceptual model, then further study will be undertaken to refine the conceptual model.

- Source areas will be aggregated into regional monitoring networks to the extent possible for groundwater monitoring. Aggregation will be based on similarities of waste streams, geographic proximity, hydrogeologic conditions, and risk involved.

- High risk sources such as single-shell tanks will continue to be monitored intensively to provide the needed detailed information.

- Focused monitoring will be proposed for facilities such as ditches and ponds using the most probable locations to detect contamination. The influent end of trenches and ponds generally would be the area where the greatest concentrations of waste would be expected and the monitoring should concentrate on those locations.

- Source detection monitoring will concentrate the most intensive monitoring on selected constituents which are the best indicators of contamination. Other constituents will be monitored less frequently.

- Target constituents for source detection monitoring will be selected based on process knowledge, geochemical behavior of the constituents, and the area-specific conceptual (hydrogeologic and geochemical) model. Target constituents will be those which are most representative of the source, most mobile, and most reliably detected at levels of interest. Ideally, the measurements will provide indicators of a wide range of the waste constituents and be distinguishable from natural background or upgradient contamination.

- Monitoring near past-practice sites where significant contamination may be present in the vadose zone and may be transported to groundwater is necessary. The regulatory requirements for monitoring, however, are not as stringent as for detection monitoring at treatment, storage, and disposal units (TSDs) as defined by the Resource Conservation and Recovery Act (RCRA).

- Detection monitoring at RCRA TSDs will focus on wells completed at the water table. Detection monitoring at deeper levels within the aquifer is not required by regulation. Assessment and compliance monitoring may require monitoring of deeper intervals and/or within a few centimeters of the water table.

- The detection monitoring requirements of RCRA final status monitoring are more protective of the environment and are preferred to interim status requirements. To expedite the transition to compliance with RCRA final status requirements, pending approval from Washington State Department of Ecology, sites which have not yet been incorporated into the Hanford Site RCRA permit will be monitored using final status procedures and statistical tests for detection monitoring.

- The preferred statistical tests for final status detection monitoring at the Hanford Site are the U.S. Environmental Protection Agency between well test and the American Society for Testing and Materials intra-well test. Analysis of variance (ANOVA) procedures should be avoided because they are not effective (resulting in lower power and higher false positive rates) for groundwater detection monitoring and are costly to implement. Other tests will be applied as they are shown on a site-specific basis to be more effective.

- Detection and compliance monitoring should be deferred or modified where groundwater flow is perturbed by nearby remediation systems when the perturbations preclude the ability to distinguish impacts of the site from impacts of remediation.

- Existing, extensive, groundwater plumes will be monitored on a regional basis and the data applied to the requirements for monitoring specific facilities within the region.

- In general, the plume monitoring of existing Hanford-wide plumes will be designed to show the extent of contamination and concentrations within the plume boundaries every 3 years. Selected wells in source areas and in areas where concentrations are observed to be changing rapidly will be sampled more frequently. Additional data collection may be required by area-specific DQOs.

- A broad suite of constituents will be monitored on an annual basis at selected transects downgradient from operational areas and along the Columbia River.

- Intensive monitoring will take place for tritium at low levels in the region from the 300 Area to the North Richland wellfield.

- Monitoring intensity will be decreased for plumes which are observed to be decreasing in extent or concentrations. Proposals to terminate monitoring will consider potential for fluxes of contaminants from the vadose zone as well as observed groundwater concentrations.

- Monitoring of contamination in deeper parts of the unconfined aquifer and in selected locations of the confined aquifer will be a priority for additional well installations. The prioritization relative to RCRA assessments, corrective measures studies, etc., will be determined through consultation with regulators.

- Requirements for RCRA TSD corrective action monitoring will be considered in preparing and obtaining regulatory approval for monitoring of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA past-practice units. Monitoring of natural attenuation and monitoring beyond the boundaries of remediation pumping well capture zones will be integrated with the ongoing plume monitoring.

- Implementation of this monitoring strategy will be on an area-specific basis and will be documented in the monitoring plans. Region-specific DQOs will be developed to implement the monitoring strategy.

Acronyms

ANOVA	analysis of variance
BHI	Bechtel Hanford, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
PUREX	plutonium-uranium extraction
RCRA	Resource Conservation and Recovery Act
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal unit

Contents

Executive Summary iii

Acronyms vii

1.0 Introduction 1.1

1.1 Goals and Objectives 1.1

1.2 Site Description 1.1

1.3 History of Groundwater Monitoring at the Hanford Site 1.5

1.4 Current Groundwater-Monitoring Project Structure 1.6

1.5 Purpose of the Strategy Document 1.6

2.0 Strategy Development Process 2.1

3.0 Regulatory Drivers 3.1

3.1 Atomic Energy Act 3.1

3.2 Comprehensive Environmental Response, Compensation, and Liability Act 3.1

3.3 Resource Conservation and Recovery Act 3.1

3.4 Hanford Federal Facility Agreement and Consent Order 3.2

4.0 Relationship to Environmental Restoration 4.1

4.1 Termination of Discharge 4.1

4.2 Active Facilities 4.1

4.3 Inactive Facilities 4.2

4.4 Monitoring of Active and Passive Remediation Systems 4.2

4.5 Relationship to Source Area Remediation 4.3

4.6 Regulatory Issues 4.3

5.0 Decision Logic 5.1

5.1 Background Data Needs 5.1

5.2 Plume Tracking 5.1

5.3 Detection and Assessment of New Impacts 5.3

5.4 Groundwater Remediation 5.3

5.5 Remediation Decisions 5.3

5.6 Monitoring Endpoints 5.3

6.0 Monitoring Strategies 6.1

6.1 Background and Conceptual Model Data 6.1
6.1.1 Requirements 6.1
6.1.2 Strategies 6.1

6.2 Source Term Monitoring 6.2
6.2.1 Requirements 6.2
6.2.2 Strategies 6.2

6.3 Plume Monitoring 6.10
6.3.1 Requirements 6.10
6.3.2 Strategies 6.11

6.4 Remedial Action Monitoring 6.17
6.4.1 Requirements 6.17
6.4.2 Strategies 6.18

6.5 Termination of Monitoring 6.18
6.5.1 Requirements 6.18
6.5.2 Strategies 6.18

7.0 Implementation 7.1

8.0 References 8.1

Figures

1-1 Radionuclide Contamination in Groundwater at the Hanford Site 1.3

1-2 Nonradioactive Contamination in Groundwater at the Hanford Site 1.4

1-3 Organization Chart for Groundwater-Monitoring Task 1.6

5-1 Hanford Integrated Groundwater Decision Logic 5.2

6-1 200-East Area Transect Guard Well Locations 6.15

Tables

3-1 RCRA Interim- and Final-Status Groundwater-Monitoring Projects, as of September 1998 ..... 3.3

6-1 Proposed Scheme for Groundwater Monitoring of Waste Sites 6.3

6-2 Maximum Contaminant Levels and Interim Drinking Water Standards 6.13

6-3 200-East Area Transect Guard Wells 6.16

1.0 Introduction

The Hanford Site is a U.S. Department of Energy (DOE) site in southeastern Washington State. The Site was used for producing defense-related plutonium from 1944 to 1988. During that time, industrial waste was discharged and has since impacted groundwater quality. This document describes a strategy for monitoring the groundwater to protect human health and the environment.

1.1 Goals and Objectives

This Hanford Site groundwater-monitoring strategy has two goals. The primary goal is to protect human health and the environment. In addition, the strategy will provide the basis for a technically defensible monitoring system. This document supports the *Hanford Site Ground-Water Protection Management Plan* (DOE 1995).

Protecting human health and the environment is the unifying objective of the regulations governing groundwater monitoring and of this strategy. Specifically, this document provides an integrated monitoring system that meets the needs of all regulatory drivers as well as the needs for other data use such as input to groundwater models. The regulatory drivers include the Atomic Energy Act of 1954, and the DOE orders which implement this act (primarily DOE 5400.1 and 5400.5), Comprehensive Environmental Resource Compensation Liability Act (CERCLA) as amended, Resource Conservation and Recovery Act (RCRA), and state of Washington regulations (including WAC 173-303, 173-216, 173-304). The groundwater monitoring will also meet legal commitments under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1989), the Site RCRA permit, and Records of Decision for CERCLA corrective action.

It is recognized that the regulations governing groundwater monitoring cannot consider all site-specific situations or all recent developments in the science. The DOE is committed to monitor groundwater in a fashion which meets the intent as well as the requirements of the regulations. In cases where a strict adherence to regulatory requirements is ineffective, options to gain approval of alternate systems will be pursued.

The reality of limited funding for ongoing groundwater monitoring must be recognized in the monitoring strategy. Integration of the monitoring under one strategy is expected to increase efficiency, reduce redundancy, and, thus, reduce costs. In this strategy, monitoring needs will be identified regardless of available funding, but it is vital to minimize the cost of meeting these needs. Areas where existing funding does not meet the goals can thus be identified so policy makers will be able to factor the technical and regulatory requirements into funding decisions.

1.2 Site Description

The Hanford Site is a DOE site in southeastern Washington State that was used for plutonium production between 1944 and 1988. Industrial discharges and releases from this mission have impacted

groundwater over approximately 250 km^2 of the 1,450 km^2 site. The impacts include radionuclides (approximately 220 km^2) and nonradioactive chemical constituents (approximately 52 km^2). Groundwater contamination on the Site is described in Hartman (1999).

The groundwater contamination on the Site has been monitored since early in the Site's history. Figure 1-1 illustrates the general extent of radionuclide contamination at the Hanford Site and Figure 1-2 illustrates the general extent of nonradioactive chemical contamination on Site.

Much of the existing groundwater contamination results from past discharges of process water and radioactive and chemical wastes to the ground. Most discharges of water to ground at the Hanford Site have ceased. Notable exceptions include the 400 Area process ponds and the 200 Areas Treated Effluent Disposal Facility which discharge treated water (after treatment, the water is considered uncontaminated). The 200 Areas State-Approved Land Disposal Site discharges water containing tritium after treatment to remove other radionuclides and chemicals. These discharges are permitted by the State under WAC 173-216. In addition, treated water from pump-and-treat groundwater remediation systems is discharged to injection wells in the 100-K, 100-H, 100-N, and 200-West Areas.

Numerous landfills containing hazardous and radioactive wastes are present on the Site and may represent potential sources of groundwater contamination. Although many landfills are no longer active, several remain in service. The low-level burial grounds store radioactive and mixed waste and continue to receive radioactive waste. Low-Level Waste Management Area-1, -2, -3, and -4, located in the 200-East and 200-West Areas, have been designated RCRA Treatment, Storage, and Disposal Areas. The Environmental Restoration Disposal Facility, located between the 200-East and 200-West Areas, is a landfill regulated under CERCLA that receives waste from remediation activities. The Central Landfill complex consists of the RCRA regulated Nonradioactive Dangerous Waste Landfill and the State-permitted Solid Waste Landfill (permitted under WAC 173-304). Both have stopped receiving waste. All other landfills are no longer active but continue to contain a variety of solid and liquid waste materials and are considered past-practice sites to be addressed under CERCLA or RCRA.

The 177 waste tanks containing high-level radioactive waste are also potential sources of contamination that remain active. The radioactive waste tanks are located in the 200-East and 200-West Areas. The single-shell tanks do not have secondary containment and many are known or assumed to have leaked in the past. Single-shell tank waste management areas have groundwater-monitoring requirements under RCRA. There is currently no groundwater monitoring for detection of contamination around double-shell waste tanks because leak detection systems are present within the secondary containment.

Numerous facilities were used for waste disposal during the production mission at the Hanford Site and in many instances have produced considerable groundwater contamination. These include ponds, cribs, ditches, injection wells, and specific retention trenches. Disposal facilities that 1) were active in 1988 and later and 2) may have received dangerous waste are regulated under RCRA; in many cases, these facilities have groundwater-monitoring requirements under that act. Other disposal facilities are considered CERCLA or RCRA past-practice facilities. Considerable contamination remains in the vadose zone under these facilities and may provide continuing sources of groundwater contamination.

