

DOE-FIU SCIENCE & TECHNOLOGY WORKFORCE DEVELOPMENT PROGRAM

STUDENT SUMMER INTERNSHIP TECHNICAL REPORT

June 18, 2012 to August 17, 2012

Database of Groundwater Pump-and-Treat Systems

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ABSTRACT

During the summer of 2012, DOE Fellow Claudia Cardona was given the opportunity to intern with the Office of Environmental Management (EM) at Department of Energy (DOE) Headquarters in Germantown, Maryland. During this time, Mrs. Cardona assisted Mr. Kurt Gerdes, Director of the Office of the Soil and Groundwater EM-12. EM-12 supports EM's mission by providing integration, planning, analysis, and guidance for ensuring safe and effective management and remediation of contaminated soil and groundwater with the goal of reducing risk and the life cycle cost of remediation. The office identifies, integrates, and advances new and best technical practices related to groundwater and soil characterization, modeling, and remediation that improve the performance of EM projects over their entire lifecycle.

This report presents a database identifying ten (10) DOE sites using pump-and-treat (P&T) systems for groundwater remediation and summarizes the P&T area, contaminants of concern (COC), contaminants treated, capital and maintenance costs, year of operation, status, gallons treated, and life-cycle costs. The Office of Soil and Groundwater EM-12 will use the obtained information to update the End-States Analysis and for P&T policy creation.

TABLE OF CONTENTS

ABSTRACT.....	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	v
1. INTRODUCTION	1
2. EXECUTIVE SUMMARY	2
3. RESULTS.....	3
3.1 Hanford Site: P&T Systems.....	4
3.2 Idaho National Laboratory (INL): P&T Systems	7
3.3 Lawrence Livermore National Laboratory (LLNL): P&T Systems	8
3.4 Moab UMTRA : P&T Systems.....	10
3.5 Oak Ridge Reservation (ORR): P&T Systems	11
3.6 Paducah Gaseous Diffusion Plant: P&T Systems.....	12
3.7 Pantex Plant: P&T Systems	13
3.8 Portsmouth Gaseous Diffusion Plant: P&T Systems.....	14
3.9 Savannah River Site (SRS): P&T Systems.....	15
3.10 DOE P&T Systems Summary.....	16
3.11 P&T Systems Cost Summary.....	17
3.12 P&T Systems Contact Information.....	18
4. CONCLUSION.....	19
5. REFERENCES	20

LIST OF TABLES

Table 1. Hanford Site P&T Systems.....	4
Table 2. Idaho National Laboratory P&T Systems.....	7
Table 3. Lawrence Livermore National Laboratory P&T Systems	8
Table 4. Moab UMTRA P&T Systems.....	10
Table 5. Oak Ridge Reservation P&T Systems	11
Table 6. Paducah Gaseous Diffusion Plant P&T Systems.....	12
Table 7. Pantex Plant P&T Systems	13
Table 8. Portsmouth Gaseous Diffusion Plant P&T Systems.....	14
Table 9. Savannah River Site P&T Systems.....	15
Table 10. DOE P&T Systems Summary.....	16
Table 11. DOE P&T Systems Cost Summary	17
Table 12. DOE P&T Systems Contact Information.....	17

1. INTRODUCTION

Pump-and-treat (P&T) systems have historically been a baseline technology for cleaning up contaminated groundwater at sites within the DOE complex. However, these systems require an evaluation for the efficiency in restoring contaminated groundwater to regulatory standards, with reasonable timeframes and within reasonable total project costs. Information about the cost of P&T systems may be valuable to the Office of Soil and Groundwater EM-12 in order to identify and evaluate the technology for new and ongoing projects.

This research was initiated with a literature examination and a review of the DOE sites with groundwater plumes. The purpose of each P&T system was reviewed the contaminant of concern as well as the construction and operational costs were documented with assistance from the field office personnel. This included a diverse group of people from the federal government, private contractors, and national laboratories.

