DOE/EA-1779

Environmental Assessment
Proposed Changes to the
Sanitary Biosolids Land Application Program
on the Oak Ridge Reservation,
Oak Ridge, Tennessee

June 2011

U.S. Department of Energy
Oak Ridge Office

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Bechtel Jacobs Company, LLC and CDM Federal Services Inc.
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may not be considered for review of the document
U.S. Department of Energy
Office of Environmental Management

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ACRONYMS

BA	biological assessment
BEA	Bureau of Economic Analysis
BJC	Bechtel Jacobs Company LLC
CDM	CDM Federal Services Incorporated
CFR	*Code of Federal Regulations*
the City	City of Oak Ridge
CRIP	Clinch River Industrial Park
CWA	Clean Water Act
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EA	environmental assessment
EAD	environmental assessment determination
EFPC	East Fork Poplar Creek
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERB	emergency response boundary
ETTP	East Tennessee Technology Park
FONSI	Finding of No Significant Impact
ISCORS	Interagency Steering Committee on Radiation Standards
LAA	land application approval
NEPA	National Environmental Policy Act of 1969
NORM	naturally occurring radioactive material
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORNERP	Oak Ridge National Environmental Research Park
POTW	publicly-owned treatment work
RCRA	Resource Conservation and Recovery Act
RESRAD	RESidual RADioactivity (computer code)
ROI	region of influence
SHPO	State Historic Preservation Officer
TDEC	Tennessee Department of Environment and Conservation
TENORM	technologically enhanced naturally occurring radioactive materials
TWRA	Tennessee Wildlife Resources Agency
USCB	United States Census Bureau
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) proposes to amend the protective boundaries, setbacks for surface water features, and areas with potential channels to groundwater from the self-imposed 500-ft and 50-ft requirements to new ones which have been assigned to each protected area based upon U.S. Environmental Protection Agency (EPA) regulations, Tennessee Department of Environment and Conservation (TDEC) guidance, and best management practices derived from formal site investigations. This change shall bring the Sanitary Biosolids Land Application Program into conformity with the requirements set forth by the EPA under provisions of the Clean Water Act (CWA): Title 40, *Code of Federal Regulations (CFR)*, Part 503, *Standards for the Use or Disposal of Sewage Sludge*; and by the TDEC Division of Water Pollution Control, *Guidelines for the Land Application and Surface Disposal of Biosolids*. (TDEC 2010)

The DOE proposes to eliminate the current lifetime loading limit of 50 tons/acre, while continuing to comply with the agronomic rate for each application site and the pollutant concentration values specified in Tables 1, 2, and 3 of 40 *CFR* Part 503.13. These tables present, respectively, the maximum allowable pollutant concentrations, cumulative pollutant loading rates, and monthly average pollutant concentrations. They are restated in the City of Oak Ridge (the City) publicly-owned treatment works (POTW) National Pollution Discharge Elimination System (NPDES) permits, numbers TN0024155 and TN0078051. These changes are necessary to maximize usage of the available land.

The DOE proposes to revise the guidance levels for radionuclide concentrations in the City municipal sludge/biosolids, in order to ensure that the potential radionuclide deposition on the land application sites is rigorously monitored.

The Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (ORR) was established in 1983 as a joint venture between the City and the DOE to promote beneficial reuse of biosolids from the City on open hayfields and reforestation plots on the ORR. Currently, six of the original sites are actively used in the program. Biosolids application activities were suspended in 2006, when the City POTW initiated changes to the solids management process. While the changes, currently ongoing, will allow the City POTW to produce Class B sludge with 20% to 25% solids, the proposed actions for this environmental assessment (EA) are intended to address application of Class A (essentially free of pathogens) or Class B (contains detectable levels of pathogens) sludge of varying percent solids content.

Formal wetlands and listed species investigations were conducted in support of the proposed actions. The proposed protective boundaries were based on the recommendations from the investigations, the regulations from 40 *CFR* Part 503, and the TDEC 2010 guidelines. The proposed setbacks range from a minimum of 10 m (33 ft), as required in 40 *CFR* Part 503, to a maximum of 30.5 m (100 ft), as recommended by TDEC, depending upon the nature of the sensitive area and the slope of the terrain.

The proposed action provides additional acreage for land application and extends the lifetime of the program. Rigorous monitoring and control of the application process will be unchanged with adherence to the agronomic loading limits and the cumulative pollutant loading limits mandated in the EPA 40 *CFR* Part 503 regulations, under which the City is self-implementing. The lifetime loading limit, derived from the 1983 and 1989 TDEC land application approval (LAA) letters, was specified in the previous EA, DOE/EA-1042, *Environmental Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation*, completed for this program. With the concurrence of the State of Tennessee Biosolids Coordinator, the lifetime loading limit has been eliminated. Continued oversight will be provided by the designated DOE contractor and through current and updated LAAs granted by the TDEC Division of Water Pollution Control.

The "no action" alternative would arbitrarily limit the lifetime of the Biosolids Program and result in insufficient application capacity.

The proposed action should not result in any increased risk due to metals, radionuclides, or organics loading in the soils at the application sites. Reducing the existing buffer zones to 10 m (33 ft) and 30.5 m (100 ft) and eliminating the lifetime loading limit should not adversely affect the soils, given the stringent biosolids monitoring required by EPA 40 *CFR* Part 503 and the maintenance of vegetative, no-mow, buffers around each sensitive area. Nitrogen loading to the soils will also remain unaffected by the changes in the proposed action, as it will continue to be limited by the agronomic application rate, updated with each biosolids sampling event, which accounts for the nitrogen from past applications, available nitrogen in the biosolids, and the plant requirements of the individual sites. Amending existing setbacks would not affect jobs, income or infrastructure, and thus transportation would not be impacted. The estimated twice daily trips to the field on application days would have a negligible effect on local traffic. Land use will not be affected since the proposed action will continue use of ORR lands already in use since 1983 for biosolids application. Finally, only a small risk of human health and safety impact may be incurred as a result of biosolids transportation, but any spills can be easily remediated with negligible risk to workers or the public.

1. INTRODUCTION

The U.S. Department of Energy (DOE) proposes to modify the current land application boundaries, setbacks, and to eliminate the 50 ton/acre lifetime loading limit. The current setbacks for ponds and potential channels to groundwater are 500 ft and 50 ft, respectively. The proposed modification will amend setbacks so as to conform to the regulatory requirements set forth by the U.S. Environmental Protection Agency (EPA) in Title 40 Part 503 of the *Code of Federal Regulations* (*CFR*), *Standards for the Use or Disposal of Sewage Sludge*; the Tennessee Department of Environment and Conservation's (TDEC) guidelines for the land application of biosolids; and the recommendations from the site investigations. If, as a result of this environmental assessment (EA), potentially significant impacts are found to result from the change in setbacks and elimination of the physical loading limit, then an environmental impact statement will be prepared, which will detail the impacts from such actions. If not, the DOE will issue a Finding of No Significant Impact (FONSI) and implement the proposed action.

1.1 PURPOSE AND NEED FOR AGENCY ACTION

The DOE and the City of Oak Ridge (the City) participate jointly in the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (ORR). The program allows for the beneficial reuse of sanitary sewage sludge from the City on open hayfields and reforestation plots on the ORR.

On February 10, 2010, the DOE issued an environmental assessment determination (EAD) for proposed changes to the Biosolids Program at the ORR. The EAD proposes: (1) modifications to the application setbacks and radiological monitoring program, (2) recognition of the City as self-implementing under 40 *CFR* Part 503, and (3) re-evaluation of the wetland and endangered species status. The EAD cites informal survey information gathered as the basis for new formal surveys. The previous wetlands and endangered species surveys were conducted in 1996 and 1997, respectively. In May 2010, a wetlands survey and a listed species survey were performed and used for evaluation in this EA. This EA evaluates environmental impacts of biosolids application to the six active sites: Scarboro, Upper Hayfield #1, Upper Hayfield #2, High Pasture, Rogers, and Watson Road. Figure 1 depicts the biosolids application sites and the location of the East Tennessee Technology Park (ETTP), Y-12 National Security Complex (Y-12), and the Oak Ridge National Laboratory (ORNL), with respect to Bear Creek Road, Bethel Valley Road, and the Oak Ridge Turnpike.

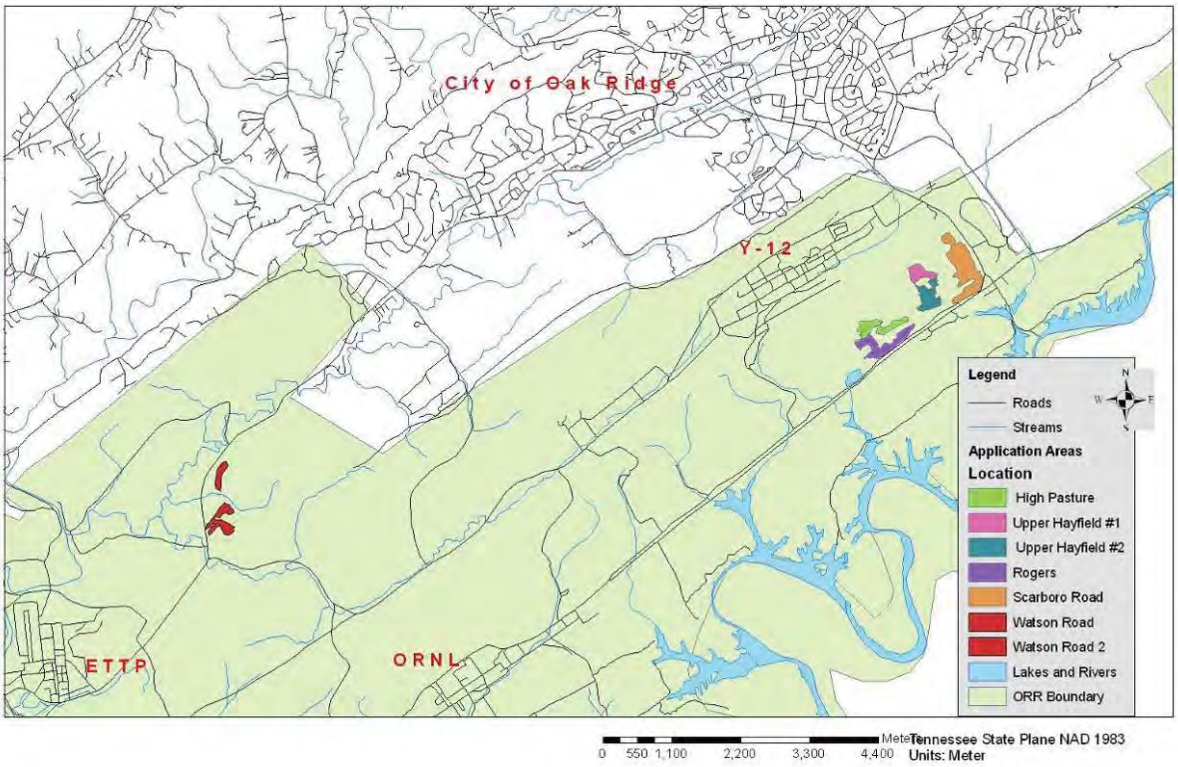

Fig.1. Location of the biosolids application sites with respect to the ETTP, Y-12, and ORNL Facilities within the region.

1.2 BACKGROUND

The City owns and operates a publicly-owned treatment works (POTW), which accepts waste from industrial, residential, and commercial sources. Under a land-license agreement with DOE, the City has been applying municipal biosolids as a beneficial soil amendment on the ORR since 1983. The DOE contributes approximately 20% of the influent to the POTW directly from the Y-12 Site, with lesser amounts from the ETTP through the Rarity Ridge treatment plant, and from the ORNL through tanker delivery of sludge. All industrial generators are required by Oak Ridge City Ordinance Number 9-91 to obtain an industrial discharge permit (IDP) from the City, which prescribes discharge limits and monitoring/reporting requirements. Land application of biosolids was suspended in 2006 when the POTW was no longer able to produce either a Class A or Class B product suitable for application due to a process change implemented at the facility. The City expects to produce a Class B solid product in the near future (Sect. 1.3).

The Biosolids Land Application Program will also retain the ability to land apply liquid amendments should the need arise, which will utilize a truck-mounted water canon (sprayer) for application.

The EPA 40 *CFR* Part 503 regulations recognize the following categories of municipal biosolids that may be land-applied. These categories are based largely upon the level of pathogens present in the biosolids:

- Class A biosolids, which are essentially free of pathogens prior to land application; referred to as Exceptional Quality (EQ) biosolids in the TDEC 2010 guidelines.
- Class B biosolids that may have low levels of pathogens, which rapidly die off when applied to soils.

Both Class A and Class B biosolids must not exceed the concentrations specified in Table 1 and Table 3 of 40 *CFR* Part 503. The ORR Biosolids Application Program may apply either class of biosolids at each of the six application sites.

Table 1 summarizes the National Environmental Policy Act of 1969 (NEPA) actions associated with the Biosolids Program.

Table 1. Summary of previous NEPA actions relevant to the ORR Biosolids Land Application Program

NEPA action	Date	Description
DOE/EA-1042	1996	Evaluated the effects of raising the lifetime sludge application from 22 tons/acre to 50 tons/acre and changing the limit for radiological concentrations from 2 times background to a risk-based dose limit of 4 mrem/yr.
DOE/EA-1356	2003	Evaluated increasing the permissible radiological dose from 4 mrem/yr to 10 mrem/yr.
FONSI	2003	Determination that potential impacts analyzed in DOE/EA-1356 were not significant.

1.3 SOLIDS HANDLING

The City owns and operates a wastewater treatment plant that processes 30 million gal a day (mgd) near Turtle Park, alongside East Fork Poplar Creek in Oak Ridge, Tennessee. This plant receives wastewater directly from the City and Y-12. The City also operates a small treatment plant in the Clinch River Industrial Park (CRIP), which was to be taken out of service in 2010. A third wastewater treatment facility owned and operated by the City is the Rarity Ridge Plant. It receives wastewater directly from the ETTP, formerly known as K-25, as well as the Rarity Ridge residential development. The CRIP plant flow will be pumped to the Rarity Ridge facility. Sludge is then hauled from the two smaller plants, and from the ORNL, to the Turtle Park Plant. The sludge from all three City POTWs and the ORNL are processed and disposed via the Turtle Park Plant.

Prior to 2001, the City used an anaerobic sludge treatment process resulting in a liquid product, which was land-applied via a truck-mounted sprayer. During the summer of 2001, the City sought unsuccessfully to convert their process to one that would produce Class A sludge with 50% to 60% solids content. The conversion of the anaerobic digesters into aerobic holding tanks began at this time. The POTW is currently developing a standard-activated sludge process, in which biosolids from both the primary and secondary sedimentation basins are fed into aerobic holding tanks and then pumped into a belt press system. The goal is to produce Class B biosolids with 20% to 25% solids content, which will then be transported to one of the six active application sites (Table 2), and applied as a soil conditioner using a standard-size discharge manure spreader.

All of the tanks formerly used for anaerobic treatment have now been converted to aerobic digesters. A drum thickener has been installed to dewater the digested sludge. Currently, the City handles approximately 27,000 gal per day (gpd) of waste-activated sludge, at a concentration of approximately 1% solids. Another 10,000 gpd of primary sludge is pumped to the sludge handling facility. The primary sludge is approximately 2.5% solids.

Each of the four (4) aerobic digesters has a capacity of approximately 400,000 gal. The hydraulic residence time in the primary digester is slightly more than eleven (11) days. The primary digester has decanting capabilities. The sludge being transferred passes through a rotating drum thickener. This drum thickener has the capability of thickening the sludge to a higher solids content that can be easily aerated in the later units. Therefore, it will be operated with a solids concentration of 3% to 5%. If the thickener is operated at only 3%, the solids residence time in the next digester unit would be more than 23 days, discounting volatile matter destruction. With volatile solids reduction occurring in the process, the total solids residence time in digestion is more than 250 days, assuming the digesters are operated at 100% capacity.

The digested solids are dewatered by means of a belt press. The solids concentration exiting the press should be in the range of 20%–25% solids. It is anticipated that the volatile matter destruction of the digestion process will be on the order of 40%. It is anticipated that the resulting Class B solids will be land applied by a farm manure spreader pulled by a tractor. Considering the capacity of the digestion tanks, adequate storage is available for inclement weather conditions during which land application is on hold. It is estimated that up to 2600 lbs of dry solids could be land-applied on an average day. Again, the Biosolids Program will retain the flexibility to land apply liquid product should the need arise.

1.4 OAK RIDGE RESERVATION BIOSOLIDS LAND APPLICATION SITES

The biosolids land application sites are located on the ORR in Oak Ridge, Tennessee. Five of the active sites are in the vicinity of Bethel Valley Road, while the remaining active site, Watson Road, is located on Highway 95, near the Horizon Center. Figures 2 through 5 depict the location of each active application site. The gross acreage for each site ranges from 27 acres (10.93 ha) to 117 acres (47.37 ha), with a total of 329 acres (133 ha). Table 2 presents the six application sites and their gross acreage values.

Table 2. ORR biosolids active land application sites gross acreage

Site	Acres (Ac)	Hectares (ha)
Upper Hayfield #1	30	12.15
Upper Hayfield #2	27	10.93
High Pasture	46	18.62
Watson Road	117	47.37
Scarboro	77	31.17
Rogers	32	12.96

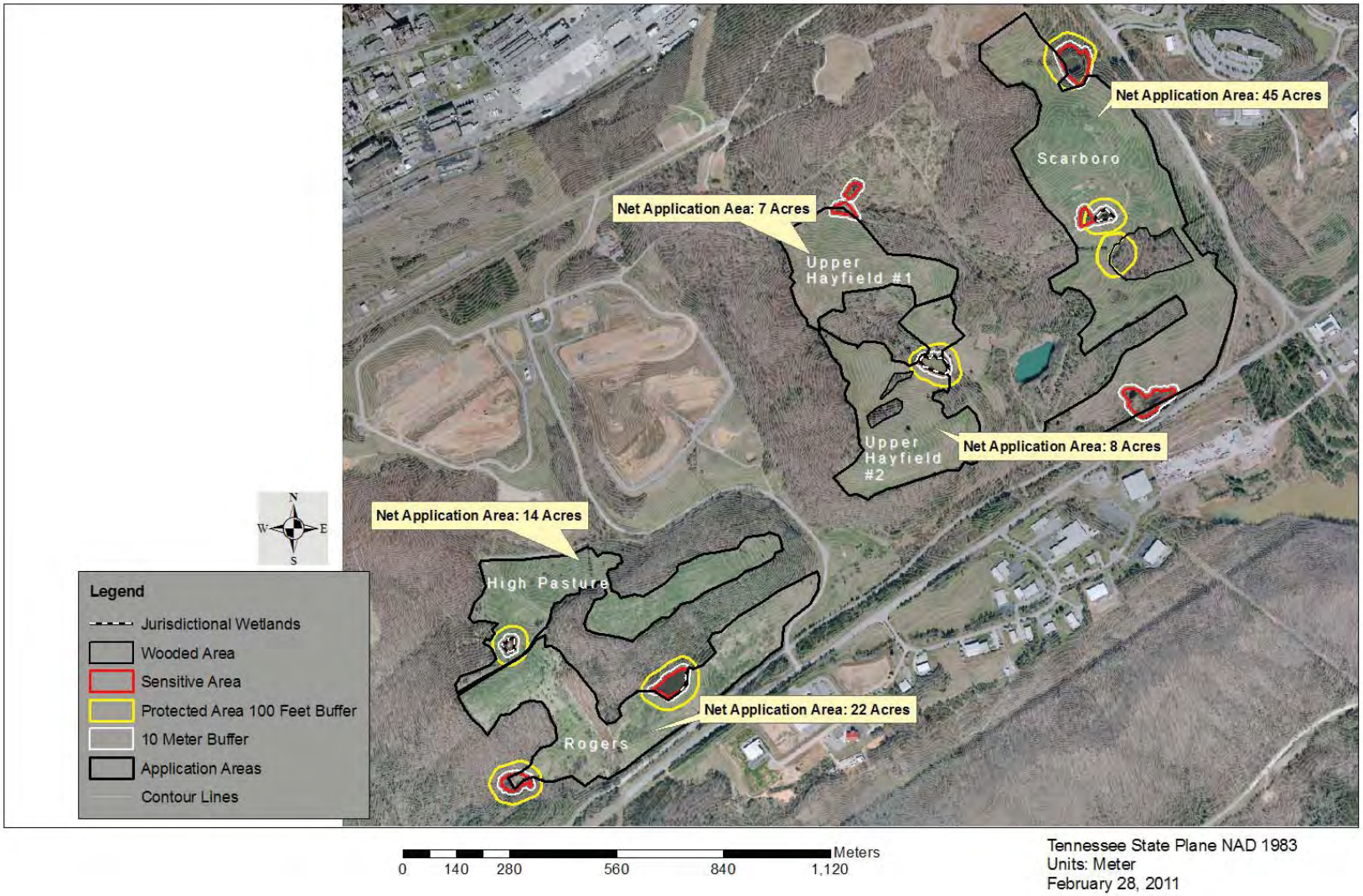

Fig. 2. Bethel Valley biosolids applications sites with proposed setbacks.

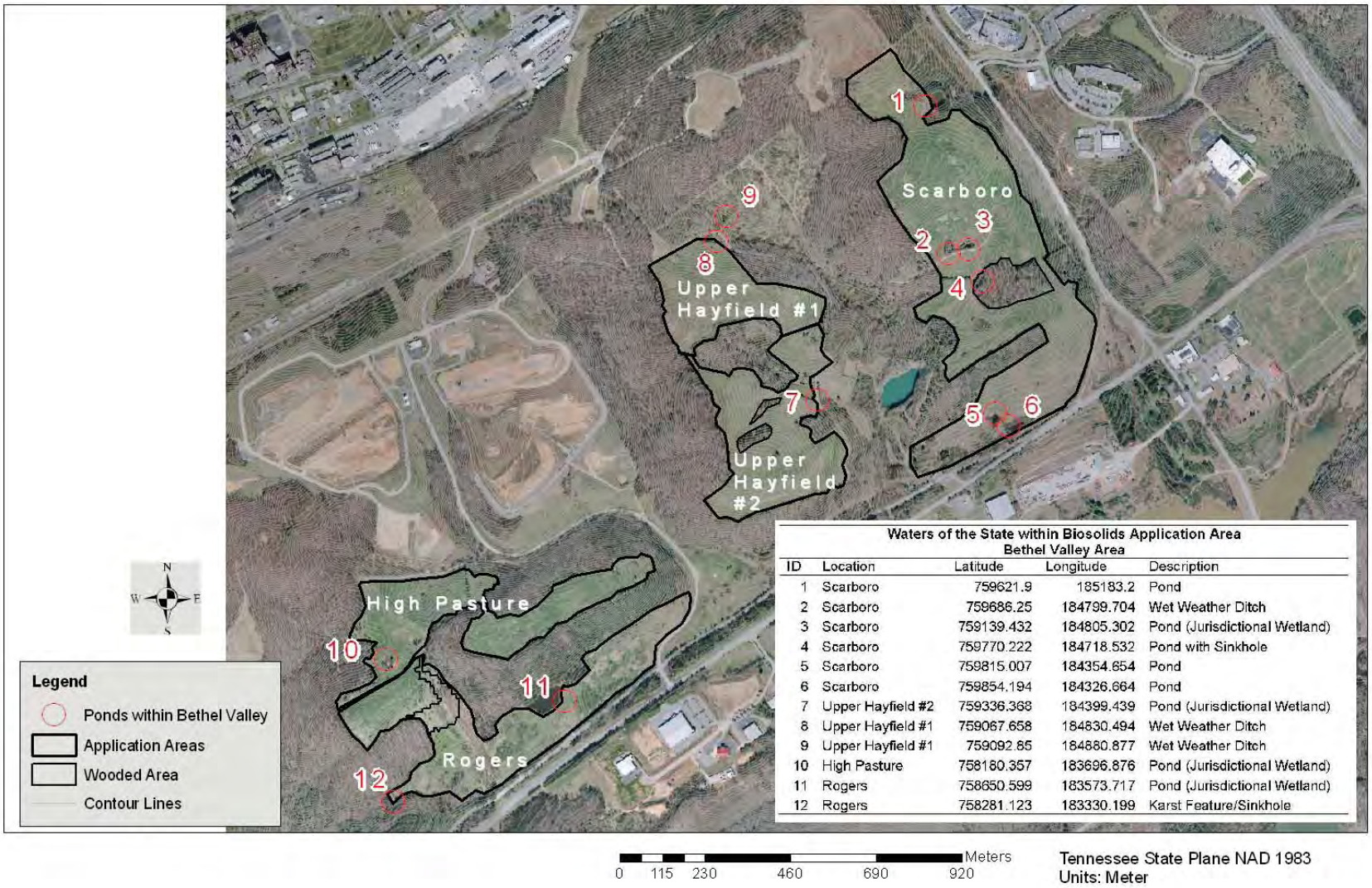

Fig. 3. Bethel Valley Area application sites waters of the state.

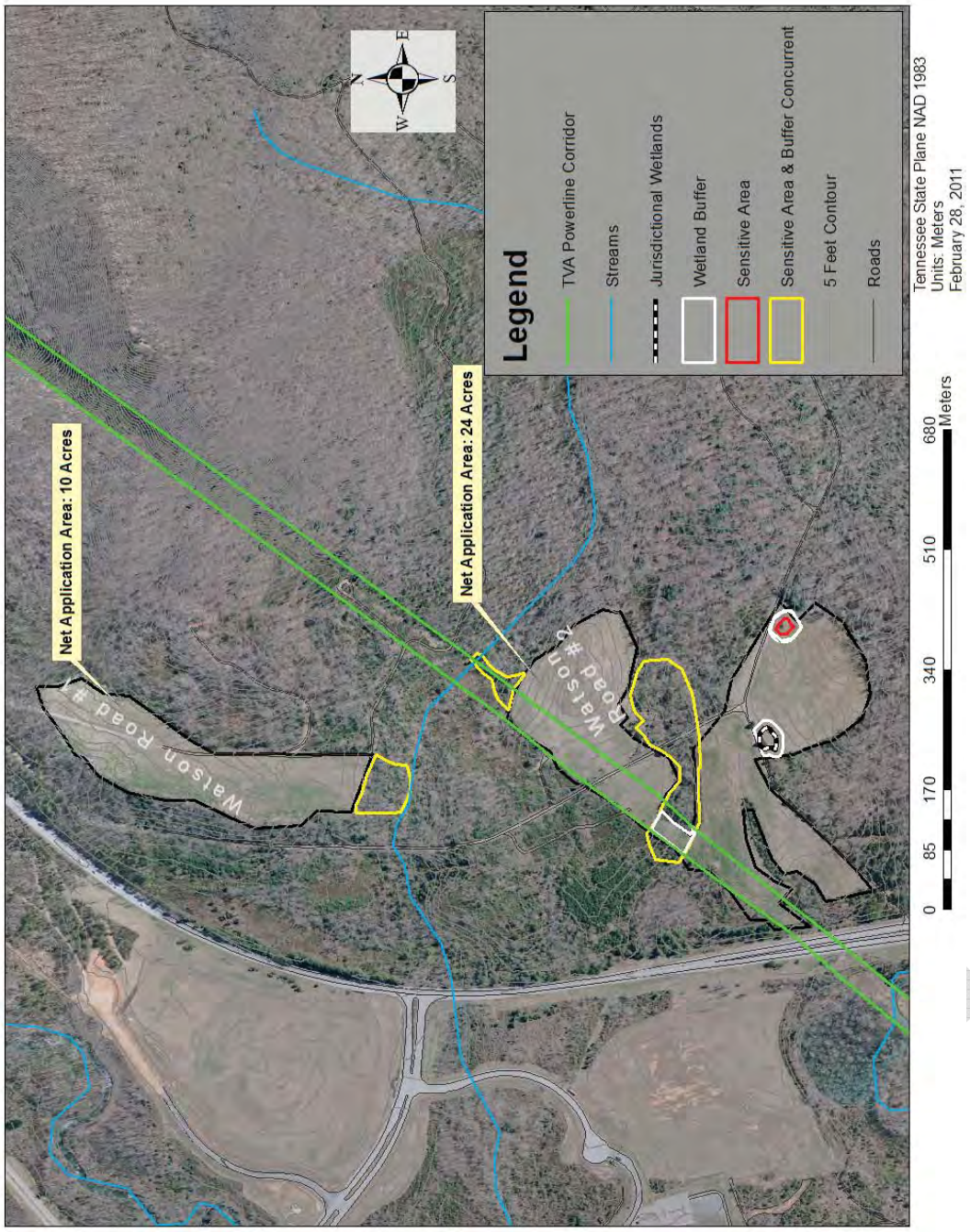

Fig. 4. Watson Road biosolids application site with proposed setbacks.

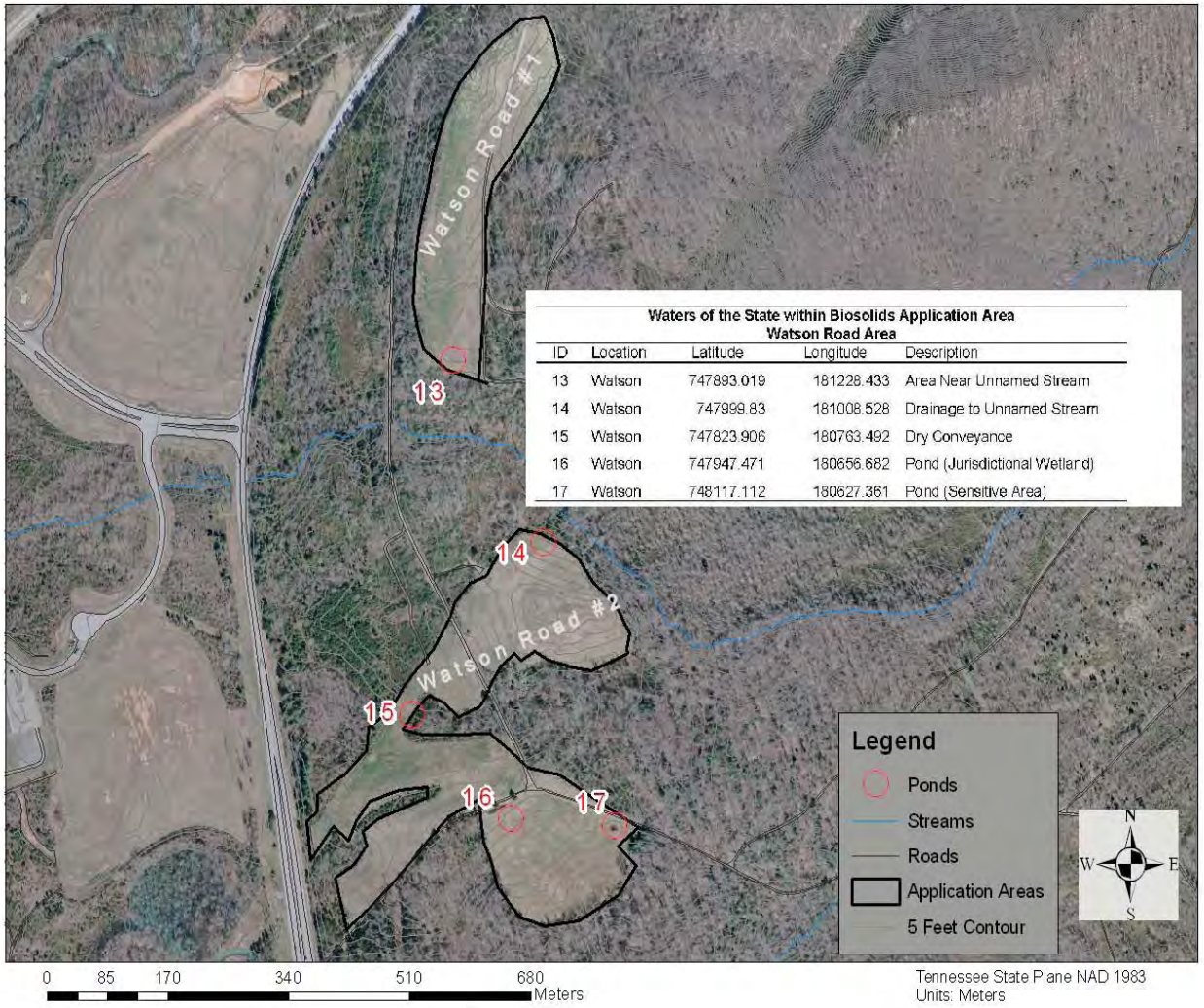

Fig. 5. Watson Road application site waters of the state.