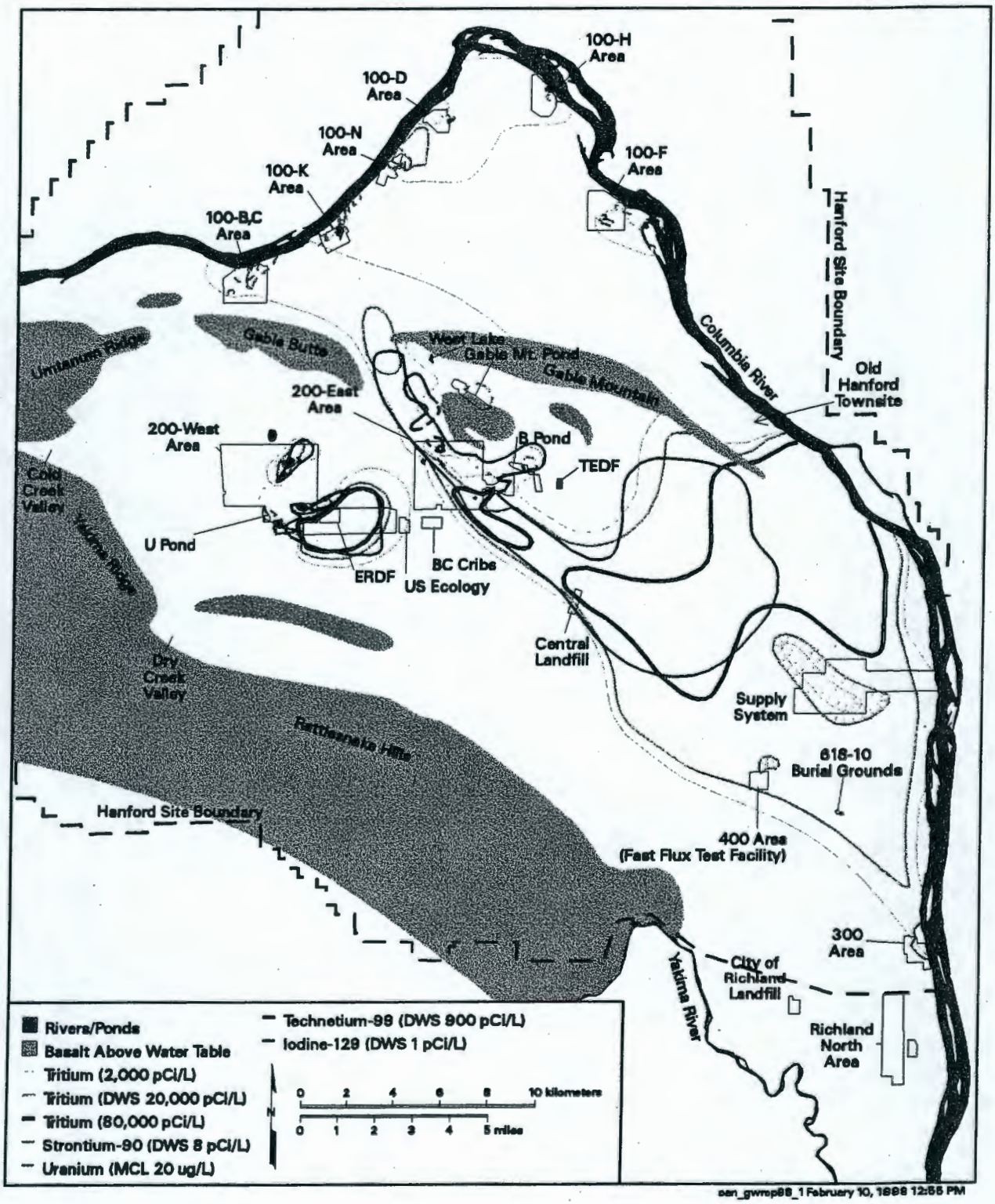

Figure 1-1. Radionuclide Contamination in Groundwater at the Hanford Site

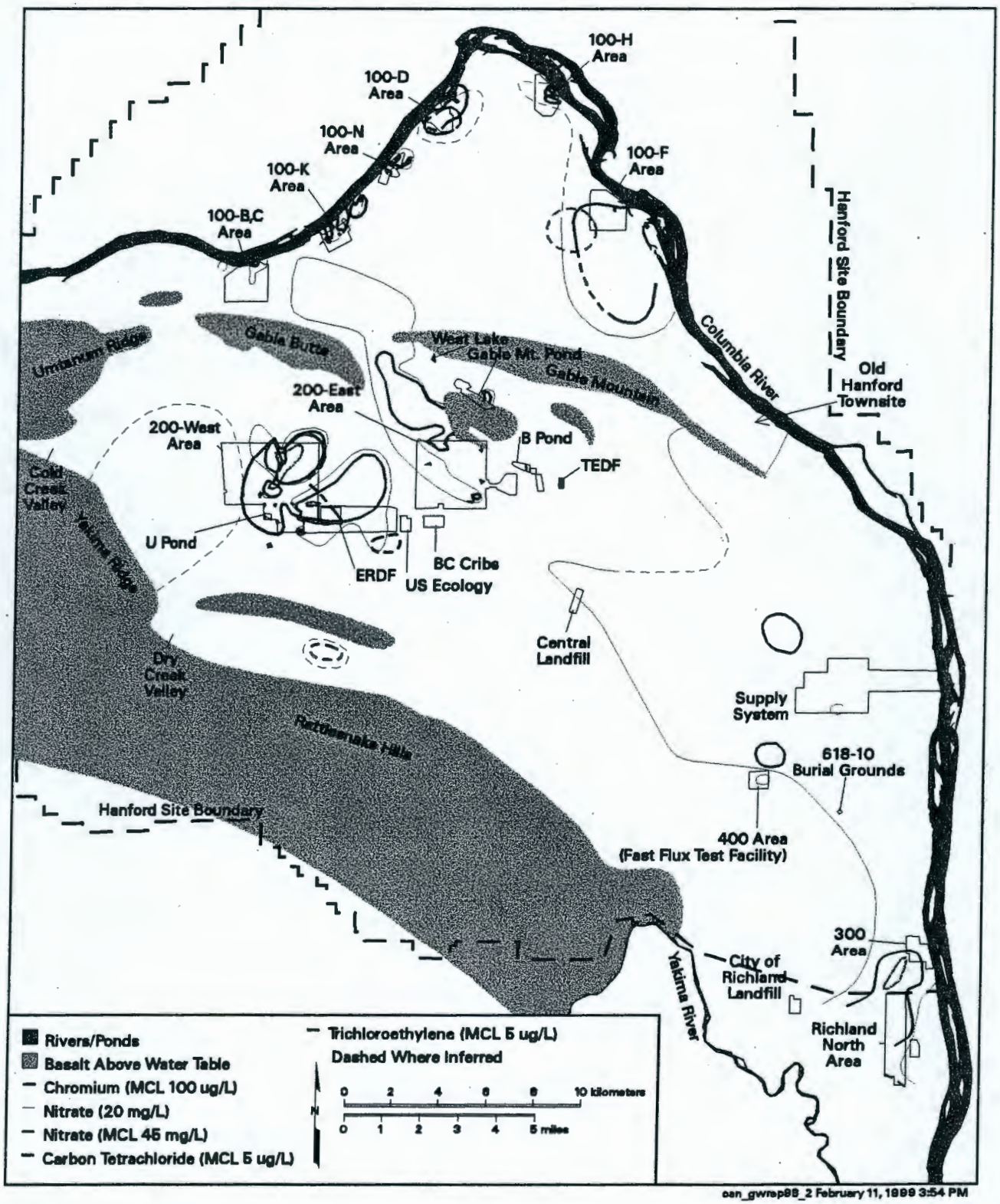

Figure 1-2. Nonradioactive Contamination in Groundwater at the Hanford Site

Miscellaneous contaminant sources such as spills, pipeline leaks, sewers, septic systems, and fuel storage tanks are also considered potential sources of groundwater contamination.

1.3 History of Groundwater Monitoring at the Hanford Site

Disposal of radioactive waste to ground started with the earliest processing at the Hanford Site. The need to understand the impacts of disposal on groundwater and to determine the best available disposal practices was recognized from the start, and a drilling program was initiated in 1946 or 1947. By 1949, 132 monitoring wells had been installed in the operational areas with approximately 26 wells in outlying areas (Brown and Rupert 1950). By 1962, approximately 400 wells were regularly monitored on the Site (Brown and Raymond 1962). The major emphasis was on determining the distribution of gross beta emitters in groundwater, although tritium was also analyzed for and reported starting in 1961.

Pacific Northwest National Laboratory[1] was given responsibility for the environmental groundwater-monitoring program in 1965. By this time, the number of cased monitoring wells had risen to more than 500. Analysis of groundwater for some limited anions, cations, and organics was first reported under the program in late 1966.

By 1974, ground disposal of liquid waste had been greatly reduced due to the deactivation of all the Hanford reactors (except N Reactor), coupled with improved treatment of several intermediate-level waste streams. Consequently, the objectives of the groundwater-monitoring program had been altered, with the main emphasis being on determining the distribution and movement with time of contaminants and determining the environmental impact of contaminants in the groundwater (Raymond et al. 1976). The Atlantic Richfield Hanford Company had been given responsibility for operations within the 200 Areas, and they conducted separate groundwater sampling and analysis programs for these areas. Rockwell Hanford Operations assumed these responsibilities in 1977 as the new prime site operations contractor.

By the mid-1980s, the emphasis was on groundwater protection, and the objectives of the groundwater-monitoring program had changed to include ensuring compliance with various federal and state of Washington regulations. In 1985, the first groundwater samples at facility-specific sites were collected to comply with RCRA. By 1987, Westinghouse Hanford Company had assumed the role of the prime site operations contractor and was conducting the 200 Areas sampling and analysis programs. In 1988, DOE Order 5400.1 (modified in 1990) superceded DOE Order 5480.1A (1981) for environmental protection. In 1990, DOE Order 5400.5 (modified 1993) for radiation protection updated DOE Order 5480.1B and lowered the DOE primary dose limit standard to 100 mrem/yr effective dose equivalent to members of the public. The previous limit was 500 mrem/yr. In addition, the order mandated a maximum limit of 4 mrem/yr effective dose equivalent to the public through the drinking water pathway. By 1989, more than 1,000 wells had been sampled and more than 650 wells were being used for groundwater monitoring. By 1990, groundwater sampling programs in support of CERCLA had been established.

---

[1] In the 1990s, Pacific Northwest Laboratory changed its name to Pacific Northwest National Laboratory. Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle.

1.4 Current Groundwater-Monitoring Project Structure

At the present time, the Sitewide comprehensive groundwater-monitoring program at Hanford is operated for DOE by Pacific Northwest National Laboratory; since 1996, this program has encompassed Sitewide monitoring, operational monitoring, site-specific monitoring for RCRA compliance, and long-term monitoring for CERCLA compliance. Bechtel Hanford, Inc. (BHI) conducts groundwater monitoring in support of operational control of CERCLA activities. BHI also manages well maintenance and well construction tasks.

The groundwater-monitoring task is organized by activity, as shown in Figure 1-3. The data quality objectives (DQO) process was conducted under the Strategic Planning Subtask.

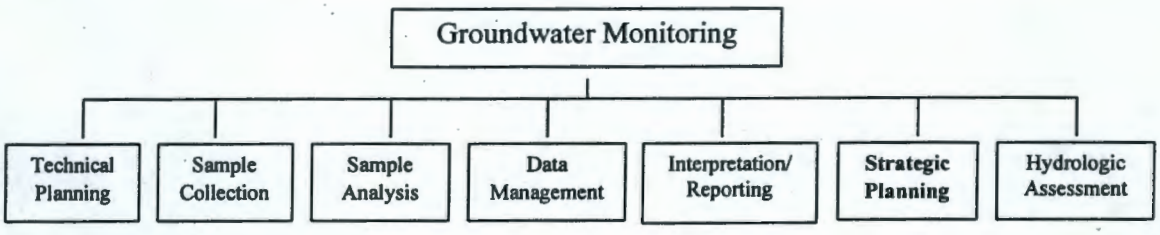

Figure 1-3. Organization Chart for Groundwater-Monitoring Task

1.5 Purpose of the Strategy Document

This document reports on the development of a Hanford Site groundwater-monitoring strategy. This strategy addresses the ongoing monitoring of existing contamination as well as monitoring near sources or potential sources of further groundwater contamination. In addition, monitoring background conditions and near locations of possible human or ecological impact are addressed. The document provides a guide for further development of monitoring strategy elements and provides a basis for implementing changes in the groundwater-monitoring system.

The groundwater strategy involves a large number of interrelated and complex issues because of the number of regulatory drivers, the number and complexity of contaminant sources and groundwater plumes, and the number of organizations who need groundwater data. The strategy was developed with input from numerous organizations within DOE and their subcontractors, regulators, and interested parties including the Hanford Advisory Board and Tribal Nations.

Some aspects of the monitoring strategy are applicable to all of the Hanford Site while other aspects must consider the site-specific situation in particular areas. This strategy addresses general aspects of the monitoring strategy and provides examples from specific areas where those strategies are being implemented. Examples of prototype applications or case histories are included throughout Section 6.0 of this document. During the development of this monitoring strategy, improvements were implemented to the monitoring system whenever possible, rather than waiting for a fully developed strategy document. This improves the timeliness of implementation and also helps clarify the advantages and pitfalls in proposed

approaches through the evaluation of prototype areas. Implementation of the monitoring strategy has thus already begun by incorporation of elements into site-specific monitoring plans.

2.0 Strategy Development Process

The DQO process (EPA 1993) guided the development of this monitoring strategy and prototype implementation of the strategy. Operating on the premise that data are collected to support specific decisions, the DQO process helps define data needs, specifies methods for fulfilling those data needs, and develops a cost-effective technical approach to collecting the data. Decision rules are developed to define how the data are expected to be used, and these rules are used to guide the monitoring network design. Thus, this strategy describes the first steps of the DQO process as it applies to the whole Hanford Site.

The DQO process for groundwater monitoring at the Hanford Site addresses numerous issues of how to implement regulatory requirements on the Site. Discrepancies between CERCLA and RCRA requirements for ongoing monitoring are addressed. In addition, technical improvements in the monitoring program can be made with input from, and agreement by, State and federal regulators. Thus, the development of the groundwater-monitoring DQOs involved considerable input from the regulatory community. The Hanford Advisory Board and representatives of Tribal Nations provided additional input and comments. Representatives from DOE and Site contractors contributed to the process.

The decision rules that are outcomes of the DQO process are tools designed to guide the development of the monitoring strategy and monitoring system for data acquisition. They are not commitments on the part of DOE or the regulators as to what regulatory decisions will be made under given circumstances. Numerous other inputs in addition to groundwater-monitoring data are needed for decisions relating to groundwater contamination and remediation. The decision rules simply describe how groundwater data are expected to be used. The quantitative decision rules will not be applied in a vacuum but be integrated with hydrologic and geochemical assessments to determine the significance of groundwater results. The development of decision rules in the DQO process provides a system for ensuring that data needs are understood and all critical data are collected.

The implementation of this strategy will be made on regional and site-specific scales. The complexity of the monitoring project with its multiple objectives and multiple source areas means that the implementation process will be vastly simplified by considering specific target areas. For example, DQOs have been developed to apply the monitoring strategy to the 200-East Area.

The groundwater-monitoring strategy takes a multi-tiered approach to developing the monitoring system. Certain objectives and approaches embodied in the strategy apply to the entire Hanford Site while others are specific to individual areas. In addition, parts of the Site have requirements under some regulations which are more prescriptive than the requirements for other parts. For example, the requirements for monitoring past discharges under RCRA are considerably more detailed than the requirements for monitoring similar discharge sites under CERCLA. Thus, currently, intensive monitoring is being performed for specific discharges that fall under RCRA, while nearby sites with no RCRA monitoring requirements are often monitored to address the general groundwater impacts in the area. In some cases, the hydrologic and geochemical situation means that unique approaches need to be considered. Care is needed to address areas of special public concern and perceived risk.