This report presents a database identifying ten (10) DOE sites using P&T systems for groundwater remediation and summarizes the P&T area, contaminants of concern (COC), contaminants treated, capital and maintenance costs, year of operation, status, gallons treated, and life-cycle costs. The Office of Soil and Groundwater EM-12 will use the obtained information to update the End-States Analysis and for P&T policy creation.

2. EXECUTIVE SUMMARY

This research work has been supported by the DOE-FIU Science & Technology Workforce Initiative, an innovative program developed by the U.S. Department of Energy's Environmental Management (DOE-EM) and Florida International University's Applied Research Center (FIU-ARC). During the summer of 2012, an FIU student (DOE Fellow Claudia Cardona) spent nine (9) weeks interning at the office of Soil and Groundwater EM-12 under the supervision of Mr. Kurt Gerdes.

At the request of DOE-EM, the Office of Soil and Groundwater Remediation (EM-12) created a database to review pump-and-treat (P&T) systems used to remediate groundwater contamination at DOE sites across the complex. Information on each P&T system was collected and summarized for ten (10) DOE sites; information collected included associated ex-situ technologies, contaminants, years of operation, status, capital, operating and maintenance costs, life-cycle cost, status, and remedial approaches.

3. RESULTS

The P&T database report provides a summary identifying the groundwater P&T systems at all DOE sites. The components of the database are listed below:

Contains information on the P&T System table, categorized by:

- ✓ Area, P&T DOE site area location
- ✓ P&T Unit Reference
- ✓ Major Contaminants: Contaminants of Concern (COC) and contaminants treated by P&T
- ✓ Years of Operation or Year Started Operation
- ✓ P&T Status
 - O= Ongoing
 - Off= Offline
 - SD= Shutdown
- ✓ Gallons Treated per Year (x1,000 Gallons)
- ✓ Average Capital Cost (Construction Cost) (x \$1,000)
- ✓ Average Annual Operating and Maintenance Cost (x \$1,000)
- ✓ Life Cycle Cost (Millions)
- ✓ Highlights, costs highlights and additional treatment information

Contains Identified P&T Systems Summary, categorized by:

- ✓ Site, DOE Complex
- ✓ Area /P&T Unit
- ✓ Principal Contaminants
- ✓ Media Quantity Treated (MG) per year)
- ✓ Additional Strategy Technology

Contains Cost P&T Systems Summary, categorized by:

- ✓ Site, DOE Complex
- ✓ Area and P&T Unit
- ✓ Media Quantity Treated (MG) per year
- ✓ Capital Cost (Construction Cost) (x \$1,000)
- ✓ Operating and Maintenance Cost (x \$1,000)

Contains P&T Systems Contact Information, categorized by:

- ✓ Site, DOE Complex
- ✓ Area and P&T Unit
- ✓ Contact, Name, Phone number and e-mail address

3.1 Hanford Site: P&T Systems

Table 1. Hanford Site P&T Systems

Area	P&T Unit	Contaminants		Years * or Year of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
		Contaminants of Concern (COC)	Contaminants Treated by P&T							
100-H	HR-3	Cr (VI), Sr-90, Tritium, ⁹⁹ Tc, Nitrate, Sulfates	Cr (VI)	1997	Offline	*71000	1,083	964	25.4	The capital and O/M costs are an annual average between 1999 and 2010; 2011 not included [\$801 (\$788.9 O/M and 11.7 capital cost)] because P&T went into cold standby in May 2011; life-cycle cost from 1999 to 2011; Gallons removed during 2010
100-D	DR-5	Cr (VI), Sr-90, Tritium, ⁹⁹ Tc, Nitrate, Sulfates	Cr (VI)	2004	Offline	*11,783	559.2	750.5	7.9	The capital and O/M costs are an annual average between 2005 and 2010; 2011 not included [\$801 (\$185.4 O/M and 2.7 capital cost)] because P&T went into cold standby in March 2011; life-cycle cost from 2005 to 2011
100-D	DX	Cr (VI), Sr-90, Tritium, ⁹⁹ Tc, Nitrate, Sulfates	Cr (VI)	2010	O	242,801	9,109	2,979	NR	DX P&T construction was completed in Dec. 2010, entered acceptance test procedures, and became fully operational in January 2011. The capital cost is an annual average between 2009 and 2011, and O/M cost is for 2011