Each of the six active sites received some biosolids application prior to 2006. The amount applied was previously limited by a physical lifetime loading limit derived from the 1983 and 1989 TDEC land application approval (LAA) letters. Under the current program, this lifetime loading limit is not required, but a calculated nitrogen loading limit is used to ensure that excess nitrogen does not accumulate and potentially cause a hazard to the environment. The intent is to provide just enough nitrogen that can be used by the site vegetation, thus preventing nitrogen contamination to surface water or groundwater. This is accomplished by means of calculating the agronomic loading rate, or the amount of biosolids that can be added annually, to maintain a net nitrogen load of zero. Updated with each biosolids analysis, this calculation incorporates the amount of nitrogen in the biosolids produced by the City, the residual nitrogen from previous applications, and the nitrogen requirements of the vegetation. Appendix A, *ORR Biosolids land Application Program Characterization Data*, presents historical data, site parameters, and the formulas used for agronomic calculations. Additionally, the program will continue to comply with the cumulative pollutant loading rates specified in Table 2 and the maximum concentration values specified in Tables 1 and 3 of 40 *CFR* 503.13. These requirements are also included in the sludge management sections of the City's National Pollutant Discharge Elimination System (NPDES) permits, numbers TN0024155 and TN0078051.

1.5 CONSTITUENTS IN BIOSOLIDS

The characteristics of the biosolids produced by the City are presented in Tables 3 through 7. They tabulate the concentrations of inorganic chemicals, heavy metals, organic chemicals, and radionuclides in the City of Oak Ridge biosolids. Biosolids land application site profiles are also provided in Tables 8 through 13. The tables in Appendix A and Tables 20 through 25 in Sect. 4 present the cumulative loading levels of ten heavy metals for the application sites through 2006, when applications were suspended, and compares them to the 40 *CFR* Part 503.13(b)(2) cumulative loading limits. The cumulative pollutant loading levels are well below the required limits.

The City issues permit limits to industrial users based upon effluent discharge limits to East Fork Poplar Creek (EFPC), the biosolids land application contaminant restrictions listed in existing permits, and agreements with EPA, TDEC, and DOE. Industrial discharge limits are developed using these restrictions, the contaminant removal efficiency of the POTW, and the needs of the industrial user petitioning to discharge to the city sanitary sewer system. At a minimum, the acceptance of contaminants prior to treatment at the POTW must not cause the POTW to exceed contaminant limitations on the effluent discharge to EFPC or on the biosolids land application sites.

No federal standards exist for radioactivity in biosolids. However, over the years, the TDEC, the City, and DOE have developed conservative concentration guidelines culminating in the identification of a number of radionuclides and activity levels based upon a 4 mrem/yr dose rate for a person living on-site (DOE/EA-1042). This was still too conservative, and in 1999, the City petitioned TDEC, and was subsequently granted permission, to increase the radionuclide land application loading criterion to 10 mrem/yr. An EA (*Environmental Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation*, DOE/EA-1356) was conducted in 2003 to evaluate potential impacts to human health and the environment for the proposed 10 mrem/yr criterion and a FONSI was issued in February 2003. This criterion is consistent with the 10 mrem/yr standard for protection of the public and the environment from airborne radionuclide releases that is recommended in the 1995 EPA regulations, 40 *CFR* Part 61, *National Emission Standards for Hazardous Air Pollutants* (NESHAP).

Table 3. Inorganic parameters and analytical levels in City of Oak Ridge biosolids (1996–2005)

Analyte	Sampling frequency	1996 levels (mg/kg dry wgt) max	1997 levels (mg/kg dry wgt) max	1998 levels (mg/kg dry wgt) max	1999 levels (mg/kg dry wgt) max	2000 levels (mg/kg dry wgt) max	2001 levels (mg/kg dry wgt) max	2002 levels (mg/kg dry wgt) max	2003 levels (mg/kg dry wgt) max	2004 levels (mg/kg dry wgt) max	2005 levels (mg/kg dry wgt) max	2006 levels (mg/kg dry wgt) max
Ammonia-nitrogen	3/year	28,672	43,000	33,000	41,000	33,000	28,000	680	20,000	15,590	13,700	424
Manganese	3/year	1345	1900	1400	1100	880	,000	1200	1665	1520	1430	1690
Nitrate	3/year	250	220	920	1000	380	230	6.9	549	920	790	61.3
Nitrite	3/year	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Organic nitrogen	3/year	64,400	86,000	52,000	62,000	92,000	55,000	35,000	85,000	97,410	43,980	16,080
pH	3/year	8	8	8.4	7.9	7.2	10.2	9.0	7.0	7.3	6.0	6.3
Potassium	Daily	5510	7100	4600	6000	3500	5000	1500	4261	3270	2540	1590
Phosphorus	3/year	31,800	48,000	32,000	47,000	35,000	7000	37,000	9600	32,400	23,800	39,600
Total Kjedahl Nitrogen	3/year	89,100	120,000	87,000	97,000	93,000	83,000	35,000	99,000	113,000	57680	16,500
Total Nitrogen	3/year	89,350	120,140	87,190	98,000	93,300	83,030	35,002	98,178	113,010	57,748.7	16,924
Total solids %	Daily	3.9%	3.6%	3.2%	3.2%	3.0%	56.7%	66.9%	4.1%	19.5%	3.1%	23.6%
Volatile solids (% of TS)	Daily	63%	63%	64%	63%	64%	65%	48%	82%	68%	52%	79%

Source: City of Oak Ridge

Table 4. Concentrations of heavy metal levels in City of Oak Ridge biosolids (1996–2000) versus 40 *CFR* Part 503.13 limits

Heavy metal	40 *CFR* Part 503.13 limits	1996 (mg/kg)		1997 (mg/kg)		1998 (mg/kg)		1999 (mg/kg)		2000 (mg/kg)	
		mean	max	mean	max	mean	max	mean	max	mean	max
Arsenic	**75**	6.71	12.80	2.53	7.50	2.4	4.3	2.7	4.7	2.1	3.8
Cadmium	**85**	9.92	19.40	3.60	5.20	3.1	4.8	3.4	3.8	3.1	4.5
Copper	**4300**	361.70	520.00	430.80	570.00	479.2	700.0	484.4	570.0	510.8	620.0
Lead	**840**	32.52	74.00	38.00	74.60	33.6	63.0	36.6	43.0	36.2	48.0
Mercury	**57**	2.16	8.20	12.00	20.00	11.0	16.0	10.6	19.0	6.0	11.0
Molybdenum	**75**	23.00	54.00	7.00	13.00	10.1	21.0	15.8	21.0	13.9	26.0
Nickel	**420**	26.23	39.70	28.20	42.00	33.5	100.0	25.5	47.0	63.1	100.0
Selenium	**100**	10.29	18.20	1.70	301.00	3.1	7.0	8.6	14.0	8.4	15.0
Zinc	**7500**	887.00	1610.00	1404.00	1910.00	1209.0	1600.0	1150.0	1400.0	1039.0	1600.0

Source: City of Oak Ridge; all values on dry-weight basis

Table 5. Concentrations of heavy metal levels in City of Oak Ridge biosolids (2000-2005) versus 40 *CFR* Part 503.13 limits

Heavy metal	40 *CFR* Part 503.13 limits	2001 (mg/kg)		2002 (mg/kg)		2003 (mg/kg)		2004 (mg/kg)		2005 (mg/kg)	
		mean	max	mean	max	mean	max	mean	max	mean	max
Arsenic	**75**	2.6	7.7	0.4	0.8	2.8	4.6	6.0	9.5	5.4	7.0
Cadmium	**85**	3.4	5.2	3.9	9.5	1.4	1.9	1.0	1.3	0.8	1.4
Copper	**4300**	584.4	680.0	418.0	610.0	710.4	869.0	725.5	843.0	632.0	768.0
Lead	**840**	46.9	63.0	18.2	26.0	40.4	52.2	25.9	34.6	30.1	37.4
Mercury	**57**	6.2	12.0	1.5	3.3	4.7	6.6	4.4	5.2	5.2	6.1
Molybdenum	**75**	14.7	20.0	3.5	7.9	9.4	14.2	18.5	29.8	31.1	38.9
Nickel	**420**	166.7	410.0	66.4	98.0	44.7	88.5	21.1	35.5	22.2	26.8
Selenium	**100**	7.6	12.0	9.7	18.0	12.4	29.0	9.6	13.2	4.8	5.1
Zinc	**7500**	1116.7	1500.0	602.0	920.0	940.8	1062.0	852.3	1070.0	826.5	1020.0

Source: City of Oak Ridge; all values on dry-weight basis

Table 6. NPDES organic parameters and concentrations of organic constituents in City of Oak Ridge biosolids

Analyte	Sampling frequency	1996 levels (mg/kg dry wt) max	1997 levels (mg/kg dry wt) max	1998 levels (mg/kg dry wt) max	1999 levels (mg/kg dry wt) max	2000 levels (mg/kg dry wt) max	2001 levels (mg/kg dry wt) max	2002 levels (mg/kg dry wt) max	2003 levels (mg/kg dry wt) max	2004 levels (mg/kg dry wt) max	2005 levels (mg/kg dry wt) max	2006 levels (mg/kg dry wt) max
Aldrin	Annually	0.025	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.33
Chlordane	Annually	2.7	1.3	0.34	3.80	6.70	0.95	18.00	3.60	2.12	<0.20	<3.30
DDD	Annually	U	0.071	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
DDE	Annually	0.01	0.023	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
DDT	Annually	U	0.0071	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
Dieldrin	Annually	0.099	0.061	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.016
Heptachlor	Annually	U	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.33
Lindane (gamma-BHC)	Annually	U	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.066
PCBs	Annually	U	U	U	7.70	N/A	19.0	35.00	0.46	1.10	<0.066	<0.066
Toxaphene	Annually	U	U	U	7.70	13	19.0	35.00	7.10	4.24	<0.40	<3.30
Trichloroethene	Annually	U	U	U	0.038	0.17	0.24	0.44	0.005	0.05	<3.30	<0.005
Benzo(a)pyrene	Annually	U	1.0	U	13	11	-	<3.30	--	-	-	-
Dimethylnitrosamine (n-nitroso-di-methylamine)	Annually	U	U	U	13	11	-	-	-	-	-	-
Hexachlorobenzene	Annually	U	U	U	13	11	0.24	0.44	0.005	0.05	<3.30	<0.005
Hexachlorobutadiene	Annually	U	U	U	13	11	-	-	-	-	-	-

Source: City of Oak Ridge
U = Undetected

Table 7. Concentrations of radionuclides in City of Oak Ridge biosolids (1996–2000)

Radionuclide	Planning level	1996 (pCi/g)		1997 (pCi/g)		1998 (pCi/g)		1999 (pCi/g)		2000 (pCi/g)		2001 (pCi/g)		2002 (pCi/g)	
		mean	max	mean	max	mean	max	mean	max	Mean	max	mean	max	mean	max
^{60}Co	10.7	0.46	7.05	0.51	8.96	0.52	1.17	0.51	0.80	0.48	0.81	0.57	1.38	0.0868	0.150
^{137}Cs	43.6	0.80	9.24	0.31	0.85	0.36	0.69	2.07	4.17	1.88	3.80	1.47	3.68	0.064	0.143
^{131}I	-	35.70	103.00	21.60	86.20	9.46	32.60	8.52	44.80	5.70	40.10	34.58	127.82	6.967	16.029
^{7}Be	-	2.72	5.05	1.70	6.15	1.30	2.69	1.08	1.89	0.72	1.09	0.18	0.55	0.142	0.214
^{40}K	120.0	7.19	12.30	6.19	8.08	6.04	9.27	5.86	7.24	5.67	10.43	3.68	6.46	0.803	1.211
^{228}Ra	20.7	1.13	1.69	1.01	1.42	0.97	1.51	0.84	1.36	0.62	0.99	0.13	0.31	0.156	0.260
^{235}U	157.0	0.75	1.85	0.35	0.71	0.33	0.83	0.36	0.73	ND	ND	NA	NA	NA	NA
^{238}U	459.5	13.30	51.00	8.00	24.20	10.60	21.90	7.62	15.70	2.58	6.20	NA	NA	NA	NA

Source: City of Oak Ridge; all values dry-weight basis
ND = not detected
NA = not available

Table 8. Upper Hayfield #1 site profile information

General site information	
Land application site name	Upper Hayfield #1
Gross acres	30
Application area in acres	7
Application area in hectares	2.84
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	None
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre *(Source: National Resources Conservation Services [NRCS], 2003)*

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.23	41	0.6%
Cadmium	0.40	39	1.0%
Chromium	7.20	-	-
Copper	29.70	1500	2.0%
Lead	4.53	300	1.5%
Mercury	0.66	17	3.9%
Molybdenum	1.07	-	-
Nickel	2.81	420	0.7%
Selenium	0.41	100	0.4%
Zinc	91.52	2800	3.3%

Table 9. Upper Hayfield #2 site profile information

General site information	
Land application site name	Upper Hayfield #2
Gross acres	27
Application area in acres	8
Application area in hectares	3.24
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth Requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.26	41	0.6%
Cadmium	0.46	39	1.2%
Chromium	7.82	-	
Copper	31.41	1500	2.1%
Lead	4.62	300	1.5%
Mercury	0.74	17	4.4%
Molybdenum	0.55	-	
Nickel	2.29	420	0.5%
Selenium	1.96	100	2.0%
Zinc	100.50	2800	3.6%

Table 10. High Pasture site profile information

General site information	
Land application site name	High Pasture
Gross acres	46
Application area in acres	14
Application area in hectares	5.67
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.31	41	0.7%
Cadmium	0.54	39	1.4%
Chromium	7.89	-	-
Copper	38.77	1500	2.6%
Lead	4.37	300	1.5%
Mercury	0.60	17	3.5%
Molybdenum	0.68	-	-
Nickel	4.03	420	1.0%
Selenium	2.02	100	2.0%
Zinc	102.68	2800	3.7%

Table 11. Rogers site profile information

General site information	
Land application site name	Rogers
Gross acres	32
Application area in acres	22
Application area in hectares	8.91
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland); Karst feature (functional wetland)
Vegetation	Orchard Grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.25	41	0.6%
Cadmium	0.60	39	1.5%
Chromium	18.31	-	-
Copper	46.18	1500	3.1%
Lead	10.50	300	3.5%
Mercury	1.11	17	6.5%
Molybdenum	3.17	-	-
Nickel	5.45	420	1.3%
Selenium	0.50	100	0.5%
Zinc	132.62	2800	4.7%

Table 12. Scarboro site profile information

General site information	
Land application site name	Scarboro
Gross acres	77
Application area in acres	45
Application area in hectares	18.23
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels			
Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.25	41	0.6%
Cadmium	0.43	39	1.1%
Chromium	6.91	-	-
Copper	27.51	1500	1.8%
Lead	3.80	300	1.3%
Mercury	0.65	17	3.8%
Molybdenum	0.68	-	-
Nickel	2.22	420	0.5%
Selenium	1.76	100	1.8%
Zinc	88.67	2800	3.2%

Table 13. Watson Road site profile information

General site information	
Land application site name	Watson Road
Gross acres	117
Application area in acres	34
Application area in hectares	13.77
Soil type	Armuchee (silt loam, moderately deep shale) and Colbert (silty clay loam)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.27	41	0.7%
Cadmium	0.48	39	1.2%
Chromium	7.27	-	-
Copper	28.34	1500	1.9%
Lead	4.31	300	1.4%
Mercury	0.53	17	3.1%
Molybdenum	0.50	-	-
Nickel	2.08	420	0.5%
Selenium	1.99	100	2.0%
Zinc	88.87	2800	3.2%

Biosolids typically contain both naturally occurring radioactive material (NORM) and human-made radionuclides. NORM may originate from radon released to the atmosphere from soil and water and enter a building through ground contact openings in a concrete slab or foundation wall. Sources of man-made contributions to sanitary sewers are from licensed discharge from DOE facilities, discharge from the Nuclear Regulatory Commission (NRC) licensees, and from others such as medical laboratories.

Under the proposed action, DOE further refines the radionuclide concentration guidelines to reflect a 50-year program life cycle (Sect. 2.1). Appendix B presents the radionuclides that will be monitored under the Biosolids Program, and the concentration guidelines based on a 50-year program life cycle. The guidelines reflect the conceptual, worst-case exposure scenario of a person residing on the actual application site, eating food and drinking water, with exposure to the radionuclides that have been land-applied from the City biosolids. In reality, the active application sites are isolated from members of the public, and access to the Bethel Valley Road site is controlled through ORR security due to proximity to the Y-12 Site.

Initially, the City biosolids will be monitored monthly for these radionuclides. This frequency may change depending on the statistical evaluation of the data.

The EPA determined from surveys that the four radionuclides most frequently found in sewage sludge are ^{131}iodine (I), ^{226}radium (Ra), ^{241}americium (Am), and ^{137}cesium (Cs) (EPA 1986). In the Interagency Steering Committee on Radiation Standards (ISCORS) survey of 313 POTW distributed around the country that had the greatest potential to receive waste from NRC licensees and in areas of higher levels of NORM, eight radionuclides were detected in more than 200 samples (^{7}beryllium [Be], ^{214}bismuth [Bi], ^{131}I, ^{40}potassium [K], ^{212}lead [Pb], ^{226}Ra, and ^{228}Ra). (ISCORS-2003-02; NUREG-1775; EPA 832-R-03-002; DOE/EH-0669). In the ISCORS survey, half of the samples were analyzed by the Oak Ridge Institute of Science and Education in Oak Ridge, TN under contract to NRC, and the other half were analyzed by the EPA's National Air and Radiation Environmental Laboratory. The survey data revealed that the samples primarily contained NORM and technologically-enhanced naturally occurring radioactive materials (TENORM) such as radium. Other than the NORM and TENORM constituents, radionuclides were at or near the detection limit and comparable with levels found in soils and fertilizers. The Association of Metropolitan Sewerage Agencies (AMSA) also conducted a survey of 55 POTWs that produced similar results to those generated by the ISCORS survey (Bastian et al. 2005).

The following radionuclides have not been included in the proposed guidelines in Table B.1 of Appendix B:

- ^{131}I: This radionuclide will be monitored through the daily gamma screening performed by the City.
- ^{214}Bi: This radionuclide indicates the presence of ^{226}Ra, which is included in the proposed guidelines.
- ^{7}Be: This naturally occurring radionuclide has a short half-life (53 days) and is produced continually by cosmic ray interactions with nitrogen and oxygen in the earth's atmosphere.
- ^{212}Pb: This naturally occurring radionuclide indicates the presence of ^{228}thorium (Th), which is included in the proposed guidelines.
- ^{227}Ac: This radionuclide indicates the presence of ^{231}protactinium (Pa), which is included in the proposed guidelines.

1.6 RELEVANT REGULATORY DRIVERS

Municipal biosolids are not regulated as a Resource Conservation and Recovery Act (RCRA) waste, or as a radiological waste, but are regulated under the provisions of 40 *CFR* Part 503 of the Clean Water Act (CWA). In these regulations, the EPA established standards for biosolids use and disposal, including risk-based, metal-loading criteria for the receiving soil. Until 2001, the City applied biosolids to the ORR under EPA permit # TNL0024155. In a letter dated July 24, 2001, the EPA Region 4 notified the City that individual sludge-only permits would not be renewed and declared its intent to prepare a general permit. However, the general sludge-only permit was not developed and the EPA Region 4 now considers the City to be self-implementing under 40 *CFR* Part 503. The requirements specified in 40 *CFR* Part 503 are restated in the sludge management sections of the City's NPDES permits, numbers TN0024155 and TN0078051, issued by TDEC.

When the City has generated sludge suitable for land application, a formal request to TDEC will be submitted for LAA. This new approval will replace the 1983 and 1989 letter approvals under which the Biosolids Program is currently operating. This new approval will reflect the revised TDEC guidance for biosolids management found in *Guidelines for the Land Application and Surface Disposal of Biosolids* (TDEC 2010). Neither the TDEC approvals nor the guidelines are enforceable, however, as stated in the May 2010 guidelines (page 5): "These guidelines are not to be construed as State Regulations…," and "Tennessee is not a delegated state to administer the Biosolids Program. Therefore, U.S. EPA-Region is the permitting authority and is the legal authority to enforce the provisions of the Part 503 regulation." [Although not included in the original source, it is assumed that U.S. EPA Region 4 is intended.] Although they are unenforceable, the TDEC guidance and LAAs are carefully considered and incorporated into the Biosolids Program. Table 14 presents a summary of the relevant regulatory drivers for the ORR Sanitary Biosolids Land Application Program.

Table 14. Summary of the relevant regulatory drivers affecting the Sanitary Biosolids Land Application Program

Relevant agency/regulatory driver	Implementation	Relevant documents
EPA	• Regulates municipal biosolids disposal under the CWA. • Recognizes the City as a self-implementing entity.	• EPA 40 *CFR* Part 503
DOE	• Issues the land use license for non-federal use of property. • Originally signed 1995, currently set to expire 10/2015..	• U.S. Department of Energy License for Non-Federal Use of Property REORDOER-3-01-0703, Supplemental Agreement No. 2, November 1, 2010
NPDES	• Establishes effluent limits and monitoring requirements for discharging treated municipal wastewater from Outfall 001 to receiving water of EFPC at mile 8.3. • Establishes effluent limits and monitoring requirements for discharging treated municipal wastewater from Outfall 001 to receiving waters of the Clinch River at mile 12.85.	• NPDES Permit No. TN0024155 for the Oak Ridge Sewage Treatment Plant (valid through 08/31/2013) • NPDES Permit #TN0078051 for the Rarity Ridge Waste Water Treatment Plant (valid through 08/31/2013)
TDEC	• Issues guidelines for the land application of biosolids in Tennessee.	• *Guidelines for the Land Application and Surface Disposal*

	• Does not regulate Biosolids Program. • Issues approval letter for application on the sites.	*of Biosolids,* (TDEC 2010) • Approval letter from TDEC Division of Water Pollution Control (May 8, 1989), for application of biosolids to ORR sites

1.7 SCOPE OF THE ANALYSIS

This EA evaluates the impact of decreasing the setbacks for ponds and potential channels to groundwater from 500 ft for ponds and 50 ft for potential channels to groundwater and eliminating the 50 ton/acre lifetime biosolids loading limit to conform to the EPA 40 *CFR* Part 503 regulations, versus no action.

The process of converting from a liquid to a solid is not addressed in this document because it was previously assessed in an earlier EA (DOE/EA-1042) and found not to have significant impact upon the ORR.

This EA conforms to the requirements of the Council on Environmental Quality (CEQ) regulations (40 *CFR* Parts 1500-1508) implementing the NEPA and DOE NEPA *Implementing Procedures* (10 *CFR* Part 1021).

2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

DOE proposes to change the setback for ponds and potential channels to groundwater in the Biosolids Land Application Program to conform to the EPA regulations of 40 *CFR* Part 503, as well as those requirements specified in the TDEC guidance for the land application of biosolids (TDEC 2010). The new setbacks are summarized in Table 15 and the action is discussed in detail in Sect. 4.1.

Table 15. Summary of setbacks (buffers) for protected areas on the ORR biosolids land application sites

Map feature number*	Site name	Protected area (type of wetland if applicable)	Latitude	Longitude	Setback
1	Scarboro	Pond (functional)	35º 59′ 5″	-84º 13′ 40″	30.5 m (100 ft) upgradient; 10 m (33 ft) downgradient
2	Scarboro	Wet weather ditch (functional)	35º 58′ 54″	-84º 13′ 37″	10 m (33 ft)
3	Scarboro	Pond (jurisdictional)	35º 59′ 9″	-84º 13′ 42″	30.5 m (100 ft)
4	Scarboro	Pond with sinkhole (functional)	35º 59′ 22″	-84º 13′ 45″	30.5 m (100 ft)
5	Scarboro	Pond	35º 58′ 23″	-84º 13′ 62″	10 m (33 ft)
6	Scarboro	Pond	35º 58′ 58″	-84º 13′ 67″	10 m (33 ft)
7	Upper Hayfield #2	Pond (jurisdictional)	35º 58′ 56″	-84º 14′ 0″	30.5 m (100 ft)
8	Upper Hayfield #1	Wet weather ditch	35º 59′ 23″	-84º 14′ 03″	10 m (33 ft)
9	Upper Hayfield #1	Wet weather ditch	35º 59′ 43″	-84º 14′ 96″	10 m (33 ft)
10	High Pasture	Pond (jurisdictional)	35º 58′ 34″	-84º 14′ 45″	30.5 m (100 ft)
11	Rogers	Pond (jurisdictional)	35º 58′ 45″	-84º 14′ 29″	30.5 m (100 ft)
12	Rogers	Karst feature with sinkhole	35º 58′ 35″	-84º 14′ 75″	30.5 m (100 ft)
13	Watson Road	Area near unnamed stream	35º 57′ 65″	-84º 21′ 80″	30.5 m (100 ft)
14	Watson Road	Drainage to unnamed stream	35º 57′ 27″	-84º 21′ 94″	30.5 m (100 ft)
15	Watson Road	Dry conveyance	35º 57′ 95″	-84º 21′ 61″	30.5 m (100 ft)
16	Watson Road	Pond (jurisdictional)	35º 57′ 1″	-84º 21′ 35″	10 m (33 ft)
17	Watson Road	Pond (functional)	35º 57′ 0″	-84º 21′ 36″	10 m (33 ft)

*Feature numbers refer to Figs. 3 and 5 from Sect. 1.4 and the Appendix C maps.

DOE proposes to eliminate the physical loading limit of 50 tons/acre that was derived from the TDEC 1983 and 1989 LAA letters. The state of Tennessee Biosolids Coordinator has concurred with this action. Continued adherence to the cumulative pollutant loading limits and maximum ceiling values specified in 40 *CFR* Part 503, Tables 1, 2, and 3, and the agronomic rates calculated for each site will ensure that land application of biosolids on the ORR does not pose a threat to human health or the environment. The cumulative loading levels through 2006 for each site are presented in Tables 20 through 25 in Sect. 4 of

this EA. The concentration values observed for constituents in the City biosolids are presented in Appendix A.

DOE proposes to revise the concentration guidance levels for radionuclides in biosolids. (See Table 7 in Sect. 1.5, and Appendix B.) The current guidance levels for site soils and the City biosolids were developed using the RESidual RADioactivity (RESRAD) 6.0 Software Program and a 10^{-4} (1 in 10,000) risk level for excess cancer. These guidance levels were evaluated in the documents DOE-EA/1042 and DOE-EA/1356. The risk level was conservatively adopted from the EPA regulatory limits for carcinogens in land-applied sludge, although radionuclides are not currently addressed in the regulations. The existing sludge concentration guidance levels were calculated assuming a 20-year program lifespan. The DOE proposes to retain the site soil concentration guidance levels and to revise the sludge concentration guidance levels to reflect a 50-year program lifespan. This will ensure that the radionuclide loading levels are monitored as rigorously as the non-radiological constituents without dependence on a physical lifetime loading limit. The limits for the site soils and the biosolids are summarized in Appendix B, Table B.1.

2.2 NO ACTION

The "no action" alternative provides an environmental baseline against which impacts of the proposed action can be compared. Under the "no action" alternative, the currently observed setbacks of 500 ft for ponds and 50 ft for potential channels to groundwater would not be changed. Similarly, the 50 ton/acre biosolids lifetime limit would continue to be in effect. Observing the 500-ft setback will result in the virtual elimination of the Scarboro site and considerably reduce the capacity of the Upper Hayfield #1 and Upper Hayfield #2 sites. The Biosolids Application Program would continue with essentially three fully functional sites and one greatly diminished one. For example, it is estimated that the available acreage on the Scarboro Road site would drop by 65%. Observing the 50 ton/acre lifetime loading limit for each site would result in program cessation within approximately five to seven years, depending on the site.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 LAND USE

The six biosolids application sites under consideration for this EA reside within the ORR. Five of the sites—Scarboro, Upper Hayfield #1, Upper Hayfield #2, High Pasture, and Rogers—are located within the Y-12 emergency response boundary (ERB) near Bethel Valley Road. The sixth site, Watson Road, is located within the ETTP ERB on Highway 95. The Bethel Valley Road sites are located within Anderson County; the Watson Road site within Roane County. Access to these sites is controlled by the respective Plant/Park Shift Superintendant (PSS) offices for each facility. The sites are accessible to the general public during scheduled Tennessee Wildlife Resources Agency (TWRA) hunting seasons.

3.2 ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL RESOURCES

The DOE Cultural Resource Management Plan (DOE/ORO-2085, *Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties Tennessee*) was developed to identify, assess, and document historic and cultural resources on the ORR. These resources include the New Bethel Baptist Church and Cemetery, George Jones Memorial Baptist Church, Freels Cabin, Bear Creek Road Checking Station, Bethel Valley Road Checking Station, and the Oak Ridge Turnpike Checking Station. Forty-six archaeological sites have been identified on the ORR. Seven DOE-owned structures are listed on the National Register of Historic Places and five of these are on the ORR. Additional potential listings include any buildings or structures directly related to the Manhattan Project (DOE/ORO-2296, *Annual Site Environmental Report 2008*).

3.3 REGIONAL DEMOGRAPHY/SOCIOECONOMICS

In order to provide relevant demographic and socioeconomic information, one must first define the region of influence for the impact analysis for the proposed action. The proposed changes will take place on DOE property located within the ORR. The land application sites are located in both Anderson and Roane counties. Because of the economic and commuter ties of these communities to surrounding areas, Knox County is also included. Thus, Anderson, Roane, and Knox counties define the region of influence for this analysis.

Oak Ridge is located in East Tennessee, approximately 25 miles northwest of Knoxville. Parts of the City lie in both Anderson and Roane counties. The City occupies approximately 85.6 square miles and has approximately 27,000 residents. Its largest employment source is from federally-funded projects, the City's principle economic activity, and it accounts for one of the biggest employment bases in the Knoxville metropolitan area. The City also has numerous recreational venues and multiple opportunities for outdoor activities.

Environmental justice concerns are addressed in Sects. 3.3.5 and 4.1.2.

3.3.1 Region of Influence

The region of influence (ROI) is defined as the geographic region that is most affected by a proposed action. The ROI for the socioeconomic analysis consists of a three-county area in Tennessee that includes Anderson, Knox, and Roane counties. Approximately 40% of the current ORR workforce resides in Knox

County, 29% in Anderson County, 16% in Roane County, and the remaining 15% in other counties outside the ROI.

3.3.2 Demographic and Economic Characteristics

Table 16 summarizes the population from 2000 to 2008 for the three counties, and Table 17 summarizes general demographic statistics by age and sex for 2008 (United States Census Bureau [USCB]). Population for the ROI has increased approximately 10.15% over the 8-year period, from 506,203 in 2000 to 557,618 in 2008. Employment for the region rose slightly at 2.4%, from 366,895 jobs in 2003 to 402,993 jobs in 2007.

The median income in Roane, Anderson, and Knox counties was $41,061, $44,193, and $45,922, respectively, in 2008 (USCB). Per capita income in 2007 in the ROI ranged from a low of $30,278 in Roane County to a high of $35,491 in Knox County (Bureau of Economic Analysis [BEA]).

The average employment rate in the ROI improved from 65.2% in 2003 to 67.8% in 2007. From 2003 to 2007, the highest average employment rate in the ROI was 72.5% in Anderson County and 71.8% in Knox County. Employment rates in Roane County were much lower, at 40.7% (BEA).

Table 16. Population estimates for Knox, Roane, and Anderson counties, TN (2000–2008)

County	2008	2007	2006	2005	2004	2003	2002	2001	2000
Knox County	430,019	423,603	416,014	408,809	402,830	398,571	392,723	387,712	383,028
Anderson County	74,169	73,246	72,735	71,725	71,319	71,365	71,340	71,317	71,232
Roane County	53,430	53,306	53,040	52,569	52,633	52,410	52,099	52,048	51,943
Total	557,618	550,155	541,789	533,103	526,782	522,346	516,162	511,077	506,203

*Source: *United States Census Bureau* (USCB)

Table 17. General demographic characteristics for Roane, Anderson, and Knox counties, Tennessee, July 2008

Sex and age	Roane	Anderson	Knox
Male	25,959	35,613	208,785
Female	27,471	38,556	221,234
Under 5 years	2669	4423	27,022
5 to 9 years	3044	4213	26,253
10 to 14 years	3193	4450	26,226
15 to 19 years	3065	4687	29,235
20 to 24 years	2763	3941	33,632
25 to 34 years	6726	9056	56,836
35 to 44 years	6955	9736	59,844
45 to 54 years	8021	11,180	63,800
55 to 59 years	3988	5319	28,213
60 to 64 years	3660	4640	23,370
65 to 74 years	4979	6222	29,443
75 to 84 years	3176	4357	18,573
85 years and over	1191	1945	7572
Median age (years)	42.7	41.8	37.7
18 years and over	42,529	57,983	334,494
21 years and over	40,958	55,681	314,234
62 years and over	11,296	15,052	67,874
65 years and over	9346	12,524	55,588
18 years and over			
Male	20,354	27,290	159,676
Female	22,175	30,693	174,818
65 years and over			
Male	4025	5208	22,988
Female	5321	7316	32,600

*Source: *United States Census Bureau* (USCB)

3.3.3 Population and Housing

Between 1960 and 1990, population growth in the ROI was slightly slower than population growth in the state of Tennessee. The ROI population increased at an average annual rate of 1% while the state population increased 1.2%, annually. Anderson County population has increased an average of only 0.4% annually in 2005 (USCB).