This strategy document outlines key outcomes that apply across the Site as well as selected strategies that apply at specific areas. The strategy summarizes key principles and agreements that guide the further development of groundwater-monitoring DQOs.

3.0 Regulatory Drivers

The three primary regulatory drivers for groundwater monitoring are the Atomic Energy Act of 1954 as amended, RCRA as implemented through Washington State regulations, and CERCLA as amended. The Tri-Party Agreement presents timetables for site remediation and describes how actions under RCRA and CERCLA will be coordinated and managed at the Hanford Site. These regulations with respect to groundwater monitoring at the Hanford Site and the orders and agreements implementing the regulations are discussed briefly in this section. For a more detailed discussion, see the Site groundwater report (Hartman and Dresel 1998).

3.1 Atomic Energy Act

The Atomic Energy Act of 1954 provided for the control of source material, special nuclear material, and waste. Under the authority of the Atomic Energy Act of 1954, DOE Orders 5400.1 and 5400.5 (DOE 1990, 1993) mandate groundwater monitoring. DOE Order 5400.1 requires DOE sites to demonstrate compliance with all federal, state, and local environmental protection regulations. DOE Order 5400.5 defines standards and requirements for radiation protection of the public and the environment. The objectives of groundwater monitoring required by DOE orders are as follows:

- verify compliance with other applicable groundwater regulations (e.g., RCRA and CERCLA)
- characterize and define hydrogeologic, physical, and chemical trends in the groundwater system
- establish baselines of groundwater quality
- provide a continuing, independent assessment of groundwater-monitoring and remediation activities
- identify and quantify new or existing groundwater contamination and quality problems.

3.2 Comprehensive Environmental Response, Compensation, and Liability Act

The CERCLA (codified in 40 CFR 300) establishes a federal program for waste cleanup at inactive sites contaminated with hazardous substances. The Hanford Site is subdivided into four areas for listing on the National Priorities List, mandating remediation under CERCLA. The U.S. Environmental Protection Agency (EPA) administers CERCLA.

3.3 Resource Conservation and Recovery Act

The RCRA regulates the generation, transportation, storage, treatment, and disposal of hazardous waste. The Washington State Department of Ecology (Ecology) under regulations set out in WAC 173-303-400 and -600 administers RCRA in Washington State. Two aspects of RCRA are of particular concern to groundwater monitoring. The past-practice regulations in RCRA mandate the remediation of parts of the Site which were no longer operating when RCRA was enacted. RCRA past practice is comparable to CERCLA. Facilities at the Hanford Site which had stored or discharged

hazardous waste and were active in 1986 are considered RCRA treatment, storage, and disposal units (TSDs) and may require monitoring for impacts to groundwater. Initially, the facilities at the Hanford Site were all regulated under RCRA interim status regulations but a schedule has been set for bringing the facilities into the Site RCRA part B permit (Permit # WA7890008967) which implements final status requirements. Ultimately, all TSDs will be either clean closed or closed under final status requirements.

3.4 Hanford Federal Facility Agreement and Consent Order

The Tri-Party Agreement is a legally binding agreement between the DOE, EPA, and Ecology that sets out a process and schedule for Site remediation. The cleanup activities are set out in an action plan as an attachment to the Tri-Party Agreement. The agreement also provides a framework for permitting TSD units at the Hanford Site. Thus, the Tri-Party Agreement is a unifying document which defines how the legal requirements of CERCLA and RCRA will be implemented at the Hanford Site.

One major impact of the Tri-Party Agreement on groundwater monitoring at the Hanford Site relates to the schedule for permitting TSDs. The TSDs are incorporated into the Hanford RCRA part B permit on a continuing basis. Until they are included in the permit, TSDs are monitored under interim status regulations. The status of RCRA units requiring groundwater monitoring and their schedule for incorporation into the permit are listed in Table 3-1.

Table 3-1. RCRA Interim- and Final-Status Groundwater-Monitoring Projects, as of September 1998 (from Hartman 1999)

TSD Units, date initiated (associated [CERCLA] groundwater operable units)	Interim-Status TSD Unit Groundwater Monitoring		Final-Status TSD Unit Groundwater Monitoring			Regulations	Year Scheduled for Part B or Closure
	Indicator Parameter Evaluation, date initiated[a]	Groundwater Quality Assessment, date initiated	Detection Evaluation	Compliance Evaluation	Corrective Action, date initiated		
1301-N LWDF, December 1987 (100-NR-2)	X					40 CFR 265.93(b) WAC 173-303-400	1999[b]
1324-N/NA LWDF, December 1987 (100-NR-2)	X					40 CFR 265.93(b) WAC 173-303-400	1998[b]
1325-N LWDF, December 1987 (100-NR-2)	X					40 CFR 265.93(b) WAC 173-303-400	1999[b]
120-D-1 ponds, April 1992 (100-HR-3)	X, clean closure in FY 1999					40 CFR 265.93(b) WAC 173-303-400	1998[c]
183-H solar evaporation basins, June 1985 (100-HR-3)					X, 1998	40 CFR 264 WAC 173-303-645(10)	1994[b]
216-S-10 pond and ditch, August 1991	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
216-U-12 crib, September 1991 (200-UP-1)		X, 1993				40 CFR 265.93(d) WAC 173-303-400	>2000[b]
216-B-3 pond, November 1988 (200-PO-1)	X, January 1998[d]					40 CFR 265.93(b) WAC 173-303-400	2000[b]
216-A-29 ditch, November 1988 (200-PO-1)	X					40 CFR 265.93(b) WAC 173-303-400	2000[b]
PUREX cribs[e] 1988 (200-PO-1)		X, 1997				40 CFR 265.93(d) WAC 173-303-400	>2000[b]

Table 3-1. (contd)

TSD Units, date initiated (associated [CERCLA] groundwater operable units)	Interim-Status TSD Unit Groundwater Monitoring		Final-Status TSD Unit Groundwater Monitoring			Regulations	Year Scheduled for Part B or Closure
	Indicator Parameter Evaluation, date initiated[a]	Groundwater Quality Assessment, date initiated	Detection Evaluation	Compliance Evaluation	Corrective Action, date initiated		
216-B-63 trench, August 1991 (200-PO-1)	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
LERF, July 1991			X, 1998[f]			40 CFR 265.93(b) WAC 173-303-400	1998[g]
LLWMA 1, September 1988	X					40 CFR 265.93(b) WAC 173-303-400	TBD[g,h]
LLWMA 2, September 1988	X					40 CFR 265.93(b) WAC 173-303-400	TBD[g,h]
LLWMA 3, October 1988	X					40 CFR 265.93(b) WAC 173-303-400	TBD[g,h]
LLWMA 4, October 1988 (200-ZP-1)	X					40 CFR 265.93(b) WAC 173-303-400	TBD[g,h]
WMA A-AX, February 1990	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
WMA B-BX-BY, February 1990		X, 1996				40 CFR 265.93(d) WAC 173-303-400	>2000[b]
WMA C, February 1990 (200-PO-1)	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
WMA S-SX, October 1991 (200-UP-1)		X, 1996				40 CFR 265.93(d) WAC 173-303-400	>2000[b]
WMA T, February 1990 (200-ZP-1)		X, 1993				40 CFR 265.93(d) WAC 173-303-400	>2000[b]
WMA TX-TY, September - October 1991 (200-ZP-1)		X, 1993				40 CFR 265.93(d) WAC 173-303-400	>2000[b]

Table 3-1. (contd)

TSD Units, date initiated (associated [CERCLA] groundwater operable units)	Interim-Status TSD Unit Groundwater Monitoring		Final-Status TSD Unit Groundwater Monitoring			Regulations	Year Scheduled for Part B or Closure
	Indicator Parameter Evaluation, date initiated[a]	Groundwater Quality Assessment, date initiated	Detection Evaluation	Compliance Evaluation	Corrective Action, date initiated		
WMA U, October 1990 (200-ZP-1)	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
NRDWL, October 1986 (200-PO-1)	X					40 CFR 265.93(b) WAC 173-303-400	>2000[b]
316-5 process trenches, June 1985 (300-FF-5)					X, 1998	40 CFR 264 WAC 173-303-645(10)	1996[b,i]

(a) Specific parameters (pH, specific conductance, total organic carbon, and total organic halides) used to determine if a facility is affecting groundwater quality. Exceeding the established limits means that additional evaluation and sampling are required (groundwater quality assessment). An X in the assessment column indicates whether an evaluation was needed or an assessment was required.
(b) Closure/postclosure plan; TSD unit will close under final status.
(c) Closure plan approval expected in fiscal year 1999; facility groundwater monitoring not required after clean closure.
(d) Reverted to indicator parameter evaluation following assessment.
(e) 216-A-10, -A-36B, and A-37-1 combined into one RCRA monitoring unit. RCRA monitoring will be performed according to interim-status groundwater quality assessment requirements.
(f) Will monitor groundwater under interim status until final-status groundwater-monitoring plan is approved.
(g) Part B permit; TSD unit scheduled to operate under final-status regulations beginning in year indicated.
(h) Facility Part B permit and final-status groundwater-monitoring plan contingent on completion of solid waste environmental impact statement.
(i) Closure plan pending Ecology approval.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
Ecology = Washington State Department of Ecology.
LERF = Liquid effluent-retention facility.
LLWMA = Low-level waste management area.
LWDF = Liquid waste-disposal facility.
NRDWL = Nonradioactive Dangerous Waste Landfill.
PUREX = Plutonium-Uranium Extraction (plant).
RCRA = Resource Conservation and Recovery Act of 1976.
TBD = To be determined.
TSD = Treatment, storage, or disposal (unit).
> = Beyond the year 2000.

4.0 Relationship to Environmental Restoration

An effective, decision-based groundwater-monitoring strategy must be coordinated with environmental restoration activities. The groundwater-monitoring data is used in making decisions regarding remedial action. Once those decisions are made and remediation is implemented then the purpose of the groundwater-monitoring changes. Some improvements and enhancements to the groundwater-monitoring system can be made under the current situation but others will depend upon progress in the Site environmental restoration mission and on the cooperation of the regulators and DOE.

This section describes the relationship of groundwater monitoring to remedial activities and discusses how monitoring needs are expected to change as remediation progresses and suggest a template for triggering changes to the monitoring with time. In keeping with other documents such as the groundwater remediation strategy (DOE 1997), CERCLA terminology will generally be used but the strategies apply to both CERCLA and RCRA past-practice operable units.

4.1 Termination of Discharge

An important step in the Hanford Site environmental restoration is reducing discharges of contaminated and uncontaminated water to surface disposal sites. Past discharges have not only provided the major source of groundwater contamination but have had a great impact on flow directions. During the post-operation period of approximately a decade, discharge of numerous waste streams has been terminated or consolidated, treatment systems have been installed, and state permits issued for the major remaining discharges. In the next few years, the impacts on the groundwater flow are expected to decline further as the mounding from past discharge dissipates. Thus, the significance of the discharges with regard to both chemistry and the groundwater flow has decreased considerably.

In the past, groundwater monitoring of operating disposal facilities was used to manage discharges and to provide input to decisions on when to retire soil-column disposal sites. That need has largely ended. Although drainage of water and contaminants from the vadose zone may persist for years after discharge ceases, it is too late to minimize contamination through operational changes at these sites. The continued groundwater-monitoring needs for remaining active and inactive facilities are discussed in Sections 4.2 and 4.3.

4.2 Active Facilities

The major ongoing discharge of contaminated water which remains, the 200 Areas State-Approved Land Disposal Site (616A Crib), is expected to continue until approximately 2030. In addition, uncontaminated water continues to be discharged at the 200 Areas Treated Effluent Disposal Facility and to a small extent to the 400 Area process ponds. The ongoing discharges continue to require groundwater monitoring. Groundwater-monitoring requirements for these discharges are defined in State waste discharge permits (Ecology 1995a, 1995b, 1996).

Several facilities on the Site continue to actively store radioactive or hazardous materials and require groundwater monitoring under Atomic Energy Act, RCRA, CERCLA, or a combination of regulations. These include the 100-K Area fuel storage basins, single-shell waste storage tanks, the Liquid Effluent Disposal Facility, low-level burial grounds, and the Environmental Restoration Disposal Facility. In some instances, the facilities are known or believed to have impacted groundwater (e.g., 100-K Area fuel storage basins and single-shell radioactive waste tanks); while in other cases, no contaminant impacts on groundwater are known or expected. Groundwater monitoring at sites which have impacted groundwater is directed at tracking the extent of existing contamination, assessing the potential for future impacts, and providing data for remedial actions. In the case of sites that impacts have not been seen, the groundwater-monitoring requirement is for the detection of any future impact.

Monitoring requirements may be reduced when the above facilities cease operation, are subject to environmental restoration, and/or it can be demonstrated that they do not pose a threat to groundwater.

4.3 Inactive Facilities

Numerous RCRA TSDs and RCRA and CERCLA past-practice facilities continue to be monitored in the period between active use and closure. These facilities include liquid waste disposal cribs, trenches, ditches, and ponds which are no longer in use and which are not storing waste in engineered structures (it is recognized that considerable waste inventories may be present in the vadose zone). Current plans for remediation of these facilities will be limited to removal of engineered structures and removal of the uppermost contaminated soils. Remediation decisions for the groundwater contamination have not been finalized; however, little additional active remediation of groundwater plumes originating from the liquid waste disposal cribs, trenches, ditches, and ponds will be performed. Detection, assessment, and compliance monitoring at individual facilities does not provide a great deal of value in supporting Site cleanup unless there is clear understanding of how the monitoring data could be used in the decision process. Strategies proposed for improving monitoring effectiveness in this situation are discussed in Section 6.2.