Table 1. Hanford Site: P&T Systems (continued)

Area	P&T Unit	Contaminants		Years * or Year of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
		Contaminants of Concern (COC)	Contaminants Treated by P&T							
100-H	HX	Cr (VI), Sr-90, Tritium, ⁹⁹ Tc, Nitrate, Sulfates	Cr (VI)	2011	O	*80,053	8,766	321	NR	HX P&T construction was completed in Sep. 2011, entered acceptance test procedures, and became fully operational in Oct. 2011. The capital cost is an annual average between 2009 and 2011, and O/M cost is for 2011
100-K	KR-4	Cr (VI), Sr-90, Tritium, ⁹⁹ Tc, Nitrate, Sulfates	Cr (VI)	1997	O	*75,271	3,274	877	54.0	HX P&T construction was completed in Sep. 2011, entered acceptance test procedures, and became fully operational in Oct. 2011. The capital cost is an annual average between 2009 and 2011, and O/M cost is for 2011
100-K	KW	Cr (VI), Sr-90, U, Tritium, Carbon, Nitrate, TCE	Cr (VI)	2007	O	94,320	1,924	790	NR	The capital cost and O/M costs are an annual average between 2007 and 2011. Gallons treated during 2011

Table 1. Hanford Site: P&T Systems (continued)

Area	P&T Unit	Contaminants		Years * or Year of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
		Contaminants of Concern (COC)	Contaminants Treated by P&T							
100-K	KX	Cr (VI), Sr-90, U, Tritium, Carbon -14, Nitrate, TCE	Cr (VI)	2008	O	237,939	1,224	1,436	NR	The capital cost and O/M costs are an annual average between 2010 and 2011. Gallons treated during 2011
200	NR-2	Sr-90, U, Petroleum, Hydrocarbons, Nitrate, Tritium, Manganese, Iron, Cr	Sr-90	1995	Off-line	NR	601	598	19.8	The capital cost and O/M costs are an annual average between 1999 and 2006. Life cycle cost between 1999 and 2011
200	UP-1	U, ⁹⁹ Tc, CCl ₄ , Nitrate	U, ⁹⁹ Tc, CCl ₄ , Nitrate	1994	SD	294,318	300	197	7.1	The capital cost and O/M costs are an annual average between 1997 and 2010. Life cycle cost between 1997 and 2011. Gallons treated during 2011
200	ZP-1	U, ⁹⁹ Tc, TCE, CCl ₄ , Chloroform	TCE, CCl ₄ , Chloroform	1996	SD	200,200	1,973	1,384	47.7	The capital cost and O/M costs are an annual average between 19997 and 2006. Life cycle cost for 15 years. Gallons treated during 2011

3.2 Idaho National Laboratory (INL): P&T Systems

Table 2. Idaho National Laboratory P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years * or Year of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
TAN	WAG1	TCE	2001	O	49,000	NA	155	NA	The P&T system TAN facility is known as the New Pump-and Treat Facility; the operational/maintenance (O/M) cost is \$60K per operates and \$95K per maintenance, and they are based on actual from 2006-2011, O/M cost includes preventive and corrective, P&T does not treat for Sr-90, full operation, operates approximately 40 hours per week since October 2001