Knox County is the largest county in the ROI with a year 2008 population of 430,019. Knox County includes the City of Knoxville, the largest city in the ROI. The City of Oak Ridge and the ORR are located in both Roane and Anderson Counties, which had populations of 53,430 and 73,169 in 2008, respectively (USCB).

There were a total of 244,536 housing units in the ROI in year 2000. Approximately 8% of the housing units were vacant, although some vacant units were used for seasonal, recreational, or other occasional purposes. Owner-occupied housing units accounted for 64% (USCB). In year 2000, the median values of owner-occupied housing units ranged from $86,500 in Roane County to $98,500 in Knox County and the median contract rent ranged from $398 in Roane County to $493 in Knox County.

According to the 2000 Census, 12.4% of the United States population and 13.5% of the Tennessee population had incomes below the poverty level in year 1999. In this analysis, a low-income population consists of any census tract in which the proportion of individuals below the poverty level exceeds the national average. Within the ROI, 13.1% of the population in Anderson County had incomes below the poverty level, Knox County had 12.6%, and Roane County had 13.9% (USCB).

3.3.4 Community Services

Community services in the ROI include public schools, fire response, medical services, and law enforcement. There are six school districts, with 132 schools that serve the ROI, and educational services are provided for 75,341 students (Institute of Education Services [IES]). The tri-county area includes a total of 48 fire stations (United States Fire Administration [USFA]), 10 hospitals (Tennessee Hospital Association [THA]) and 12 local law enforcement agencies employing over 1200 law enforcement officers (police and sheriffs) in the tri-county ROI that serve the regional populations (Federal Bureau of Investigation [FBI]).

3.3.5 Environmental Justice

Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, signed by President Clinton in February 1994, requires each federal agency to formulate a strategy for addressing issues in human health—and the environment—in related programs, policies, planning and public participation processes, enforcement, and in rulemakings. The White House memorandum accompanying the Executive Order directs federal agencies to "Analyze the environmental effects…of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA." Pursuant to the EO, environmental justice analyses identify and address any disproportionately high and adverse human health or environmental effects on minority or low-income populations from the proposed actions included in this EA. Adverse health effects may include bodily impairment, infirmity, illness, or death. Adverse environmental effects include socioeconomic effects, when those impacts are interrelated to impacts on the natural or physical environment. Minorities include individuals classified by the USCB as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and Hispanic or Latino, and those classified under two or more races.

For the purposes of this analysis, a minority population consists of any census tract in which minority representation is greater than the national average of 30.7%. The distribution of minority and economically disadvantaged populations changed little between the years 1990 and 2000. See Sect. 4.1.2 for a discussion about a minority population on one of the ORR census tracts.

3.4 GEOLOGY AND SOILS

The ORR lies within the Valley and Ridge Physiographic Province. The Valley and Ridge Province is characterized by steep-sided parallel ridges with broad intervening valleys, generally oriented in a northeast-southwest direction. The ORR lies ~16 km (10 miles) southeast of the Cumberland Mountains and ~3 km (70 miles) northwest of the Blue Ridge Mountains. Elevations on the ORR range from ~230 m (750 ft) above mean sea level (MSL) along the Clinch River to ~385 m (1260 ft) MSL along the highest ridge tops. The Valley and Ridge Province is part of the southern Appalachian fold and thrust belt. The bedrock stratigraphy of the ORR ranges in age from Lower Cambrian to Upper Ordovician and consists primarily of rock units of the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Group.

The Upper Hayfield #1, Upper Hayfield #2, High pasture, Rogers, and Scarboro Road application sites have all had thorough hydrogeological evaluations and were found to be suitable for the land application of biosolids by TDEC Division of Solid Waste (TDEC, 1983). The Watson Road site underwent a full hydrogeological evaluation and was found to be suitable for the land application of biosolids by TDEC-Division of Wastewater (TDEC, 1989). The Upper Hayfield #1, Upper Hayfield #2, High Pasture, Rogers, and Scarboro Road land application sites are located on the southeast side of Chestnut Ridge. The land surface there is hilly with moderate to steep slopes and total relief of up to 200 feet. Chestnut Ridge is strongly dissected with long, deep drain ways which trend both east-west and north-south.

The direction of surface drainage is quite variable over these sites; however, all the sites drain first into Bethel Valley and subsequently into the Melton Hill Reservoir of the Clinch River about 1 mile to the southeast. The drainage pattern of the area is generally rectangular. Several sinks or depressions occur on these application sites. The application sites referenced predominantly overlie the Knox with just their southeast portions underlain by Chickamauga.

The Cambrian-Ordovician-aged Knox Group is composed primarily of thick-bedded siliceous or cherty dolomite and interbedded dolomitic limestone. These rocks are generally fine to medium-grained and thinly to massively bedded. Chert occurs in the Knox as irregular beds, lenses and nodules.

This group generally underlies broad ridges with fairly gentle slopes to the southeast. Thickness of the Knox Group ranges from 900 m (2469 ft) to 1000 m (2743 ft) (Butz 1984).

Knox dolomite gives rise to dissolution or karst features and sinkholes are common. The Knox Group weathers to form deep residual clay soils, commonly more than 100 feet in thickness. Knox soils resist erosion because of the abundant chert on the surface. The Knox weathers to form generally thick, orange to reddish brown, silty, residual clays with varying amounts of chert fragments and blocks. These soils are mostly Fullerton associations.

The Ordovician-aged Chickamauga Group dominantly comprises limestone sequences with calcareous shales and siltstones. Limestones are generally gray to blue-gray and argillaceous or shaley. Thickness of the Chickamauga can reach 670 m (2208 ft) (Butz 1984). Some beds of relatively “purse” limestone may occur within the Chickamauga in addition to interbedded calcareous shales of varying thickness. Chert

occurs sparsely in the Chickamauga limestone. The surfaces of valleys underlain by this group are irregular, with the more silty and cherty layers underlying low ridges and hills. Sinkholes do occur, but are not as numerous nor as large as those found within the Knox Group. Chickamauga soils are thinner than those derived from the Knox and may be brown to reddish-brown to yellowish in color. The soils may contain limestone "float", particularly in horizons close to the soil-bedrock interface. The Chickamauga soils here are mostly Collegedale and Sequoia associations, but some areas may have Leadvale and Armuchee soil.

Strata in the area generally dip southeastward at about 25 to 35 degrees, although dips may vary considerably in some areas due to small local structures, faults, etc. The Copper Creek fault occurs just southeast of the application sites, its trace extending along the upper northwest side of Haw Ridge whereby the Cambrian Rome formation is thrust over the Ordovician Chickamauga limestone. Intense jointing has occurred in the subject area as attested to by the previously mentioned sinkholes and the strongly dissected land surface, the joints probably being related to the Copper Creek fault. No structures are located on these land application sites.

Groundwater moves mainly within a system of solution enlarged joints in the carbonate bedrock. Groundwater movement is probably generally southeastward toward the Clinch River, but locally such flow may be either to the northeast or southwest to the deep drainages which cut through Haw Ridge and Copper Creek fault. Sinks in the area may provide a substantial recharge system for the groundwater reservoir, although some of the sinks appear to be "filling in" with the colluvial sediments wherein percolation would be greatly retarded. One spring occurs just to the northwest of the western most application site, High Pasture, however, this spring is up-gradient from the proposed site and is not affected by land application operations.(source: *Environmental Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation* (DOE/EA-1356), pages 3-4 through 3-6.)

3.5 WATER QUALITY

Surface water is drained from the ORR by a network of small streams that are tributaries of the Clinch River. Generally, the Clinch River tributaries conform to the physiography of the Valley and Ridge Province by paralleling the Clinch for a long distance before crossing a ridge gap to unite with it. The net effect is a trellis pattern that can be seen on a map such as the topographic map of the Oak Ridge area. Each of the three ORR DOE facilities, the ETTP, Y-12, and ORNL, affects a different sub basin of the Clinch River. Drainage from Y-12 enters both Bear Creek and EFPC; ORNL drains into White Oak Creek and several tributaries of the Clinch River; and ETTP drains predominantly into Poplar Creek and Mitchell Branch (DOE 1996). Surface water quality on the ORR is influenced by the geochemistry and soil-water interactions of the sub basins. Water quality is also affected by wastewater discharges by groundwater transport of contaminants from land disposal of waste. All effluent discharged from ORR facilities to receiving streams must meet various chemical limits that are specified in the NPDES permits for each site.

The water quality of EFPC is also heavily influenced by activities at Y-12. Discharges from Y-12 at the headwaters and from the Oak Ridge POTW near the middle of the stream's length constitute a large percentage of the stream's mean annual flow. The stream also receives urban and agricultural runoff. Water and sediment in EFPC contain metals, organic chemicals, and radionuclides from past operations at Y-12. These include ammonia, copper, mercury, nitrogen, petroleum-based oils and greases, perchloroethylene, PCBs, and residual chlorine. Recent actions taken at Y-12 to reduce the input of contaminants to EFPC have shown positive results in water quality improvement. (Source: *Environmental*

Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation (DOE/EA-1356), page 3-6.)

3.6 FLOODPLAINS AND WETLANDS

In May 2010, CDM Federal Services Incorporated (CDM) conducted a wetlands survey of the six active biosolids application areas covered in this proposed action. As a result, five jurisdictional and four functional wetlands were identified. The results of this survey are documented in the *Wetlands Walk Over Survey Report of the Biosolids Application Areas* (CDM 2010a) in Appendix C.

The topography of the application areas varies from steep, ridged slopes to relatively flat-lying floodplains. Karst features and rock outcrops are common. The majority of the biosolids application areas are well drained due to the slopes and high relief, but low relief, poorly drained areas are common. The ORR includes a wide variety of habitats. These include hardwood forest, pine forest, mixed hardwood/pine forest, pine plantations, open grass/agricultural fields, ponds (both permanent and vernal), streams, wetlands, and industrial areas. Approximately 70% of the ORR is in natural or planted forest. Because of their unique protected status by association with the ORR facilities, several areas of these habitats and the associated wildlife have received limited human disturbance since 1942. The ORR has also been established as a Wildlife Management Area under a cooperative agreement between the DOE and the TWRA and includes the 20,000-acre Oak Ridge National Environmental Research Park (ORNERP) and several state Natural Areas. In 1989, the ORNERP was designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as one of six units of the Southern Appalachian Biosphere Reserve.

Aquatic habitats on the ORR include small streams, Bear Creek, East Fork Popular Creek, the Clinch River, and several scattered ponds. Several species of fish, reptiles, and amphibians are found in these areas.

All six of the active biosolids application sites are open grassland field areas, surrounded for the most part by woodlands. The sites are devoid of caves, perennial streams, and large bodies of water. Small ponds and vernal ponds occur on all six of the locations. These features provide ecological habitat for amphibians, as well as other wildlife. Two of the application sites, Rogers and Scarboro Road, include rock outcrop features and sinkholes. Boundaries of the application sites are dominated by mature hardwood tree species that provide suitable habitat for a wide variety of plant and animal species.

For the biosolids application sites, three criteria had to be met for an area to be afforded the status of jurisdictional wetland, according to the *Corps of Engineers Wetland Delineation Manual* (Y-87-1):

- Visible signs of wetlands hydrology. (The areas either had standing water at the time of the site visit, or there were physical clues, such as watermarks or channels, that indicate the area was frequently inundated.)
- Wetland-type soil (gleyed or mottled soils), which were compared to color chips for the evaluation.
- Wetland-type vegetation. In the application sites, these species were predominantly herbaceous.

The results of the evaluation are summarized in Table 18 and illustrated in Figs. 3 and 5.

Four functional wetlands were identified that did not meet all three of these criteria, but were considered to perform the same functions of a wetland in that they served as habitat for amphibians, birds, and other wildlife.

Table 18. Jurisdictional and functional wetlands identified on the ORR biosolids land application sites

Map feature number	Site name	Description of area	Type of wetland	Latitude	Longitude
1	Scarboro	Pond	Functional	35º 59′ 5″	-84º 13′ 40″
2	Scarboro	Wet weather ditch	Functional	35º 58′ 54″	-84º 13′ 37″
3	Scarboro	Pond	Jurisdictional	35º 59′ 9″	-84º 13′ 42″
4	Scarboro	Pond with sinkhole	Functional	35º 59′ 22″	-84º 13′ 45″
7	Upper Hayfield #2	Pond	Jurisdictional	35º 58′ 56″	-84º 14′ 0″
10	High Pasture	Pond	Jurisdictional	35º 58′ 34″	-84º 14′ 45″
11	Rogers	Pond	Jurisdictional	35º 58′ 45″	-84º 14′ 29″
16	Watson Road	Pond	Jurisdictional	35º 57′ 1″	-84º 21′ 35″
17	Watson Road	Pond	Functional	35º 57′ 0″	-84º 21′ 36″

3.7 CLIMATE AND AIR QUALITY

The Oak Ridge area is located in a temperate, continental climate. Summers are warm and humid and winters are typically cool. Spring and fall are transitional seasons, normally warm and sunny. Severe weather (e.g., tornadoes or high winds, severe thunderstorms with damaging lighting, extreme temperatures or heavy precipitation) is rare. Average annual rainfall is approximately 140 cm (55 in). The Oak Ridge area has one of the lowest average wind speeds in the United States. Local terrain is the dominant influence on daily wind patterns and contributes to the low average wind speed. Prevailing wind directions are either southwesterly daytime winds or northeasterly nighttime winds. The Oak Ridge area is an attainment area (i.e., within permissible limits) with respect to National Ambient Air quality Standards for all criteria pollutants (sulfur dioxide, particulate matter, nitrogen dioxide, carbon monoxide, ozone, and lead). (Source: *Environmental Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation* (DOE/EA-1356), page 3-9.)

3.8 ECOLOGICAL RESOURCES

Terrestrial habitats on the ORR include hardwood forest, pine forest, mixed hardwood/pine forest, pine plantations, open grass/agricultural fields, and industrial areas. Approximately 70% of the ORR is in natural or planted forest. Because of their unique protected status by association with the ORR facilities, several areas of these habitats and associated wildlife have received limited human disturbance since 1942. In 1988 the ORR was designated as a unit of the Southern Appalachian Biosphere Reserve within the United Nations' Man and the Biosphere Program. The ORR has also been established as a Wildlife Management Area under a cooperative agreement between DOE and TWRA and includes the 20,000-acre Oak Ridge National Environmental Research Park and several state Natural Areas. (Source: *Environmental Assessment Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation* (DOE/EA-1356), page 3-9.)

3.8.1 Listed Species

A Listed Species Survey of the biosolids application areas was conducted in May 2010 by CDM and documented in a report for DOE in June 2010 (CDM 2010b). The focus of the survey was on state-listed and federally-listed species that may use the subject area and potentially ecologically sensitive habitat areas that support these species. The survey found that the ORR biosolids application sites provide suitable habitat for eleven listed species, including five birds (cerulean warbler, northern harrier, sharp-shinned hawk, vesper sparrow, yellow-bellied sapsucker), four mammals (gray bat, Indiana bat, southeastern shrew, and meadow jumping mouse), one salamander (four-toed salamander) and one fish (Tennessee dace). The gray bat and Indiana bat are federally-endangered species and are discussed below (see Section 4.8.1).

The ORR contains a wide diversity of quality wildlife habitats. Habitats include hardwood forest, mixed forest, forest edge, field, wetland, riparian, and shrub. Many of the wildlife species, such as the white-tailed deer (*Odocoileus virginianus*), are ubiquitous and can be found in almost any habitat, although they may show a preference for a certain type. Other species, such as the blue grosbeak (*Guiraca caerulea*) or yellow-breasted chat (*Icteria virens*), are to be found only in specific habitat types while yet others require large tracts of unbroken forest (e.g., pileated woodpecker [*Dryocopus pileatus*]).

Hunting on the ORR occurs for wild turkey (*Meleagris gallopavo*), white-tailed deer, and Canada goose (*Branta canadensis*). Public deer, goose, and turkey hunts on the ORR are managed by the TWRA. These are the only hunting activities allowed on the ORR (Neil Giffen, ORNL, personal communication, March 26, 2010).

Aquatic habitats on the ORR include small streams, Bear Creek, East Fork Poplar Creek, the Clinch River, and several scattered ponds. Several species of fish, reptiles, and amphibians are found in these areas. Muskrat (*Ondatra zibethica*) and beaver (*Castor canadensis*) are found close to aquatic areas. The muskrat prefers open terrain where aquatic vegetation and dense growths of riparian grasses, sedges, and rushes exist, and beavers are found in locations where there are trees for food and for building dams and lodges. Mink (*Mustela vison*) and raccoon (*Procyon lotor*) are found in aquatic habitats but range into forest and field areas. Large mammals visit aquatic areas to drink water.

Most of the wildlife species observed during the surveys are those typical of the ORR.

Birds observed include woodpeckers (common flicker [*Colaptes auratus*], downy woodpecker [*Picoides pubescens*], hairy woodpecker [*Picoides villosus*], pileated woodpecker [*Dryocopus pileatus*], and red-bellied woodpecker [*Melanerpes carolinus*]), hawks (red-shouldered [*Buteo lineatus*] and red-tailed [*Buteo jamaicensis*]), sparrows (American tree [*Spizella arborea*], chipping [*Spizella passerina*], field [*Spizella pusilla*], song [*Melospiza melodia*], and white-throated [*Zonotrichia albicollis*]), vultures (black [*Coragyps atratus*] and turkey [*Cathartes aura*]), and flycatchers (eastern bluebird [*Sialia sialis*], eastern phoebe [*Sayornis phoebe*], and eastern wood pewee [*Contopus virens*]). Common birds of forest and forest edges identified include crow (*Corvus brachyrhynchos*), robin (*Turdus migratorius*), gnatcatcher (*Polioptila caerulea*), jay (*Cyanocitta cristata*), cardinal (*Cardinalis cardinalis*), thrasher (*Toxostoma rufum*), chickadee (*Poecile caronlinensis*), wren (*Thryothorus ludovicianus*), mockingbird (*Mimus polyglottos*), titmouse (*Baeolophus bicolor*), towhee (*Pipilo erythrophthalmus*), and turkey (*Meleagris gallopavo*). Other bird species noted during the surveys were American kestrel (*Falco sparverius*), belted kingfisher (*Ceryle alcyon*), black-crowned night heron (*Nycticorax nycticorax*), cedar waxwing (*Bombycilla cedrorum*), European starling (*Sturnus vulgaris*), killdeer (*Charadrius vociferous*), mourning dove (*Zenaida macroura*), and pine warbler (*Dendroica pinus*).

Mammals observed during the surveys included eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), northern raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*). Amphibians observed during the surveys were bull frog (*Rana catesbeiana*), chorus frogs (*Pseudacris triseriata*), eastern newts (*Notophthalmus viridescens*), and spring peepers (*Hyla crucifer*).

3.8.2 Plants

All six of the sites are fields that are mowed bi-annually: generally once in late May and once in late August. These fields do not provide potential habitat for listed plant species. A plant survey was conducted as part of the previously completed biosolids application EA and no listed plant species were identified (DOE/EA-1356). In addition, no listed species were identified during the recent surveys) Habitats in adjacent areas, such as forests and ridges, may provide the potential for listed plants to exist. These adjacent areas would be protected from impact from the biosolids application with the maintenance of a buffer between the fields of application and the surrounding habitats.

3.8.3 Vertebrates

Three sources were consulted for the survey in Appendix D, including the Tennessee Natural Heritage Program, the ORR species of concern list (Table D.1 in Appendix D), and the TWRA. These sources were consulted in concert with the ecological surveys to make determinations regarding ecologically sensitive areas. Information from the ORR was checked for species of ORR concern that may be impacted by the proposed biosolids application. Lastly, the TWRA and Tennessee Wildlife Resources Commission (TWRC) Wildlife in Need of Management database were consulted to make sure all species listed as in need of management have been considered.

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained (DOE/EA-1356). For the six study areas, this means they are mowed on an annual basis to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass. This habitat, although limited in value to many listed species (i.e., forest-dependent species), would be beneficial to others (i.e., species dependent on open field habitats).

4. POTENTIAL ENVIRONMENTAL IMPACTS

4.1 PROPOSED ACTION – SETBACK AMENDMENT

As described in Sect. 2.1, the proposed action amends the current 500-ft application setback around waters of the state and the 50-ft setback for potential channels to groundwater, to reflect current regulatory requirements, as set forth in EPA 40 *CFR* Part 503, while also applying recommendations provided in the current TDEC biosolids application guidance (TDEC 2010). Additionally, the proposed action eliminates the 50 ton/acre biosolids lifetime loading limit previously imposed on the program.

Figures 1–4 in this report present the biosolids application areas and the relevant surface water features and areas of concern identified in the most recent Wetlands Survey and Listed Species Survey, conducted in May 2010 (CDM 2010a and 2010b). Prior to 2006, the application process included the use of truck-mounted water canons applying sludge with low percent solids content to the sites. The proposed action takes into account several changes to the program upon resumption of biosolids land application activities:

- As described in Sect. 1.2.1, the City's POTW has recently undergone a conversion from an anaerobic processing system to an aerobic system, and is expected to produce a Class B material.
- The upgraded system will produce a product with 20% to 25% solids content that will be applied with a standard-sized manure spreader, although the program retains the ability to apply product of varying percent solids content.

In accordance with 40 *CFR* Part 503, for each sensitive area identified by either the wetlands survey or the listed species survey, the Biosolids Program will maintain a minimum 10 m (33 ft) buffer zone inside of which no application or mowing will take place. The results of these two surveys in conjunction with the recommendations set forth in the TDEC biosolids land application guidance (TDEC 2010) were used to establish in some cases, larger setbacks of 30.5 m (100 ft) to provide additional protection of certain areas. Figures 2 and 4 present the proposed setbacks surrounding areas of concern identified by the wetlands survey and the listed species survey. Each application site is summarized below and Table 19 presents a summary of the relevant protected areas with their recommended buffer zones. More information regarding the identification of sensitive areas can be found in the respective survey reports.

The surveys identified, evaluated, and numbered the features (ponds, wetlands, wet weather ditches, sensitive habitats, and karst features) on the biosolids application areas. In the following sections, designated setbacks refer to Figs. 2 and 4, and feature numbers refer to those listed on Figs. 3 and 5.

Scarboro

As shown in Fig. 3, there are six surface water features of significance on the Scarboro site, including three ponds, one pond with a sinkhole, one wet weather ditch, and one jurisdictional wetland. Feature 1 is a pond. The relatively steep slope up-gradient from the feature, however, will necessitate a 30.5-m (100 ft) protective setback and the minimum 10-m setback down-gradient from the pond. Feature 2 was given a minimum 10-m (33 ft) setback since it had no additional special considerations necessitating a larger area. Feature 3, a pond, was afforded a 30.5-m (100 ft) setback since it is a jurisdictional wetland. Feature 4, a pond with a sinkhole, resides at the edge of a small wooded area, a habitat for breeding amphibians and other species. For this reason, it was given a 30.5-m (100 ft) setback. Features 5 and 6, because of their proximity to one another, are defined as one sensitive area with a 10-m (33 ft) setback surrounding both ponds as a unit.

Upper Hayfield #1

Features 8 and 9 on the Upper Hayfield #1 site are described as wet weather ditches, meaning they occasionally have standing water during periods of, or immediately following, rain events. They each have a 10-m (33 ft) setback.

Upper Hayfield #2

Feature 7 on the Upper Hayfield #2 site is a pond identified as a jurisdictional wetland, and has a 30.5-m (100 ft) setback since it is located in terrain with a moderately steep slope of 8%–15%.

High Pasture

Feature 10 on the High Pasture site is a pond identified as a jurisdictional wetland, and has a 30.5-m (100 ft) setback since it is located in terrain with a moderately steep slope of 8%–15%.

Rogers

Feature 11 on the Rogers site is a pond with a small jurisdictional wetland identified along the southeast border. It has been assigned a 30.5-m (100 ft) setback due to slopes to the north in excess of 15%. Feature 12 is a karst feature/sinkhole that also has a 30.5-m (100 ft) setback. It is defined as a functional wetland, which the wetlands walk over survey recommended be afforded the same measure of protection as that of a jurisdictional wetland due to the moderate to steep slopes surrounding it.

Watson Road

The Watson Road area feature numbers discussed below refer to those listed in Fig. 5, and designated setbacks are depicted on Fig. 4.

Feature 13 is an area near an unnamed stream. Because the designated sensitive area is sufficiently far (>100 ft) from the stream, the buffer boundary runs concurrently and is as protective or more than the 30.5-m (100 ft) setback. Feature 14 is an area of drainage to the unnamed stream and similarly has a sensitive area boundary sufficiently large that it runs concurrently with its setback boundary. Feature 15 is a dry conveyance, meaning that it is dry for most of the year but can convey water in a rain event. Feature 16 is a pond identified as a jurisdictional wetland. Due to the relatively flat slope in this area, Feature 16 is designated with a 10-m (33 ft) setback, except to the east where the boundary extends beyond 33 ft to a wooded area. Feature 17 is a pond with a 10-m (33 ft) setback.

Table 19. Summary of setbacks for protected areas on the ORR biosolids land application sites

Map feature number*	Site name	Protected area (type of wetland if applicable)	Latitude	Longitude	Setback
1	Scarboro	Pond (functional)	35º 59′ 5″	-84º 13′ 40″	30.5 m (100 ft) upgradient; 10 m (33 ft) downgradient
2	Scarboro	Wet weather ditch (functional)	35º 58′ 54″	-84º 13′ 37″	10 m (33 ft)
3	Scarboro	Pond (jurisdictional)	35º 59′ 9″	-84º 13′ 42″	30.5 m (100 ft)
4	Scarboro	Pond with sinkhole (functional)	35º 59′ 22″	-84º 13′ 45″	30.5 m (100 ft)
5	Scarboro	Pond	35º 58′ 23″	-84º 13′ 62″	10 m (33 ft)
6	Scarboro	Pond	35º 58′ 58″	-84º 13′ 67″	10 m (33 ft)
7	Upper Hayfield #2	Pond (jurisdictional)	35º 58′ 56″	-84º 14′ 0″	30.5 m (100 ft)
8	Upper Hayfield #1	Wet weather ditch	35º 59′ 23″	-84º 14′ 03″	10 m (33 ft)
9	Upper Hayfield #1	Wet weather ditch	35º 59′ 43″	-84º 14′ 96″	10 m (33 ft)
10	High Pasture	Pond (jurisdictional)	35º 58′ 34″	-84º 14′ 45″	30.5 m (100 ft)
11	Rogers	Pond (jurisdictional)	35º 58′ 45″	-84º 14′ 29″	30.5 m (100 ft)
12	Rogers	Karst feature with sinkhole	35º 58′ 35″	-84º 14′ 75″	30.5 m (100 ft)
13	Watson Road	Area near unnamed stream	35º 57′ 65″	-84º 21′ 80″	30.5 m (100 ft)
14	Watson Road	Drainage to unnamed stream	35º 57′ 27″	-84º 21′ 94″	30.5 m (100 ft)
15	Watson Road	Dry conveyance	35º 57′ 95″	-84º 21′ 61″	30.5 m (100 ft)
16	Watson Road	Pond (jurisdictional)	35º 57′ 1″	-84º 21′ 35″	10 m (33 ft)
17	Watson Road	Pond (functional)	35º 57′ 0″	-84º 21′ 36″	10 m (33 ft)

*Feature numbers refer to Figs. 3 and 5 from Sect. 1.4 and the Appendix C maps.

Summation

While the source of the 500-ft setback previously assigned to surface water features (DOE/EA-1356) is uncertain, it is assumed that it was assigned to be conservatively protective, as the majority of the biosolids product at that time was a liquid, applied with a water cannon. A vegetative cover, or no mow zone, was not established. For reference, the 2001 TDEC guidelines specify a 200-ft setback for spray application. Again, a vegetative cover was not included in the recommendations. However, the 2010 TDEC guidelines do recommend the presence of a vegetative cover, as well as specifying a 100-ft setback upgradient of the surface water features for sloped application areas, and 33-ft downgradient, for all forms of product. In this proposed action, DOE will designate a vegetative cover, no mow or maintenance zone, of approximately 10 m (33 ft) around surface water and sensitive habitats indentified in the surveys. The vegetative cover areas will not be marked in the field, unless they coincide with the setbacks, to avoid creating a mowing hazard.

The 2010 TDEC guidance does not distinguish between a liquid or solid product in its recommendations. While the majority of the biosolids product that is the subject of this proposed action is expected to be

solid, the program will consider product of varying percent solid content for land application. For low percent solids product, special care will be taken to avoid conditions that would increase the potential for contamination of surface water features, such as windy or high precipitation conditions. Additionally, biosolids will not be stored on the sites prior to application.

The proposed setback amendments reflect the results of the surveys, conform to the requirements of 40 *CFR* Part 503, and follow the recommendations set forth in the TDEC guidance for land disposal of biosolids (TDEC 2010). For surface water features, they reflect whether an application is made up-gradient or down-gradient of a surface water feature and address the slope of the terrain adjacent to a given feature. Additionally, the presence of a buffer zone with a vegetative cover serves to further minimize the potential for runoff to any waters of the state. The cumulative effect of these recommended administrative and engineered controls, when applied to the appropriate field conditions, will be setbacks that are protective of the environment and the public.

4.1.1 Regional Demography/Socioeconomics

The proposed action would not result in a net change in employment since the proposed actions will not require any net change in personnel to operate the existing Biosolids Land Application Program.

4.1.2 Environmental Justice

As discussed in Sect. 3.3.5 regarding EO 12898, federal agencies must achieve environmental justice by identifying and addressing, disproportionately high and adverse human health or environmental effects of activities on minority and low-income populations. Adverse health effects may include bodily impairment, infirmity, illness or death. Adverse environmental effects include socioeconomic effects, when those impacts are interrelated to impacts on the natural or physical environment.

Environmental justice impacts occur if minority or low-income populations incur adverse effects due to a particular action, in this case the proposed action, where a minority population is defined as any census tract in which minority representation is greater than the national average of 30.7%. Only one of the census tracts near the ORR currently includes a minority population greater than the national average of 30.7%. As of the 2000 census, minorities represented 40.1% of the population in Tract 201 (USCB). No federally-recognized Native American group lives within 50 miles of the ORR.

The Sanitary Biosolids Land Application Program operations are conducted on the ORR near Y-12 and the ETTP. The only minority community located in close proximity to active application operations is the Scarboro Community. This African-American community is located within 2 miles of the active ORR land application sites near Y-12. Located in east Oak Ridge, it is bounded to the west by East Fork Ridge and to the east by Pine Ridge. It is a small urban community of approximately 650 individuals that is located approximately 457 m (1500 ft) northwest of Y-12 along the ORR boundary. The community occupies an area of approximately 101 ha (250 acres). Land in the Scarboro Community was cleared and divided into lots ranging in size from approximately 0.1 to 0.20 ha (0.25 to 0.5 acre). The Scarboro Community Center Park and various churches and small businesses are also located in the Scarboro Community.

No adverse impacts, either health or environmental, to minority or low-income populations are expected as a result of implementing the proposed action as described in this EA. There are no measureable dose or risk impacts to any on-site or off-site receptors resulting from the proposed action. All of the biosolids application sites are located on the ORR and fenced off from the public, and mitigating measures are incorporated, in the form of setbacks, to avoid exposure to wetlands and floodplains. Because the areas in

use are not directly adjacent to any minority community and no off-site contamination is expected, no minority community should encounter any adverse impact as a result of the proposed action.

4.1.3 Archaeological, Cultural, and Historical Resources

In compliance with Sect. 106 of the National Historic Preservation Act, the DOE consulted with the State Historic Preservation Officer (SHPO) regarding impact of the original biosolids land application operation in the 1996 EA (DOE/EA-1042). The SHPO response was in agreement with the DOE's determination that the biosolids project would have no effect on properties included on, or eligible for, inclusion on the National Register of Historic Places. Since the Biosolids Program proposed action only uses existing application sites already considered under the 1996 EA determination, no further consultation is necessary since no archaeological, cultural, and historic resources will receive any adverse impact as a result of the application program.

4.1.4 Geology and Soils

The land application of biosolids at the six active sites using amended setbacks is not expected to have any impact on site geology or soils. Setbacks range from 10 m (33 ft) for areas with relatively low slopes, to 30.5 m (100 ft) for areas with moderate to steep slopes, in accordance with TDEC guidance to be protective of soils and groundwater (TDEC 2010). Transport of contaminants from the land application of biosolids to groundwater is extremely unlikely unless channels or fissures exist in the soil matrix. For this reason, biosolids application is not permitted near rock outcrops, sinkholes, or other geologic features that would lend themselves to act as channels to groundwater. Inorganic compounds, heavy metals, and other trace parameters in the biosolids site soils were evaluated as a part of a previous EA (DOE/EA-1042) and were found to have no significant impact.