Two RCRA TSDs have been closed with requirements for ongoing groundwater monitoring due to contamination remaining in the subsurface. The 183-H Solar Evaporation Basins and the 300 Area process trenches have undergone a "modified closure." Groundwater remediation at these facilities is being performed under CERCLA but is incorporated in the RCRA permitting process. Groundwater-monitoring requirements continue to be defined separately for CERCLA, RCRA, and Atomic Energy Act, but the monitoring is coordinated to avoid duplication.

4.4 Monitoring of Active and Passive Remediation Systems

Groundwater sampling directed at operating groundwater pump-and-treat remediation systems will not be dealt with directly in this strategy. These active remediation systems have particular needs related to the operation of the extraction and injection wells, maintenance of the treatment systems, delineation and control of capture zones, and optimization of extraction efficiencies. The sampling and analysis associated with the operation of the active remediation systems is the subject of separate monitoring plans. Any additional sampling to meet other objectives within the areas of active remediation will be

coordinated with the remediation sampling and data shared between the remediation projects and groundwater-monitoring projects to avoid redundancy and ensure data utility.

Passive remediation systems such as the permeable reduction-oxidation barrier for chromium remediation in the 100-D Area also will require monitoring to ensure the systems are performing to specifications and are meeting cleanup goals. The ongoing monitoring of these passive systems will be integrated with the monitoring of plumes, offsite impacts, and other nearby sources to achieve the greatest efficiencies.

4.5 Relationship to Source Area Remediation

The relationship between groundwater monitoring and source area remediation is complex. In part, this is due to the decoupling of source and groundwater operable units in the Tri-Party Agreement. Extra care is needed to be sure that effective source control is instituted. It is generally assumed for groundwater operable units that source remediation under source operable units will control future impacts to groundwater. Thus, monitoring systems designed to address existing groundwater contamination may not meet the objectives of demonstrating the effectiveness of source remediation. This groundwater-monitoring strategy considers explicitly the needs for monitoring source areas.

4.6 Regulatory Issues

The standard CERCLA investigation progresses from a remedial investigation/feasibility study to a record of decision and remedial action. At the Hanford Site, remediation has been accelerated at a number of sites through interim records of decision which specify interim remedial measures. Thus, final records of decision are still pending at all but one groundwater operable unit (1100-EM-1 is the exception). However, the process for evaluating the need for expedited responses or interim remedial measures with respect to groundwater is essentially complete for all parts of the Site. (It is currently expected that the interim record of decision for the 100-HR-3 groundwater operable unit will be modified to address chromium contamination in the western part of the operable unit.) With few exceptions, no further measures are expected before final records of decision. The groundwater-monitoring data needs for final records of decision are primarily to provide temporal information on the changes in contaminant distributions. Groundwater-monitoring requirements for CERCLA operable units are specified in Tri-Party Agreement change agreements.

Between the issuance of an interim record of decision and a final record of decision for specific sites, the primary groundwater-monitoring goal is to ensure that the interim remedial measures are meeting remediation goals. Where active remediation is occurring this entails performance monitoring of the remediation system and evaluation of any movement of contaminants beyond the capture zone of the remediation. For areas where no active remediation has been instituted, the monitoring goal is generally to ensure that the plumes are dissipating as expected. Groundwater monitoring ensures that any decision not to remediate groundwater remains justifiable. In those cases, groundwater monitoring is in essence performed in lieu of active remediation and represents a cost savings over expensive treatment systems or where no available technology exists to treat the contamination (e.g., tritium).

Several CERCLA operable units contain RCRA TSDs. In keeping with the goals of RCRA and CERCLA integration, these RCRA units are considered to be in corrective action when a record of decision or interim record of decision is signed. The most rigorous method for initiating corrective action monitoring is to incorporate monitoring requirements in a change to the site RCRA part B permit. Permit modifications require a separate administrative process from the CERCLA record of decision and thus, incorporation of the changes to the permit may lag the remediation. A coordinated effort is necessary on the parts of the owner/operator and the regulator(s) to avoid the disconnect between RCRA and CERCLA processes.

An additional administrative inefficiency is that numerous RCRA TSDs have not been incorporated into the permit and are regulated under interim status regulations (see Table 3-1). The conflicting system of monitoring sites under interim status detection or assessment monitoring while the site is in corrective action under a record of decision *should* be avoided because it is in conflict with the regulations and does not further the goal of environmental protection. To the present time, however, interim status monitoring has continued for many months until the TSD is incorporated into the Site permit. Although regulators have flexibility to grant waivers from parts of interim status monitoring requirements or to modify monitoring systems, waivers have not been granted to date to address these problems.

Thus far, remediation agreements have not been finalized (e.g., final record of decision) for any RCRA past-practice operable units. Under the RCRA process, the remediation decisions are to be documented in the Site permit (Section 4.0). The preparation of this part of the Site permit is expected to begin in FY 1999. Groundwater-monitoring requirements for the operable units may be specified in monitoring plans or Tri-Party Agreement change agreements and approved by Ecology. Minor modifications to the monitoring plans may be made through documented change procedures without permit modification. It is yet to be determined if new monitoring plans will be required for RCRA past-practice sites that are incorporated into the Site permit or if existing monitoring plans are adequate.

5.0 Decision Logic

A decision logic diagram has been developed as a tool for integrating the requirements for groundwater monitoring under the variety of regulatory drivers (Figure 5-1). The diagram places the monitoring objectives into the decision-based structure used in the DQO process and covers the major anticipated use for groundwater-monitoring data. Different parts of the Site are at different stages in the investigation, and thus, the process outlined in the logic diagram is well underway in many if not most areas. In those cases where the process is well underway, the decision logic diagram is useful in describing the needs for ongoing groundwater monitoring. The diamonds on the logic diagram are the decisions for which continued groundwater-monitoring data may be needed. Decision rules will be developed to indicate how groundwater-monitoring data are anticipated to be used to address these decisions.

The decision logic diagram can be subdivided into six groups representing distinct parts of the process. These groups are discussed in the following sections.

5.1 Background Data Needs

Boxes 1-5 represent the background data needed to develop a monitoring system. The vast amount of historical data and the current monitoring systems are recognized as vital inputs to the process (box 1). The background data also include site history, waste inventories, discharge times and amounts, site geology, water levels and hydraulic properties, and other data indicating the extent of potential groundwater impacts. These data are used to develop the conceptual model for the site or portion of the site under consideration (boxes 2-4). The detail required in the conceptual model will depend on the region in question and the particular concerns that need to be addressed. Box 5 in the logic diagram explicitly recognizes the compelling need to address negative impacts from the intrusive aspects of groundwater investigations. Any wells on the site that may be providing a conduit for contaminant migration need to be reconfigured or decommissioned. Currently, the amount of well remediation and abandonment is limited by available funding.

5.2 Plume Tracking

Boxes 6-8 represent the "plume tracking" decisions needed to address existing groundwater contamination. Approximately 250 km^2 of the Site are underlain by groundwater contamination at levels greater than drinking water standards. The presence of contamination has implications for groundwater use on the Site. Thus, the presence of contamination has been identified as an important input to decisions on future Site uses (DOE 1999). Although DOE management of the Hanford Site provides de-facto restrictions on groundwater use, needs for decisions regarding water use occur periodically. For example, the location of groundwater contamination was considered in siting the Laser Interferometer Gravitational-Wave Observatory Facility. Contaminant discharges have largely ceased and much of the existing contamination is expected to decay, disperse, or be discharged slowly to the Columbia River. The DQO process identified a need to continue to assess the extent of contaminants on a periodic basis to confirm the expected decline in concentrations and for public assurance.

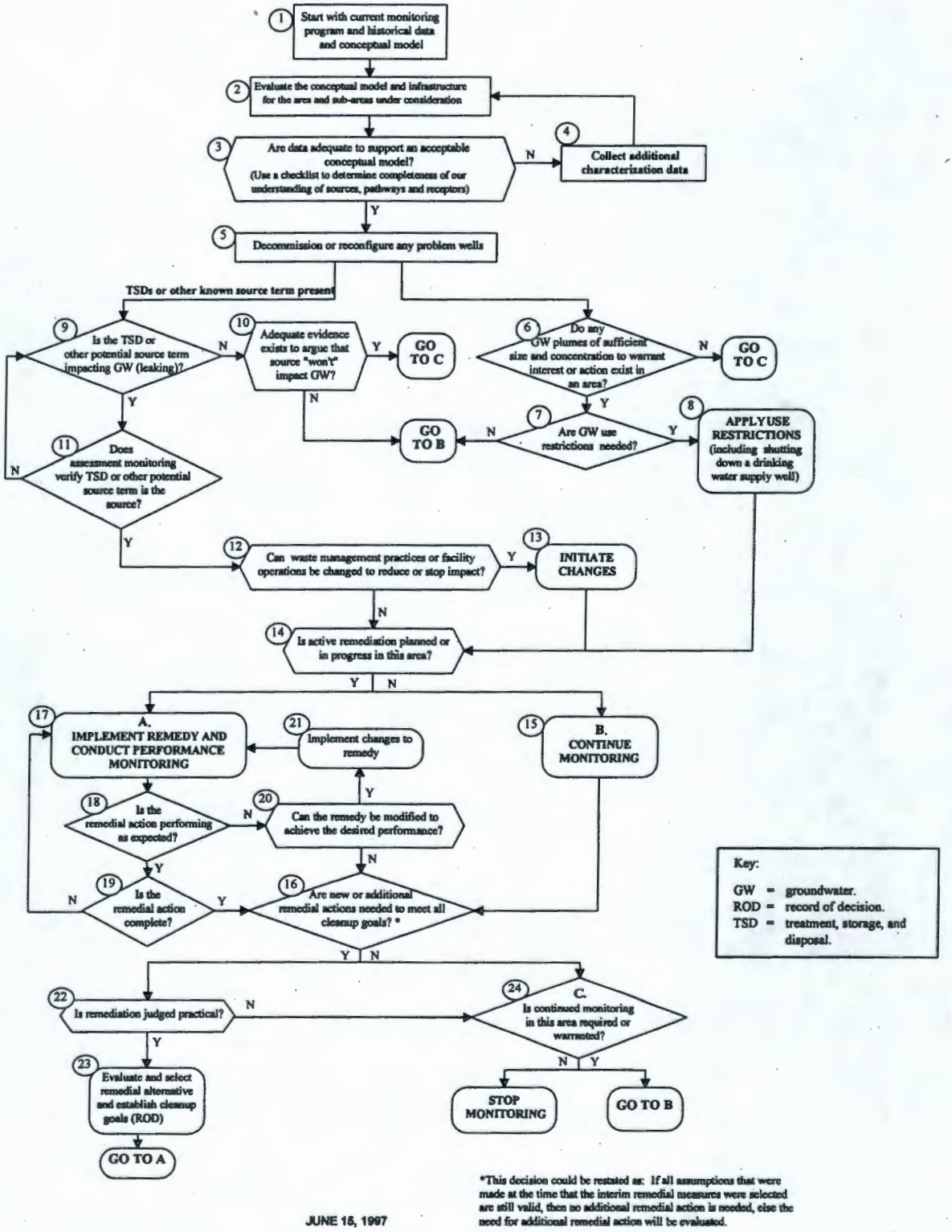

Figure 5-1. Hanford Integrated Groundwater Decision Logic

5.3 Detection and Assessment of New Impacts

Boxes 9-13 of the logic diagram address the detection and assessment of new or relatively new impacts to groundwater. In spite of the termination of contaminant discharge, considerable contamination remains in storage and disposal facilities as well as in the vadose zone beneath many discharge points. Thus, ongoing continuous monitoring for impacts is needed near a number of facilities. Much of the groundwater monitoring on the Site performed to meet the requirements of RCRA falls under this group of decisions. In particular, RCRA detection, assessment, and compliance monitoring address this part of the logic diagram. RCRA assessment and compliance goals do address groundwater contamination that has been identified with a particular regulated facility and thus, overlap to some extent with the plume tracking decisions, above. One of the goals for this monitoring strategy is to provide a monitoring system where the interface between monitoring for specific facilities and monitoring of broad-based contamination becomes seamless.

5.4 Groundwater Remediation

Boxes 14-21 of the logic diagram address groundwater remediation. Many remediation decisions have already been made on the Site, and groundwater and source remediation is underway in several areas. Boxes 17-21 essentially address the performance of active groundwater remediation. This performance monitoring also involves numerous activities in addition to groundwater monitoring and is necessarily performed on a project-specific level. The remediation projects, managed by BHI, will develop the plans for performance monitoring, so these decisions will not be considered further in this document.

5.5 Remediation Decisions

Box 16 of the logic diagram, "Are new or additional remedial actions needed to meet all cleanup goals?" deserves additional discussion because it is crucial to defining the uses for continued groundwater monitoring. Although many remediation decisions have been made, these decisions are set out in records of decision for interim actions in most cases. Even where the record of decision is for final action, the need to reevaluate the action is expressly recognized in both the record of decision and in the regulations. Thus, continued groundwater monitoring will be used both to support the remedial decisions and for input to final decisions where required. This portion of the logic diagram is designed to recognize that all groundwater-monitoring activities are part of DOE's Environmental Restoration Program and will continue to be used to ensure groundwater protection and management goals are met. Thus, results from source area monitoring and plume monitoring will be used for ongoing evaluation of remedial decisions. New data from groundwater monitoring may indicate the need for further action.

5.6 Monitoring Endpoints

Boxes 22-24 of the diagram address the endpoint of the monitoring. Monitoring is not seen as an end in itself and will be terminated when it no longer provides needed input to the decision process.

The rest of this document will set out monitoring strategies for the groups of decisions set out in Section 5.0.

6.0 Monitoring Strategies

6.1 Background and Conceptual Model Data

6.1.1 Requirements

Background data needs (boxes 1-5) are covered in this section. The ongoing monitoring system is not designed to address these needs specifically. However, updating our understanding of the conceptual model and interpreting historical data and data from other areas is an integral part of a successful monitoring program. This supporting information is needed to define an effective monitoring system and is vital in interpreting the monitoring results.