3.3 Lawrence Livermore National Laboratory (LLNL): P&T Systems

Table 3. Lawrence Livermore National Laboratory P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
200	Main Site	PCE, TCE, Cr(VI), Tritium	23	O	4,382	25,778	4,222	NA	GAC, Air Stripping, Bioremediation treatability for TCE, MNA for Tritium, SVE/Dual Extraction
300	General Services/OU-1	TCE	20	O	2,440	862.6	152	NA	GAC, Air Stripping, Bioremediation treatability for TCE, MNA for Tritium, SVE/Dual Extraction
300	Building 834/OU-2	TCE, Nitrates, TBOS/TKEBS	17	O	94	2,075	148	NA	GAC, Physical/Chemistry, Phytoremediation of Nitrate through misting; SVE/Dual Extraction
300	HE Process Area/OU-4	HE (RDX and HMX), TCE, Nitrate, ClO-4	13	O	3,345	4,789	725	NA	GAC, Physical/Chemistry, MNA for Nitrate
300	Building 850 Pit 7/ OU-5	Tritium, U, TCE, ClO-4, Nitrate	2	O	47	1,623	255	NA	MNA for Tritium; Monitoring only for Uranium and Nitrate and In-situ Bioremediation Treatability Study for Perchlorate at Building 850

Table 3. Lawrence Livermore National Laboratory: P&T Systems (continued)

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
300	Building 854/U-6	TCE, Nitrate, ClO-4, PCBs	13	O	1,260	506	341	NA	GAC, Physical/Chemistry, Phytoremediation of Nitrate through misting; SVE/Dual Extraction
300	Building 832 Canyon/OU-7	TCE, Nitrate, ClO-4	13	O	3,461	3,389	419	NA	Phytoremediation of Nitrate through misting; SVE/Dual Extraction

Each-operation unit can have multiple facilities, each with different started day operation; dates-reported is the longest running treatment facility in that operational unit (OU).

3.4 Moab UMTRA: P&T Systems

Table 4. Moab UMTRA P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
Tailing Pile	NWP	U, NH ₃	7	O	12,750	15,800	900	Not Reported	Chemical removal; treatment by Evaporation
Former Millsite	NEP	U	Not Reported	O	Not Reported	5,100	300	Not Reported	Not Reported

3.5 Oak Ridge Reservation (ORR): P&T Systems

Table 5. Oak Ridge Reservation P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
Y-12	UEFPC	TCE, PCE	12	O	10,800	11,678	465	NA	P&T acts as a containment

P&T acts a containment system; it was installed to contain a VOC plume on the Y-12 site and prevent it from migration offsite. Since it is not remediating the onsite plume, there has not been a significant reduction in the influent concentration; it will be turned off when the containment is no longer needed.

3.6 Paducah Gaseous Diffusion Plant: P&T Systems

Table 6. Paducah Gaseous Diffusion Plant P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
NE	C-614	TCE	15	O	79,649	5,100	1,200	Not Reported	Air Stripping
NW	C-612	⁹⁹ Tc, TCE	17	O	109,271	15,800		Not Reported	Air stripping, GAC-Vapor phase activated carbon for TCE and sand filtration with Ion Exchange for ⁹⁹ Tc

NW P&T facility construction cost (capital cost) was \$13.2 M in 1995 and optimized at \$2.6 M in 2010; NE and NW facility operational costs are collected as a unit. The 2011 operating costs are provided.

3.7 Pantex Plant: P&T Systems

Table 7. Pantex Plant P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
Playa 1	P1PTS	RDX, Cr (VI)	4	O	106,000	9,411	1,000	39,5550	GAC and IX; ISB to degrade the TCE and Perchlorate; monitoring wells to monitor whether the system is effectively degrading the COCs; SVE treating residual NAPL and soil gas
SE	SEPTS	RDX, Cr (VI), TCE, ClO ₄	17	O	128,000	1,850	1,300	38,411	GAC and IX; P & T consists of 62 extraction wells and 3 injection wells; ISB and SVE

SEPTS: Initial concentration level (ug/L) (Influent -2011 Average) ~ 460RDX and ~245 Cr (VI), Actual Concentration Level (ug/L) (Effluent-2001 Average) None Detected RDX<2 ug/L and Cr (VI) = 19 ug/L; Remedial Goal (ug/L) RDX, TDX, DNX, MDX <2, Total Chromium <100.