Eliminating the lifetime loading limit will have no adverse effect, as the cumulative metals loading limits prescribed in 40 *CFR* Part 503 will still be observed, thereby protecting the public and environment from potential adverse impacts. Cumulative loading levels of ten heavy metals are tracked as a part of the program to ensure that they are below the cumulative heavy metals loading limits required by 40 *CFR* Part 503. Tables 5–10 present the cumulative heavy metal loading levels through 12/31/2006 for each site and compare them to those concentration ceiling values in 40 *CFR* Part 503, Table 1. As one can see, the actual loading levels are well below EPA limits.

Table 20. Heavy metal loading levels for the Upper Hayfield #1 site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.23	41	0.6%
Cadmium	0.40	39	1.0%
Chromium	7.20	-	NA
Copper	29.70	1500	2.0%
Lead	4.53	300	1.5%
Mercury	0.66	17	3.9%
Molybdenum	1.07	-	NA
Nickel	2.81	420	0.7%
Selenium	0.41	100	0.4%
Zinc	91.52	2800	3.3%

Table 21. Heavy metal loading levels for the Upper Hayfield #2 site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.26	41	0.6%
Cadmium	0.46	39	1.2%
Chromium	7.82	-	NA
Copper	31.41	1500	2.1%
Lead	4.62	300	1.5%
Mercury	0.74	17	4.4%
Molybdenum	0.55	-	NA
Nickel	2.29	420	0.5%
Selenium	1.96	100	2.0%
Zinc	100.50	2800	3.6%

Table 22. Heavy metal loading levels for the High Pasture site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.31	41	0.7%
Cadmium	0.54	39	1.4%
Chromium	7.89	-	NA
Copper	38.77	1500	2.6%
Lead	4.37	300	1.5%
Mercury	0.60	17	3.5%
Molybdenum	0.68	-	NA
Nickel	4.03	420	1.0%
Selenium	2.02	100	2.0%
Zinc	102.68	2800	3.7%

Table 23. Heavy metal loading levels for the Rogers site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.25	41	0.6%
Cadmium	0.60	39	1.5%
Chromium	18.31	-	NA
Copper	46.18	1500	3.1%
Lead	10.50	300	3.5%
Mercury	1.11	17	6.5%
Molybdenum	3.17	-	NA
Nickel	5.45	420	1.3%
Selenium	0.50	100	0.5%
Zinc	132.62	2800	4.7%

Table 24. Heavy metal loading levels for the Scarboro site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.25	41	0.6%
Cadmium	0.43	39	1.1%
Chromium	6.91	-	NA
Copper	27.51	1500	1.8%
Lead	3.80	300	1.3%
Mercury	0.65	17	3.8%
Molybdenum	0.68	-	NA
Nickel	2.22	420	0.5%
Selenium	1.76	100	1.8%
Zinc	88.67	2800	3.2%

Table 25. Heavy metal loading levels for the Watson Road site vs. 40 *CFR* Part 503.13 (b)(2) limits

Heavy metal	Cumulative pollutant loading levels as of 12/31/06 (kg/ha)	40 *CFR* Part 503.13 Cumulative loading limits (kg/ha)	Percentage of allowable loading attained
Arsenic	0.27	41	0.7%
Cadmium	0.48	39	1.2%
Chromium	7.27	-	NA
Copper	28.34	1500	1.9%
Lead	4.31	300	1.4%
Mercury	0.53	17	3.1%
Molybdenum	0.50	-	NA
Nickel	2.08	420	0.5%
Selenium	1.99	100	2.0%
Zinc	88.87	2800	3.2%

4.1.5 Water Quality

4.1.5.1 Surface pathway to groundwater

One potential pathway for contaminants to be transported off-site is from the surface to groundwater receptors. In 40 *CFR* Part 503, the concentration limits for contaminants of concern are derived from extensive fate and transport and exposure modeling. This modeling is documented in the *Technical Support Document for Land Application of Sewage Sludge* (EPA 822/R-93-001b). Fourteen exposure pathways were modeled, including migration of metals from the application site to groundwater. The results established that metals applied to the surface within the prescribed regulatory limits result in minimal impact to groundwater due to the strong tendency of the metals to bind with the upper few centimeters of a clay column. Radionuclides of concern in this proposed action are metal species and thus their transport is retarded by the upper few centimeters of the soil column. This retardation and retention of the metals in the upper layer of the soil and the vadose (unsaturated) zone result in minimal impact to the groundwater from contaminants of concern. Pathogens are similarly not considered to pose a threat to groundwater, as research indicates that pathogens from Class B biosolids are degraded through sunlight and attenuation within a short amount of time.

Nitrogen does not pose a threat to groundwater since biosolids applications are limited by the calculated agronomic loading rate, resulting in no excess nitrogen available for transport to groundwater or off-site receptors.

4.1.5.2 Surface pathway to surface water

Pathogenic, chemical, and radiological contaminants in biosolids applied to land may be transported by surface runoff to receiving waters such as streams, ponds, or wetlands. Potential adverse effects from exposure to these contaminants could occur in aquatic organisms in the surface water or in humans or animals drinking the water or consuming food organisms living in the water. Nitrogen or other nutrients in the biosolids could also have potential adverse effects on surface water quality should these nutrients reach excessive levels in the water. Most of the application sites on the ORR have a heavy herbaceous cover and reduction of runoff has been directly related to the density of vegetative cover on the site (DOE/EA-1042). The use of setbacks, heavy vegetative cover, avoidance of excessive slopes, and natural attenuation of the Class B solids will substantially reduce any threat to surface waters on or near active land application sites.

Similar to the groundwater pathway, because the biosolids are applied at a rate determined by the agronomic loading rate, there will not be excess nitrogen available for transport to surface water features either on-site or off-site. Organic compounds resulting from the land application of City biosolids have not been found to accumulate in active land application sites and would not pose a threat to surface and ground waters, given the existing program management practices.

Although some small surface water features are present at a number of sites, no adverse impacts are expected due to the reasons listed above and because setbacks that conform to the regulatory requirements set forth in 40 *CFR* Part 503.1 and the recommendations of the TDEC biosolids application guidance (TDEC 2010) are used to minimize the threat of exposure to contaminants. Additionally, prior to the initial TDEC approval of these sites in 1983, a detailed hydrogeological evaluation of each site was completed which documented the suitability of the sites for the land application of biosolids. Best management practices for biosolids management, as documented in 40 *CFR* Part 503.14, restrict the application of biosolids application during precipitation events or when the ground is frozen or flooded, thereby minimizing the likelihood of runoff. Avoiding areas with excessive slope (i.e., >15%) also eliminates a major risk factor for runoff to occur.

None of the biosolids application sites are located in wetlands. Jurisdictional and functional wetlands are present within all of the sites, as documented in the most recent wetlands survey conducted as a part of this EA (Tables 2 and 4). In consideration of TDEC biosolids land application guidance, a 30.50 m (100 ft) buffer has been established around these wetlands, which will be marked in the field to ensure that biosolids appliers will recognize their borders and not inadvertently apply into the wetlands or too closely to their borders.

The 40 *CFR* Part 503 regulations prohibit the land application of biosolids within any area designated as a floodplain. None of the land application sites are located within a 100-year floodplain.

4.1.5.3 City of Oak Ridge POTW discharge to EFPC

Heavy metal and radionuclide contaminants typically partition to the solid phase that is land-applied, as opposed to the water phase that exits the City of Oak Ridge NPDES discharge point to lower EFPC (City of Oak Ridge, NPDES Permit, 2001). This is based upon historical data collected since the program began in 1983 and the fact that most metals and long-lived radionuclides have a higher density and typically weigh more than water. As a conservative measure to simulate worse case environmental impacts from the proposed action, predictive modeling, RESRAD modeling, and risk assessment scenarios (DOE/EA-1356) assume 100% of the radionuclides and heavy metals would partition to the solid phase and thus, be land-applied on the ORR. The sludge management sections of the City NPDES permits require adherence to the 40 *CFR* Part 503 limits for heavy metals. Although radionuclide monitoring for treated discharges through the City of Oak Ridge NPDES discharge point is not required by TDEC or EPA, monthly samples of the City biosolids will be analyzed for the radionuclides listed in Table B.1 of Appendix B until the data evaluation indicates that this activity may cease or be conducted at a reduced frequency.

4.1.6 Floodplains and Wetlands

As stated earlier, federal regulatory requirements as presented in 40 *CFR* Part 503, TDEC guidelines (TDEC 2010), and site selection criteria (DOE/EA-1042) specifically prohibit biosolids application in wetlands or 100-year floodplains. During the original hydrogeologic evaluation of the land application sites, floodplains were not identified within any of the active sites. Biosolids application will not take place within a 100-year floodplain, or in any wetland.

As detailed in the wetlands survey conducted in May 2010, five jurisdictional wetlands and four functional wetlands were identified across the six active sites. Jurisdictional wetlands were identified based upon protocols outlined in the *United States Army Corps of Engineers Wetlands Delineation Manual* (Y-87-1). These protocols consider such things as general hydrologic conditions of the area, relative dominance of hydrophilic plants, and soil and sediment characteristics to make a determination. For the biosolids application sites specifically, three criteria had to be met to be afforded the status of jurisdictional wetlands (see also Sect. 3.8):

- Visible signs of wetlands hydrology. (The areas either had standing water at the time of the site visit, or there were physical clues such as watermarks or channels that indicate the area was frequently inundated.)
- Wetland-type soil, gleyed or mottled soils, which were compared to color chips for the evaluation.
- Wetland-type vegetation. In the application sites, these species were predominantly herbaceous.

The results of the evaluation are summarized in Table 6 and illustrated in Figs. 3 and 5.

The four functional wetlands did not meet all three of these criteria in some measure, but were considered to perform the same functions of a wetland in that they served as habitat for amphibians, birds, and other wildlife. Consequently the wetlands survey recommended that these areas be afforded the same degree of protection as the jurisdictional wetlands. Thus, as presented in Figs. 2 and 4, each of these has a minimum 10-m (33 ft) setback established around them.

4.1.7 Climate and Air Quality

No air quality impacts have been identified for the proposed action. Minor odor problems have been reported from a few past biosolids application sites located immediately adjacent to public access highways. Because of the remoteness of most of the six active application sites, no odor problems to the public would be expected. An air dispersion model was performed as a part of the environmental assessment (DOE/EA-1356). The modeling simulates the on-site exposure of a person standing on a biosolids application site, inhaling fugitive radioactive particulates downwind during application.

Results are listed in Table 26.

Table 26. Air dispersion modeling results to an on-site receptor

Radionuclide	Air activity (pCi/m^3)	Dose (mrem/yr)
^{60}Cobalt	8.33×10^{-8}	1.12×10^{-8}
^{137}Cesium	3.23×10^{-8}	7.21×10^{-10}
^{235}Uranium	6.23×10^{-9}	5.35×10^{-7}
^{238}Uranium	7.24×10^{-7}	8.33×10^{-5}

The maximum exposure of an individual breathing the biosolids as they are land-applied 260 operational days per year, 8 hours each day, is 0.00008 mrem/yr. This level is considered to be negligible. As emissions travel off-site, the concentration of radionuclides drops substantially, resulting in an even lower exposure to an off-site individual.

4.1.8 Ecological Resources

The proposed action is not expected to cause adverse impacts to any biota at the application sites. Amended setbacks follow recommendations set forth in TDEC biosolids land application guidance (TDEC 2010) to be protective of water resources and wildlife. Adherence to the cumulative metals loading ceilings in 40 *CFR* Part 503 ensures that the environment will be protected even with the elimination of the 50 ton/acre lifetime loading limit. Some short-term impacts to wildlife would be realized, but would be limited to minimal physical disturbance as a direct result of the application vehicles on the site.

4.1.8.1 Listed Species

Impacts to any state or federally-listed species from the proposed action would be minimized through adherence to the application regulations set forth in 40 *CFR* Part 503, the recommendations developed during the listed species survey, and the 2010 TDEC guidance for land application of biosolids.

Vehicular traffic required to spread biosolids could potentially impact vertebrate habitats. Nests established in the grassy areas where biosolids are applied would be subject to disturbance by traffic and biosolids application. Currently tractors mow the fields twice per year, generally in late spring (May) and late summer (August). The application process used will call for the biosolids to be trucked over to the application sites and dumped at a central location where a front-end loader will then fill the manure

spreader. All of these vehicles pose a potential, albeit small, threat to wildlife on the ground through direct contact with them. Tree dwelling species, such as birds, would have little risk of adverse impact from the presence of vehicle traffic on the application sites.

Application of biosolids pose the potential to increase heavy metal concentrations in the soils and thus bioaccumulate in certain biota, such as earthworms that are then eaten by shrews and birds. However, as previously stated, the ORR Biosolids Application Program shall adhere to the conservative heavy metals loading limits set forth in 40 *CFR* Part 503, which will minimize any possibility of adverse effects to biota from heavy metals.

According to the most recent listed species survey report (Appendix D) these fields do not provide potential habitat for listed plant species. A plant survey was conducted as part of the previously completed biosolids application EA and no listed plant species were identified (DOE/EA-1356). Habitats in adjacent areas, such as forests and ridges, may provide the potential for listed plants to exist. These adjacent areas would be protected from impacts from the biosolids application with the maintenance of the proposed buffers between the application fields and the surrounding habitats.

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained (DOE/EA-1356). For the six study areas, this means they are mowed twice yearly to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass. This habitat, although limited in value to many listed species (i.e., forest-dependent species), would be beneficial to others (i.e., species dependent on open field habitats).

The ORR biosolids application sites provide suitable habitat for 11 listed species, including five birds (cerulean warbler, northern harrier, sharp-shinned hawk, vesper sparrow, yellow-bellied sapsucker), four mammals (gray bat, Indiana bat, southeastern shrew, and meadow jumping mouse), one salamander (four-toed salamander) and one fish (Tennessee dace).

The gray bat and Indiana bat are federally-endangered and are discussed below. At the request of the U.S. Fish and Wildlife Service, a biological assessment (BA) was performed in 2002 to evaluate the specific impacts of the proposed actions upon the federally endangered gray and Indiana bats, as documented in the 2003 EA (DOE/EA-1356). Many of the conclusions of the BA are still valid. The results of the BA were that neither of these species would be expected to be impacted, if present, due to restrictions regarding the application of biosolids within 500 ft of a U.S. Waterway, the extremely low levels of radionuclides found in application site soils and plant tissues that have been observed through program monitoring, and the low occurrence of potential roosting habitat (e.g., caves, exfoliating trees) on the active application sites. Specifically, the BA found that the proposed action would be unlikely to adversely impact the gray bat for the following reasons:

- The absence of caves from the ORR application sites, reducing the likelihood of roosting habitat.
- The absence of large water bodies present on the application sites, reducing the likelihood of foraging habitat.
- The rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils and vegetation, reducing the likelihood of accumulation of radionuclides within insects that consume vegetation and represent a food source for the gray bat (DOE/EA-1356).

- The established buffer zone of 500 ft around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with the gray bat, if present.

Because the first three reasons are still valid under the proposed action, a reduced buffer around waters of the state would likely still not adversely impact the gray bat. Besides the gray bat and Indiana bat, two state-listed mammals may use the biosolids application areas. These two species are southeastern shrew and meadow jumping mouse. The southeastern shrew is a species within the Soricidae family that lives in forests near wet areas. Buffering will protect the forest habitats needed for this shrew. The meadow jumping mouse prefers moist grasslands near ponds or streams. Buffering the ponds will protect it from the biosolids application. Similar to the vesper sparrow, impacts to this mouse will be minimized by avoiding mowing operations from May to August to allow completion of the breeding cycle. Impact from machinery used on the fields for the application of the biosolids, maintenance of the fields, etc. would occur; however, impact will be minimized if mowing does not occur during the meadow jumping mouse breeding cycle.

The four-toed salamander prefers vernal ponds and forest habitats for key portions of its life cycle. The ponds on the biosolids application sites will be protected by the proposed buffers. The adjacent woodlands to vernal ponds are important to salamanders, such as the four-toed salamander. Such a pond and woodland habitat occur in the middle of the Scarboro site and thus, this area is also protected by a buffer in the proposed action.

Tennessee dace are reported as living in the unnamed creek adjacent to the Watson Road site (Fig. 4). This unnamed tributary is within the Aquatic Natural Area (ANA) 3 of the ORR. The buffer zone established near this unnamed creek should protect it from the runoff from the biosolids application fields, and protect the habitat of this Tennessee State fish species in need of management.

4.1.8.2 Plants and Habitats

Current habitats are similar to others areas on the ORR that include forest, stream, and pond habitat, with agricultural type uses interspersed. The ORR currently consists of predominantly forest habitat with some sparse urban and agriculture land as shown in f the document called “Oak Ridge Reservation Physical Characteristics” (Parr and Hughes 2006). Currently the biosolids application areas are maintained as field habitats that mimic, in many ways, agricultural fields. Surrounding these fields are forest, stream, intermittent stream, wetland, and pond habitats (Figures 2-5). Since these fields will be maintained to allow for the biosolids application, habitats and plants should change very little over the time period of the biosolids application. In addition, proposed unmowed vegetative buffers as presented in Table 15 will help to limit impacts to sensitive plant habitats. Therefore, no substantial impacts to current habitats or plant species are anticipated with the proposed action.

4.1.8.3 Animals

Animals observed during the walk over survey (see Section 3.8.1 and Appendix D) are typical of species observed in similar habitats on the ORR. As is the case with impacts to listed species noted in Section 4.1.8.1 above, impacts to non-listed wildlife from the proposed action would be minimized through adherence to the application regulations set forth in 40 *CFR* Part 503, the recommendations developed during the listed species survey, and the 2010 TDEC guidance for land application of biosolids.

As noted in Section 4.1.8.1 above, vehicular traffic could potentially impact vertebrate habitats. Nests established in the field areas where biosolids are applied would be subject to disturbance by traffic and biosolids application. Tractors mow the fields twice per year, generally in late spring (May) and late summer (August). All of these vehicles pose a potential, albeit small, threat to wildlife on the ground through direct contact with them.

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained (DOE/EA 1356). For the six study areas, this means they are mowed twice yearly to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass. This habitat, although limited in value to many species (i.e., forest dependent species), would be beneficial to others (i.e., species dependent on open field habitats).

Areas such as ponds, wet weather ditches, ponds with sinkholes, sinkholes, areas adjacent streams, drainages that lead to streams, dry conveyances, and forests will be protect by the proposed non-mowed vegetative buffers listed in Table 15. By protecting these features, wildlife such as small mammals, bats, birds, frogs, and salamanders dependent on these habitats and habitats adjacent to these features would benefit. In addition, impacts to wildlife dependent on the field habitats of the application sites would be minimized by avoiding mowing operations from May to August in order to allow the completion of the breeding cycle. Buffering of streams will also help protect fish from the runoff from the biosolids application fields.

No substantial impacts to non-listed wildlife species are anticipated from the proposed action.

4.1.9 Potential Radiological Impacts

As noted earlier, there are no federal standards for biosolids radiological content and land application areas.

Dose-based radionuclide concentration guidelines were developed as a part of the previous EA (DOE/EA 1356, 2003) using RESRAD modeling and assuming a 20-year program lifecycle. These guidelines, summarized in Appendix B, have been updated to reflect a 50-year program lifecycle. Conservative assumptions such as on-site farmers and pica (soil-eating) child receptors were used. The dose-based radionuclide planning levels were calculated to be protective of human health at a maximum dose of 10 mrem/year to the most exposed (conservative) individual. The 10 mrem/year criterion used is the same as in the *National Emission Standards for Hazardous Substances* regulations at 40 *CFR* Part 62 and lower than the 25 mrem/year limit for land disposal of radioactive wastes in the TDEC rules (TDEC Chapter 1200-2-11-.16).

The worker exposure to radionuclides scenario would be where a worker is exposed via incidental ingestion and inhalation of particulates while handling biosolids during both treatment and land application operations.

The human health risk analysis from DOE/EA-1356 (2003) concludes that the combined chemical and radiological risks to employees exposed to biosolids during the land application process are minimal at 4×10^{-7}, and are within DOE and EPA acceptable risk criteria (i.e., less than 1×10^{-4}). Non-carcinogenic risks were estimated to be <1, for both the worker and the trespasser, indicating that no adverse effects would be expected from exposure to biosolids or biosolid-amended soils.

Transients could be exposed to the biosolid-amended soils. The combined chemical radiological risks to transients exposed to soil are also minimal at 1×10^{-7} and within the DOE and EPA acceptable risk

criteria for excess lifetime cancer risk of $<1 \times 10^{-4}$. Non-carcinogenic risks were estimated to be <1, for both the worker and the trespasser, indicating that no adverse effects would be expected from exposure to biosolids or biosolid-amended soils.

Impact to human health for a resident farmer (conservative assumption) due to radiological exposure to 10 mrem/yr dose is within the acceptable risk criteria of 1×10^{-4}.

4.1.10 Transportation

The Biosolids Program will, on a typical day, make two trips to the application areas to deliver and apply biosolids. No unusual traffic conditions are expected that would pose an added risk for transportation. There is, however, ongoing construction on Oak Ridge Turnpike (Highway 95) to widen the road to two lanes in each direction; this impacts transportation to the Watson Road site in the form of slower traffic, due to construction zone speed limits, and interrupted flow of traffic, due to construction activity. In the unlikely event of a transportation-related spill, there would be little potential for contamination with the higher solids content biosolids as they would be relatively easy to contain and recover quickly. If a liquid product were to be spilled, it would have a higher potential for contaminating the environment, but it would be dealt with through the appropriate spill response plan implemented by the City. The notification requirements for a spill of biosolids or petroleum products are specified in *Application of Sanitary Biosolids on the Oak Ridge Reservation, Spill Response Plan, Oak Ridge Tennessee* (Bechtel Jacobs Company LLC [BJC]/OR-1218/R11).

Road Improvements in the Watson Road Area

A road improvement project was undertaken to upgrade the roads serving the Watson Road application site due to their degraded condition. The roads included were: Watson Road, the eastern section of Old County Road, and Salvage Yard Road. These roads were graded to remove any soft sediment buildup, with some areas receiving 2 in. of stone as a stabilizing base before applying a minimum of 6 in. of firmly compacted pug-mix stone over the entire roadways.

The ditches were reworked to improve drainage throughout the area. This included the reshaping and rerouting of some ditches that will not only improve the life of the road, but establish better defined drainage. Four corrugated metal culverts were also added under the road at various locations to aid in directing the drainage. Riprap was placed at all of the culvert outlets and inlets and in many drainage areas to help reduce erosion that could occur during heavy runoff conditions.

Access points into the fields from the roads were established to ensure the safe transition of loaded trucks delivering product into the fields.

Silt fencing and straw bales were used in the road upgrades to control sediment runoff, and the bare areas were seeded to prevent future erosion.

The environmental impact of these road improvements is small. Improved drainage from the ditch modifications, combined with mitigating measures such as riprap placed at the culvert outlets and inlets, will reduce the possibility of erosion on the sites. Overall the road improvement project will improve access to the sites and will not negatively impact any of the designated sensitive areas.

4.1.11 Human Health and Safety

Human health issues of concern are chemical contamination from the biosolids, particularly buildup of heavy metals in the soil, and the survival of residual pathogens (viruses, bacteria, parasites, and some fungi) in the biosolids and soil. The potential health impacts are summarized below.

Heavy metal concentrations in the biosolids are well below the ceiling concentration limits established by EPA in 40 *CFR* Part 503.13(b), Table 1, and the cumulative metal loading for the application sites is below the values in 40 *CFR* 503.13(b), Table 2. As detailed in the human health risk assessment for the biosolids land application sites, the hazard index (HI) for toxic (i.e., noncarcinogenic) effects from heavy metals is <1.0, which is within acceptable limits. For cancer effects, risks to an employee applying the biosolids and risks to a transient on the application site are also below the DOE and EPA acceptable value (DOE/EA-1356, 2003).

Activities associated with the transportation of the biosolids will be detailed in future TDEC land application submittals. This will include health and safety training for the operators, and a spill response plan which will be the responsibility of the City.

4.1.12 Accidents

Accidents during transportation to or from the application sites are possible, albeit unlikely. In the unlikely event of a transportation-related spill, the solid product could be easily recovered with minimal chance of posing a risk to the public or the environment from pathogens. Further, since heavy metal levels must meet EPA land application criteria prior to application, they do not pose a threat to humans or the environment, should a spill occur. The trace amount of radionuclides contained within the biosolids would produce a maximum exposure of 0.14 mrem/yr, with an associated risk of 4×10^{-7} to a worker, which is below the acceptable EPA and DOE limitations (DOE/EA-1356, 2003).

4.2 NO ACTION

Under this scenario it is assumed that nothing changes from the current program conditions, which have been evaluated in the previous environmental assessments listed in Table 1 of Sect. 1.2. Current setbacks of 500 ft from surface water would be observed, and the lifetime loading limit of 50 tons/acre would remain in effect. The impacts are as follows (Sect. 2.1):

- Due to the large setbacks in the no action scenario, there could be an even lower risk of contaminants migrating to surface water, groundwater, or off-site receptors, although this was not confirmed through soil or surface water testing.
- Total available biosolids application acreage would be decreased, significantly in some cases, such as would be the case for the Scarboro site.
- The lifetime loading limit would arbitrarily limit the program lifetime.

4.3 COMPARISON OF ALTERNATIVES

Table 27 presents the relevant information concerning both alternatives for basis of comparison.

Table 27. Alternatives comparison summary

Action	Summary	Impacts
Proposed Action: Amend current application buffers to conform with 40 *CFR* Part 503 and utilize 2010 TDEC biosolid applications guidance as appropriate; eliminate 50 ton/acre lifetime loading limit	• Protective of waters of the state • Extends program lifetime • Maximizes use of application sites	A small risk of contamination to surface water may exist from the closer proximity of the application area to surface water features. This is mitigated, however, through use of vegetative, no-mow buffer.
No Action: Continue biosolids application with 500-ft setback around waters of the state and 50 ft around potential routes to groundwater; continue with 50 ton/acre lifetime loading limit	• Lowers available application acreage • Eliminates a large portion of one site, Scarboro • Arbitrarily restricts useful life of each site	No increase in health, environmental, and transportation risks. Program has less acreage on which to apply biosolids. Program ceases in near future.

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5. POTENTIAL CUMULATIVE AND LONG-TERM IMPACTS

This section evaluates the impacts from the proposed action and the no action alternative, in combination with other unrelated actions that could result in adverse impact to the environment. Cumulative impact is defined as: "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." (40 *CFR* Part 1508.7, *Protection of the Environment*, "Cumulative Impact") The impact from multiple actions are considered to be cumulative based upon their contribution—however minor—to the proposed action in this EA.

Other actions that could impact the public or the environment could act synergistically with those potential impacts from the proposed action. Thus, any potential impacts from other actions in the area are considered and evaluated on a cumulative basis with the impacts presented in Sect. 4 of this EA.

Projects that would be considered relevant for consideration in cumulative impacts would be the ongoing remediation and decontamination and decommissioning (D&D) projects at Y-12, and the road-widening construction along Highway 95 (Oak Ridge Turnpike), north of the I-40 interchange.

5.1 CUMULATIVE IMPACTS BY RESOURCE AREA

5.1.1 Geology and Soils

The ceiling concentrations for heavy metals (Table 1, 40 *CFR* Part 503), the concentration guidance levels for radionuclides in the biosolids (Table B.1, Appendix B), and the comprehensive monitoring program are designed to prevent future environmental and public impact from biosolids land application on the ORR. The safety factor provided by the concentration guidance levels for radionuclides in biosolids, derived from the TDEC-approved, dose-based approach, ensures protection of the environment.

The proposed action should not result in any increased risk due to metals, radionuclides, or organics loading in the soils at the application sites. As discussed in Sect. 4, reducing the existing buffer zones to 10 m (33 ft) and 30.5 m (100 ft) and eliminating the lifetime loading limit should not adversely affect the soils, given the stringent biosolids monitoring required by EPA 40 *CFR* Part 503 and the maintenance of vegetative, no-mow, buffers around each sensitive area. Nitrogen loading to the soils will also remain unaffected by the changes in the proposed action, as it will continue to be limited by the agronomic application rate, updated with each biosolids sampling event, which accounts for the nitrogen from past applications, available nitrogen in the biosolids, and the plant requirements of the individual sites. No soils will be removed or excavated from the application sites in conjunction with any Y-12-related activities. Additionally, no construction activities are planned for any of these sites and, therefore, no potential cumulative effects from the proposed action are expected.

5.1.2 Water Resources

Implementation of the proposed action would not contribute cumulative adverse impacts to the surface water or groundwater of the ORR or surrounding communities. Section 4 evaluated the potential impacts of the reduced setbacks around surface water features on the application sites and concluded that with the combination of setbacks with vegetative cover, along with identification and protection of special features such as sinkholes, there is no increased risk of surface water or groundwater contamination from constituents in the biosolids product. Radionuclides are bound to the solid matrix of the biosolids and are

not readily released when the material is saturated. Restricting the application rate to meet the nitrogen requirements of the site vegetation protects the ORR waters from potential nitrogen contamination.

The proposed action would not contribute to surface water discharges that could occur from ongoing Y-12 remedial or D&D actions. No groundwater withdrawals are planned as any part of the proposed action. Additionally, there is not expected to be any interaction between the proposed action and any environmental restoration actions involving groundwater recovery or discharge. Since no chemical or radiological impacts to groundwater were identified as a result of the evaluation in Sect. 4, no cumulative impacts would be expected as well.

5.1.3 Ecological Resources

The implementation of the proposed action will have little effect on ecological resources. Wetlands and ecologically sensitive areas identified in the wetlands (Appendix C) and listed species (Appendix D) surveys are protected with ample setbacks, as recommended in the surveys and TDEC guidance (TDEC 2010), to ensure that wetlands and wildlife receive no adverse impacts as a result of biosolids application. Since activities at Y-12 similarly do not impact the wetlands or wildlife at the sites, no cumulative impacts to ecological resources are expected.

5.1.4 Cultural Resources

Since no cultural or historic resources have been identified on the ORR biosolids application sites, implementing the proposed action will not contribute to any cumulative effects on the archaeological resources of the ORR.

5.1.5 Air Quality

In the previous environmental assessment developed in 2003 (DOE/EA-1356), an air dispersion model was presented to evaluate the possible impacts from the formation of dust particulates at the point of application. The model simulated an on-site receptor inhaling fugitive radioactive particulates downwind during application.

The maximum exposure of an individual breathing the biosolids as they are land-applied for 260 operation days per year, 8 hours each day is 0.00008 mrem/yr. This corresponds to 0.01% of the total 0.7 mrem/yr off-site exposure received by an individual from cumulative operations conducted on the ORR or any concurrent projects in and around the application sites that have the potential to produce dust emissions (*Annual Site Environmental Report*, DOE/ASER). Thus, the proposed action would not be expected to adversely impact air quality in and around the ORR.

5.1.6 Socioeconomic

Environmental effects from the proposed action on the economy and surrounding communities of the ROI would be non-existent. The impact of amending the existing setbacks would not affect jobs, income, or the infrastructure. Thus, no cumulative impacts are expected as a result of the implementation of the proposed action.

5.1.7 Environmental Justice

As discussed in Sects. 3.3.5 and 4.1.2, no potential effects to environmental justice were identified from the proposed action. Similarly, no other projects are known to have a potential to contribute to cumulative effects.

5.1.8 Transportation

Implementation of the proposed action is not expected to impact the local traffic since there are no known changes to employment expected as a result of this action. As negligible increases in traffic are expected from the twice-daily trips to and from the application areas, no cumulative or long-term impacts to traffic are expected. Because access roads to the ORR biosolids land application sites are restricted from public use, there should be no cumulative impacts for this roadway access.

5.1.9 Land Use

The proposed action would not result in changes to land use because activities would occur on sites that have been in use since 1983 for biosolids land application activities. The net increase in useable acreage due to the proposed action will not affect land use.

5.1.10 Human Health and Safety

No operations included as a part of the proposed action would increase chemical or radiological risk since the processing is essentially similar to what was already being done on the sites. Some additional risk may be involved with increased transportation to and from the application sites, but any potential spills can be easily remediated with little or no risk to the worker, the public, or the environment.

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6. PERMIT AND REGULATORY REQUIREMENTS

Municipal biosolids are not regulated as a RCRA waste or as a radiological waste. Municipal biosolids are included in the solid waste exemption for domestic sewage provided in 40 *CFR* Part 261.4(a), "Identification and Listing of Hazardous Waste, Exclusions."

The EPA regulates the land application of municipal biosolids under *Standards for the Use or Disposal of Sewage Sludge*, 40 *CFR* Part 504, which were promulgated under section 405(d) and (e) of the CWA, 33 United States Code 1345(d), (e), as amended by the Water Quality Act of 1987. In these amendments to section 405 of the CWA, Congress issued a mandate to reduce the potential environmental risks and maximize the beneficial use of biosolids. Accordingly, the EPA established standards for biosolids use and disposal, including risk-based, metal-loading criteria for the receiving soil. As discussed in Sect. 1.3, the City applied biosolids to the ORR under EPA permit number TNL024155 until 2001, when the individual sludge-only permits were discontinued (*Guidelines for the Land Application and Surface Disposal of Biosolids*, TDEC 2001). The EPA Region 4 now considers the City to be self-implementing under 40 *CFR* Part 503.