When insufficient information is available to develop the conceptual model to the necessary level of detail for a particular area of the Site or for a specific decision, then additional data needs will be addressed through special studies. Any data gaps will be addressed in project plans as they are identified.

6.1.2 Strategies

Developing a realistic conceptual model of site hydrogeology and contaminants is vital to designing and operating a successful groundwater-monitoring project. To this end, conceptual model development will be integrated into the monitoring project design and will be addressed in future monitoring plans. To the degree possible, historical groundwater data, process knowledge, and data from other media such as waste streams and surface water will be used in the development of the conceptual model before further data collection activities. Only significant data gaps will be addressed through additional data collection activities.

The hydrogeologic reassessment of the 200-East Area is an example of the type of project that might fall under the conceptual model development category. Currently, work is underway to reevaluate the stratigraphy of the 200-East Area and surroundings with particular emphasis on how the presence or absence of the Ringold lower mud impacts contaminant transport. Previous interpretations of the contaminant distribution in this area did not distinguish adequately between contaminants above or below the mud and did not consider confining conditions produced beneath the mud unit.

To use the historical data effectively, a comprehensive workable system is needed for retrieving groundwater data. Improved capabilities for visualizing spatial and temporal data distributions are also needed to integrate the vast amounts of data available. The core of the data system is the Hanford Environmental Information System (HEIS) which is maintained for DOE by BHI. Additional data sources include the Hanford geographic information system, the Hanford well database, project-specific databases, and files of well logs and well completion diagrams.

The groundwater project has an additional responsibility to ensure that groundwater investigations do not compound the environmental problems on the Site. This responsibility includes appropriate disposal

of purge water and other investigation-derived waste and proper abandonment of monitoring wells. Wells for abandoning will be prioritized so wells will be abandoned when their physical presence will interfere with remediation or other vital site activities, when the well may provide a pathway for further contaminant migration to groundwater, and finally when the well can no longer provide useful data. Specific requirements for well usage and well abandonment are set out in Attachment 7 to the Hanford Facility RCRA Permit (Permit # WA7890008967). This document spells out appropriate uses for wells constructed to various quality standards and requirements for well abandonment.

6.2 Source Term Monitoring

6.2.1 Requirements

Source term monitoring is designed to detect and assess the significance of any new impacts to groundwater. In addition, it is concerned with timely detection of new or increasing impacts from sources that have already impacted groundwater. For example, in many cases, it is important to continue monitoring to detect less mobile constituents after a site has impacted groundwater with more mobile species. Near source monitoring of known plumes is considered in Section 6.3. There is some overlap between the decisions associated with source monitoring and plume monitoring.

Source term monitoring is required by RCRA and Atomic Energy Act. Some ongoing source monitoring may also be required under CERCLA until source remediation is complete and to monitor the success of remedial activities. In general, the monitoring requirements for RCRA TSDs are the most stringent. Source term monitoring is also warranted to some degree at CERCLA and RCRA past-practice disposal sites and at selected operating DOE facilities.

6.2.2 Strategies

6.2.2.1 Monitoring Strategies Applicable to all Sites

Sites with a high risk and a potential for new contaminant impacts need the most intensive monitoring in terms of the sampling frequency and the spatial coverage of the wells. Sites where remedial actions have occurred or where risks are low are amenable to less frequent monitoring and less spatially intensive monitoring. Other sites will need intermediate levels of monitoring. A number of strategies for source area monitoring have been considered in the DQO process. These include aggregation of sites into a common monitoring network, applying innovative approaches to meeting RCRA statistical evaluation requirements, and emphasizing the collection and evaluation of data to meet multiple drivers.

Monitoring close to a potential source provides the most timely detection of new groundwater impacts if the coverage of the source area is adequate. Monitoring somewhat further from the source ensures that the whole source area is covered while still being able to detect impacts. In addition, when multiple sources are located in close proximity, the efficiency of monitoring can be improved by monitoring around multiple sources. For example, this approach is taken in monitoring low-level waste

management areas and the plutonium-uranium extraction (PUREX) cribs. The strategy documented here combines monitoring selected wells close to sources with monitoring further out to combine the advantages of early detection with improved coverage.

Monitoring of the sites should be based on the type of waste site, its operational history, and the status of the remedial investigations in the area. The proposed scheme for grading the monitoring of RCRA and past-practice sites is shown in Table 6-1. Liquid waste sites which are currently receiving or storing radioactive or hazardous wastes require close-in RCRA or equivalent monitoring. This would include, for example, the Liquid Effluent Retention Facility and the single-shell tanks. Solid waste sites which may have received liquid hazardous waste in the past (low-level burial grounds) require monitoring under RCRA but monitoring could take place at the periphery of large waste areas rather than at the boundaries of individual TSDs. Barring the institution of alternate monitoring – such as vadose zone monitoring – groundwater monitoring is expected to continue through the period of postclosure care. Liquid waste sites that have been closed are amenable to further aggregation.

Aggregation of sites for the purposes of groundwater monitoring under RCRA can occur in one of two ways. The most formal way is to define waste management areas containing several TSDs in the permitting documentation. Examples at the Hanford Site include the Low-Level Waste Management Area-1, -2, -3, and -4 and single-shell tank waste management areas (e.g., WMA-T, WMA-TX-TY,

Table 6-1. Proposed Scheme for Groundwater Monitoring of Waste Sites

Waste Site Type	Current Use	Monitoring Strategy
Single-shell tanks (SSTs)	Continued storage of hazardous and radioactive liquid, sludge, and solids.	Intensive nearfield monitoring of individual tank farms based on tank waste constituents and/or indicators.
Low-level waste burial grounds	Continued disposal and storage of radioactive solids. Potentially stores hazardous chemical solids and liquids from past disposal.	Monitor boundaries of waste management areas. Modify monitoring design and statistical evaluation.
Dangerous waste landfills	Storage of dangerous and other waste. Most waste is dry.	Monitor near boundaries. Aggregate monitoring with other nearby facilities if possible.
Liquid waste disposal cribs and trenches	Unused. Formerly used for disposal of radioactive and hazardous liquids. Contamination probably present in the vadose zone.	Aggregate monitoring with nearby facilities. Monitor for attenuation of existing plumes and limited nearfield monitoring of selected wells to confirm source impacts are declining.
Liquid waste disposal ponds and ditches	Unused. Formerly used for disposal of dilute radioactive and hazardous liquids.	Limit monitoring to most probable locations for detection of contaminant breakthrough (e.g., head end of ditches) and monitoring of attenuation of existing plumes. Aggregate sites where possible.

WMA-B-BX-BY, and WMA-S-SX). However, *for the purposes of groundwater monitoring*, a less formal aggregation of TSDs has been agreed to by DOE and Ecology in areas such as the PUREX cribs. At the PUREX cribs, three individual TSDs are subject to interim status assessment monitoring using a single unified monitoring network.

The degree of site aggregation allowable for sites under RCRA regulation is not clearly defined. In the future, a monitoring system designed to confirm contamination will remain restricted to the central plateau (the plateau near the center of the Hanford Site where the 200 Areas are located) may be sufficient. The system could be designed to monitor boundaries and selected areas within the area. This would be analogous to treating the central plateau as a single waste management area. Given the complexity and variety of the waste sites, a more effective strategy at the present time is believed to be the formation of smaller groups of waste sites based on proximity, waste characteristics, and status of source term remedial actions. Thus, for the immediate future, aggregation will be restricted to groups of waste sites in close proximity (e.g., the vicinity of PUREX, the vicinity of B Plant) which share similar waste histories.

Each group of waste sites to be considered an aggregate or waste management area would be most effectively monitored at the periphery of the group with selected monitoring points near most significant sources. Monitoring will be focused on the most probable locations for detection of contamination, e.g., the head end of ditches. Even where detection monitoring is not aggregated with other nearby sites, monitoring only the most probable locations based on the site conceptual model for detection of contaminant breakthrough is an effective strategy.

Now that the major decisions regarding interim remedial measures for groundwater and source remediation have been made, there is less value in intensive monitoring at sites that are no longer active. In some instances at the Hanford Site, groundwater monitoring cannot distinguish the specific source of contaminant plumes when multiple disposal facilities are located in close proximity. This does not generally impair the ability to make decisions on remediation of source or groundwater operable units. The objective of confirming the decline of groundwater contamination at inactive sites would be better served by taking a regional approach to the monitoring. Regional monitoring networks should be coordinated with the more intensive site-specific monitoring required at active facilities such as tank farms.

Efficiencies in monitoring can be achieved by monitoring certain constituents at less frequent intervals than others. Constituents that are the best indicators of contamination and the most likely to change rapidly should be monitored more frequently while constituents that are unlikely to be seen and would only change gradually due to their low mobility should be monitored less frequently or not monitored until indicator species change. Focusing on the constituents of concern is the most effective way to ensure that hazards are identified quickly at a minimum of cost.

6.2.2.2 Monitoring Strategies for Source Monitoring of Past-Practice Sites

Numerous past-practice sites exist on the Hanford Site, and many of these are known to have contaminated groundwater with radionuclides and/or hazardous chemicals. In addition, past releases

to the vadose zone create the potential for breakthrough of contaminants to groundwater. In general, the driving force for contaminant transport through the vadose zone declines considerably when discharge is terminated. Continued transport may result from slow drainage of moisture in the vadose zone or through addition of water from other sources such as nearby disposal sites, leaking water lines, or stormwater/ snowmelt runoff. For these reasons, continued monitoring near selected past-practice disposal facilities is warranted.

Detailed detection monitoring similar to that required at RCRA TSDs is impractical if not impossible at past-practice sites. The preferred strategy to address these sites is to monitor wells closest to the downgradient boundary of groups of sites and selected wells near the sites with the greatest possibility of future impacts. The criteria for choosing sites of possible future impact include the waste types and volumes discharged, the time period of operation, the facility size, and the location of monitoring wells further downgradient. The information obtained from monitoring the waste sites with the greatest possibility of new impacts provides valuable insight into the possibility of impacts from the other, less intensively monitored facilities.

6.2.2.3 Monitoring Strategies for RCRA TSDs

A number of strategies have been developed to address monitoring of RCRA TSDs. Some of the strategies discussed in the following four sections have been implemented in past years and are included in this document to describe inclusively the approaches to monitoring at the Hanford Site.

6.2.2.3.1 Permit Status

One of the inconsistencies in groundwater monitoring at the Hanford Site is that not all RCRA waste management areas are included in the Site RCRA part B permit, i.e., monitored according to RCRA final status regulations as specified in WAC 173-303-645. The facilities subject to part A permits continue to be monitored under requirements stipulated in the interim status regulations [40 CFR 265, Subpart F and WAC 173-303-400(3) by reference]. All TSDs that undergo closure, irrespective of permit status, shall be closed pursuant to the authorized State Dangerous Waste Program in accordance with WAC 173-303-610. If clean closure cannot be achieved, the TSD will be closed as a land disposal unit, and a postclosure permit will be required. The postclosure permit will specify groundwater-monitoring requirements (per WAC 173-303-645) and corrective actions, if necessary.

Interim status prescribes that indicator evaluation for site impacts to groundwater be performed using a t-test of the means at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over initial background. Statistical evaluations are performed for each of the indicator parameters specified in 40 CFR 265.92(b)(3) (i.e., specific conductance, total organic carbon, total organic halides, and pH). The owner/operator has the latitude, within the regulations, to choose a t-test that will accommodate the data collected. However, there is much less choice with regard to the data collection requirements (i.e., four replicate measurements analyzed on the same sample for each indicator parameter). In addition, no matter which t-test is used, the (statistical) comparisons made cannot change. That is, the owner/operator must collect a background data set (from upgradient wells) for each indicator parameters and compare these background data (collected earlier) to the data from each well

individually, each time they are sampled. Based on process knowledge and the interpretation of existing contaminant plumes, these parameters are not always the most sensitive indicators of contaminant releases from Hanford Site facilities. In addition, the statistical tests required under interim status are not as effective as some tests allowable under final status regulations as discussed below. Final status regulations provide the option of monitoring for site-specific contaminants of interest for detection monitoring.

It is recommended that final status monitoring approaches and allowable statistical tests be used for detection monitoring of RCRA sites regardless of whether the unit has been included in the Site part B permit. If final-status-type detection monitoring of interim status sites indicates statistically significant evidence of contamination to groundwater from a facility then *assessment* monitoring as required under interim status would be triggered. Detection monitoring triggers *compliance* monitoring under final status. There are sufficient differences between the regulatory objectives of interim status assessment and final status compliance monitoring that it would be difficult to continue monitoring per final status requirements after a constituent of interest is detected at the compliance point (downgradient well). Detected is defined as statistically significant evidence of contamination as described in WAC 173-303-645(9)(f).

6.2.2.3.2 Statistical Applications

There are two general approaches to detecting groundwater quality impacts at a waste disposal facility. The first approach is the traditional upgradient versus downgradient (or inter-well or between-well) comparisons where new downgradient monitoring results are compared to a series of measurements obtained from well(s) that are located upgradient of the facility. The second approach is the intra-well comparisons where new downgradient measurements are compared to their own historical baseline conditions.

Final status *detection* monitoring regulations require the use of statistical tests for determining if a site has impacted groundwater. The final status regulations are written to expressly provide greater flexibility in the selection of constituents of interest, sampling procedure and interval, and statistical methods than that stipulated in the interim status regulations. The final status regulations (WAC 173-303-645(8)(h)) specify that the statistical method will be one of the following: parametric or nonparametric analysis of variance (ANOVA), tolerance or prediction interval procedure, a control chart approach, or another statistical test method approved by the regulator. The use of ANOVA methods (which compare the mean concentration of a downgradient compliance well with the mean background [upgradient] concentration) is not recommended for the following reasons (Gibbons 1994, p. 260; EPA 1992, p. 67):

- The ANOVA methods may have a lower power (high false negative rates) for detecting a narrow plume of contamination.