P1PTS: Initial concentration level (ug/L) (Influent -2011 Average) ~ 77 RDX, Actual Concentration Level (ug/L) (Effluent-2001 Average) None Detected RDX<2 ug/L; Remedial Goal (ug/L) RDX, TDX, DNX, MDX <2.

SE P&T Capital Cost only accounts for the expansion to the well-field required to finalize this remedial action system. It does not capture the cost for its initial installation as a treatability system and expansion through interim corrective measures before becoming part of the CERCLA Selected Remedy in 2008. Life-Cycle Cost: SEPTS ~ \$39,550,000 and P1PTS ~ \$38,411,000. Life-Cycle Cost assumes 29 years of operation and maintenance as presented in the CERCLA Record decision plus capital cost which accounts for the first year of the remedy.

3.8 Portsmouth Gaseous Diffusion Plant: P&T Systems

Table 8. Portsmouth Gaseous Diffusion Plant P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
7U	X-627	⁹⁹ Tc, TCE	8	O	7,938	Not Reported	417	Not Reported	GAC and Air Stripping, in 2011 completed of X-701 IRM, intermittent as needed operation then
X-701B	X-623 / X-624	⁹⁹ Tc, TCE	17/22	O*	3,109 / 2,669	Not Reported	163/138	Not Reported	GAC and Air Stripping
5U	X-622	TCE	20	O	14,157	Not Reported	912	Not Reported	GAC and Air Stripping
X-749	X-120	⁹⁹ Tc, TCE	NR	NR	NR	Not Reported	Not Reported	Not Reported	GAC and Air Stripping

3.9 Savannah River Site (SRS): P&T Systems

Table 9. Savannah River Site P&T Systems

Area	P&T Unit	Contaminants Treated by P&T	Years of Operation	Status	Gallons Treated Per Year (1,000 Gallons)	Average Capital Cost (x1,000)	Average Annual O&M Cost (x 1,000)	Life-cycle Costs (Millions)	Highlights
A/M	A2 Stripper	PCE, TCE	29	O	225,000	Not Reported	315	Not Reported	Air Stripping
A/M	M1 Stripper	PCE, TCE	16	SD*	125,000	Not Reported	413	Not Reported	Air Stripping
TNX	TNX	TCE	12	Off*	24,000	Not Reported	120	Not Reported	Air Stripping

SD*: Temporary shut down and monitoring planned as preliminary step in ceasing operation

Off*: Operation is interrupted pending proposed change in remedy to in-situ enhanced bioremediation

3.10. DOE P&T Systems Summary

Table 10. DOE P&T Systems Summary

Site	Area/P&T Unit	Principal Contaminants	Media Quantity Treated (MG) per year	Additional Strategy Technology
Hanford	100/HR3,DR5,DX,HX, KR4,KW,KX 200/NR2,UP1,ZP1	Cr (VI), Sr-90, U, Tritium, ⁹⁹ Tc, Nitrate, Sulfates, CCl ₄ , TCE, Chloroform	1,308	Ion Exchange (IX), Air Stripping, GAC, ISRM, MNA, Apatite PRB
INL	TAN/WAG1	TCE	49	In-Situ Bioremediation (ISB)
LLNL	200/Main Site 300/OU1, OU2, OU5, OU6, OU7	PCE, TCE, Cr (VI), Tritium, Nitrate, TBOS/TKEBS, HE(RDX and HMX), ClO ₄ ⁻ , U	39	GAC, Air Stripping, In-Situ Bioremediation (ISB), MNA, SVE
Moab	Tailing Pile /NWP Former Millsite /NEP	U, NH ₃	13	Treatment by Evaporation
ORR	Y-12 / UEFPC	TCE, PCE	11	P&T acts as a containment
Paducah	NE/C-614 NW/C-612	⁹⁹ Tc, TCE	189	Air Stripping, GAC, Sand Filtration, Ion Exchange (IX)
Pantex	SE / SEPTS Playa / PIPTS	RDX, TCE, ClO ₄ ⁻ , HE	234	GAC, Ion Exchange, ISB, SVE
Portsmouth	7U / X-647 X-10B/ X-623 & X-624 5U/ X-622 X-749 / X-120	⁹⁹ Tc, TCE	31	GAC, Air Stripping
SRS	AM / A2 / M1 TNX / TNX	TCE, PCE	374	Air Stripping
West Valley	WMA -1,2,3,4,5	Not Reported	Not Reported	Not Reported