Section 405(f) (1) of the CWA requires that any NPDES permit issued to a POTW must include conditions to implement the municipal biosolids regulations issued under section 405(d), unless permitted by a state authorized by EPA to administer the Biosolids Land Application Program. As the state of Tennessee is not currently an authorized state, the City NPDES permits, numbers TN0024155 and TN0078051, include implementation provisions in the sludge management sections.

The City received permission to use the application sites on the ORR through a land license agreement with DOE. The current agreement was effective beginning November 1, 2010 and will expire on October 31, 2015.

The TDEC-issued LAA letters to the City in 1983 and 1989. The ten-year period and the five-tons/acre/year application limit specified in the 1989 letter were used by the Sanitary Biosolids Land Application Program to develop the lifetime loading limit for the program of 50 tons/acre, presented for elimination in this proposed action. Establishment of a lifetime loading limit was considered a conservative best management practice, pending further guidance from TDEC. The May 2010 TDEC guidance for biosolids management found in *Guidelines for the Land Application and Surface Disposal of Biosolids*, along with concurrence from the state of Tennessee Biosolids Coordinator, support the elimination of the lifetime loading limit.

As discussed in Sect. 1.3, when the City has generated sludge suitable for land application, a formal request to TDEC will be submitted for LAA. This new approval will replace the 1983 and 1989 letter approvals and will reflect the 2010 TDEC guidance for biosolids management. Neither the TDEC approvals nor the guidelines are enforceable; however, as stated on page 5 of the guidelines: "These guidelines are not be construed as State Regulations…" and "Tennessee is not a delegated state to administer the Biosolids Program. Therefore, U.S. EPA Region is the permitting authority and is the legal authority to enforce the provisions of the Part 503 regulation." Although they are unenforceable, the TDEC guidance and approval are carefully considered and incorporated into the Biosolids Program.

The City's wastewater treatment plant receives discharges of radionuclides from state-licensed industrial facilities, a local hospital, and the Y-12 facility. There are no regulatory standards that establish acceptable concentrations for radionuclides in municipal biosolids. However, in an effort to ensure that the biosolids remain acceptable for long-term land application, the City established a dose-based methodology for determining acceptable radionuclide concentrations. The City obtained approval from

the TDEC Division of Radiological Health to develop sewer release criteria based on a dose rate of 10 mrem/year (DOE/EA-1356, Appendix A). Using the RESRAD computer code, radiological concentration guidelines for the site soils and the biosolids were developed and documented in environmental assessments conducted in 1996 (DOE/EA-1042) and 2003 (DOE/EA-1356). The proposed action modifies these documents to reflect a 50-year program life cycle, establish a list of radionuclides to be monitored in the Biosolids Program, and to establish an independent analysis of the biosolids for these radionuclides.

For the proposed action, no changes to the NPDES permits will be required. All conditions of 40 *CFR* Part 503 will be conducted, as implemented in the permits.

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APPENDIX A.
ORR BIOSOLIDS LAND APPLICATION PROGRAM CHARACTERIZATION DATA

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A.1 CITY OF OAK RIDGE BIOSOLIDS CHARACTERISTICS

This section discusses the characterization of the biosolids from the City of Oak Ridge POTW, which are being land-applied on the ORR. Biosolids characteristics discussed include constituent inorganic chemicals, heavy metals, organic chemicals, radionuclides, and pathogens as they relate to biosolids.

Inorganic Chemicals

The City of Oak Ridge biosolids will be sampled for classical inorganic chemistry parameters at the frequency specified in the NPDES permit and the TDEC land application guidelines. **Table A.1** presents the maximum levels of each required analyte found in the City's biosolids from 1996 to 2005.

Heavy Metals

Heavy metal sampling and analysis is based upon the total amount of biosolids produced by the POTW on an annual basis. The City currently produces between 900 and 1000 metric tons (dry weight) a year. Under the EPA 40 *CFR* Part 503 regulations, amounts greater than 290 metric tons a year require quarterly sampling. **Tables A.2** and **A.3** present the maximum concentration of each heavy metal in the City biosolids, as well as the maximum allowable concentration for each metal for the years 1996–2000, and 2001–2005, respectively. **Tables A.6 through A.11 provide the site profiles and cumulative loading statistics**

Organic Chemicals

The City's NPDES permit requires annual sampling of the biosolids for organic analytical parameters. **Table A.4** presents the results of selected organic compounds analysis for the City biosolids.

Radionuclides

Because of contributions of natural background radiation, atmospheric deposition, industrial operations, and various medical uses including medical diagnostics, all biosolids contain some radioactive material. Bulk gamma emitters are monitored by the POTW on a daily basis. The ORNL analyzed the biosolids for selected radionuclides (e.g. ^{60}Co, ^{137}Cs, ^{131}I, ^{235}U and ^{238}U) from composite samples on a quarterly basis until 2002, at which time such analysis was suspended. **Table A.5** presents the radiological characterization data for the Oak Ridge biosolids from 1996 to 2002. Radiological parameters that are naturally occurring remain fairly constant, while the constituent ^{131}I, a commonly used isotope for medical testing, shows spiking, which is to be expected. All of the constituents remain well below their respective planning levels.

Since data are not available after 2002, plotting the data lends some information regarding possible trends. As **Fig. A.1** illustrates, with the exception of ^{131}I, the trend is one of generally level, or decreasing radiological concentration in the biosolids. It is therefore reasonable to expect that if current conservative management practices, including daily gross gamma screening, are continued, that radiological concentrations on the ORR biosolids sites should remain low.

Independent testing of the City biosolids resumed in June 2010. A composite of City sludge at the stage prior to press introduction was prepared from aliquots collected over the course of the month and was analyzed by a commercial laboratory. This will continue on a monthly basis until the data evaluation indicates otherwise.

New concentration guidelines for radiological monitoring are presented in Appendix B.

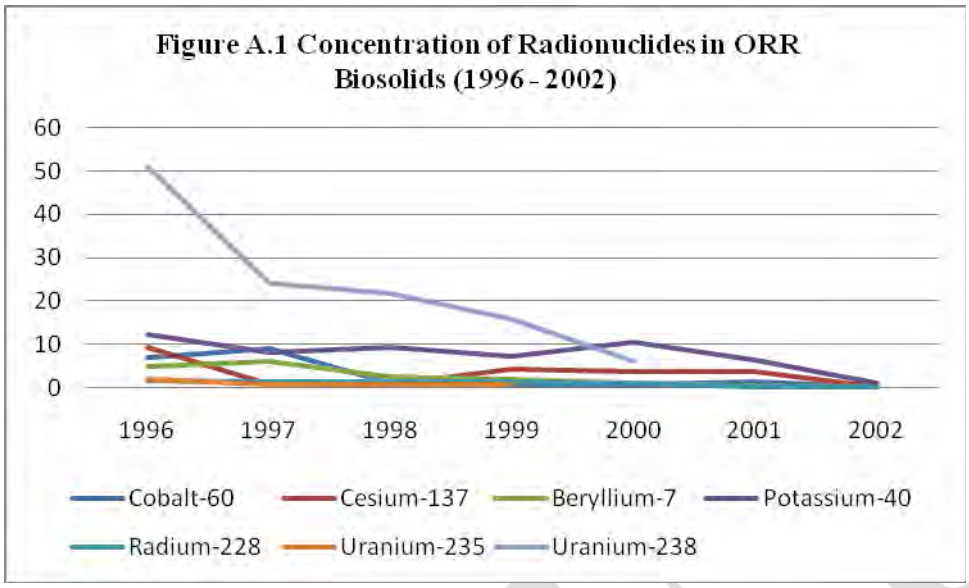
Figure A.1 Concentration of Radionuclides in ORR Biosolids (1996 - 2002)
60
50
40
30
20
10
0
1996
1997
1998
1999
2000
2001
2002
Cobalt-60
Cesium-137
Beryllium-7
Potassium-40
Radium-228
Uranium-235
Uranium-238

Table A.1. Inorganic parameters and analytical levels in City of Oak Ridge biosolids (1996–2005)

Analyte	Sampling frequency	1996 levels (mg/kg dry wgt) max	1997 levels (mg/kg dry wgt) max	1998 levels (mg/kg dry wgt) max	1999 levels (mg/kg dry wgt) max	2000 levels (mg/kg dry wgt) max	2001 levels (mg/kg dry wgt) max	2002 levels (mg/kg dry wgt) max	2003 levels (mg/kg dry wgt) max	2004 levels (mg/kg dry wgt) max	2005 levels (mg/kg dry wgt) max	2006 levels (mg/kg dry wgt) max
Ammonia-nitrogen	3/year	28,672	43,000	33,000	41,000	33,000	28,000	680	20,000	15,590	13,700	424
Manganese	3/year	1345	1900	1400	1100	880	,000	1200	1665	1520	1430	1690
Nitrate	3/year	250	220	920	1000	380	230	6.9	549	920	790	61.3
Nitrite	3/year	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Organic nitrogen	3/year	64,400	86,000	52,000	62,000	92,000	55,000	35,000	85,000	97,410	43,980	16,080
pH	3/year	8	8	8.4	7.9	7.2	10.2	9.0	7.0	7.3	6.0	6.3
Potassium	Daily	5510	7100	4600	6000	3500	5000	1500	4261	3270	2540	1590
Phosphorus	3/year	31,800	48,000	32,000	47,000	35,000	7000	37,000	9600	32,400	23,800	39,600
Total Kjedahl Nitrogen	3/year	89,100	120,000	87,000	97,000	93,000	83,000	35,000	99,000	113,000	57,680	16,500
Total Nitrogen	3/year	89,350	120,140	87,190	98,000	93,300	83,030	35,002	98,178	113,010	57,748.7	16,924
Total solids %	Daily	3.9%	3.6%	3.2%	3.2%	3.0%	56.7%	66.9%	4.1%	19.5%	3.1%	23.6%
Volatile solids (% of TS)	Daily	63%	63%	64%	63%	64%	65%	48%	82%	68%	52%	79%

Source: City of Oak Ridge

Table A.2. Concentrations of heavy metal levels in City of Oak Ridge biosolids (1996–2000) versus 40 *CFR* Part 503.13 limits

Heavy metal	40 *CFR* Part 503.13 limits	1996 (mg/kg)		1997 (mg/kg)		1998 (mg/kg)		1999 (mg/kg)		2000 (mg/kg)	
		mean	max	mean	max	mean	max	mean	max	mean	max
Arsenic	**75**	6.71	12.80	2.53	7.50	2.4	4.3	2.7	4.7	2.1	3.8
Cadmium	**85**	9.92	19.40	3.60	5.20	3.1	4.8	3.4	3.8	3.1	4.5
Copper	**4300**	361.70	520.00	430.80	570.00	479.2	700.0	484.4	570.0	510.8	620.0
Lead	**840**	32.52	74.00	38.00	74.60	33.6	63.0	36.6	43.0	36.2	48.0
Mercury	**57**	2.16	8.20	12.00	20.00	11.0	16.0	10.6	19.0	6.0	11.0
Molybdenum	**75**	23.00	54.00	7.00	13.00	10.1	21.0	15.8	21.0	13.9	26.0
Nickel	**420**	26.23	39.70	28.20	42.00	33.5	100.0	25.5	47.0	63.1	100.0
Selenium	**100**	10.29	18.20	1.70	301.00	3.1	7.0	8.6	14.0	8.4	15.0
Zinc	**7500**	887.00	1610.00	1404.00	1910.00	1209.0	1600.0	1150.0	1400.0	1039.0	1600.0

Source: City of Oak Ridge; all values on dry-weight basis

Table A.3. Concentrations of heavy metal levels in City of Oak Ridge biosolids (2000-2005) versus 40 *CFR* Part 503.13 limits

Heavy metal	40 *CFR* Part 503.13 limits	2001 (mg/kg)		2002 (mg/kg)		2003 (mg/kg)		2004 (mg/kg)		2005 (mg/kg)	
		mean	max	mean	max	mean	max	mean	max	mean	max
Arsenic	**75**	2.6	7.7	0.4	0.8	2.8	4.6	6.0	9.5	5.4	7.0
Cadmium	**85**	3.4	5.2	3.9	9.5	1.4	1.9	1.0	1.3	0.8	1.4
Copper	**4300**	584.4	680.0	418.0	610.0	710.4	869.0	725.5	843.0	632.0	768.0
Lead	**840**	46.9	63.0	18.2	26.0	40.4	52.2	25.9	34.6	30.1	37.4
Mercury	**57**	6.2	12.0	1.5	3.3	4.7	6.6	4.4	5.2	5.2	6.1
Molybdenum	**75**	14.7	20.0	3.5	7.9	9.4	14.2	18.5	29.8	31.1	38.9
Nickel	**420**	166.7	410.0	66.4	98.0	44.7	88.5	21.1	35.5	22.2	26.8
Selenium	**100**	7.6	12.0	9.7	18.0	12.4	29.0	9.6	13.2	4.8	5.1
Zinc	**7500**	1116.7	1500.0	602.0	920.0	940.8	1062.0	852.3	1070.0	826.5	1020.0

Source: City of Oak Ridge; all values on dry-weight basis

Table A.4. NPDES organic parameters and concentrations of organic constituents in City of Oak Ridge biosolids

Analyte	Sampling frequency	1996 levels (mg/kg dry wt) max	1997 levels (mg/kg dry wt) max	1998 levels (mg/kg dry wt) max	1999 levels (mg/kg dry wt) max	2000 levels (mg/kg dry wt) max	2001 levels (mg/kg dry wt) max	2002 levels (mg/kg dry wt) max	2003 levels (mg/kg dry wt) max	2004 levels (mg/kg dry wt) max	2005 levels (mg/kg dry wt) max	2006 levels (mg/kg dry wt) max
Aldrin	Annually	0.025	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.33
Chlordane	Annually	2.7	1.3	0.34	3.80	6.70	0.95	18.00	3.60	2.12	<0.20	<3.30
DDD	Annually	U	0.071	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
DDE	Annually	0.01	0.023	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
DDT	Annually	U	0.0071	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.33
Dieldrin	Annually	0.099	0.061	U	0.38	0.67	0.95	0.26	0.71	0.21	<0.02	<0.016
Heptachlor	Annually	U	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.33
Lindane (gamma-BHC)	Annually	U	U	U	0.38	0.67	0.95	0.26	0.36	0.21	<0.02	<0.066
PCBs	Annually	U	U	U	7.70	N/A	19.0	35.00	0.46	1.10	<0.066	<0.066
Toxaphene	Annually	U	U	U	7.70	13	19.0	35.00	7.10	4.24	<0.40	<3.30
Trichloroethene	Annually	U	U	U	0.038	0.17	0.24	0.44	0.005	0.05	<3.30	<0.005
Benzo(a)pyrene	Annually	U	1.0	U	13	11	-	<3.30	--	-	-	-
Dimethylnitrosamine (n-nitroso-di-methylamine)	Annually	U	U	U	13	11	-	-	-	-	-	-
Hexachlorobenzene	Annually	U	U	U	13	11	0.24	0.44	0.005	0.05	<3.30	<0.005
Hexachlorobutadiene	Annually	U	U	U	13	11	-	-	-	-	-	-

Source: City of Oak Ridge
U = Undetected

Table A.5. Concentrations of radionuclides in City of Oak Ridge biosolids (1996–2000)

Radionuclide	Planning level	1996 (pCi/g)		1997 (pCi/g)		1998 (pCi/g)		1999 (pCi/g)		2000 (pCi/g)		2001 (pCi/g)		2002 (pCi/g)	
		mean	max	mean	max	mean	max	mean	max	mean	max	mean	max	mean	max
^{60}Co	10.7	0.46	7.05	0.51	8.96	0.52	1.17	0.51	0.80	0.48	0.81	0.57	1.38	0.0868	0.150
^{137}Cs	43.6	0.80	9.24	0.31	0.85	0.36	0.69	2.07	4.17	1.88	3.80	1.47	3.68	0.064	0.143
^{131}I	-	35.70	103.00	21.60	86.20	9.46	32.60	8.52	44.80	5.70	40.10	34.58	127.82	6.967	16.029
^{7}Be	-	2.72	5.05	1.70	6.15	1.30	2.69	1.08	1.89	0.72	1.09	0.18	0.55	0.142	0.214
^{40}K	120.0	7.19	12.30	6.19	8.08	6.04	9.27	5.86	7.24	5.67	10.43	3.68	6.46	0.803	1.211
^{228}Ra	20.7	1.13	1.69	1.01	1.42	0.97	1.51	0.84	1.36	0.62	0.99	0.13	0.31	0.156	0.260
^{235}U	157.0	0.75	1.85	0.35	0.71	0.33	0.83	0.36	0.73	ND	ND	NA	NA	NA	NA
^{238}U	459.5	13.30	51.00	8.00	24.20	10.60	21.90	7.62	15.70	2.58	6.20	NA	NA	NA	NA

Source: City of Oak Ridge; all values dry-weight basis
ND = not detected
NA = not available

Pathogens

Class A biosolids have pathogen contents that are below detection limits and are therefore suitable for use in home gardens or distribution to the community. Class B solids have a pathogen content that makes it suitable to be applied in bulk form to agricultural land, forest, reclamation sites, or public sites where physical and temporal buffers exist to provide for natural attenuation and processes to reduce pathogen levels sufficiently within a short amount of time, to prevent adverse impacts to the environment.

Class A or Class B biosolids, with varying percent solids content, may be land-applied on the ORR. The City of Oak Ridge POTW is currently developing a process to produce Class B biosolids. Whether biosolids are applied in liquid or solid form, existing program limits for heavy metals, nitrogen, and radionuclides are all calculated on a dry-weight basis. For this reason, all analytical results, calculations for risk assessment, and RESRAD modeling involving biosolids will be done on a dry-weight basis and will cover both liquid or solid materials.

Class B biosolids are well suited for land application on the ORR because the existing access restrictions further support additional time for environmental attenuation. Class A biosolids have fewer restrictions regarding how and where they can be applied, but result in higher treatment costs to meet Class A standards.

A.2 OAK RIDGE RESERVATION LAND APPLICATION SITE CHARACTERISTICS

This section discusses the six ORR sites currently utilized for biosolids application by the City of Oak Ridge. Site profile sheets are provided in Tables **A.6** through **A.11,** which present physical characteristics of the sites, nitrogen-loading, heavy metal, and radionuclide-loading levels. They also present relevant NEPA characteristics, such as threatened and endangered species, wetlands, etc.

The profiles document the vegetation type and nitrogen requirements for each site. The agronomic loading limit takes into account previous applications of biosolids, nitrogen compound levels obtained from analysis of the biosolids, and the nitrogen growth needs of the vegetation found on the application site. The plant-available nitrogen (PAN) is calculated to determine annual vegetation nitrogen needs. The calculation is presented below.

Plant Available Nitrogen = (MR)(Organic Nitrogen) + (VR)(Ammonia Nitrogen) + Nitrate Nitrogen

Where,

MR = the mineralization rate, which is the rate at which organic nitrogen is released as readily available nitrogen

VR = the volatilization rate, which is the rate at which ammonia nitrogen is released directly to the atmosphere without being utilized by plants.

This calculation is revised as new nitrogen analyses are performed. By using this methodology, all available nitrogen is utilized by the plants to sustain growth, eliminating the threat of excess nitrogen as a potential groundwater contaminant.

Table A.6. Upper Hayfield #1 site profile information

General site information	
Land application site name	Upper Hayfield #1
Gross acres	30
Application area in acres	7
Application area in hectares	2.84
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	None
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre *(Source: National Resources Conservation Services [NRCS], 2003)*

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.23	41	0.6%
Cadmium	0.40	39	1.0%
Chromium	7.20	-	-
Copper	29.70	1500	2.0%
Lead	4.53	300	1.5%
Mercury	0.66	17	3.9%
Molybdenum	1.07	-	-
Nickel	2.81	420	0.7%
Selenium	0.41	100	0.4%
Zinc	91.52	2800	3.3%

Table A.7. Upper Hayfield #2 site profile information

General site information	
Land application site name	Upper Hayfield #2
Gross acres	27
Application area in acres	8
Application area in hectares	3.24
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth Requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels			
Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.26	41	0.6%
Cadmium	0.46	39	1.2%
Chromium	7.82	-	
Copper	31.41	1500	2.1%
Lead	4.62	300	1.5%
Mercury	0.74	17	4.4%
Molybdenum	0.55	-	
Nickel	2.29	420	0.5%
Selenium	1.96	100	2.0%
Zinc	100.50	2800	3.6%

Table A.8. High Pasture site profile information

General site information	
Land application site name	High Pasture
Gross acres	46
Application area in acres	14
Application area in hectares	5.67
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.31	41	0.7%
Cadmium	0.54	39	1.4%
Chromium	7.89	-	-
Copper	38.77	1500	2.6%
Lead	4.37	300	1.5%
Mercury	0.60	17	3.5%
Molybdenum	0.68	-	-
Nickel	4.03	420	1.0%
Selenium	2.02	100	2.0%
Zinc	102.68	2800	3.7%

Table A.9. Rogers site profile information

General site information	
Land application site name	Rogers
Gross acres	32
Application area in acres	22
Application area in hectares	8.91
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland); Karst feature (functional wetland)
Vegetation	Orchard Grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.25	41	0.6%
Cadmium	0.60	39	1.5%
Chromium	18.31	-	-
Copper	46.18	1500	3.1%
Lead	10.50	300	3.5%
Mercury	1.11	17	6.5%
Molybdenum	3.17	-	-
Nickel	5.45	420	1.3%
Selenium	0.50	100	0.5%
Zinc	132.62	2800	4.7%

Table A.10. Scarboro site profile information

General site information	
Land application site name	Scarboro
Gross acres	77
Application area in acres	45
Application area in hectares	18.23
Soil type	Fullerton association (reddish brown, silty, residual clays w/chert fragments)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.25	41	0.6%
Cadmium	0.43	39	1.1%
Chromium	6.91	-	-
Copper	27.51	1500	1.8%
Lead	3.80	300	1.3%
Mercury	0.65	17	3.8%
Molybdenum	0.68	-	-
Nickel	2.22	420	0.5%
Selenium	1.76	100	1.8%
Zinc	88.67	2800	3.2%

Table A.11. Watson Road site profile information

General site information	
Land application site name	Watson Road
Gross acres	117
Application area in acres	34
Application area in hectares	13.77
Soil type	Armuchee (silt loam, moderately deep shale) and Colbert (silty clay loam)
Soil density	1.6 g/cm^3
Threatened and endangered species	None
Designated wetlands on-site	Pond (jurisdictional wetland)
Vegetation	Orchard grass
Vegetation nitrogen growth requirement	120 lb/acre (*Source*: *NRCS, 2003*)

Calculated site chemical-loading levels

Parameter	Calculated cumulative level as of 12/31/06 (dry wgt)	40 *CFR* Part 503, Table 2 limit (kg/ha)	% Limit
Arsenic	0.27	41	0.7%
Cadmium	0.48	39	1.2%
Chromium	7.27	-	-
Copper	28.34	1500	1.9%
Lead	4.31	300	1.4%
Mercury	0.53	17	3.1%
Molybdenum	0.50	-	-
Nickel	2.08	420	0.5%
Selenium	1.99	100	2.0%
Zinc	88.87	2800	3.2%

APPENDIX B.
RADIOLOGICAL CONCENTRATION GUIDELINES

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Table B.1. Soil guidelines and sludge limits

Radionuclide	Soil concentration guideline (pCi/g dry wgt)	Sludge limit (pCi/g dry wgt)[a]	Source for soil guideline
^{232}Th		0.97	DOE/EA-1779
^{241}Am	7.7	23	DOE/EA-1042
^{60}Co	1.3	25	DOE/EA-1356
^{137}Cs	5.2	25	DOE/EA-1356
^{152}Eu	2.8	24	DOE/EA-1356
^{155}Eu	99.0	5500	DOE/EA-1356
^{3}H	520	4500	DOE/EA-1042
^{40}K	5.5	16	DOE/EA-1042
^{237}Np	1.5	4.3	DOE/EA-1042
^{231}Pa	0.81	2.3	DOE/EA-1042
^{210}Pb	2.5	15	DOE/EA-1042
^{238}Pu	9.1	32	DOE/EA-1042
^{239}Pu/^{240}Pu	8.3	24	DOE/EA-1042
^{226}Ra	0.11	0.32	DOE/EA-1042
^{228}Ra	0.95	23	DOE/EA-1042
^{99}Tc	35.5	102	DOE/EA-1042
^{228}Th	0.66	34	DOE/EA-1042
^{229}Th	1.5	4.3	DOE/EA-1042
^{230}Th	14.8	43	DOE/EA-1042
234U	98	280	DOE/EA-1356
235U	22	63	DOE/EA-1356
238U	120	350	DOE/EA-1356
^{54}Mn	5.4	650	DOE/EA-1356
^{65}Zn	3.5	520	DOE/EA-1356
^{90}Sr	3.2	16	DOE/EA-1356
^{134}Cs	2.3	110	DOE/EA-1356
^{154}Eu	2.6	18	DOE/EA-1356

[a] Calculated based on 50-year program life cycle

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September 2010 Update

City of Oak Ridge Radionuclide Limits for Land Applied Sludge

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September 13, 2010

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Calculation of Updated Radionuclide Limits for Land-Applied Sludge

The City of Oak Ridge's existing radionuclide limits for land-applied sludge were based on the assumption of a 20-year land application period and an application rate of 4 tons/acre. In this report, the City's limits have been updated to correspond to a 50-year application period at a rate of 7 tons/acre.

The sludge limits are based on: (1) the soil concentration guidelines in Table B.2, (2) the amount of dilution expected on the application site (i.e., mixing of sludge into soil), and (3) the amount of loss that will occur due to radioactive decay during the land application period.

The sludge limits are calculated as follows:

On a per acre basis, the total quantity of a radionuclide, Q_a (pCi), that can be present in the land application site soil at the time residency begins is the soil concentration guideline multiplied by the corresponding soil mass, which is 9.15×10^5 kg (9.15×10^8 g), assuming a mixing depth of 0.15 m and a soil density of 1500 kg/m^3.

$$Q_a = C_{soil_a} \times m_{soil}$$

C_{soil} = Concentration limits for radionuclide "a" in soil, (pCi/g)

m_{soil} = mass of soil in top 0.15 m of one acre, (g)

For a given radionuclide, the total activity that can be land-applied, I_a, annually on a per acre basis, assuming a constant input, without exceeding the corresponding soil concentration guideline, can be calculated as follows:

$$I_a = \frac{Q_{a(t)}\lambda}{(1 - e^{-\lambda t})}$$

I_a = Annual allowable input quantity (total activity) per acre (pCi/year)

$Q_{a(t)}$ = Quantity (total activity) of radionuclide "a" per acre in top 15 cm at time, t (pCi)

λ = decay constant (years^{-1})

t = time (50 years)

The annual allowable input quantity, I_a, can then be converted to a sludge limit, SL_a, by dividing the quantity by the mass of sludge land-applied on a per acre basis each year (7 dry tons per acre per year or 6.36×10^6 g):

$$SL_a = \frac{I_a}{m_{sludge}}$$

SL_a = Sludge limit for radionuclide "a"

I_a = Annual allowable input quantity

m_{sludge} = Mass of sludge land applied annually (g)

Table B.2. City of Oak Ridge land application sludge limits (September 2010 Update)

Radionuclide	Soil concentration guideline (pCi/g dry wgt)	Sludge limit[a] (pCi/g dry wgt.)	Soil guideline dose basis
^{227}Ac	0.56	3.2	4 mrem/yr
^{241}Am	7.7	23	4 mrem/yr
^{152}Gd	19.6	56	4 mrem/yr
^{3}H	520	4500	4 mrem/yr
^{40}K	5.5	16	4 mrem/yr
^{237}Np	1.5	4.3	4 mrem/yr
^{231}Pa	0.81	2.3	4 mrem/yr
^{210}Pb	2.5	15	4 mrem/yr
^{238}Pu	9.1	32	4 mrem/yr
$^{239/240}$Pu	8.3	24	4 mrem/yr
^{226}Ra	0.11	0.32	4 mrem/yr
^{228}Ra	0.95	23	4 mrem/yr
^{99}Tc	35.5	102	4 mrem/yr
^{228}Th	0.66	34	4 mrem/yr
^{229}Th	1.5	4.3	4 mrem/yr
^{230}Th	14.8	43	4 mrem/yr
^{232}Th[b]	NA[b]	0.97	4 mrem/yr
^{54}Mn	5.4	650	10 mrem/yr
^{60}Co	1.3	25	10 mrem/yr
^{65}Zn	3.5	520	10 mrem/yr
^{90}Sr	3.2	16	10 mrem/yr
^{134}Cs	2.3	110	10 mrem/yr
^{137}Cs	5.2	25	10 mrem/yr
^{152}Eu	2.8	24	10 mrem/yr
^{154}Eu	2.6	18	10 mrem/yr
^{155}Eu	99	5500	10 mrem/yr
^{234}U	98	280	10 mrem/yr
^{235}U	22	63	10 mrem/yr
^{238}U	120	350	10 mrem/yr

[a] Fifty years of land application at an application rate of 7 dry tons per acre

[b] Based on dose source ratio (DSR) for 50-year application period for on-site resident from *ISCORS Assessment of Radioactivity in Sewage Sludge: Modeling to Assess Radiation Doses* (NUREG-1783, EPA 832-R-03-002A, DOE/EH-0670). The ISCORS DSR was adjusted to reflect an application rate of 7 dry tons per acre per year.

APPENDIX C.
SUMMARY OF SETBACKS, WETLANDS WALK OVER SURVEY REPORT OF THE BIOSOLIDS APPLICATION AREAS (JUNE 2010), AND ORR BIOSOLIDS LAND APPLICATION SITE MAPS

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Table C.1 Summary of setbacks (buffers) for protected areas on the ORR biosolids land application sites

Map feature number*	Site name	Protected area (type of wetland if applicable)	Latitude	Longitude	Setback
1	Scarboro	Pond (functional)	35º 59′ 5″	-84º 13′ 40″	30.5 m (100 ft) upgradient; 10 m (33 ft) downgradient
2	Scarboro	Wet weather ditch (functional)	35º 58′ 54″	-84º 13′ 37″	10 m (33 ft)
3	Scarboro	Pond (jurisdictional)	35º 59′ 9″	-84º 13′ 42″	30.5 m (100 ft)
4	Scarboro	Pond with sinkhole (functional)	35º 59′ 22″	-84º 13′ 45″	30.5 m (100 ft)
5	Scarboro	Pond	35º 58′ 23″	-84º 13′ 62″	10 m (33 ft)
6	Scarboro	Pond	35º 58′ 58″	-84º 13′ 67″	10 m (33 ft)
7	Upper Hayfield #2	Pond (jurisdictional)	35º 58′ 56″	-84º 14′ 0″	30.5 m (100 ft)
8	Upper Hayfield #1	Wet weather ditch	35º 59′ 23″	-84º 14′ 03″	10 m (33 ft)
9	Upper Hayfield #1	Wet weather ditch	35º 59′ 43″	-84º 14′ 96″	10 m (33 ft)
10	High Pasture	Pond (jurisdictional)	35º 58′ 34″	-84º 14′ 45″	30.5 m (100 ft)
11	Rogers	Pond (jurisdictional)	35º 58′ 45″	-84º 14′ 29″	30.5 m (100 ft)
12	Rogers	Karst feature with sinkhole	35º 58′ 35″	-84º 14′ 75″	30.5 m (100 ft)
13	Watson Road	Area near unnamed stream	35º 57′ 65″	-84º 21′ 80″	30.5 m (100 ft)
14	Watson Road	Drainage to unnamed stream	35º 57′ 27″	-84º 21′ 94″	30.5 m (100 ft)
15	Watson Road	Dry conveyance	35º 57′ 95″	-84º 21′ 61″	30.5 m (100 ft)
16	Watson Road	Pond (jurisdictional)	35º 57′ 1″	-84º 21′ 35″	10 m (33 ft)
17	Watson Road	Pond (functional)	35º 57′ 0″	-84º 21′ 36″	10 m (33 ft)

*Feature numbers refer to Figs. 3 and 5 from Sect. 1.4 and the Appendix C maps

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Wetlands Walk Over Survey Report of the Biosolids Application Areas

Date Issued – June, 2010

Prepared by
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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

An Environmental Assessment (EA), DOE/EA-1356, was issued in February 2003 for the Biosolids program on the Oak Ridge Reservation (ORR) and a finding of No Significant Impact (FONSI) was issued. The Department of Energy (DOE) proposes to modify the Biosolids program, which will result in several changes not analyzed in DOE/EA-1356. The analysis included in DOE/EA-1356 is based on a wetlands survey conducted in 1996. However, an informal survey conducted in 2009 identified potential additional wetland areas. CDM was contracted to perform a formal wetlands survey for all six active application sites (Table 1) and an analysis of potential impacts to all wetlands. This information will be included in a new EA to be prepared as directed by the Environmental Assessment Determination (EAD) issued by DOE on February 10, 2010.