- The ANOVA methods are more sensitive to spatial variability than to contamination. Spatial variability affects mean concentrations but typically not the variance; hence small yet consistent differences will achieve statistical significance. In contrast, contamination affects both variability and mean concentration; therefore, a much larger effect is required to achieve statistical significance.

- The ANOVA methods are more costly. They require four independent samples per semiannual event or eight per year. Other methods (e.g., prediction limit, tolerance limit, control chart) require a single measurement per sampling event or two per year. In addition, collection of four independent samples at a given well may necessitate waiting several months if the natural groundwater velocity at that well is slow.

For these reasons, the preferred statistical methods to be applied at the Hanford Site for detection monitoring are the EPA two-stage between-well test and/or the intra-well Shewart-CUSUM control chart methods (EPA 1992; ASTM 1996). The method to be applied depends on the site-specific conditions. For example, the between-well tests are based on the assumption that site impact is the only cause of variation between upgradient and downgradient water quality. However, large spatial variability often exists and may invalidate upgradient versus downgradient comparison results. Also, for those facilities that have no definable hydraulic gradient (e.g., in parts of the 200-East Area), have no existing contamination, have too few background wells to meaningfully characterize spatial variability, or have radial flow (e.g., the B Pond system), intra-well comparisons using the combined Shewart-CUSUM control chart methods improve performance. For situations specified above, intra-well comparisons are preferable to their inter-well counterparts because they completely eliminate the spatial component of variability. Due to the absence of spatial variability, the uncertainty in measured concentrations is decreased making intra-well comparisons more sensitive to real releases. Of course, past observations can be used as baseline data in an intra-well detection comparison only if the well is known to be uncontaminated or if the baseline contamination is not site related and is steady. Control charts do not efficiently handle data sets with a significant fraction of nondetects (i.e., greater than approximately 25%), making them appropriate only for those constituents with a high frequency of occurrence in monitoring wells. Therefore, control charts tend to be most useful for inorganic parameters (e.g., metals and geochemical monitoring parameters) that occur naturally in the groundwater. Where the constituents of interest are not detected in the baseline data, a practical quantitation or detection limit may be used as the control limit.

The preferred statistical methods (two-stage between-well test and/or the intra-well Shewart-CUSUM control chart methods) do not require a suite of independent samples to be collected from each well during a given sampling event. The sampling procedure of collecting four independent samples as described in WAC 173-303-645(8)(g)(i) is unnecessary. Generally, an alternate sampling procedure as allowed by WAC 173-303-645(8)(g)(ii) for final status will be recommended. WAC 173-303-645(9)(d) states that for final status monitoring, a sequence of at least four samples must be collected semiannually from each well under detection monitoring. The collection of a four-sample sequence is not needed using the preferred statistical tests so semiannual sampling using single samples will be proposed in monitoring plans which use the preferred statistical tests. Similarly, WAC 173-303-645(10)(f) says that a semiannual sequence of four samples is to be collected under final status compliance monitoring. By the same reasoning, an alternate sampling method of semiannual sampling of single samples as allowable under WAC 173-303-645(8)(g)(ii) is recommended.

The advantages of the proposed statistical methods for final status monitoring include improved power (lower false negative rates), lower false positive rates, and lower sampling and analysis costs. In addition, the control chart methods are amenable to automation allowing for rapid discovery and notification of exceedances of control limits.

The proposed intra-well method assumes that a suitable baseline can be determined. If contamination is preexisting, trends will often be observed in the baseline database from which the mean and variance are computed. This will lead to upward biased estimates and inflated control limits. When significant trends in baseline data sets are found, their source should be identified before continuation of detection monitoring as there may be evidence of a prior site impact. If the source of the trend is found to be unrelated to the facility, then an alternative indicator may be used for that well or all wells at the facility (ASTM 1996, p. 13) or one may use the transformation procedure as specified in Gibbons (1994, p. 165) to remove the trend. In this way, unbiased estimates of the baseline mean, variance, and control limits are obtained even in the presence of a trend potentially caused by a historical release. The single well method proposed will be very sensitive to temporal changes at a given location which may not be related to the TSD. Thus, it is important to consider the hydrogeologic setting when choosing a statistical method and when interpreting the results.

The proposed between-well method assumes that the upgradient wells are representative of the concentrations expected in the downgradient wells in the absence of impact from the TSD. This may not be the case if the upgradient concentrations vary considerably or exhibit a trend across the site.

6.2.2.3.3 RCRA Groundwater Monitoring and CERCLA Groundwater Remediation

Several RCRA TSDs have had their monitoring networks adversely impacted by proximate groundwater remediation activities. This is a particular problem for RCRA regulated units which remain in detection monitoring while the groundwater is perturbed by pump-and-treat systems. Examples of RCRA units impacted by remediation activities include the 200-West Area Low-Level Waste Management Area-4 burial grounds, the Waste Management Area U tank farm, 1301-N and 1325-N trenches, and the 183-H solar evaporation basins. In this situation, the transient effects of the remediation compromise the use of trend analysis and upgradient-downgradient statistical comparisons and may make previously designed monitoring systems invalid under new flow regimes.

In the case of the 183-H solar evaporation basins, Ecology has approved a final status corrective action monitoring network that is scaled back considerably because of the effects of the remediation system. A similar approach to monitoring the 1301-N and 1325-N trenches while the pump-and-treat system is impacting the flow regime is recommended. However, currently the closure plan (RL 1998) states that RCRA monitoring during and after closure activities will continue according to the existing interim status monitoring plan. The closure plan for these facilities has been incorporated into a modification of the Hanford Site RCRA Permit (Ecology 1994) and will become effective in 1999. In accordance with the Tri-Party Agreement and WAC 173-303-610(7)(i), postclosure care for each dangerous waste management unit must consist of groundwater monitoring and reporting as required by WAC 173-303-645 (i.e., final status groundwater monitoring). Therefore, this inconsistency needs to be resolved with Ecology.

It is recommended that detection monitoring at burial grounds in areas where flow is impacted by pump-and-treat remediation (e.g., Low-Level Waste Management Area-4) be modified or deferred until remediation is complete. In addition, statistical evaluation of the data should be suspended until flow conditions and upgradient concentrations stabilize. This recommendation is consistent with EPA and

Ecology guidance (EPA 1992a, p. 7-1; Ecology 1995, p. 47). Ecology and EPA guidance states that "after terminating treatment and before collecting water samples to assess attainment, a period of time must pass to ensure that any transient effects of treatment on the groundwater system have sufficiently decayed." Ecology and EPA recommend achievement of steady state conditions before collecting data to determine whether cleanup standards have been attained. Currently, the groundwater flow conditions have not stabilized at Low-Level Waste Management Area-4. Therefore, water samples (collected before site conditions have reached steady state conditions) should not be used to make regulatory decision concerning whether or not the site has impacted groundwater quality. The current monitoring system is unlikely to provide a reliable indication of contamination from Low-Level Waste Management Area-4.

Because of the greater potential for significant near-term groundwater impacts at tank farm waste management areas, continued intensive monitoring for detection is needed. However, it should be recognized that the ability to distinguish effects of the waste management area from upgradient and preexisting plumes will be diminished where remediation is perturbing the local flow. Waste Management Area TX-TY tank farm is currently in assessment and the assessment plan addresses a monitoring strategy for that unit. Waste Management Area U tank farm remains in detection, and it is recommended that any evaluation of impacts from this unit rely heavily on site-specific parameters rather than the standard RCRA indicator parameters.

6.2.2.3.4 Site-Specific Considerations

A number of successes in tailoring the monitoring of RCRA TSDs to the specific conditions at the Hanford Site should be noted. These serve to illustrate ways that the flexibility in the monitoring system can address Site conditions. This section also discusses additional strategies to tailor the monitoring to provide effective detection and assessment of RCRA TSDs at the Hanford Site.

Tri-Party Agreement milestone M-24-00 specifies that "installation of groundwater wells shall mean that wells have been drilled, adequately sealed, and screened over no more than 15 feet of the aquifer unless otherwise negotiated with Ecology." Approval has been received from Ecology to use longer screen intervals than specified in a number of monitoring wells. This is expected to increase the useful life of wells in areas where the water table is declining. Older wells which are not compliant with WAC well construction standards continue to provide vital monitoring data. Approval has been obtained from Ecology to integrate data from these wells into RCRA evaluations. Criteria for appropriate uses of older wells are included in the Site Permit as discussed in Section 6.1.

Past data and process knowledge have been used to refine constituent lists for RCRA assessment and compliance monitoring, minimizing the costly monitoring for Appendix IX constituents. Insecticides (endrin, lindane, methoxychlor, and toxaphene) and herbicides (2,4-D and 2,4,5-TP Silvex) are listed as part of the Interim Primary Drinking Water Constituents (40 CFR 265, Appendix III) and therefore are required to be sampled quarterly during the first year of RCRA monitoring. This requirement was waived for the 100-D Ponds because these constituents were not discharged to the facility (see *Groundwater Monitoring Plan for the 100-D Ponds*, WHC-SD-EN-AP-048, Section 3.3.10 [WHC 1991). These strategies have improved the ability to concentrate on obtaining the most important data while minimizing costs.

Groundwater-monitoring networks for RCRA detection monitoring consist predominantly of wells completed at the top of the aquifer but also include deeper wells for a number of TSDs. The deep wells were installed because of inadequate data to support a conceptual model for RCRA sites. There is some potential for wastes to be driven deeper into the aquifer at sites where discharges have created significant increases in vertical gradients. As discussed above, the termination of discharge is decreasing groundwater mounding throughout the site and the potential for large downward gradients at any TSD has diminished. There is little reason to believe that contamination will be detected in the deeper parts of the unconfined aquifer before detection in shallow wells so minimal monitoring of deep wells is warranted now that considerable data have been collected to support the conceptual model. Continued monitoring near the top of the aquifer for breakthrough of contamination from the vadose zone is warranted, however, at many sites. At those sites which remain in detection monitoring, it is recommended that the network be restricted to the top of the aquifer where the most timely detection of any contamination would occur. Decisions on required monitoring of deeper parts of the aquifer will be made based on the drivers for plume monitoring discussed in Section 6.3.

6.3 Plume Monitoring

6.3.1 Requirements

The major goals of plume monitoring are to identify and describe the extent of existing groundwater contaminant plumes. This includes assessing the rate of spread or decrease in the extent of contamination and the magnitude of impacts within the plume boundaries. This information is important for determining potential restrictions on water or land use and input to decisions for groundwater and/or source area remediation.

6.3.1.1 Historical and Continued Monitoring

The groundwater monitoring performed during the past 50 years has provided considerable data to identify the significant groundwater plumes and determine their extent. Major decisions on implementing interim groundwater remedial measures have been made and, in many cases, documented in records of decision based on this information. Continued plume monitoring is warranted to confirm that the existing conceptual models of site contamination are accurate, to evaluate plume attenuation, and for public assurance. Changes in the groundwater flow system have been induced by the termination of site discharges. These changes are expected to effect the direction and rate of contaminant flow. Continued monitoring will provide data to assess those changes.

6.3.1.2 Regulatory Requirements

Monitoring of the extent of groundwater contamination is required under the Atomic Energy Act and mandated in DOE orders. The primary drivers are to assess "existing and emerging groundwater quality problems" and to provide data to evaluate the exposure off the Site and make estimates of radiation dose to the public. At the Hanford Site, the groundwater data are not used directly in the dose assessments but provide supporting information on the location and quantity of radioactive byproducts being transported

off the Site. To fulfill that objective, information is needed on the distribution of contaminants throughout the Site and some understanding of the rate of transport as well as specific concentrations at the Site boundary.

Plume monitoring may also be required under CERCLA and RCRA past-practice remedial actions to provide data to make decisions on the need for remedial measures and to evaluate the effectiveness of remedial actions. In this context, natural attenuation of a plume with no enhanced remediation is considered a remedial action (i.e., EPA Directive 9200.4-17 [EPA 1995]). The CERCLA activities primarily involve collecting sufficient data to make remedial decisions needed for a record of decision, and thus, tend to be focused and short term. Data are also needed for performance monitoring and operations of active remediation systems such as the six currently active pump-and-treat systems. Evaluation of the regional sufficiency of the remediation and attenuation of plumes generally involves collection of long-term monitoring trend data.

Monitoring of plumes to determine the rate and extent of contaminant movement may be required under RCRA in interim status assessment monitoring and final status corrective action monitoring. At the Hanford Site, many of the TSDs which have contributed to groundwater contamination are located in close proximity to past-practice facilities which have released similar contaminants. Although trend analysis and chemical fingerprinting techniques can help identify specific sources, the ability to distinguish the precise source of contaminants in the distal portions of co-mingled plumes is restricted. Evaluation of the extent and rate of spread (or dissipation) of contaminant plumes is best performed through a coordinated monitoring network. Monitoring plans for individual TSDs or waste management areas may refer to the coordinated plume evaluation to avoid duplication of effort. This is in keeping with Section II.F of the Hanford Site RCRA Permit which states, "results from other investigation activities shall be used whenever possible to supplement and/or replace sampling required by this Permit."

The Tri-Party Agreement mandates coordination of evaluation and remediation of plumes resulting from TSD and past-practice sources. Although coordination occurs on the remediation level, the Tri-Party Agreement mandates that TSDs be clean closed under interim status or brought into the Site Final Status Permit and closed under RCRA requirements. Groundwater monitoring may be a RCRA permitting requirement, so there is the potential for redundant monitoring systems. One possible solution is to determine the corrective action and monitoring needs for the TSD at the time of preparation of the record of decision for CERCLA. The record of decision for an operable unit is signed by DOE, Ecology, and EPA and would be an appropriate place to document a coordinated monitoring requirement for the operable unit and any TSDs contained in the unit. The RCRA permit could then incorporate the relevant parts of the record of decision. In any case, better coordination between groundwater-monitoring requirements of the permitting process and CERCLA and RCRA past-practice process is needed. In the absence of such clarification, coordination may still occur through negotiation of the requirements in the Hanford Site RCRA Permit and monitoring plans.