3.11 P&T Systems Cost Summary

Table 11. DOE P&T Systems Cost Summary

Site	Area/P&T Unit	Media Quantity Treated (MG) per year	Capital Cost (x \$1,000)	O/M Cost (\$1,000)
Hanford	100/HR3,DR5,DX,HX, KR4,KW,KX 200/NR2,UP1,ZP1	1,308	19,527.2	7,318.6
INL	TAN/WAG1	49	Not Reported	155
LLNL	200/Main Site 300/OU1, OU2, OU5, OU6, OU7	39	39,023.4	5,597
Moab	Tailing Pile /NWP Former Millsite /NEP	13	20,900	1,200
ORR	Y-12 / UEFPC	11	11,700	470
Paducah	NE/C-614 NW/C-612	189	20,900	1,200
Pantex	SE / SEPTS Playa / PIPTS	234	11,261	2,300
Portsmouth	7U / X-647 X-10B/ X-623 & X-624 5U/ X-622 X-749 / X-120	31	Not Reported	1,630
SRS	AM / A2 / M1 TNX / TNX	374	Not Reported	848
West Valley	WMA -1,2,3,4,5	Not Reported	Not Reported	Not Reported

3.12 P&T Systems Contact Information

Table 12. DOE P&T Systems Contact Information

Site	Area/P&T Unit	P&T Site Contact		
		Name	Phone Number	E-mail address
Hanford	100/HR3,DR5,DX,HX, KR4,KW,KX 200/NR2,UP1,ZP1	Mike Thompson Naomi M Bland	(509)373-0750 (509)376-5594	K_M_Mike_Thompson@arl.gov Naomi.Bland@arl.goe.gov
INL	TAN/WAG1	Nicole K Hernandez	(208)526-5678	nernnk@id.doe.gov
LLNL	200/Main Site 300/OU1, OU2, OU5, OU6, OU7	Claire Holtzapple Ariel Robertson	(625)422-0670	Claire.Holtzapple@aok.doe.gov ariel.robertson@nnsa.doe
Moab	Tailing Pile /NWP Former Millsite /NEP	Joe Ritchey	(970)257-2120	Joe.ritchey@gjemtac.doe.gov
ORR	Y-12 / UEFPC	Jason Darby	(865)241-6343	DarbyJD@oro.doe.gov
Paducah	NE/C-614 NW/C-612	David Dollins	(270)441-6819	Dave.Dollins@lex.doe.gov
Pantex	SE / SEPTS Playa / PIPTS	Richard R. Bonczek	(859)219-4051	Rich.bonczel@lex.doe.gov
Portsmouth	7U / X-647 X-10B/ X-623 & X-624 5U/ X-622 X-749 / X-120	Amy Lawson	(740)897-2112	Amy.Lawson@lex.doe.gov
SRS	AM / A2 / M1 TNX / TNX	Brian Hennessey	(803)952-8365	Brian.hennessey@srs.gov
West Valley	WMA -1,2,3,4,5	Catherine Bohan	Not Available	Catherine.m.bohan@wv.doe.gov

4. CONCLUSION

Information related to the pump-and-treat systems across the DOE complex was collected and a database was created. Twelve information tables have been included in this report, including information on the P&T areas, contaminants of concern (COC), contaminants treated, capital and maintenance costs, year of operation, status, gallons treated, and life-cycle costs. The Office of Soil and Groundwater EM-12 will use the obtained information to update the End-States Analysis and for P&T policy creation.

5. REFERENCES

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