Table 1. Oak Ridge Reservation biosolids land application sites (1996 Survey)

Site name	Gross acreage (ac)	Hectares (ha)
Upper Hayfield #1	30	12.15
Upper Hayfield #2	27	10.93
High Pasture	46	18.62
Watson Road	117	47.37
Scarboro	77	31.17
Rogers	32	12.96

1.2 BACKGROUND

The topography of the application areas varies from steep ridged slopes to relatively flat lying floodplains. Karst features and rock outcrops are common. The majority of the application areas are well drained due to the slopes and high relief, but low relief, poorly drained areas are common. The ORR includes a wide variety of habitats. These include hardwood forest, pine forest, mixed hardwood/pine forest, pine plantations, open grass/agricultural fields, ponds (both permanent and vernal), streams, wetlands, and industrial areas. Approximately 70% of the ORR is in natural or planted forest. Because of their unique protected status by association with the ORR facilities, several areas of these habitats and associated wildlife have received limited human disturbance since 1942. The ORR was designated as a unit of the Southern Appalachian Biosphere Reserve within the United Nations' Man and the Biosphere Program. The ORR has also been established as a Wildlife Management Area under a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA) and includes the 20,000-acre Oak Ridge National Environmental Research Park and several state Natural Areas.

Aquatic habitats on the ORR include small streams, Bear Creek, East Fork Popular Creek, the Clinch River, and several scattered ponds. Several species of fish, reptiles, and amphibians are found in these areas.

All six of the biosolids application sites are open grassland field areas surrounded, for the most part, by woodlands. The sites are devoid of caves, perennial streams, and large bodies of water. Small ponds and vernal ponds occur on all six of the locations. These features provide ecological habitat for amphibians, as well as other wildlife. Two of the locations (Rogers and Scarboro) include rock outcrop features and sinkholes. Boundaries of the application sites are dominated by mature hardwood tree species that provide suitable habitat for a wide variety of plant and animal species.

The Clean Water Act (CWA) prohibits significant discharges of pollutants, including those from municipal sewage sludge, into waters of the state without a permit authorizing these discharges. Under the CWA, 40 *CFR* 503 regulates the disposal of municipal sewage sludge. Unlike many other aspects of the CWA, the state of Tennessee does not enforce the Section 503 requirements directly. Instead, these requirements for the treatment and disposal of sewage sludge are included in the National Pollutant Discharge Elimination System Permits that the state of Tennessee issues to sewage treatment facilities. All activities must be in compliance with the requirements of these regulations and permits. In addition, the state of Tennessee has published guidance for the protection of surface water and wetlands during land application operations. (*Guidelines for the Land Application and Surface Disposal of Biosolids. Tennessee Department of Environment and Conservation Division of Water Pollution Control,* June 2001). The guidance considers the nature of the biosolids, method of application, the slope of the land receiving the biosolids, and proximity of surface water of wetlands.

2. METHODOLOGY

2.1 ECOLOGICAL WALK OVER SURVEYS

Ecological walk over surveys were conducted at the six active sites (High Pasture, Rogers, Upper Hayfield #1, Upper Hayfield #2, Scarboro, and Watson Road) for biosolids application. Aerial map (figures) of the six proposed locations were developed. These figures include the delineation of potentially ecologically sensitive features with proposed buffers.

Ecological features such as ponds, wetlands, vernal ponds, streams, rock outcrops, sinkholes, fields, and forests were checked on each site. A map of the ORR, depicting 15 ponds and wetlands within the Bethel Valley sludge application areas was used for initial planning. All 15 of these areas were also field checked. Observations were recorded in order to develop the figures showing the ecological features. Surface water bodies were documented on the area maps. Suspected wetlands areas were investigated using protocols outlined in the *United States Army Corps of Engineers Wetlands Delineation Manual* (Y-87-1). Hydrology of the area, relative dominance of hydrophilic plant species, and soil and sediment characteristics were all considered in the wetlands determinations.

For the biosolids area study, key characteristics looked for in the field were:

- Visible signs of the wetlands hydrology (the areas either had standing water at the time of the investigation, or there were physical clues such as watermarks, channels, and so on that indicated that the area was frequently inundated)
- Wetland type soil (gleyed or mottled soils), which were compared to color chips for the evaluation
- Wetland-type vegetation. In the areas in question, these species were predominantly herbaceous.

Potential wetlands must meet all three criteria in order to be afforded the status of jurisdictional wetlands.

2.2 PREVIOUS INVESTIGATIONS

Documents of previous investigations were reviewed, including DOE/EA-1356 with the results of the 1996 Science Applications International Corporation investigation, and the relevant Resource Management Plans for the ORR (ORNL/NERP-7 and -8, 1993). These studies identified several wetlands in and near the application areas. All of these areas were included in the 2010 walk over surveys.

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3. OBSERVATIONS

3.1 GENERAL OBSERVATIONS

While there are no major streams that are adjacent to or run through the existing land application sites, the ORR biosolids land application sites have a number of small tributaries and streams that exist in wooded areas and boundaries of the active sites. These tributaries are protected by buffer zones that prohibit the land application of biosolids material.

There are a number of ponds, depressions, and other areas of internal drainage. Some of the ponds are old farm ponds. Other ponds were formed when roadbeds blocked wet weather conveyances. Due to the steep slopes across much of the region, very few natural ponds are found in the application areas. Some of the depressions are located in mowed fields, and are otherwise indistinguishable from the surrounding fields. Largely due to the steepness of the slopes in many of the application areas, even the depressed areas are often well drained, or form ephemeral ponds. Only a few (6) of the potential wetlands areas were found to meet all of the criteria of a jurisdictional wetlands (Table 2). Most of these wetlands areas are associated with small ponds. All of the jurisdictional wetlands noted in this survey are small and isolated wetlands. The locations of these jurisdictional wetlands are documented on the maps. These areas will be marked in the field with flagging to assist both maintenance and application personnel in avoiding these areas.

Table 2. Jurisdictional wetlands on Oak Ridge Reservation biosolids land application sites (2010 Survey)

Site name	Latitude	Longitude
High Pasture	35º 58′ 34″	-84º 14′ 45″
Rogers	35º 58′ 45″	-84º 14′′ 29″
Upper Hayfield #1 and Upper Hayfield #2	35º 58′ 56″	-84º 14′ 0″
Scarboro	35º 59′ 9″	-84º 13′ 42″
Watson Road	35º 57′ 1″	-84º 21′ 35″

Several other areas did not meet all three criteria for jurisdictional wetlands, but still functioned as wetland areas. It is recommended that these areas receive the same protection afforded to the jurisdictional wetlands. These areas are also marked on the appropriate maps.

3.1 SPECIFIC JURISDICTIONAL WETLAND AREAS

3.1.1 High Pasture (Figs. 1 and 2)

- A small wetland well within the application area.
- Completely surrounded by a buffer of briers, small trees, and grasses.

- The slope of the surrounding area is relatively steep (slopes in the 8-15% range to the west), increasing the probability of runoff from biosolids applied upslope from the wetland entering the wetlands.

Fig. 1. High Pasture Wetlands (35º 58′ 34″, -84º 14′ 45″).

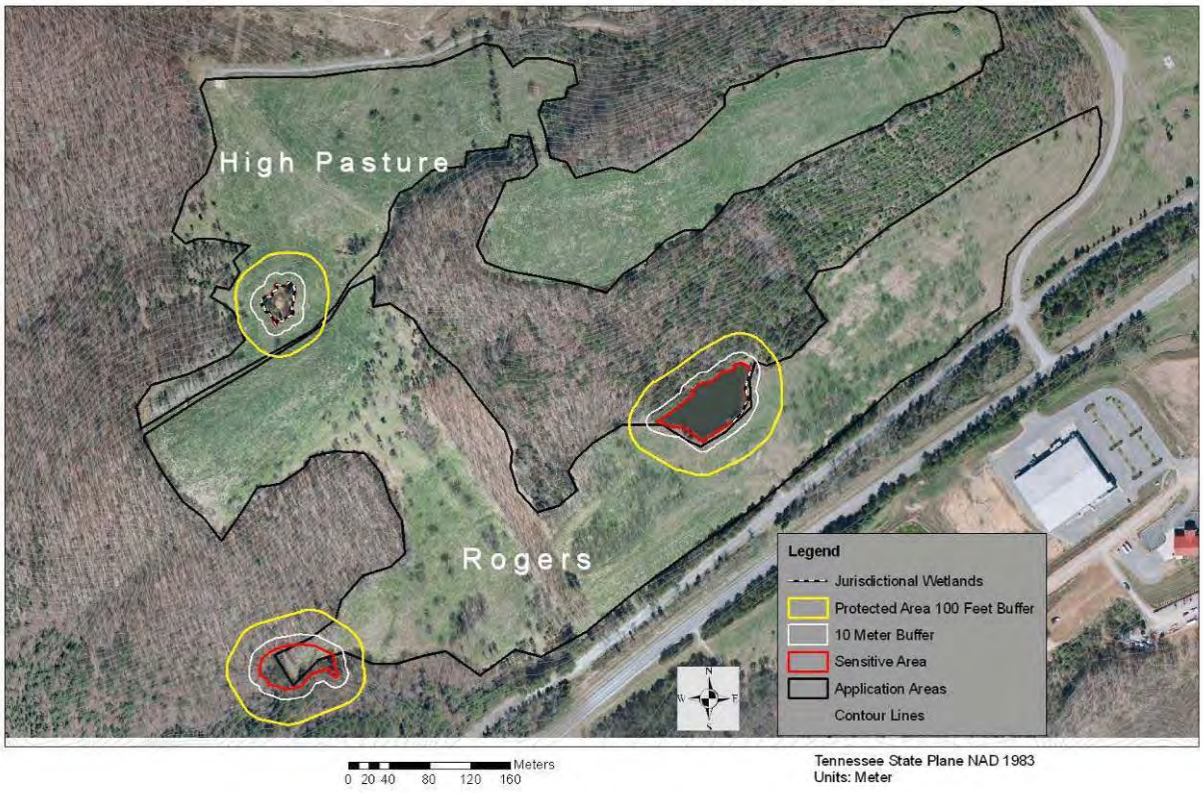

Fig. 2. High Pasture and Rogers area.

3.1.2 Rogers (Figs. 2 and 3)

- A small jurisdictional wetland area associated with a large pond. The pond is located north of, and on the upslope edge of, the application area.
- The wetland skirts the southern and eastern edge of the pond (Fig. 2), and follows a small stream that drains out of the pond to the east.
- The wetland is unlikely to be seriously impacted by biosolids applied south (down slope) of the pond, although application to the area immediately to the west of the pond increases the probability of runoff entering the pond. The slope in this area is estimated to be in excess of 15% to the northwest of the pond.

Fig. 3. Rogers wetlands (35° 58′ 45″, -84° 14′ 29″).

3.1.3 Upper Hayfield #1/Upper Hayfield #2 (Figs. 4 and 5)

- Small, discontinuous wetland associated with a permanent pond. The wetland is restricted to a thin line around the edges of the pond.
- The pond lies within Upper Hayfield #2.
- Steep slopes surrounding the pond increase the probability of runoff from the application areas entering the pond and wetland if a substantial buffer is not applied. These slopes are estimated to range from 8-15%.

Fig. 4. Upper Hayfields wetlands (35º 58′ 56″, -84º 14′ 0″).

Fig. 5. Upper Hayfields wetlands area.

3.1.4 Scarboro (Figs. 6 and 7)

- The area noted in Fig. 6 and the middle of Fig. 7 is very small, and probably ephemeral.
- This area serves as habitat for several species of amphibians.
- The slopes immediately surrounding this area are moderate (0 – 8% range).

At the time of the investigation, the vegetative buffer was thin, and was less than 10 m.

Fig. 6. Scarboro wetland (35° 59′ 9″, -84° 13′ 42″).

Fig. 7. Scarboro wetland area.

3.1.5 Watson Road Wetlands (Figs. 8, 9 and 10)

In the Watson Road area, two small areas were noted that met the criteria for jurisdictional wetlands (Figs. 8 and 9). These areas are located within the application area fields. Neither area had a vegetative buffer zone at the time of the investigation

3.1.5.1 Watson Road-East Wetlands (Figs. 8 and 9)

- The eastern area was very small, and a subsequent site walk showed that it had dried out since the initial inspection.
- At the time of the site walk, there was no apparent vegetative buffer.
- Slopes immediately surrounding the area are very gradual.
- At the time of the initial site walk, this wetland served as habitat for amphibians.
- This area was not identified in the earlier reports.

3.1.5.2 Watson Road-West Wetlands (Figs. 9 and 10)

- The western wetland, although small, is larger and deeper than the eastern area.
- At the time of the site walk, there was no apparent vegetative buffer.
- Slopes immediately surrounding the area are very gradual (0 – 8% range).
- At the time of the initial site walk, this wetland served as habitat for amphibians.
- This area was not identified in the earlier reports.

Fig. 8. Watson Road-eastern wetlands area (35º 57′ 1″, -84º 21′ 35″).

Fig. 9. Watson Road-western wetlands (35° 57′ 0″, -84° 21′ 36″).

Fig. 10. Watson Road-west wetlands.

3.2 Functional Wetland Areas

In addition to the jurisdictional wetlands described above, there are several areas that perform the function of wetlands. These areas, while not meeting all of the criteria for jurisdictional wetlands, serve as habitat for amphibians, birds, and other wildlife. Three significant functional wetlands are listed in Table 3. It is recommended that these three areas be afforded the same degree of protection as the jurisdictional wetlands.

Table 3. Functional wetlands on ORR biosolids land application sites (2010 Survey)

Site name	Latitude	Longitude
Scarboro	35º 59′ 5″	-84º 13′ 40″
Scarboro	35º 58′ 54″	-84º 13′ 37″
Scarboro	35º 59′22″	-84º 13′ 45″
Watson Road	35º 57′ 0″	-84º 21′ 36″

4. CONCLUSIONS

The biosolids application areas contain both surface water and wetlands areas. These areas are of variable ecological importance, and current conditions, such as vegetative cover or topography, make some areas more suitable than others for the proposed application of biosolids. While many areas (such as the Rogers wetlands area and the northern Scarboro pond) should receive little negative impact from the proposed operations, other areas will continue to need protection, at least at the current levels. The wetlands areas in the Bethel Valley area had been previously identified. However, the two wetlands identified in the Watson Road area had not been identified in the 1996 survey. Maps (Figs. 1-10) depict the sensitive areas (both jurisdictional and functional wetlands), as well as associated buffer zones. All of the wetland areas noted in this survey are presented on these maps.

Many of the areas proposed to receive the biosolids have steep slopes. In some cases, such as the High Pasture, Upper Hayfields #1 and #2, and Scarboro wetlands, the surface water and wetland areas are situated such that runoff of biosolids would be very likely to enter these areas if application occurs to the edge of the buffer zone. Figures 11 and 12 depict the slopes within the biosolids application areas. Figure 11 illustrates slopes in the 8-15% range near surface water features, and Rogers has slopes in excess of 15% near one of its ponds.

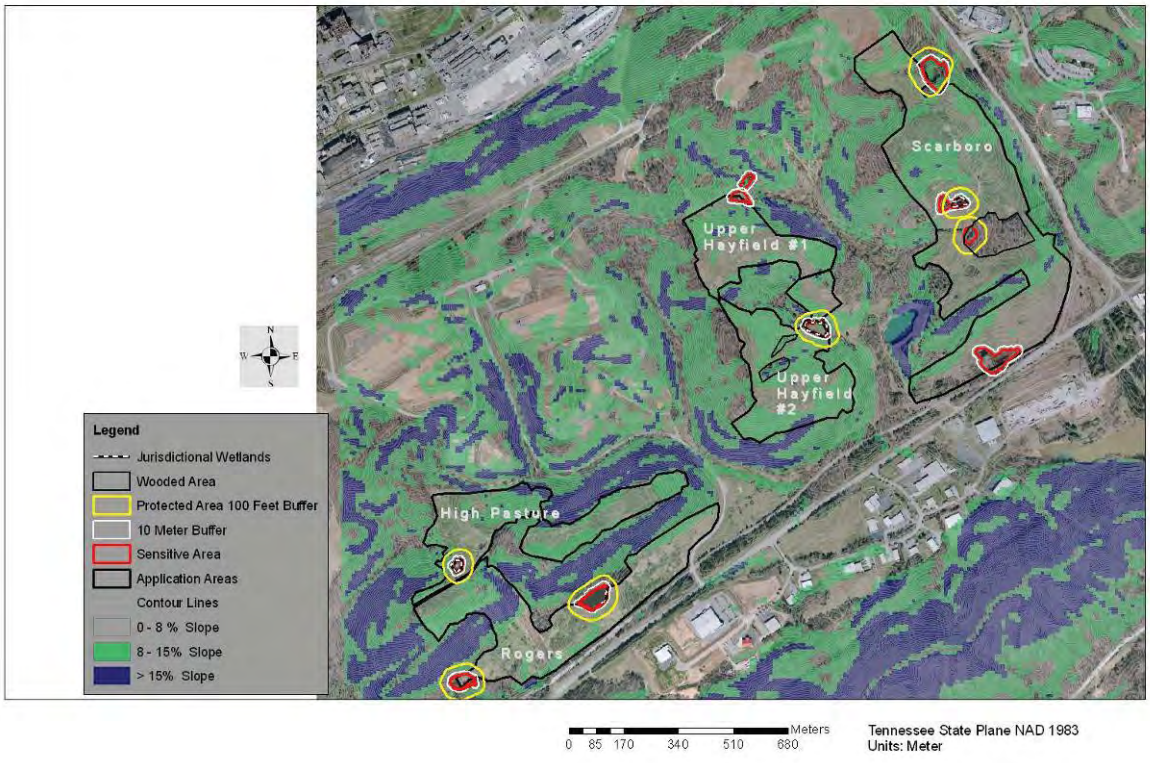

Fig. 11. Bethel Valley biosolids application area with slopes.

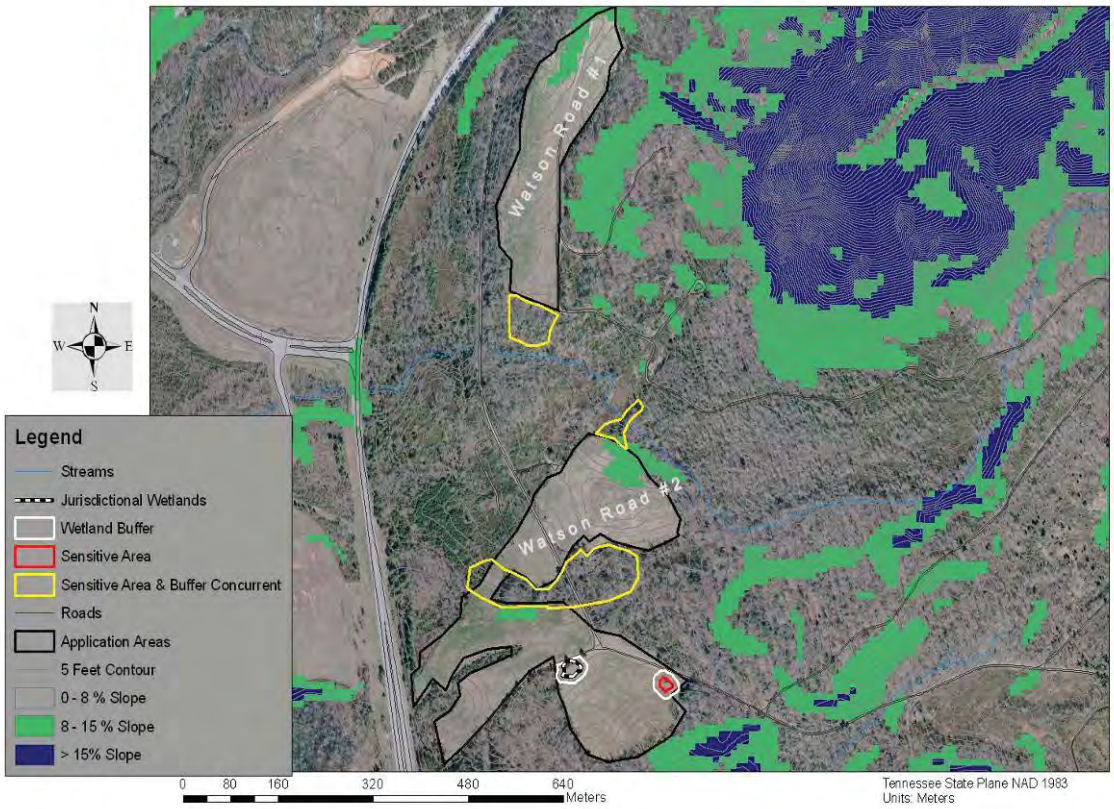

Fig. 12. Watson Road biosolids application area with slopes

5. RECOMMENDATIONS FOR MITIGATION

Recommendations for mitigation is as follows:

- Clearly delineate buffer areas of the wetlands shown on Figs. 1-3 and 5-10.
- Due to the potential for runoff from biosolids application, buffers greater than 10 m should be considered on areas with steep slopes leading into wetlands areas in the High Pasture, Upper/Lower Hayfields, and Scarboro Road application areas identified in this report.
- A 10-m buffer area is recommended as a no disturbance buffer. Disturbance from mowing, plowing, etc. should be prohibited within the buffer areas. By adopting and maintaining these areas as no disturbance buffer areas, impacts to wetland, creeks, drainages, ponds, and vernal ponds could be limited.

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6. REFERENCES

DOE 2003. *Environmental Assessment, Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation* (DOE/EA-1356). Oak Ridge, TN.

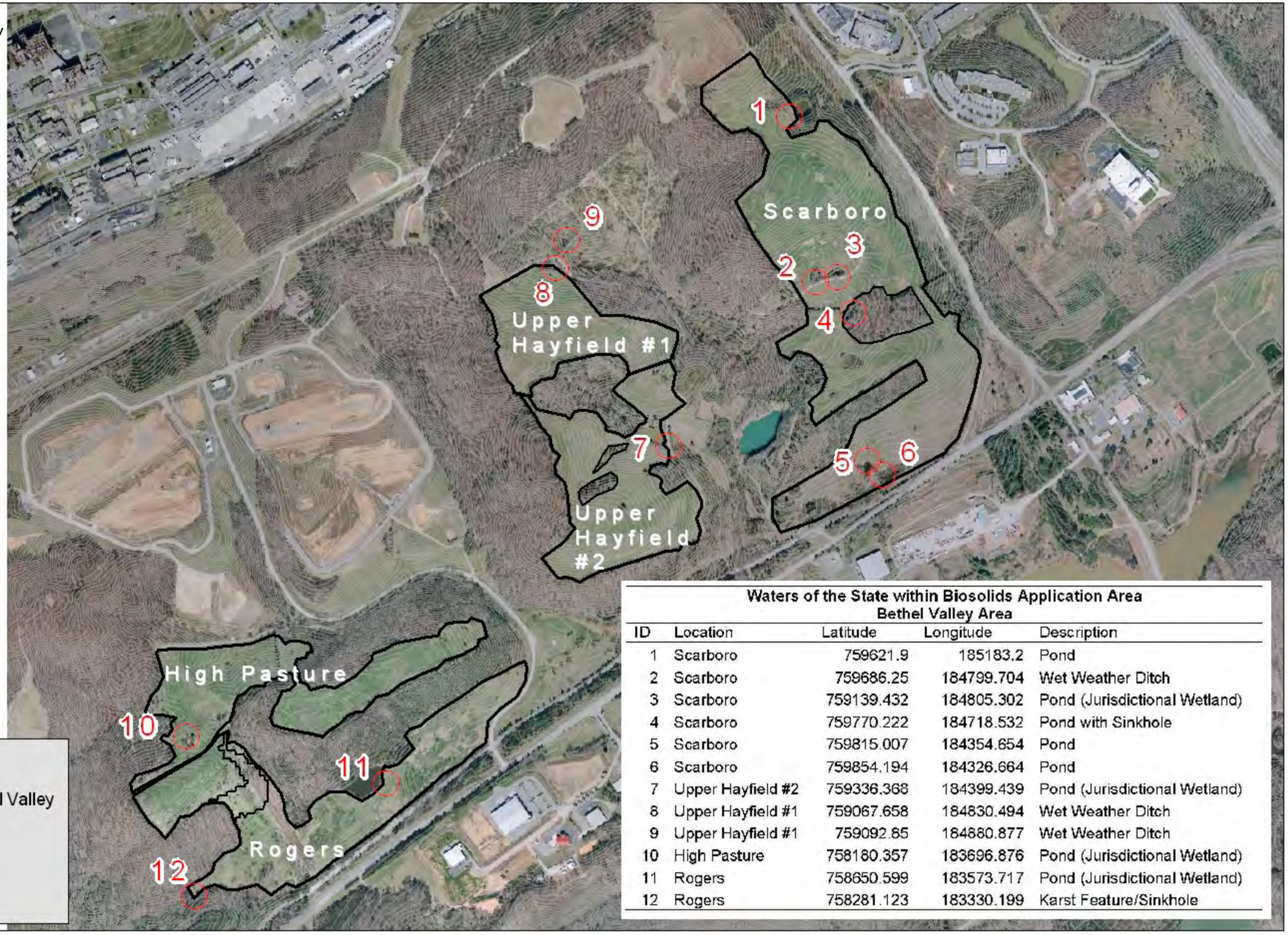
ORNL 1993. *Resource Management Plan for the Oak Ridge Reservation* (ORNL/NERP-7), Volume 29: "Rare Plants on the Oak Ridge Reservation Environmentally Sensitive Sites Containing Special Plants, Animals, and Communities," Environmental Sciences Division Publication No. 4054, Oak Ridge, TN.

ORNL 1993. *Resource Management Plan for the Oak Ridge Reservation* (ORNL/NERP-8), Volume 30: "Oak Ridge National Environmental Research Park Natural Areas and Reference Areas – Oak Ridge Reservation Environmentally Sensitive Sites Containing Special Plants, Animals, and Communities," Environmental Sciences Division Publication No. 3995, Oak Ridge, TN.

Figure C.1 Bethel Valley Biosolids Application Sites with Proposed Buffers

Tennessee State Plane NAD 1983
Units: Meter
February 28, 2011

Figure C.2.Bethel Valley Area Application Sites Waters of the State



Waters of the State within Biosolids Application Area
Bethel Valley Area

ID	Location	Latitude	Longitude	Description
1	Scarboro	759621.9	185183.2	Pond
2	Scarboro	759686.25	184799.704	Wet Weather Ditch
3	Scarboro	759139.432	184805.302	Pond (Jurisdictional Wetland)
4	Scarboro	759770.222	184718.532	Pond with Sinkhole
5	Scarboro	759815.007	184354.654	Pond
6	Scarboro	759854.194	184326.664	Pond
7	Upper Hayfield #2	759336.368	184399.439	Pond (Jurisdictional Wetland)
8	Upper Hayfield #1	759067.658	184830.494	Wet Weather Ditch
9	Upper Hayfield #1	759092.85	184880.877	Wet Weather Ditch
10	High Pasture	758180.357	183696.876	Pond (Jurisdictional Wetland)
11	Rogers	758650.599	183573.717	Pond (Jurisdictional Wetland)
12	Rogers	758281.123	183330.199	Karst Feature/Sinkhole

Figure C.3 Bethel Valley Biosolids Application Sites with Slopes

Tennessee State Plane NAD 1983
Units: Meter
February 28, 2011

Figure C.4 Watson Road Biolosolids Application Sites with with Proposed Buffers

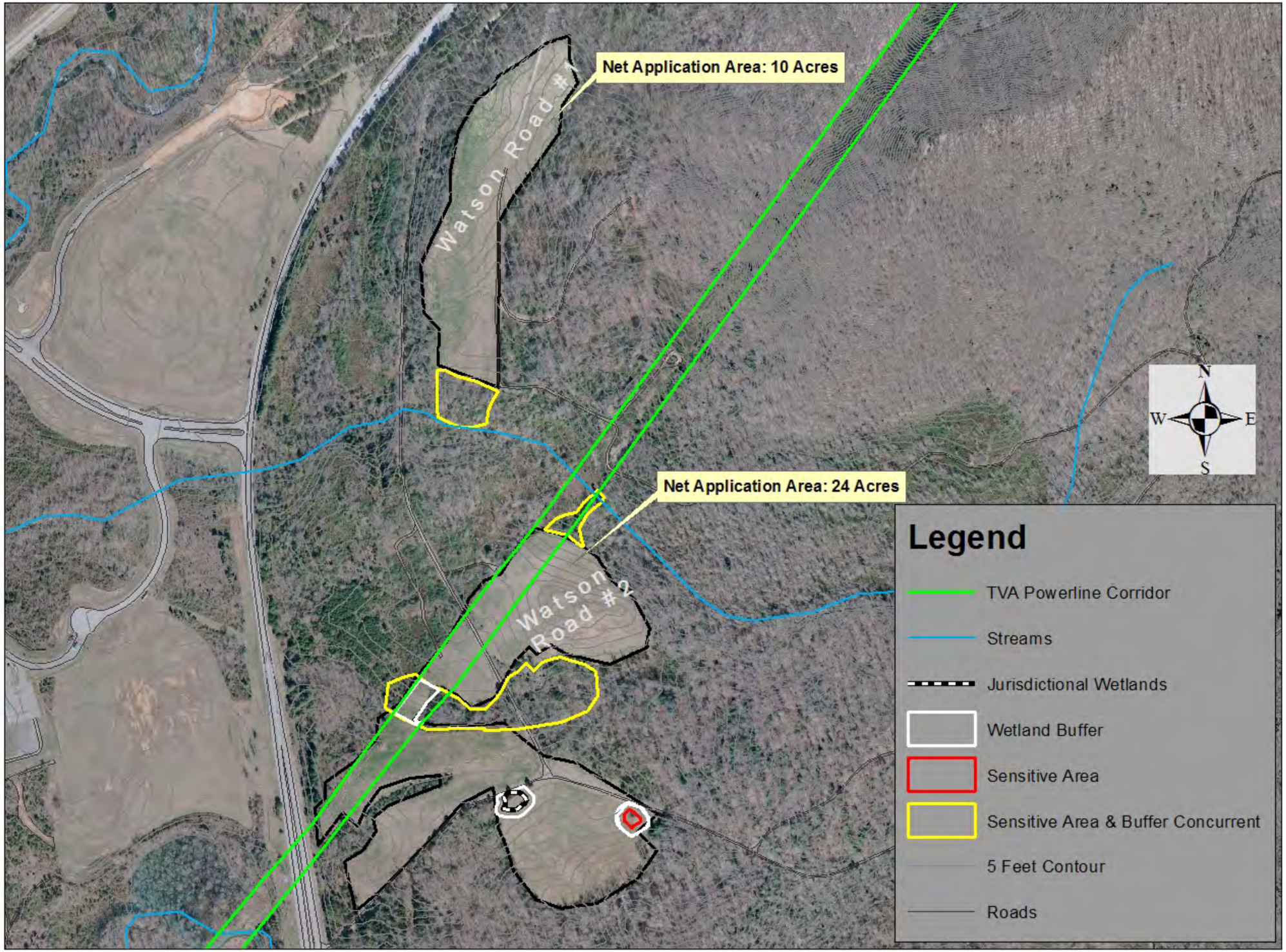
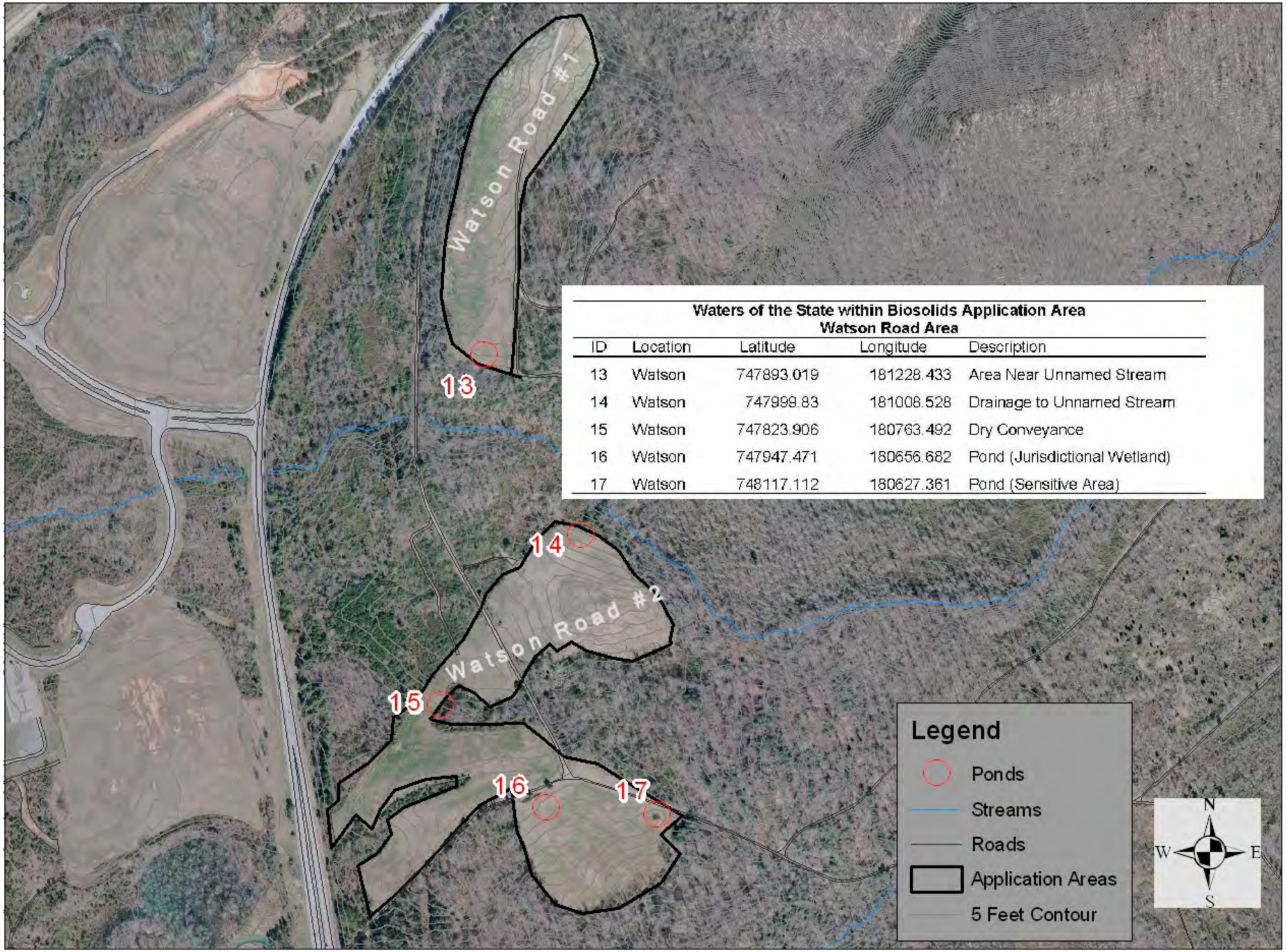