6.3.2 Strategies

Ongoing monitoring of existing plumes continues at the Hanford Site. Somewhat different strategies may apply to areas where remedial actions are taking place versus areas not yet subject to records of

decision or other agreements. Alterations to the monitoring system are expected in different parts of the Site from the period of remediation through the postclosure care period.

Monitoring of groundwater plumes at the Hanford Site is largely dependent on collecting data from older wells which may not be optimally constructed or located due to plume dynamics over time. Wells which are not constructed to current WAC standards will continue to be used unless they provide a pathway for contaminant migration, which generally is not a problem with wells located away from source areas. Wells with long open intervals are evaluated to determine if they provide useful information. In general, pumps are placed near the water table even if a long perforated interval exists. In the absence of vertical gradients or low-permeability zones, these wells usually produce water representative of the aquifer at the pump elevation. The wells will be evaluated on a case-by-case basis.

The objective of plume monitoring is to describe the contaminant distribution within the plume and to track plume migration. In general, contaminants are tracked at levels equal to the Drinking Water Standards (40 CFR 141 and WAC 246-290). Drinking water standards of interest for the most significant groundwater contaminants on the Site are listed in Table 6-2.

In certain circumstances, contamination may be tracked at levels considerably below the standards. One such example is tritium in the southern part of the Site where a more sensitive analytical method is employed to assess the movement of the leading edge of the plume. Lower levels of contamination may be of interest to evaluate contaminant transport properties or to understand other aspects of the Site conceptual model. Still other examples are near receptor locations where warning levels of half the drinking water standard are tracked to provide an early warning of potential exposure. Near the Columbia River (which flows along the Site boundary), aquatic toxicity criteria are of concern. The level of interest for chromium near the river is a conservative 11 μg/L because of aquatic criteria rather than the drinking water standard of 100 μg/L.

A groundwater project quality assurance goal is to use analytical methods which have detection levels of less than one half the drinking water standard. This is not always practical. For example, the available commercial method for iodine-129 analysis is 1 pCi/L which is the same as the interim drinking water standard. Some constituents may be reported at detection levels greater than applicable standards as part of multi-element analytical methods. This is acceptable if the constituent is not considered to be a contaminant of interest for that area or if data at lower detection levels are not needed for decision-making purposes.

In some areas, the plumes have been identified and characterized relatively recently so little data are available. In that situation, the site-specific DQOs likely will indicate a need for relatively intensive monitoring to provide a baseline for spatial and temporal changes. [An example of this is the chromium plume in the western part of the 100-D Area which was only monitored by two wells until 1997. Further information is needed to describe baseline conditions. Although an interim record of decision has been issued for this site, it did not deal specifically with that plume. Passive groundwater remediation (in situ reduction-oxidation manipulation) has been instituted in this area providing further impetus for collecting trend data.] Other plumes are well characterized and have considerable trend data. Areas of those plumes

Table 6-2. Maximum Contaminant Levels and Interim Drinking Water Standards

Constituent	MCL or DWS	Agency[a]	EPA Status
Aluminum[b]	0.05 mg/L	EPA	Final
Antimony	0.006 mg/L	EPA	Final
Arsenic	0.05 mg/L	EPA, DOH	Under review
Barium	2 mg/L 1 mg/L	EPA DOH	Final
Cadmium	0.05 mg/L	EPA	Final
Carbon tetrachloride	5 µg/L	EPA, DOH	Final
Chloride[b]	250 mg/L	EPA, DOH	Final
Chloroform (THM) [c]	80 µg/L 100 µg/L	EPA EPA, DOH	Proposed Final
Chromium	100 µg/L	EPA, DOH	Final
cis-1,2-Dichloroethylene	70 µg/L	EPA	Final
Copper[b]	1.0 mg/L	EPA, DOH	Final
Cyanide	200 µg/L	EPA	Final
1,4-Dichlorobenzene	75 µg/L	EPA	Final
Fluoride	4 mg/L 2 mg/L[b]	EPA, DOH EPA	Final/under review Final
Iron[b]	0.3 mg/L	EPA	Final
Lead	0.015 mg/L[d] 0.05 mg/L	EPA DOH	Final
Manganese[b]	50 µg/L	EPA, DOH	Final
Mercury (inorganic)	0.002 mg/L	EPA, DOH	Final
Methylene chloride	5 µg/L	EPA	Final
Nickel	0.1 mg/L	EPA	Final/being remanded
Nitrate, as NO_3^-	45 mg/L	EPA, DOH	Final
Nitrite, as NO_2^-	3.3 mg/L	EPA	Final
Pentachlorophenol	1 µg/L	EPA	Final
pH[d]	6.5 to 8.5	EPA	Final
Selenium	0.05 mg/L 0.01 mg/L	EPA DOH	Final
Silver[b]	0.1 mg/L	EPA, DOH	Final
Sulfate	500 mg/L 250 mg/L[b]	EPA EPA	Proposed Final
Tetrachloroethylene	5 µg/L	EPA, DOH	Final
Thallium	0.02 mg/L	EPA	Final
Total dissolved solids[b]	500 mg/L	EPA	Final
1,1,1-Trichloroethane	0.2 mg/L	EPA	Final
Trichloroethylene	5 µg/L	EPA, DOH	Final
Zinc[b]	5 mg/L	EPA, DOH	Final
Antimony-125	300 pCi/L[e]	EPA	Interim
Beta particle and photon activity	4 mrem/yr[f]	EPA, DOH	Final
Carbon-14	2,000 pCi/L[e]	EPA	Interim
Cesium-137	200 pCi/L[e]	EPA	Interim
Cobalt-60	100 pCi/L[e]	EPA	Interim
Iodine-129	1 pCi/L[e]	EPA	Interim
Ruthenium-106	30 pCi/L[e]	EPA	Interim
Strontium-90	8 pCi/L[e]	EPA	Interim
Technetium-99	900 pCi/L[e]	EPA	Interim

Table 6-2. (contd)

Constituent	MCL or DWS	Agency[a]	EPA Status
Total alpha (excluding uranium)	15 pCi/L[c]	EPA, DOH	Final
Tritium	20,000 pCi/L[c]	EPA	Interim
Uranium	20 µg/L	EPA	Proposed

(a) DOH = State of Washington Department of Health at WAC 246-290;
EPA = U.S. Environmental Protection Agency at 40 CFR 141, 40 CFR 143, and EPA 822-R-96-001.
(b) Secondary maximum contaminant level.
(c) Standard is for total trihalomethanes (THM).
(d) Action level.
(e) Concentration assumed to yield an annual dose equivalent of 4 mrem/yr.
(f) Beta and gamma radioactivity from anthropogenic radionuclides. Annual average concentration shall not produce an annual dose from anthropogenic radionuclides equivalent to the total body or any internal organ dose greater than 4 mrem/yr. If two or more radionuclides are present, the sum of their annual dose equivalents shall not exceed 4 mrem/yr. Compliance may be assumed if annual average concentrations of total beta, tritium, and strontium-90 are <50, 20,000, and 8 pCi/L, respectively.
DWS = Drinking water standard.
MCL = Maximum contaminant level.

which are not changing rapidly generally need less intensive monitoring. Monitoring data sufficient to characterize the extent of the contamination in a given region of the Site and to provide an estimate of the concentrations at any location within the plume should be collected periodically. Discussions in the DQO process between regulators, DOE, and contractors determined that sampling every 3 years was appropriate for monitoring the major plumes emanating from the 200-East Area of the Site (e.g., tritium, iodine-129, nitrate). This sampling interval is believed to be applicable to most major plumes on the Site and will generally be applied to monitoring of other plumes unless different agreements have been made.

More frequent monitoring is warranted near the Site boundaries. A significant interest in being able to assess migration off the Site is expressed in DOE orders and is needed for public assurance. More frequent monitoring is also warranted at or near water supply wells or other potential areas for exposure to groundwater contaminants to ensure that appropriate groundwater use restrictions are applied. In particular, spatially and temporally intensive monitoring will continue in the vicinity of the southern boundary of the Site because of the potential for any migration off the Site to impact drinking water supplies.

There is a need to confirm that the plume monitoring is addressing the appropriate constituents. Monitoring of a broad suite of constituents at selected locations, combined with the near-source detection monitoring discussed in Section 6.2 will serve to address this need. In the 200-East DQO process, two transects were proposed to fulfill this need. These transects will be monitored for a broad range of indicator parameters on an annual basis. The use of transects at a distance from the source areas complements the source area monitoring in providing assurance that contamination is not "being missed." An additional transect along the river is also planned to ensure impacts to the Columbia River continue to be well defined. The transects are shown in Figure 6-1, and the constituent lists are given in Table 6-3. If unexpected contamination is detected at the transects, then increased monitoring to evaluate the risk is warranted.

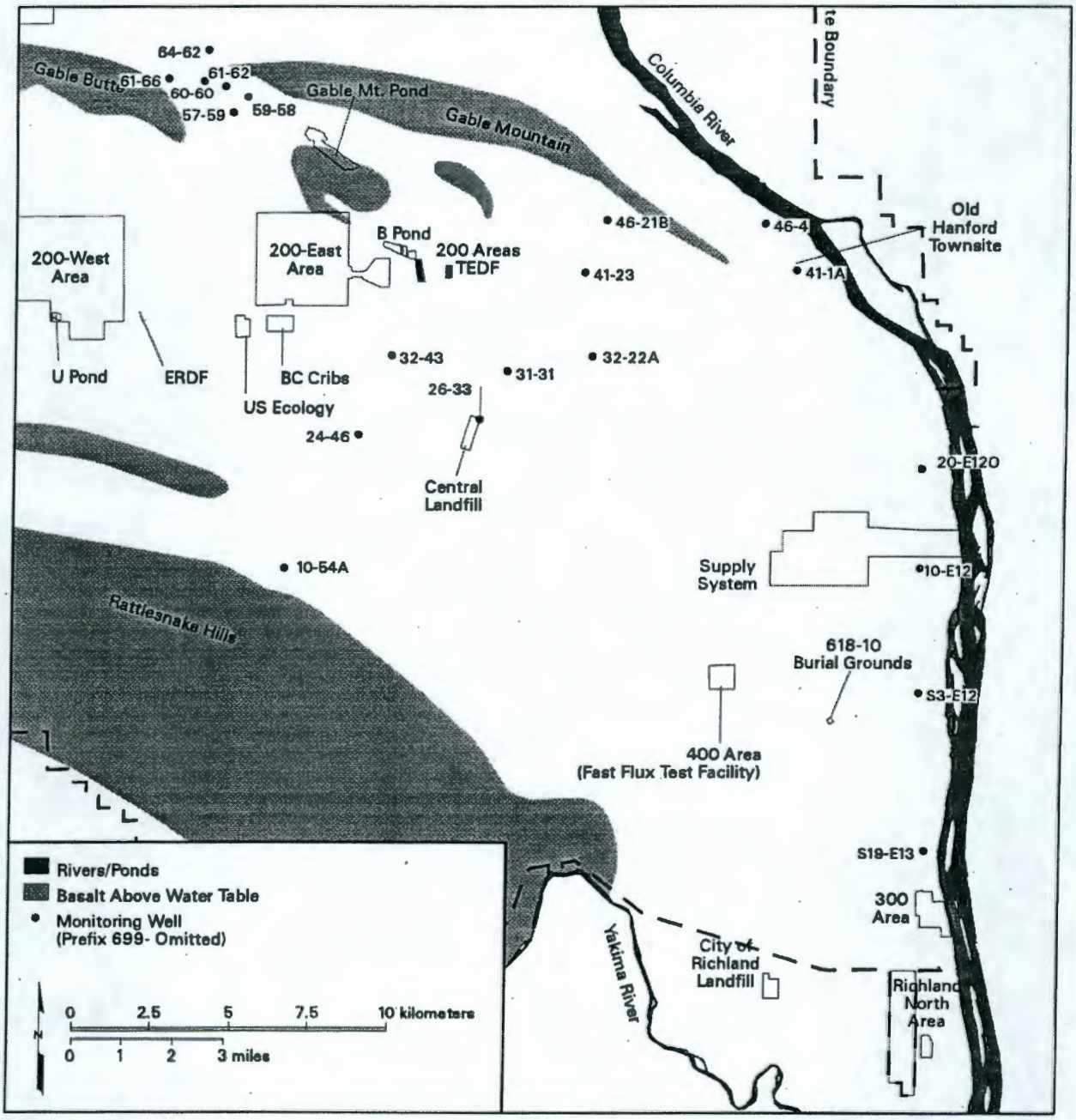

Figure 6-1. 200-East Area Transect Guard Well Locations

Table 6-3. 200-East Area Transect Guard Wells

Gap	Southeast	River
699-57-59	699-24-46	699-10-E12
699-59-58	699-26-33	699-20-E12O
699-60-60	699-31-31	699-41-1A
699-61-62	699-32-22A	699-46-4
699-61-66	699-32-43	699-S3-E12
699-64-62	699-41-23[a]	699-S19-E13[b]
	699-46-21B[a]	
	699-10-54A[a]	

Constituent List: Inductively coupled-plasma metals; anions; gross alpha, beta, and gamma; strontium-90; technetium-99; tritium; total organic halides; total organic carbon; and alkalinity.

(a) Reduced list - Sample tritium, alpha, beta, anions annually; full list - sample every 3 years.

(b) Also monitors Richland North Area and southern portion of the Hanford Site.

Important goals for plume monitoring in areas of active remediation are to ensure that no significant amounts of contamination are moving beyond areas of remediation and that remaining contamination outside the zone of influence of the remediation system is attenuating as expected. For this monitoring strategy, monitoring for the overall magnitude of the contaminants in the plume with particular emphasis on monitoring the areas beyond the capture zone of remediation systems will be considered as plume monitoring. Monitoring of the target contaminants for the purposes of managing the performance of the remediation will be considered below. These systems will be coordinated to preclude redundancy and share resources.

Many groundwater contaminant plumes are expected to decline in extent and in concentration through remediation or natural attenuation. When groundwater data demonstrates that attenuation is occurring, the groundwater-monitoring effort should decrease. Groundwater monitoring will need to provide sufficient data to make decisions regarding remediation in the absence of a final record of decision or a TSD closure. The strategy of reducing monitoring based on demonstrated attenuation would generally occur in the period after an interim record of decision for the area has been signed but could occur earlier, depending on the Tri-Party Agreement schedule.

Reduction in monitoring could be based on a number of considerations. First, the number of wells monitored can be reduced if the areal extent of contamination is diminishing. In addition, even if the overall extent of detected contamination remains relatively constant, a decline in concentrations throughout the plume suggests that the impact and potential risk is declining. In that case, monitoring data may still be needed from the whole plume area but the number of wells and/or sampling frequency within the

network can be reduced. As an example, the ability to safely reduce the monitoring network for the major plumes from the 200-East Area was demonstrated by a combination of spatial statistical techniques and hydrogeologic judgement (Hartman et al. 1998).

Ultimately, it is expected that the point of compliance monitoring for waste management areas/ landfills will provide the monitoring necessary for most remaining plumes. There is an expectation that areas outside the central plateau would be remediated to allow release from institutional controls. Public assurance will be maintained by limited monitoring near the Site boundary and any potential points of exposure.

The extent of contamination in the deeper parts of the aquifer system at the Hanford Site are not as well characterized as the contamination at the top of the unconfined aquifer. The data available indicate that most of the contamination remains near the water table but local conditions may lead to contamination transport to deeper parts of the unconfined aquifer, semi-confined or confined parts of the Ringold Formation, or the uppermost basalt confined aquifer system (Hartman 1999).

6.4 Remedial Action Monitoring

6.4.1 Requirements

Groundwater monitoring is needed to evaluate whether remediation is performing as expected and to determine if the remedial action is complete. For active remediation systems such as pump-and-treat remediation, performance monitoring is needed to evaluate capture zones, optimize the operation of the remediation system, and to make decisions regarding continuation of operations. The requirements for performance monitoring are site-specific and have been considered through DQOs for the particular sites. Performance monitoring will not be considered explicitly in this monitoring strategy.

Requirements for groundwater monitoring may be written into the record of decision (interim or final) for a CERCLA operable unit or placed in the Site permit for a RCRA past-practices operable unit. Groundwater-monitoring requirements may be specified during corrective action for a RCRA TSD. The requirements for monitoring when a TSD is present in an operable unit undergoing remediation have been considered separately at the Hanford Site, thus far. Thus, requirements for corrective action monitoring above and beyond that determined in the record of decision have been written into the Site part B permit for TSDs within those operable units.

Point-of-compliance monitoring may be required during Site remediation. Monitoring at the point of compliance may trigger additional evaluation for remedial action or may determine when remediation goals are attained. For example, at the 1100-EM-1 Operable Unit, a line of compliance wells has been specified for the trichloroethylene plume. If concentrations exceed the drinking water standards at those wells, then further action will be evaluated. In contrast at the 100-HR-3 Operable Unit, the Columbia River is considered the line of compliance for the chromium contamination. Remediation will continue until standards are attained.

6.4.2 Strategies

As discussed in Section 6.4.1, performance monitoring of pump-and-treat remediation will be considered in site-specific DQOs, and are not discussed explicitly in this document. Ongoing plume monitoring discussed in Section 6.3 provides a continuing assessment of the overall impact of remediation. The flow dynamics produced during aquifer pumping make it more difficult to present a realistic view of contaminant concentrations within the zone of influence of remediation systems. In addition, contaminant concentrations may often rebound upon cessation of pumping, indicating that samples from monitoring wells do not always provide a good indication of remaining contaminant mass. However, plume monitoring provides fundamental data to evaluate the remediation effectiveness over time. Groundwater monitoring thus will continue through the period of remediation and for a sufficient time after remediation to ensure that goals have been met.

The point-of-compliance monitoring provides a base for design of plume monitoring systems. Careful integration of the different requirements will be undertaken to ensure that data can be used for multiple objectives.

6.5 Termination of Monitoring

6.5.1 Requirements

It is expected that some level of groundwater monitoring will be required for the foreseeable future until all remediation is complete, all waste sites are closed, and all operations have ceased. However, monitoring of specific areas or waste sites may be scaled back or terminated either by demonstrating a lack of impact or by demonstrating that cleanup is complete.

Generally, CERCLA requires a review of a site record of decision at least every 5 years. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires 5 years of monitoring after cleanup (40 CFR 300.430(f)(5)(iii)(c)). The level of monitoring, constituents, and number of samples is determined on a site-specific basis.

Monitoring of RCRA TSDs can be terminated if the site is clean-closed. Clean closure generally requires some amount of characterization to determine that the site has not impacted the environment with hazardous constituents. Sites which cannot be clean-closed may be closed with waste in place. In that case, postclosure care is required. The period of postclosure care for TSDs is generally 30 years but may be decreased or increased by the regulators. Groundwater-monitoring requirements during postclosure are essentially the same as required during operation of a TSD under a RCRA final status permit.

6.5.2 Strategies

Decisions to terminate groundwater monitoring will generally not be made on the basis of the monitoring data alone. Both remediating and/or closing a source area and data from other media such as soil sampling may be required to support cessation of groundwater monitoring. In the case of RCRA TSDs, expediting closure of sites that are expected to be clean-closed could result in significant savings of

monitoring costs. Expediting closure of units which will be closed as landfills will also ultimately decrease costs by reducing the time until the end of the postclosure care period. The prioritization of closure activities is beyond the scope of this strategy.

Groundwater-monitoring data will be used to support decisions regarding successful site remediation and thus the need for continued monitoring. The area of groundwater contamination at levels above regulatory or compliance standards is expected to decline through natural attenuation and remediation. Statistical analysis of the data for the trend in concentrations at monitoring wells and for the extent of contamination will be used to demonstrate when cleanup levels have been attained. A degree of monitoring near potentially significant contaminant sources is important to show when contaminant fluxes from the source areas have declined.

7.0 Implementation

Implementation of this groundwater-monitoring strategy will largely take place on an area-specific basis. Different areas of the site are at different stages in the investigation, remediation, and permitting process, and thus, the monitoring strategy will be tailored to site-specific conditions. During the course of implementation, details of the strategy and monitoring network design for one area are expected to provide valuable information that can be applied to subsequent areas of the site.

The implementation of this monitoring strategy will be documented in monitoring plans. Separate monitoring plans will continue to be prepared for each RCRA TSD waste management area or group of waste management areas. An integrated monitoring plan (Hartman et al. 1998) describes the combined Site groundwater monitoring by referencing specific monitoring plans and describing the Sitewide groundwater monitoring applicable to multiple sites and multiple requirements.

Sample scheduling for most parts of the groundwater monitoring has been integrated into a single system. Monitoring of state-permitted disposal sites and the National Pollutant Discharge Elimination System monitoring at 100-N Area have not been integrated with the other sampling. Some special studies are scheduled separately. The coordination of sample scheduling helps avoid duplication of effort and redundant well trips. Cosamples for different constituents are often collected by different projects and the unified scheduling allows them to be collected at the same time.

For each region of the Site, the groundwater-monitoring project will develop monitoring DQOs that describe the specific monitoring objectives and provide the basis for the network design. The DQOs will be based on the decision logic diagram. Specific decision rules applicable to groundwater monitoring will be included in a decision rule catalog so they may be referenced in the DQO development for other areas.

Certain strategies recommended in this document require regulator approval. This is true in particular for revisions to RCRA monitoring. The major strategies are summarized in the Executive Summary. Regulatory approval on general strategies may occur through an agreement in principle signed by DOE and the regulatory agencies. Specific strategies may be approved through monitoring plan approval or Tri-Party Agreement change control from the regulators. Issues relating to approval of the strategies may be resolved through the Efficiency Issue Resolution Process or through Tri-Party Agreement modifications.

8.0 References

40 CFR 141, U.S. Environmental Protection Agency, "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule." *Code of Federal Regulations*.

40 CFR 143, U.S. Environmental Protection Agency, "National Secondary Drinking Water Regulations." *Code of Federal Regulations*.

40 CFR 300, U.S. Environmental Protection Agency, "National Oil and Hazardous Substances Pollution Contingency Plan." *Code of Federal Regulations*.

American Society for Testing and Materials. 1996. *Provisional standard guide for developing appropriate statistical approaches for groundwater detection monitoring programs*. Committee D-18 on Soil and Rock, Designation PS 64-96, American Society of Testing and Materials, West Choshocton, Pennsylvania.

Atomic Energy Act of 1954, as amended, Chapter 1073, 68 Stat. 919, 42 USC 2011, et seq.

Barnett, DB, JS Schmid, SS Lowe, WL Allen, NA Ballantyne, CH Dohrer, MJ Hartman, FN Hodges, DG Horton, VG Johnson, KJ Lueck, DJ Ortiz, AJ Knepp, BH Ford, SP Hope, DK Typler, RD Hildebrand, DE Olson, RE Peterson, GL Kasza, DA Myers, RE Brown, and JR Raymond. 1962 *Hanford experience in the radiological monitoring of ground water*. HW-SA-2566, General Electric Company, Richland, Washington.

Brown, RE and HG Rupert. 1950. *The underground disposal of liquid wastes at the Hanford Works, Washington*. HW-17088, Hanford Works, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act. 1980. Public Law 96-150, as amended, 94 Stat. 2767, 42 USC 9601 et seq.

DOE. See U.S. Department of Energy.

Ecology. See Washington State Department of Ecology.

EPA. See U.S. Environmental Protection Agency.

Gibbons, RD. 1994. *Statistical methods for groundwater monitoring*. John Wiley & Sons, Inc. New York.

Hartman, MJ (ed.). 1999. *Hanford Site groundwater monitoring for fiscal year 1998*. PNNL-12086, Pacific Northwest National Laboratory, Richland, Washington.

Hartman, MJ and PE Dresel (eds.). 1998. *Hanford Site groundwater monitoring for fiscal year 1997.* PNNL-11793, Pacific Northwest National Laboratory, Richland, Washington.

Hartman, MJ. 1991. *Groundwater monitoring plan for the 100-D Ponds.* WHC-SD-EN-AP-048, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hartman, MJ, PE Dresel, JP McDonald, RB Mercer, DR Newcomer, and EC Thornton. 1998. *Integrated monitoring plan for the Hanford groundwater monitoring project.* PNNL-11989, Pacific Northwest National Laboratory, Richland, Washington.

Raymond, JR, DA Myers, JJ Fix, VL McGhan, and PM Schrotke. 1976. *Environmental monitoring report on radiological status of the ground water beneath the Hanford Site January-December 1974.* BNWL-1970. Pacific Northwest Laboratory, Richland, Washington.

Resource Conservation and Recovery Act (RCRA) of 1976. 42 USC 6901 et seq., as amended.

U.S. Department of Energy (DOE). 1990. "General environmental protection program." DOE Order 5400.1.

U.S. Department of Energy (DOE). 1993. "Radiation protection of the public and the environment." DOE Order 5400.5.

U.S. Department of Energy (DOE). 1997. *Hanford Site groundwater remediation strategy.* DOE/RL-94-95 Rev. 1, U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy (DOE). 1999. *Revised draft Hanford remedial action environmental impact statement and comprehensive land-use plan.* DOE/EIS-0222D, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy, Richland Operations Office (RL). 1995. *Hanford Site ground water protection management plan.* DOE/RL-89-12, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

U.S. Department of Energy, Richland Operations Office (RL). 1998. *100-NR-1 treatment, storage, and disposal units corrective measures study/closure plan.* DOE/RL-96-39, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

U.S. Environmental Protection Agency (EPA). 1992. "Statistical analysis of groundwater monitoring data at RCRA facilities – draft addendum to interim final guidance" in *Statistical training course for ground-water monitoring data analysis.* EPA/530-R-93-003. U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1993. *Data quality objectives process for Superfund.* EPA 540-R-93-071, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1995. *Consistent implementation of the FY 1993 guidance on technical impracticability of ground-water restoration at superfund sites*. EPA Directive 9200.4-17, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1996. *Drinking water regulations and health advisories*. EPA 822-R-96-001, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Washington Administrative Code (WAC). 1984. "Dangerous waste regulations." WAC 173-303, Olympia, Washington.

Washington Administrative Code (WAC). 1988. "Minimal functional standards for solid waste handling." WAC 173-304, Olympia, Washington.

Washington Administrative Code (WAC). 1993. "State waste discharge permit program." WAC 173-216, Olympia, Washington.

Washington Administrative Code (WAC). 1998. "Public water supplies." WAC 246-290, Olympia, Washington.

Washington State Department of Ecology (Ecology). 1994. *Dangerous waste portion of the Resource Conservation and Recovery Act permit for the treatment, storage, and disposal of dangerous waste*, as amended, Permit Number 7890008967, effective September 28, 1994, Olympia, Washington.

Washington State Department of Ecology (Ecology). 1995a. *State waste discharge permit (216 Permit) for the 200 Area Treated Effluent Disposal Facility (TEDF)*. Permit No. ST 4502, issued in compliance with the provisions of Chapter 90.48 RCW, as amended, and Chapter 173-216 WAC, as amended, Olympia, Washington.

Washington State Department of Ecology (Ecology). 1995b. *State waste discharge permit (216 Permit) for the 200 Area Effluent Treatment Facility (ETF)*. Permit No. ST 4500, issued in compliance with the provisions of Chapter 90.48 RCW, as amended, and Chapter 173-216 WAC, as amended, Olympia, Washington.

Washington State Department of Ecology (Ecology). 1996. *State waste discharge permit no. ST401 (400 Area process pond)*. Olympia, Washington.

Washington State Department of Ecology (Ecology), U.S. Department of Energy (DOE), and U.S. Environmental Protection Agency (EPA). 1989. *Hanford federal facility agreement and consent order between U.S. Environmental Protection Agency, the U.S. Department of Energy, and the State of Washington Department of Ecology, May 15, 1989*, as amended. Olympia, Seattle, and Richland, Washington.