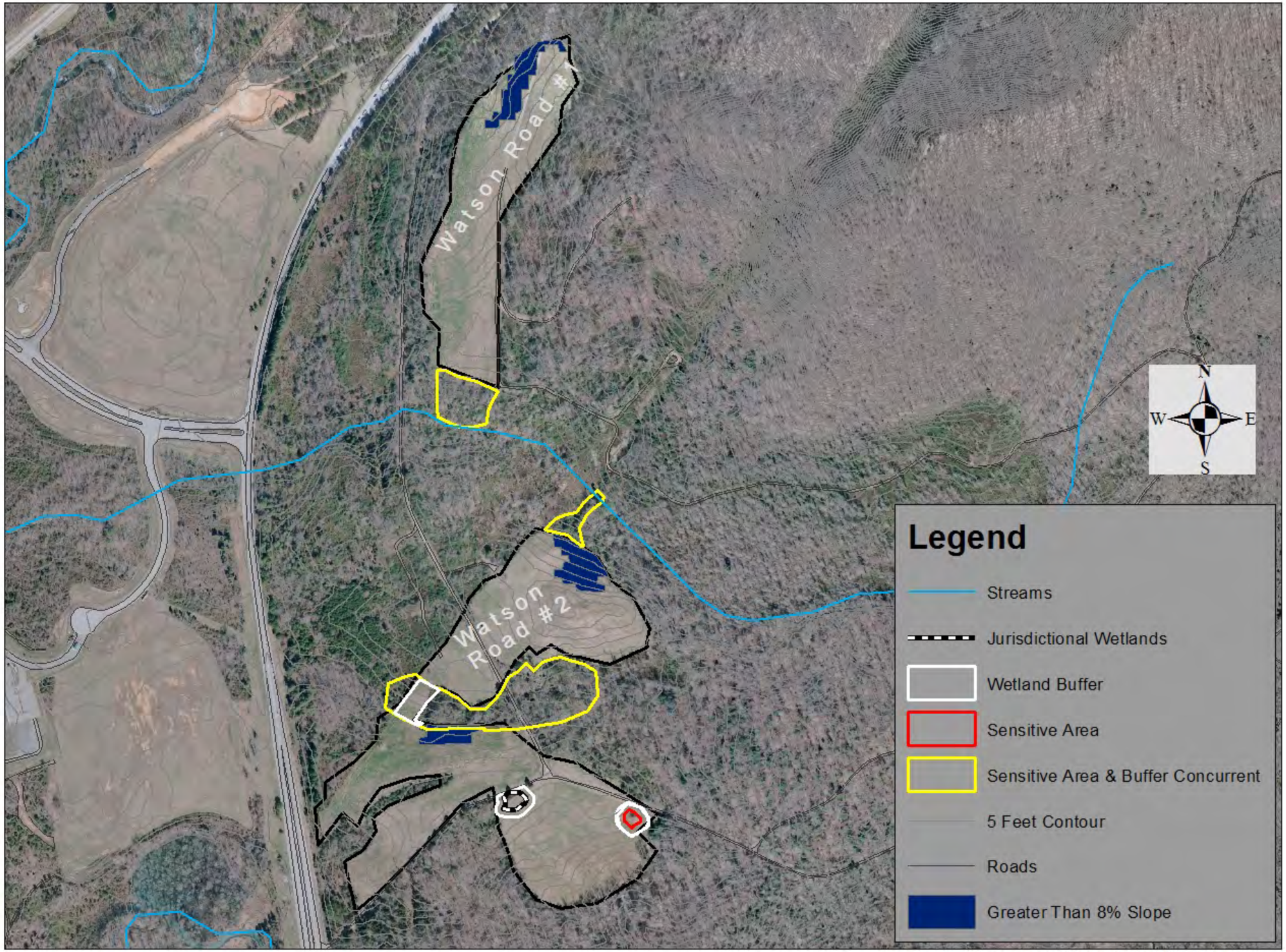
Figure C.5. Watson Road Biosolids Application Site Waters of the State



Waters of the State within Biosolids Application Area
Watson Road Area

ID	Location	Latitude	Longitude	Description
13	Watson	747893.019	181228.433	Area Near Unnamed Stream
14	Watson	747999.83	181008.528	Drainage to Unnamed Stream
15	Watson	747823.906	180763.492	Dry Conveyance
16	Watson	747947.471	180656.682	Pond (Jurisdictional Wetland)
17	Watson	748117.112	180627.361	Pond (Sensitive Area)

Figure C.6. Watson Road Biosolids Application Site with Slopes



APPENDIX D.
ORR ANIMAL SPECIES OF SPECIAL CONCERN AND LISTED SPECIES WALK OVER SURVEY REPORT OF THE BIOSOLIDS LAND APPLICATIONS AREAS (JUNE 2010), AND APPLICATION SITE MAPS

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The following list identifies sensitive wildlife species found on the Oak Ridge Reservation. Some of these (e.g., anhinga) have been seen only once or a few times; others (e.g., sharp-shinned hawk, southeastern shrew) are comparatively common and widespread on the reservation. (Updated April 2010.)

Table D.1. Animal species of special concern reported from the Oak Ridge Reservation [a]

Scientific name	Common name	Status [b]		
		Federal	State	PIF [c]
Fish				
Phoxinus tennesseensis	Tennessee dace		NM	
Amphibians and Reptiles				
Crytobranchus alleganiensis	Hellbender	MC	NM	
Hemidactylium scutatum	four-toed salamander		NM	
Birds				
DARTERS				
Anhinga anhinga	Anhinga		NM	
BITTERNS & HERONS				
Ardea alba	great egret		NM	
Egretta caerulea	little blue heron		NM	
Egretta thula	snowy egret		NM	
KITES, HAWKS, EAGLES, & allies				
Haliaeetus leucocephalus	bald eagle	[d]	NM	
Circus cyaneus	northern harrier		NM	
Accipiter striatus	sharp-shinned hawk		NM	
Buteo platypterus	broad-winged hawk			RI
FALCONS				
Falco peregrinus	peregrine falcon	[e]	E	RI
GROUSE, TURKEY, & QUAIL				
Bonasa umbellus	ruffed grouse			RI
Colinus virginianus	northern bobwhite			RI
RAILS, GALLINULES, & COOTS				
Gallinula chloropus	common moorhen		NM	
OWLS				
Aegolius acadicus	northern saw-whet owl	MC	T	RI
Tyto alba	barn owl		NM	
GOATSUCKERS				
Caprimulgus carolinensis	chuck-will's-widow			RI
Caprimulgus vociferus	whip-poor-will			RI
SWIFTS				
Chaetura pelagica	chimney swift			RI

Table D.1. Animal species of special concern reported from the Oak Ridge Reservation [a] (cont.)

Scientific name	Common name	Status [b]		
		Federal	State	PIF [c]
KINGFISHERS				
Ceryle alcyon	belted kingfisher			RI
WOODPECKERS				
Melanerpes erythrocephalus	red-headed woodpecker			RI
Sphyrapicus varius	yellow-bellied sapsucker	MC	NM	
Picoides pubescens	downy woodpecker			RI
Colaptes auratus	northern flicker			RI
TYRANT FLYCATCHERS				
Contopus cooperi	olive-sided flycatcher		NM	RI
Contopus virens	eastern wood-pewee			RI
Empidonax trailii	willow flycatcher			RI
Empidonax virescens	Acadian flycatcher			RI
SWALLOWS				
Progne subis	purple martin			RI
TITMICE & CHICKADEES				
Poecile carolinensis	Carolina chickadee			RI
NUTHATCHES				
Sitta pusilla	brown-headed nuthatch			RI
KINGLETS, GNATCATCHERS, & THRUSHES				
Hylocichla mustelina	wood thrush			RI
THRASHERS & MOCKINGBIRDS				
Toxostoma rufum	brown thrasher			RI
SHRIKES				
Lanius ludovicianus	loggerhead shrike	MC	NM	RI
VIREOS				
Vireo flavifrons	yellow-throated vireo			RI
WOOD WARBLERS				
Vermivora chrysoptera	golden-winged warbler	MC	NM	RI
Vermivora pinus	blue-winged warbler			RI
Dendroica cerulea	cerulean warbler		NM	RI
Dendroica discolor	prairie warbler			RI
Dendroica fusca	blackburnian warbler			RI
Mniotilta varia	black-and-white warbler			RI
Helmitheros vermivorus	worm-eating warbler			RI
Seiurus motacilla	Louisiana waterthrush			RI
Oporornis formosus	Kentucky warbler			RI
Wilsonia canadensis	Canada warbler			RI

Table D.1. Animal species of special concern reported from the Oak Ridge Reservation [a] (cont.)

Scientific name	Common name	Status [b]		
		Federal	State	PIF [c]
Wilsonia citrina	hooded warbler			RI
Icteria virens	yellow-breasted chat			RI
TANAGERS				
Piranga olivacea	scarlet tanager			RI
Piranga rubra	summer tanager			RI
CARDINALS, GROSBEAKS, & allies				
Passerina cyanea	indigo bunting			RI
TOWHEES, SPARROWS, & allies				
Pipilo erythrophthalmus	eastern towhee			RI
Spizella pusilla	field sparrow			RI
Ammodramus savannarum	grasshopper sparrow			RI
Pooecetes gramineus	vesper sparrow		NM	
BLACKBIRDS & allies				
Sturnella magna	eastern meadowlark			RI
Mammals				
Myotis grisescens	gray bat	E	E	
Sorex longirostris	southeastern shrew		NM	
Zapus hudsonius	meadow jumping mouse		NM	

[a] Land and surface waters of the ORR exclusive of the Clinch River, which borders the ORR.
[b] E = endangered, T = threatened, MC = species of management concern, NM = in need of management, RI = regional importance
[c] Partners in Flight
[d] The bald eagle was federally delisted effective August 8, 2007.
[e] The peregrine falcon was federally delisted effective August 25, 1999.

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Listed Species Walk Over Survey Report of the Biosolids Application Areas

Date Issued—June 2010

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BECHTEL JACOBS COMPANY LLC

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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

An Environmental Assessment (EA), DOE/EA-1356, was issued in February 2003 for the Biosolids program on the Oak Ridge Reservation (ORR) and a finding of No Significant Impact (FONSI) was issued. The Department of Energy (DOE) proposes to modify the Biosolids program, which will result in several changes not analyzed in DOE/EA-1356. The analysis included in DOE/EA-1356 is based on a wetlands survey conducted in 1996. However, an informal survey conducted in 2009 identified potential additional wetland areas. CDM was contracted to perform a formal wetlands survey for all six active application sites (Table 1) and an analysis of potential impacts to all wetlands. This information will be included in a new EA to be prepared as directed by the Environmental Assessment Determination (EAD) issued by DOE on February 10, 2010.

Table 1. Oak Ridge Reservation biosolids land application sites (1996 Survey)

Site name	Gross acreage (ac)	Hectares (ha)
Upper Hayfield #1	30	12.15
Upper Hayfield #2	27	10.93
High Pasture	46	18.62
Watson Road	117	47.37
Scarboro	77	31.17
Rogers	32	12.96

1.2 PURPOSE OF LISTED SPECIES WALK OVER SURVEYS

The purpose of this report is to document observations made during walk over surveys conducted between March 30 and April 2, 2010 on the six active land application sites included in the Biosolids Program. The focus of the surveys was on state-listed and federally-listed species that may use the subject area and potentially ecologically sensitive habitat areas that support these species.

This report assumes that nutrient, heavy metal, and radionuclide loading will be limited to ensure the protection of all ecological receptors. The report includes the following sections: Introduction and Background (Sect. 1), Methodology (Sect. 2), Observations and Database Consultation (Sect. 3), Conclusions (Sect. 4), Recommendations (Sect. 5), and References (Sect. 6).

1.3 BACKGROUND

Terrestrial habitats on the ORR include hardwood forest, pine forest, mixed hardwood/pine forest, pine plantations, open grass/agricultural fields, and industrial areas. Approximately 70% of the ORR is in natural or planted forest. Because of their unique protected status by association with the ORR facilities, several areas of these habitats and associated wildlife have received limited human disturbance since 1942. In 1988 the ORR was designated as a unit of the Southern Appalachian Biosphere Reserve within the United Nations' Man and the Biosphere Program. The ORR has also been established as a Wildlife Management Area under a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA) and includes the 20,000-acre Oak Ridge National Environmental Research Park and several state Natural Areas.

The ORR contains a wide diversity of quality wildlife habitats. Habitats include hardwood forest, mixed forest, forest edge, field, wetland, riparian, and shrub. Many of the wildlife species, such as the white-tailed deer (*Odocoileus virginianus*), are ubiquitous and can be found in almost any habitat, although they may show a preference for a certain type. Other species, such as the blue grosbeak (*Guiraca caerulea*) or yellow-breasted chat (*Icteria virens*), are to be found only in specific habitat types, while yet others require large tracts of unbroken forest (e.g., pileated woodpecker [*Dryocopus pileatus*]).

Hunting on the ORR occurs for wild turkey (*Meleagris gallopavo*), white-tailed deer, and Canada goose (*Branta Canadensis*). Public deer, goose, and turkey hunts on the ORR are managed by the TWRA. These are the only hunting activities allowed on the ORR (Neil Giffen, ORNL, personal communication, March 26, 2010).

Aquatic habitats on the ORR include small streams, Bear Creek, East Fork Poplar Creek, the Clinch River, and several scattered ponds. Several species of fish, reptiles, and amphibians are found in these areas. Muskrat (*Ondatra zibethica*) and beaver (*Castor canadensis*) are found close to aquatic areas. The muskrat prefers open terrain where aquatic vegetation and dense growths of riparian grasses, sedges, and rushes exist, and beavers are found in locations where there are trees for food and for building dams and lodges. Mink (*Mustela vison*) and raccoon (*Procyon lotor*) are found in aquatic habitats, but range into forest and field areas. Large mammals visit aquatic areas to drink water.

All six of the active application sites within the Biosolids Program are open grassland field areas surrounded, for the most part, by woodlands. The sites are devoid of caves, perennial streams, and large bodies of water. Small ponds and vernal ponds occur on all six of the locations. These features provide ecological habitat for amphibians, as well as other wildlife. Two of the locations (Rogers and Scarboro) include rock outcrop features and sinkholes. Boundaries of the application sites are dominated by mature hardwood tree species that provide suitable habitat for a wide variety of plant and animal species.

2. METHODOLOGY

2.1 ECOLOGICAL WALK OVER SURVEYS

Ecological walk over surveys were conducted at the six active application sites (High Pasture, Rogers, Upper Hayfield #1, Upper Hayfield #2, Scarboro, and Watson Road). Aerial map figures (i.e., Figs. 1-6, shown at the end of this appendix) of the six sites were developed. These figures include the delineation of potentially ecologically sensitive features, proposed buffer areas that may be considered in the EA, and surface slope information.

Ecological features such as ponds, wetlands, vernal ponds, streams, rock outcrops, sinkholes, fields, and forests were checked on each site. Previously identified ponds at the sites were also field checked. Observations were recorded in order to develop the figures showing the ecological features. Wildlife species encountered during the walk over surveys were also noted.

2.2 DATABASE CONSULTATION OF LISTED AND RARE WILDLIFE SPECIES

Three different databases for listed and rare species were consulted in concert with the ecological walk over surveys. The Tennessee Natural Heritage Program Rare Species Observations for Anderson County and Roane County was checked for state and federally listed species that might use the habitats in and around the biosolids application areas (Tennessee Natural Heritage 2009). Species lists and observation record information from the ORR, including information on federally-listed, state-listed, and Partners in Flight species of regional importance (i.e., ORR species of special concern) were checked for species of ORR concern that may be impacted by the biosolids application. Last, the Tennessee Wildlife Resources Agency (TWRA) and Tennessee Wildlife Resources Commission (TWRC) wildlife in need of management database was consulted to make sure all species listed as in need of management have been considered.

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3. OBSERVATIONS AND DATABASE CONSULTATION

General observations from the walk over surveys are discussed in Sect. 3.1. Endangered, threatened, wildlife in need of management, and ORR special concern species are discussed in Sect. 3.2. Within this section the results of the database consultation are also discussed.

The ecological walk over surveys resulted in a number of areas being noted and mapped as ecological features to be considered for buffering from biosolids application. These areas are discussed in Sects. 3.3 and 3.4. Consultation with three databases of listed species revealed a number of listed species, along with their associated habitats, as worthy for consideration of protection from the application of biosolids.

3.1 GENERAL OBSERVATIONS

Most of the wildlife species observed during the walk over surveys are those typical of the ORR.

Birds observed include woodpeckers (common flicker [*Colaptes auratus*], downy woodpecker [*Picoides pubescens*], hairy woodpecker [*Picoides villosus*], pileated woodpecker [*Dryocopus pileatus*], and red-bellied woodpecker [*Melanerpes carolinus*]), hawks (red-shouldered [*Buteo lineatus*] and red-tailed [*Buteo jamaicensis*]), sparrows (American tree [*Spizella arborea*], chipping [*Spizella passerina*], field [*Spizella pusilla*], song [*Melospiza melodia*], and white-throated [*Zonotrichia albicollis*]), vultures (black [*Coragyps atratus*] and turkey [*Cathartes aura*]), and flycatchers (eastern bluebird [*Sialia sialis*], eastern phoebe [*Sayornis phoebe*], and eastern wood pewee [*Contopus virens*]). Common birds of forest and forest edges identified include crow (*Corvus brachyrhynchos*), robin (*Turdus migratorius*), gnatcatcher (*Polioptila caerulea*), jay (*Cyanocitta cristata*), cardinal (*Cardinalis cardinalis*), thrasher (*Toxostoma rufum*), chickadee (*Poecile caronlinensis*), wren (*Thryothorus ludovicianus*), mockingbird (*Mimus polyglottos*), titmouse (*Baeolophus bicolor*), towhee (*Pipilo erythrophthalmus*), and turkey (*Meleagris gallopavo*). Other bird species noted during the surveys were American kestrel (*Falco sparverius*), belted kingfisher (*Ceryle alcyon*), black-crowned night heron (*Nycticorax nycticorax*), cedar waxwing (*Bombycilla cedrorum*), European starling (*Sturnus vulgaris*), killdeer (*Charadrius vociferous*), mourning dove (*Zenaida macroura*), and pine warbler (*Dendroica pinus*).

Mammals observed during the surveys included eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), northern raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*). Amphibians observed during the surveys were bull frog (*Rana catesbeiana*), chorus frogs (*Pseudacris triseriata*), eastern newts (*Notophthalmus viridescens*), and spring peepers (*Hyla crucifer*).

3.2 THREATENED, ENDANGERED, AND WILDLIFE SPECIES IN NEED OF MANAGEMENT

A number of surveys have been completed previously on the ORR prior to the walk over surveys documented in this report. Some of these are listed below.

1996–Survey of protected terrestrial vertebrates on the ORR (Mitchell et al. 1996).

1997–Threatened and Endangered Species Survey was conducted by TN & Associates, Inc., of the biosolids application areas on the ORR in the spring and summer of 1997 (TN & Associates, 1997). The objective of the study was to survey six active and one inactive biosolids application sites in search of federally and state-listed threatened and endangered plant species and vertebrate habitat.

2003–The 2003 Environmental Assessment (EA) included a summary of previously completed surveys along with the results of plant and animal surveys that were conducted by grouping the listed species known to occur on the ORR (or for which there is habitat) according to their environmental requirements (e.g., water and light availability). Potential listed habitat on the biosolids application sites was categorized according to physical gradients, the resulting intersection of potential habitat and protected species guided the surveys. Plant species were actively searched in the early spring and late summer growing seasons (DOE/EA-1356, 2003).

3.2.1 Plants

All six of the sites are fields that are mowed bi-annually. These fields do not provide potential habitat for listed plant species. A plant survey was conducted as part of the previously completed biosolids application EA and no listed plant species were identified (DOE/EA-1356). In addition, no listed species were identified during the walk over surveys. Habitats in adjacent areas, such as forests and ridges, may provide the potential for listed plants to exist. These adjacent areas would be protected from impacts from the biosolids application with the maintenance of a buffer between the fields of application and the surrounding habitats.

3.2.2 Vertebrates

As stated earlier, three sources were consulted, including the Tennessee Natural Heritage Program, the ORR species of concern list, and the Tennessee Wildlife Resources Agency (GWRA). These sources were consulted in concert with the ecological walkover surveys to make determinations regarding ecologically sensitive areas. Information from the ORR was checked for species of ORR concern that may be impacted by the proposed biosolids application. Last, the TWRA and TWRC wildlife in need of management database was consulted to make sure all species listed as in need of management have been considered.

3.2.2.1 Species Considered But Eliminated

After the walk over surveys and consultation with the above referenced databases, eight species listed with the state of Tennessee as “in need of management” that were thought as possibly present in the vicinity of the biosolids application area, were eliminated from further consideration and concern. The ORR Wildlife Coordinator checked this list and confirmed that they are not expected to be present on the ORR for the reasons provided in Table 1 (personal communication, Neil R. Giffen, ORR Wildlife Coordinator, April 13, 2010).

Table 2. Tennessee State listed species that were considered and then eliminated

Species	Genus Species	Rationale	State status
Swainson's warbler	*Limnothlypis swainsonii*	No records on the ORR	**In need of management**
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	Listed as in the area in 1964, but not documented on the ORR. No records in more recent studies from 1996 to the present.	**In need of management**
Eastern wood rat	*Neotoma floridana*	No records on the ORR	**In need of management**
Woodland jumping mouse	*Napaeozapus insignis*	Listed on an undated historical list. No records in more recent studies from 1996 to the present.	**In need of management**
Cinereus shrew	*Sorex cinereus*	Listed on an undated historical list. No records in more recent studies from 1996 to the present.	**In need of management**
Long-tailed shrew	*Sorex dispar*	Listed on an undated historical list. No records in more recent studies from 1996 to the present.	**In need of management**
Smoky shrew	*Sorex fumeus*	Listed on an undated historical list. No records in more recent studies from 1996 to the present.	**In need of management**
Southern bog lemming	*Synaptomys cooperi*	Listed on an undated historical list. No records in more recent studies from 1996 to the present.	**In need of management**

Source: Tennessee Natural Heritage (July 2009) and the ORR (April 2010)

3.2.2.2 Federal and Tennessee State Listed Species

There are a total of eleven federal- and state-listed species that could occur in the vicinity of the biosolids application areas (Table 2). These species are listed on the Tennessee Natural Heritage Program Rare Species Observations for Anderson County and Roane County and have been documented to be present on the ORR (Tennessee Natural Heritage 2009). The state-listed species are also listed on the TWRA and TWRC list as wildlife "in need of management."

Habitat for all of these species potentially occurs in the vicinity of the biosolids application areas. The one possible exception to this is the Indiana bat. There are no records of the Indiana bat being identified on the ORR since the 1950s. However, the United States Fish and Wildlife Service (USFWS) requires the protection of Indiana bat habitat because the ORR area is within the historic range of the species. Trees that may serve as potential roosts (i.e., trees 6 inches diameter at breast height or larger with exfoliating bark, cracks, or crevices) may be removed between October 15 and March 31. If potential roost trees are to be removed outside of that window, two nights of mist netting are required to confirm the absence of Indiana bats (personal communication, Neil R. Giffen, ORR Wildlife Coordinator, April 13, 2010).

The list provided in Table 2 is updated from the list provided in DOE/EA-1356 (2003). The updated list is based on current field observations of the biosolids application areas, habitats located in the vicinity of the biosolids application areas, all available records and observations for the ORR, and a current check of the databases mentioned previously.

The application sites offer potentially suitable habitats to five state-listed bird species: the cerulean warbler, northern harrier, sharp-shinned hawk, vesper sparrow, and yellow-bellied sapsucker (Table 2). Cerulean warblers are potential forest breeders on the ORR and have been documented as present during breeding bird surveys on the ORR. The northern harrier is a wintering species and has been observed from time to time foraging in the Freel's Bend area of the ORR (personal communication, Neil R. Giffen, ORR Wildlife Coordinator, April 27, 2010). Sharp-shinned hawks are a year-round resident of the ORR and are a forest breeder. These hawks usually feed along the edges of forests and fields. The ORR is at the edge of the northern boundary of the vesper sparrow's wintering range and the southern extent of its breeding range. Vesper sparrows have been identified on the ORR in the past and have the potential to use the biosolids application areas. Yellow-bellied sapsuckers are a fairly common wintering woodpecker and use forest and forest edge habitats.

In addition to the listed Indiana bat and birds which were discussed previously, there are three mammals (gray bat, meadow jumping mouse, and southeastern shrew), one salamander (four-toed salamander), and one fish (Tennessee dace) which may use the biosolids application areas or habitats nearby. The gray bat has been documented on the ORR, foraging along the Clinch River. There is a slight possibility that this bat could forage along the water courses that are near the biosolids application sites. The meadow jumping mouse and the southeastern shrew have been identified on the ORR. The jumping mouse prefers moist grasslands near ponds or streams, while the southeastern shrew prefers forest and forests near wet areas. The four-toed salamander requires vernal ponds and woodlands, but will wander from time to time from these habitats. This salamander has been documented in 1996 south of the Watson Road location and in 2009 on Chestnut Ridge on the Bear Creek Valley side (personal communication, Neil R. Giffen, ORR Wildlife Coordinator, April 27, 2010). Tennessee dace is a small fish that has been documented in the unnamed creek near the Watson Road area (Figs. 4, 5, and 6). This unnamed tributary creek is documented in the 1993 Resource Management Plan for the ORR as within the Aquatic Natural Area (ANA) 3 of the ORR (ORNL 1993). This unnamed creek eventually flows to the north into lower East Fork Poplar Creek.

Table 3. Federal- and Tennessee State-listed species that could be present in the vicinity of the proposed biosolids application areas

Species	Genus species	State and federal status	Notes
Cerulean warbler	*Dendroica cerulea*	Tennessee in need of management	Documented on the ORR
Northern harrier	*Circus cyaneus*	Tennessee in need of management	Documented on the ORR
Sharp-shinned hawk	*Accipiter striatus*	Tennessee in need of management	Documented on the ORR
Vesper sparrow	*Pooecetes gramineus*	Tennessee in need of management	Documented on the ORR
Yellow-bellied sapsucker	*Sphyrapicus varius*	Tennessee in need of management	Documented on the ORR
Four-toed salamander	*Hemidactylium scutatum*	Tennessee in need of management	Documented on the ORR
Gray bat	*Myotis grisescens*	Federally endangered	Forage along water courses
Indiana bat	*Myotis sodalis*	Federally endangered	Not documented since the 1950s on ORR, but habitat protected because within historic range of species
Meadow jumping mouse	*Zapus hudsonius*	Tennessee in need of management	Documented on the ORR
Southeastern shrew	*Sorex longirostris*	Tennessee in need of management	Documented on the ORR
Tennessee dace	*Phoxinus tennesseensis*	Tennessee in need of management	It is documented that Tennessee dace are in the unnamed tributary near the Watson Road application areas within Aquatic Natural Area (ANA) 3 of the ORR.

3.2.2.3 ORR Special Concern Species

Partners-In-Flight notes a number of birds as being of regional importance. Table 3 lists these ORR species of special concern that are potential breeders or year-round residents of the biosolids application areas. Many of the species listed in Table 3 are dependent or partially dependent on the forested habitats that are near or adjacent to all of the biosolids application areas. Many others are dependent or partially dependent on the field habitats that would be used for biosolids application.

3.3 BETHEL VALLEY AREAS ECOLOGICAL FEATURES

The entire Bethel Valley area is shown in Figs. 1, 2, and 3. Figure 1 shows the locations of ecologically sensitive areas with proposed buffer zones, Fig. 2 identifies the waters of the state within the application sites, and Fig. 3 presents quantitative information regarding slopes at the sites. The Bethel Valley area includes five of the six biosolids application sites: High Pasture, Rogers, Upper Hayfield #1, Upper Hayfield #2, and Scarboro. Ecologically sensitive features are described below.

3.3.1 High Pasture (Fig. 2, Location 10)

This area contains a very small pond with wetlands and frog egg masses, surrounded by steep slopes to the southwest of the parcel. Chorus frogs and peepers were heard at this pond.

3.3.2 Rogers (Fig. 2)

Throughout are planted walnuts (*Juglans nigra*) and a large grove of sycamore (*Platanus occidentalis*) trees that bisect the area in a north-south direction.

- (Location 11) One fairly large pond on the northern edge of the eastern portion of the area. The pond receives drainage from the west and north and then has a discharge to the east.
- (Location 12) Drainage feature into a rock outcrop and sinkhole in the extreme western portion of the Rogers area. Drainage comes into the sinkhole from the south and, for the most part, from the large field to the east. Chorus frogs and peepers were heard in this area.

3.3.3 Upper Hayfield #1 (Fig. 2)

This field includes a couple of low spots in the southern portion and comes within a few feet of a pond that straddles the Hayfield #1 and #2.

- (Location 8) In the northeast corner there is a drainage feature that does not hold water all of the time.
- (Location 9) Across the road from the drainage feature and to the north is a pond surrounded by trees and shrubs. This pond appears to fluctuate quite a bit, depending on rainfall.

3.3.4 Upper Hayfield #2 (Fig. 2, Location 7)

Adjacent to the northeast portion of this field is a pond. This pond borders the gravel road to the east with grass, shrubs, and trees surrounding the pond, and steep slopes to the south.

Table 4. This table identifies birds that are listed for regional importance by Partners in Flight, listed as species of special concern on the ORR, and either are potential breeders or year-round residents of the biosolids application areas (source: PIF (2010).

Common name	Scientific name
Acadian flycatcher	*Empidonax virescens*
belted kingfisher	*Ceryle alcyon*
black-and-white warbler	*Mniotilta varia*
blue-winged warbler	*Vermivora pinus*
broad-winged hawk	*Buteo platypterus*
brown thrasher	*Toxostoma rufum*
Carolina chickadee	*Poecile carolinensis*
cerulean warbler	*Dendroica cerulea*
chimney swift	*Chaetura pelagica*
chuck-will's-widow	*Caprimulgus carolinensis*
downy woodpecker	*Picoides pubescens*
eastern meadowlark	*Sturnella magna*
eastern towhee	*Pipilo erythrophthalmus*
eastern wood-pewee	*Contopus virens*
field sparrow	*Spizella pusilla*
grasshopper sparrow	*Ammodramus savannarum*
hooded warbler	*Wilsonia citrine*
indigo bunting	*Passerina cyanea*
Kentucky warbler	*Oporornis formosus*
Louisiana waterthrush	*Seiurus motacilla*
northern bobwhite	*Colinus virginianus*
northern flicker	*Colaptes auratus*
prairie warbler	*Dendroica discolor*
purple martin	*Progne subis*
whip-poor-will	*Caprimulgus vociferus*
red-headed woodpecker	*Melanerpes erythrocephalus*
scarlet tanager	*Piranga olivacea*
summer tanager	*Piranga rubra*
willow flycatcher	*Empidonax trailii*
wood thrush	*Hylocichla mustelina*
worm-eating warbler	*Helmitheros vermivorus*
yellow-breasted chat	*Icteria virens*
yellow-throated vireo	*Vireo flavifrons*

3.3.5 Scarboro (Fig. 2)

This is the largest of the active application sites.

- (Location 1) Pond to the north surrounded by fairly steep slopes and loblolly pines (*Pinus taeda*). Remnants of a former homestead were also noted.
- (Locations 2 & 3) A pond/wetland area near the center of the Scarboro area. Egg masses, frogs, and newts were present in the pond.
- (Location 4) One vernal pond in the south central portion of the site. This pond is surrounded by cedars and hardwoods, is adjacent to a sinkhole and is part of a rock outcrop feature that continues to the east and encompasses a woodlot to the east. Chorus frogs and peepers were heard and seen in the pond. This vernal pond/woodland provides habitat for variety of salamanders, frogs, and listed birds.
- (Locations 5 & 6) In the extreme southern portion of the field is an east-west oriented segment of the Scarboro area. The west border includes some old field-type habitat. In the center of this portion of the area are two ponds. The northern of the two is a typical pond with cleared field up to the edge, along with some trees and shrubs. This pond is connected to another pond just to the south via a drainage line. The southern most of the two ponds appears to be a pond with a level that fluctuates with rainfall runoff. This pond contained frog egg masses, and chorus frogs and peepers were heard.

3.4 WATSON ROAD AREA

The Watson Road area is shown in Figs. 4, 5, and 6 and depict the ecologically sensitive areas, details regarding identified waters of the state, and regional slope information, respectively. This area includes one field area to the north and then a series of connected fields to the south.

3.4.1 Watson Road Northern Field (Fig. 5, Location 13)

This area is adjacent to an unnamed stream to the south. This stream is reported to contain Tennessee dace. This dace is a Tennessee fish species "in need of management."

3.4.2 Watson Road Southern Field (Fig. 5)

Four ecologically sensitive areas were identified on the southern fields of the Watson Road site and are discussed below.

- In the northeast corner (Location 14), there is a drainage that feeds into an unnamed stream. Tennessee dace, a Tennessee species "in need of management" is thought to inhabit the stream. Chorus frogs, peepers, birds, as well as signs of other wildlife, were seen in this area.
- There is an east-west drainage system that bisects the area (Location 15). This system drains the wooded areas to the east and continues through a culvert under a gravel road, continues through another wooded area westward, and then finally crosses a narrow portion of the field as the drainage continues west.
- A small vernal pond (Location 16) is located in the south central portion of the southern Watson Road area. This pond contained many egg masses of three different species of frogs.
- A small vernal pond (Location 17, eastern marginal wetland) is located in the southeastern corner of the area. At the time of the walk over survey this pond contained water, along with egg masses of two different species of frogs. At the time of the walk over, tractor and mower tracks were visible within the pond. When field-checked a couple of weeks after the walk over, the pond appeared to be completely dried up.

4. CONCLUSIONS

The ecological walkdowns conducted for the biosolids application areas resulted in identification of ecologically sensitive areas to be considered in the biosolids EA. Section 3.3 identifies those sensitive areas for the application sites located on Bethel Valley Road, and Sect. 3.4 identifies those for the Watson Road application area.

4.1 FEDERAL AND TENNESSEE STATE LISTED SPECIES

All six of the sites are fields that are mowed periodically. These fields do not provide potential habitat for listed plant species. A plant survey was conducted as part of the previously completed biosolids application EA and no listed plant species were identified (DOE 2003). In addition, no listed species were identified during the walk over surveys of March 30-April 2, 2010. Habitats in adjacent areas, such as forests and ridges, may provide the potential for listed plants to exist. These adjacent areas would be protected from impacts from the biosolids application with the maintenance of a buffer between the fields of application and the surrounding habitats.

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained (DOE 2003). For all of the six study areas this means that the areas are mowed on an annual basis to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass. This habitat, although limited in value to many listed species (i.e., forest dependent species), would be beneficial to others (i.e., species dependent on open field habitats).

The ORR biosolids application sites provide suitable habitat for eleven listed species, including five birds (cerulean warbler, northern harrier, sharp-shinned hawk, vesper sparrow, yellow-bellied sapsucker), four mammals (gray bat, Indiana bat, southeastern shrew, and meadow jumping mouse), one salamander (four-toed salamander) and one fish (Tennessee dace). (See Table 2.) The gray bat and Indiana bat are federally endangered and are discussed first below.

At the request of the U.S. Fish and Wildlife Service, a Biological Assessment (BA) was performed in 2002 to evaluate the specific impacts of the proposed actions upon the federally endangered gray and Indiana bats, as documented in DOE/EA-1356 (DOE 2003). Many of the conclusions of the BA are still valid. The results of the BA were that neither of these species would be expected to be impacted, if present, due to restrictions regarding the application of biosolids within 500 ft of a U.S. Waterway, the extremely low levels of radionuclides found in application site soils and plant tissues that have been observed through program monitoring, and the low occurrence of potential roosting habitat (e.g., caves, exfoliating trees) on the active application sites. Specifically, the BA found that the proposed action would be unlikely to adversely impact the gray bat for the following reasons:

- The absence of caves from the ORR application sites, reducing the likelihood of roosting habitat
- The absence of large water bodies present on the application sites, reducing the likelihood of foraging habitat
- The rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils and vegetation, reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the gray bat (DOE 2002)

- The established buffer zone of 500 ft around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the gray bat is present.

Because the first three reasons are still valid, a reduced buffer around waters of the state would likely still not adversely impact the gray bat. Besides the gray bat and Indiana bat, two state-listed mammals may use the biosolids application areas. These two species are southeastern shrew and meadow jumping mouse. (See Table 2.) The southeastern shrew is a species of shrew in the Soricidae family that lives in forests near wet areas. Some level of buffering should be established to protect the forest habitats needed for this shrew. The meadow jumping mouse prefers moist grasslands near ponds or streams. Ponds would be buffered and protected from the biosolids application. Similar to the vesper sparrow, impacts to this mouse could be minimized by avoiding mowing operations from May to August to allow completion of the breeding cycle. Assuming the planned mowing of the fields in the proposed program is the same as proposed in the 2003 EA, mowing would occur in spring and early fall. Impacts from machinery used on the fields for the application of the biosolids, maintenance of the fields, etc. would occur; however, impact could be minimized if mowing did not occur during the meadow jumping mouse breeding cycle.

The four-toed salamander prefers vernal ponds and forest habitats for key portions of its life cycle. The ponds on the biosolids application sites should have protective buffer zones established to protect them from biosolids operations. The adjacent woodlands to vernal ponds are important to salamanders such as the four-toed salamander. Such a pond and woodland habitat occur in the middle of the Scarboro site and is recommended to be buffered from the biosolids application (Fig. 2, Location 4). Four-toed salamanders tend to wander during different parts of the year. Because of this, limiting mowing to once a year would also be beneficial to this salamander.

Tennessee dace are reported as living in the unnamed creek adjacent to the Watson Road site (Fig. 4). This unnamed tributary is within the ANA 3 of the ORR (ORNL 1993). Protecting this unnamed creek from the runoff from the biosolids application fields would also protect the habitat of this Tennessee State fish species in need of management.

5. RECOMMENDATIONS FOR MITIGATION

Recommendations for mitigation include:

- Clearly delineate buffer areas to be protective of environmentally sensitive habitats shown on Fig. 1.
- Monitor nutrient, heavy metal, and radionuclide loading to ensure the protection of ecological receptors.
- Due to the potential for runoff from biosolids application, buffers larger than 10 m should be considered on areas with steep slopes leading into the ecological sensitive areas identified in this report. Minimize mowing of all the proposed biosolids application fields. Limiting mowing to one time a year in late fall or winter would be beneficial to species using the fields and the field edges. May to August would be times most critical to breeding wildlife using the fields.
- A 10-m buffer area is recommended as a no disturbance buffer. Disturbance from mowing, plowing, etc. should be prohibited within the buffer areas. By adopting and maintaining these areas as no disturbance buffer areas, impacts to resident wildlife and listed species habitats (e.g., forest, wetland, creeks, drainages, pond, vernal pond, rock out crops, sinkholes) could be limited. Wildlife species that would benefit from the buffering include birds, mammals, reptiles, amphibians, and fish. Listed species benefiting from the no disturbance buffer include two federally endangered species (Table 2), nine state in need of management species (Table 2), and thirty-one ORR species of concern (Table 3).

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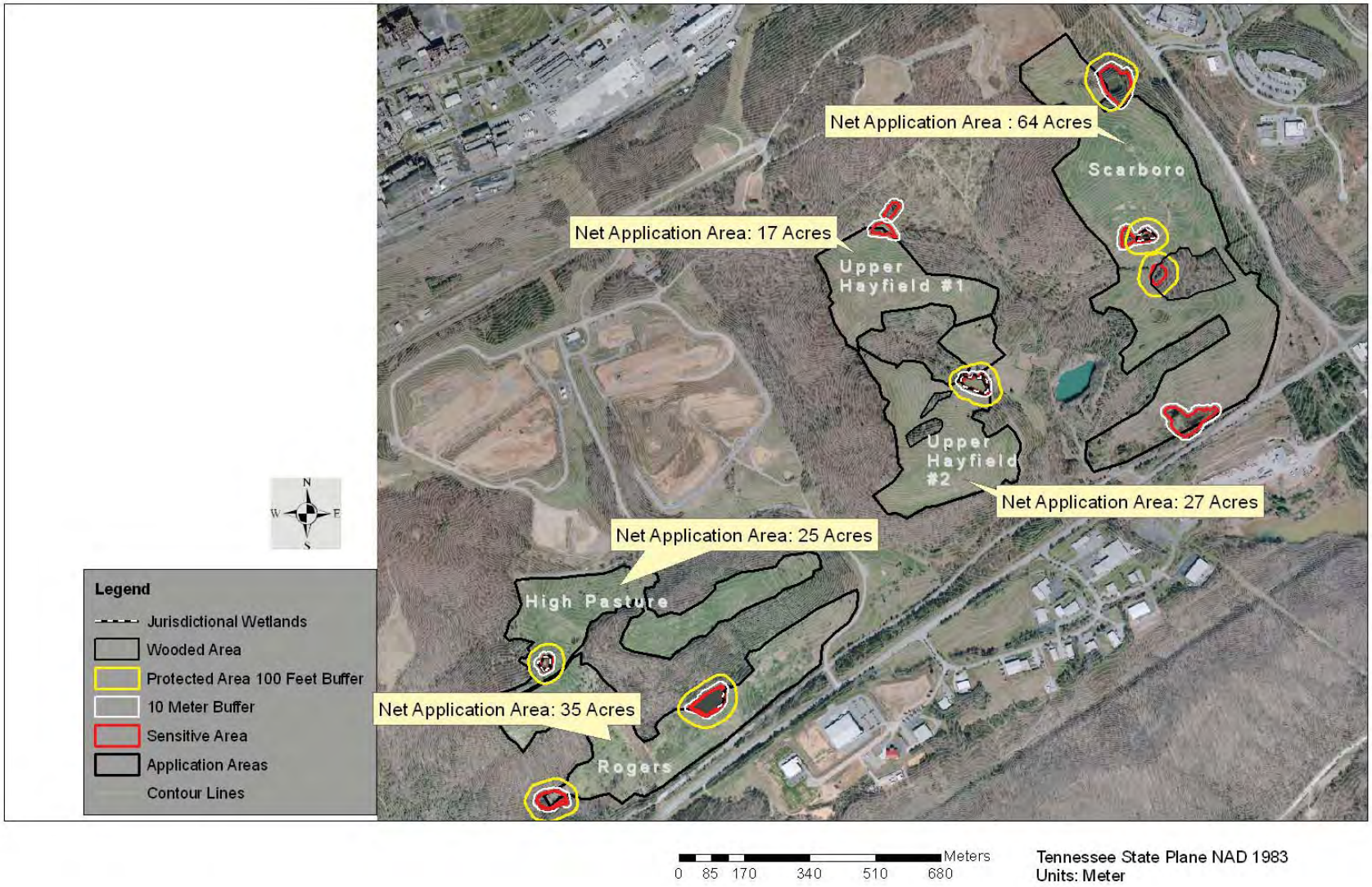
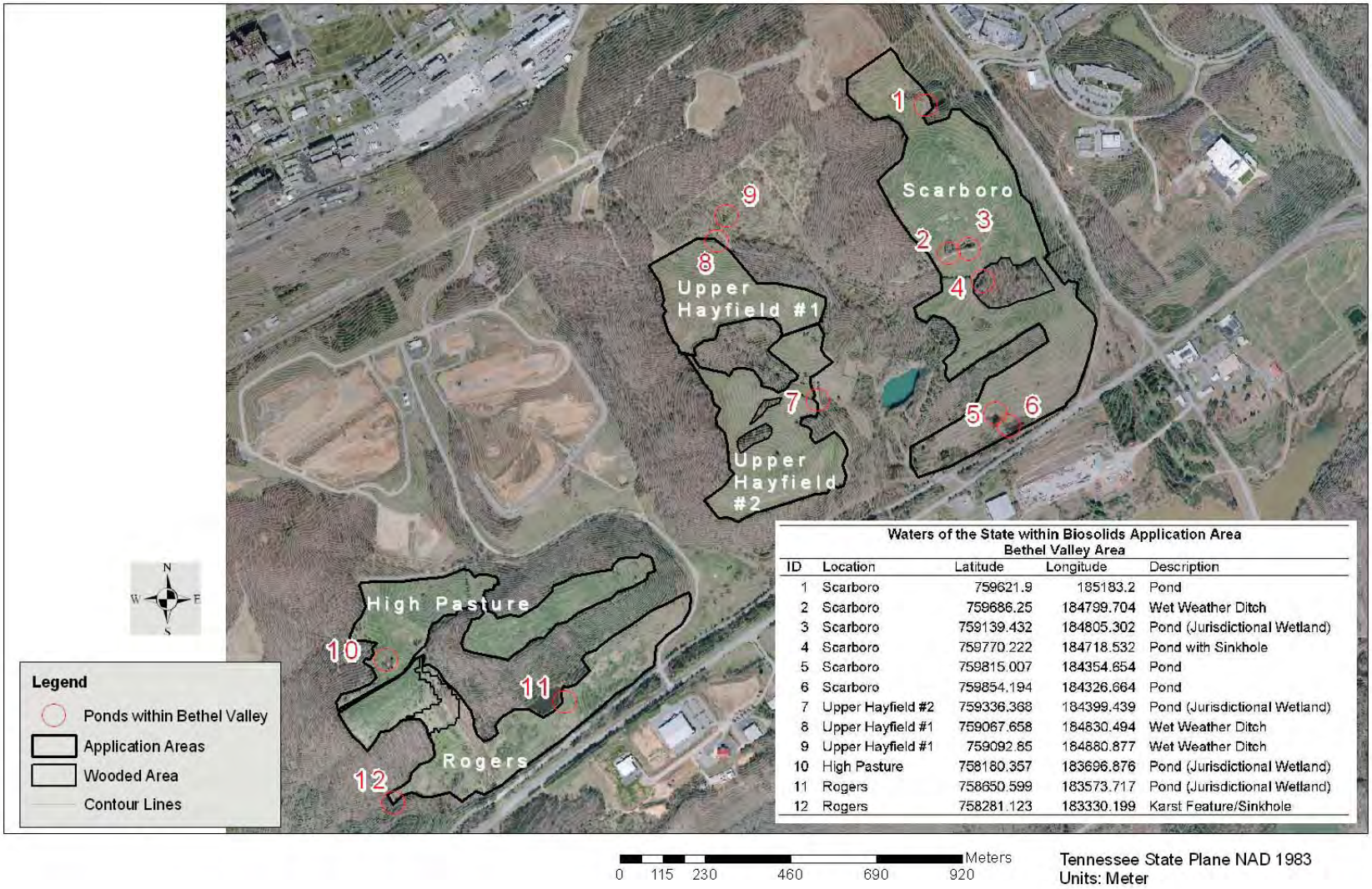


Fig. 1. Bethel Valley biosolids application sites with proposed buffers.



Waters of the State within Biosolids Application Area
Bethel Valley Area

ID	Location	Latitude	Longitude	Description
1	Scarboro	759621.9	185183.2	Pond
2	Scarboro	759686.25	184799.704	Wet Weather Ditch
3	Scarboro	759139.432	184805.302	Pond (Jurisdictional Wetland)
4	Scarboro	759770.222	184718.532	Pond with Sinkhole
5	Scarboro	759815.007	184354.654	Pond
6	Scarboro	759854.194	184326.664	Pond
7	Upper Hayfield #2	759336.368	184399.439	Pond (Jurisdictional Wetland)
8	Upper Hayfield #1	759067.658	184830.494	Wet Weather Ditch
9	Upper Hayfield #1	759092.85	184880.877	Wet Weather Ditch
10	High Pasture	758180.357	183696.876	Pond (Jurisdictional Wetland)
11	Rogers	758650.599	183573.717	Pond (Jurisdictional Wetland)
12	Rogers	758281.123	183330.199	Karst Feature/Sinkhole

Fig. 2. Bethel Valley area application sites waters of the state.

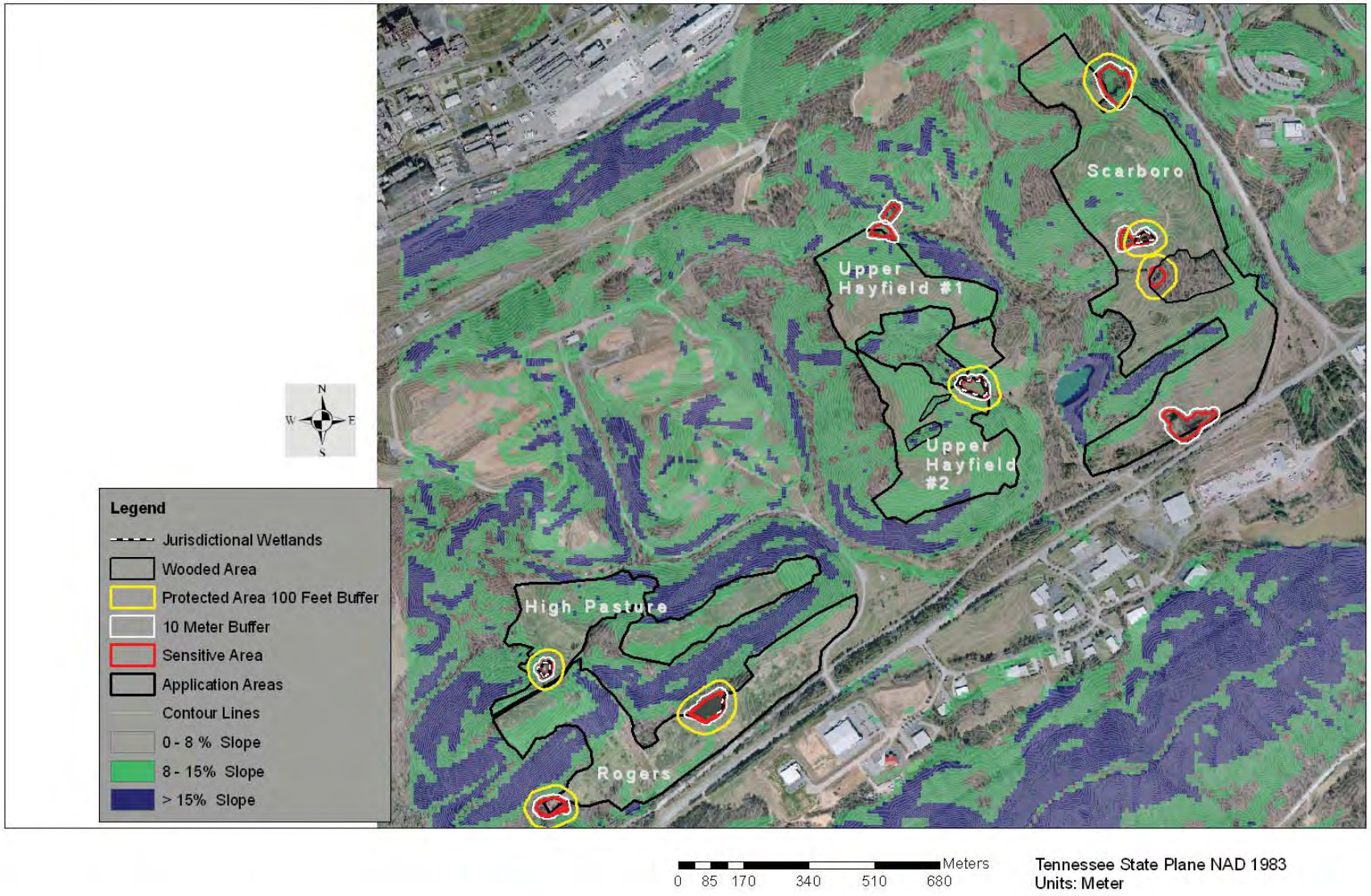


Fig. 3. Bethel Valley area biosolids application sites with slopes.

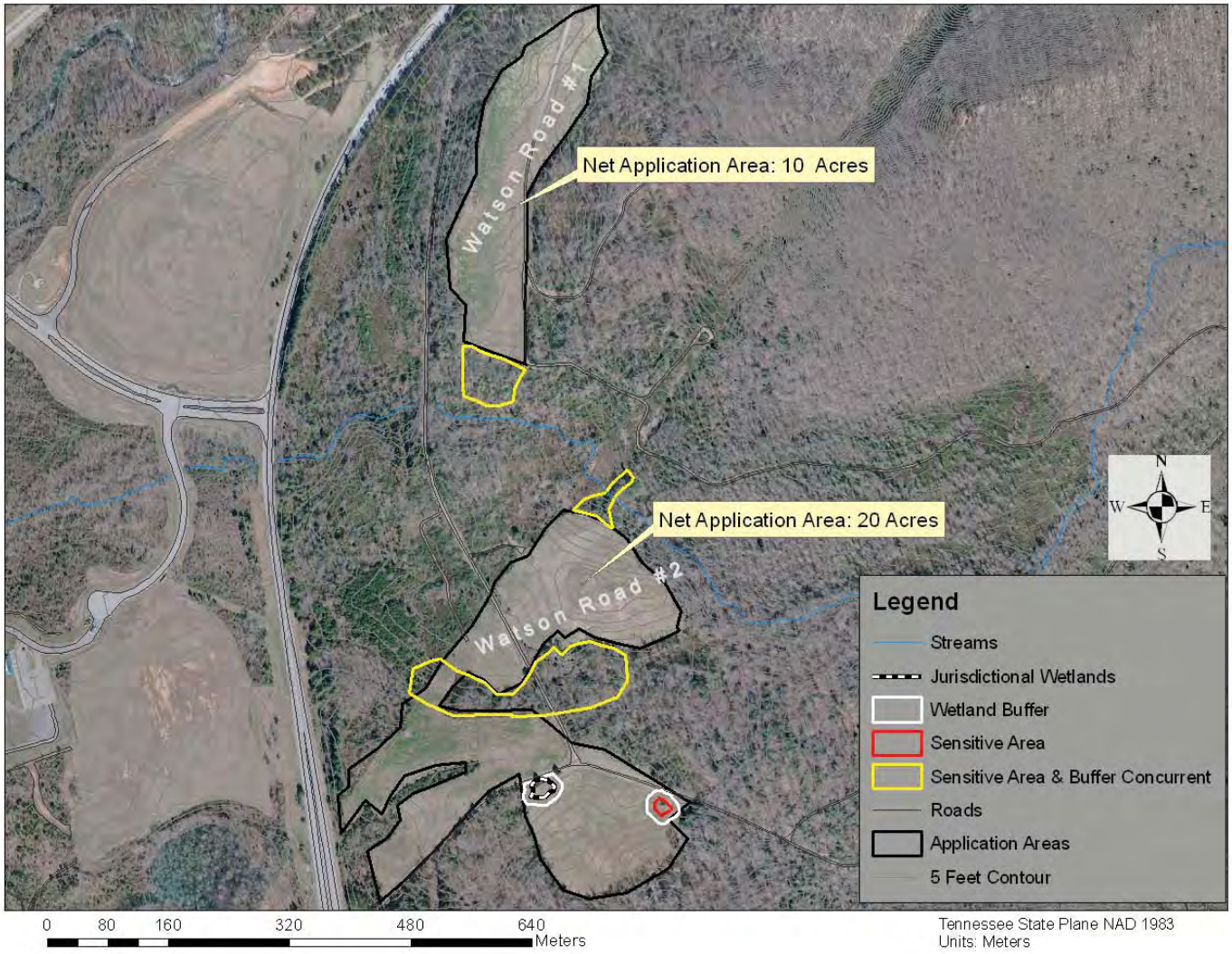
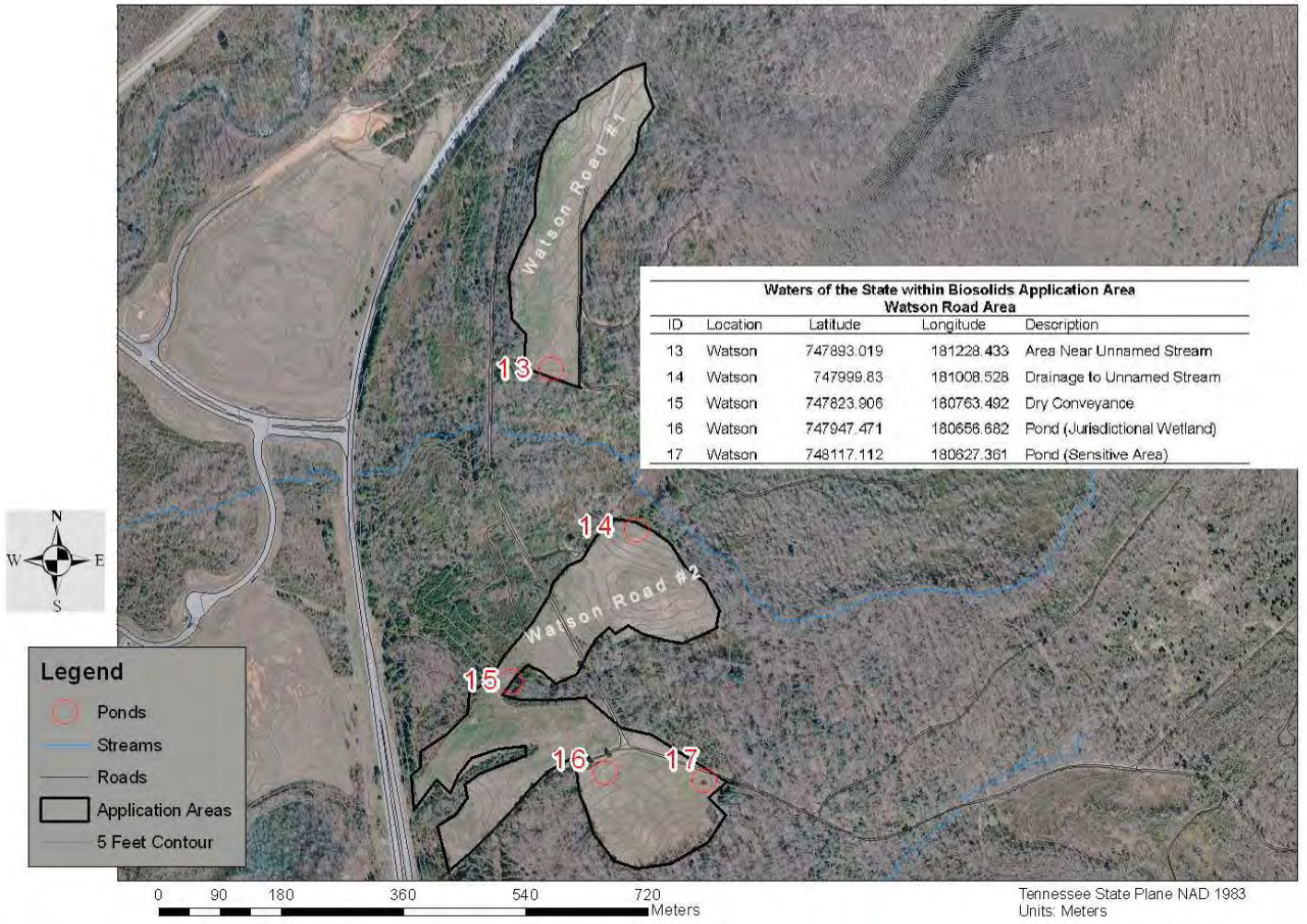


Fig. 4. Watson Road biosolids application sites with proposed buffers.



Waters of the State within Biosolids Application Area
Watson Road Area

ID	Location	Latitude	Longitude	Description
13	Watson	747893.019	181228.433	Area Near Unnamed Stream
14	Watson	747999.83	181008.528	Drainage to Unnamed Stream
15	Watson	747823.906	180763.492	Dry Conveyance
16	Watson	747947.471	180656.682	Pond (Jurisdictional Wetland)
17	Watson	748117.112	180627.361	Pond (Sensitive Area)

Fig. 5. Watson Road biosolids application sites waters of the state.

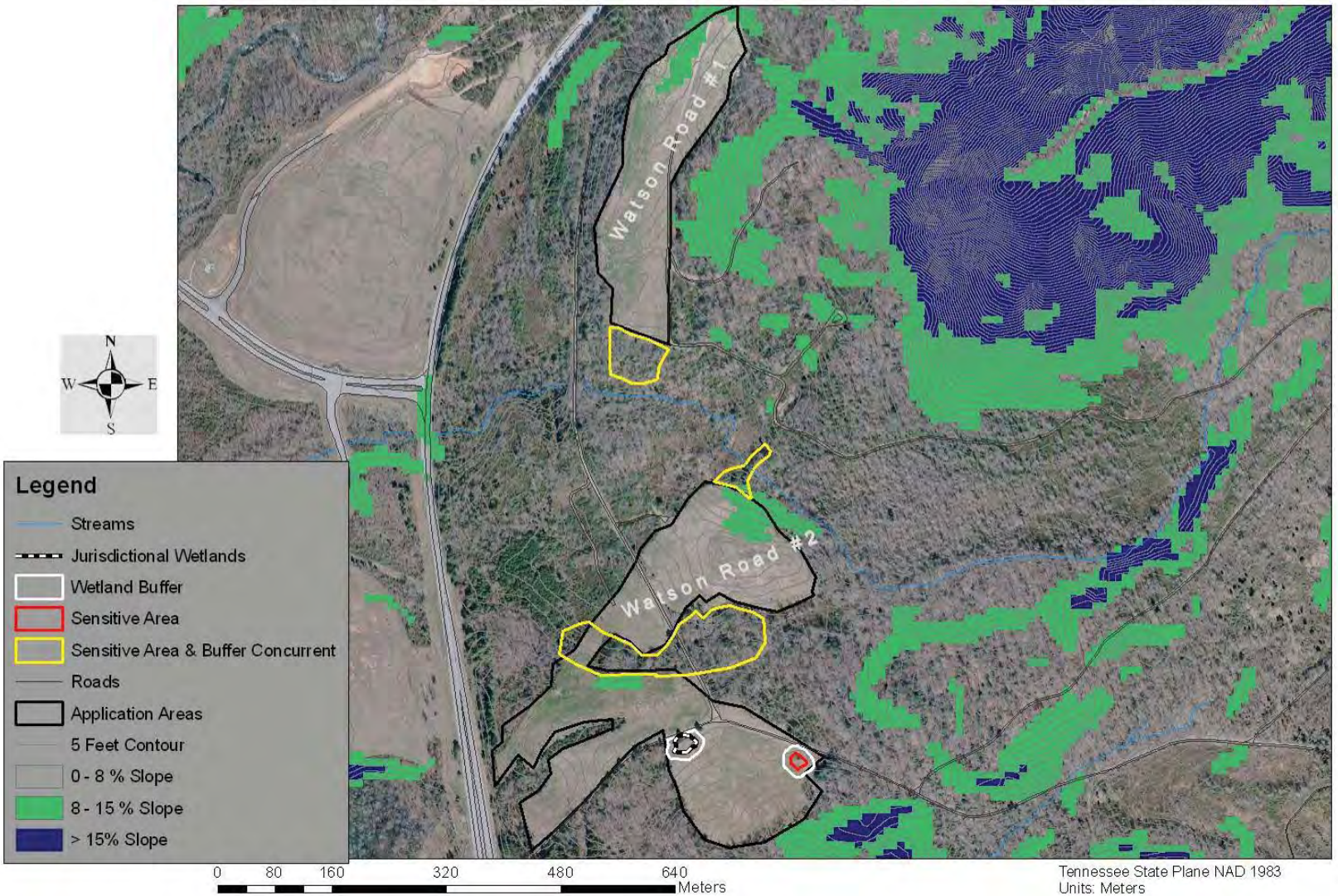


Fig. 6. Watson Road biosolids application sites with slopes.

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