

Recent Trends in the Selection of Remedies for Groundwater, Soil, and Sediment at Superfund Sites

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Superfund Remedies and Reporting

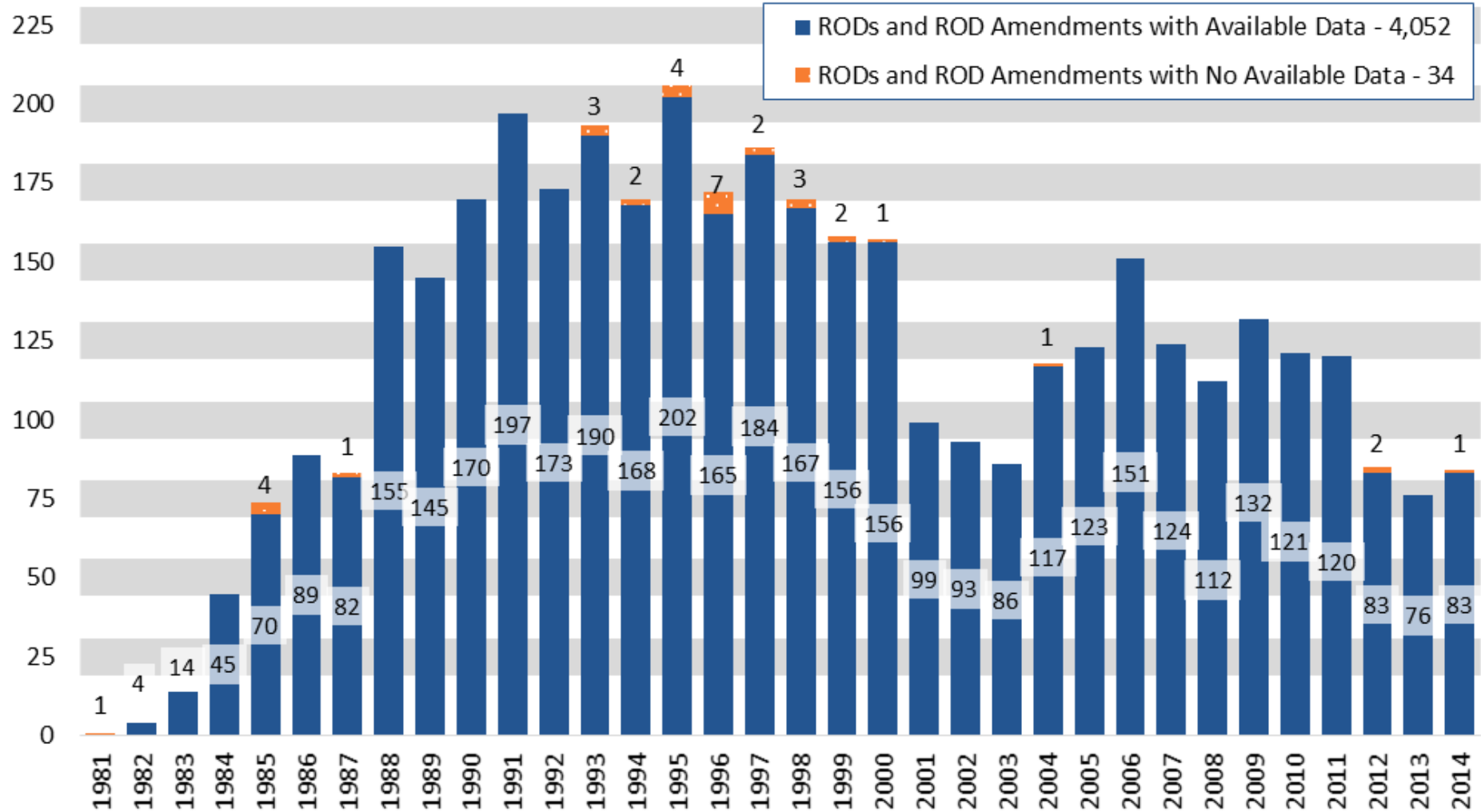
- ◆ EPA selects and modifies remedies for NPL sites in “decision documents”:
 - » Records of Decision (RODs)
 - » ROD Amendments and
 - » Explanation of Significant Differences (ESDs)
- ◆ Remedies summarized every 3-4 years in *Superfund Remedy Report (SRR)* series
- ◆ Report provides information to help site managers make future remedy decisions
- ◆ Also helps technology developers and vendors, and cleanup service providers evaluate cleanup market
- ◆ Presentation summarizes findings of latest report (*Superfund Remedies Report, 15th Edition*)

SRR Methodology

- ◆ Analysis based on Superfund remedies documented in RODs, ROD Amendments and ESDs
- ◆ Compiles and analyzes a subset of remedy data:
 - » Remedies
 - » Media and waste
 - » Contaminants of concern (COCs)
- ◆ Evaluates remedy trends from Fiscal Years 1982 to 2014
- ◆ For recent 3-year period (FY 2012 to 2014), documents remedies and trends in 308 decision documents

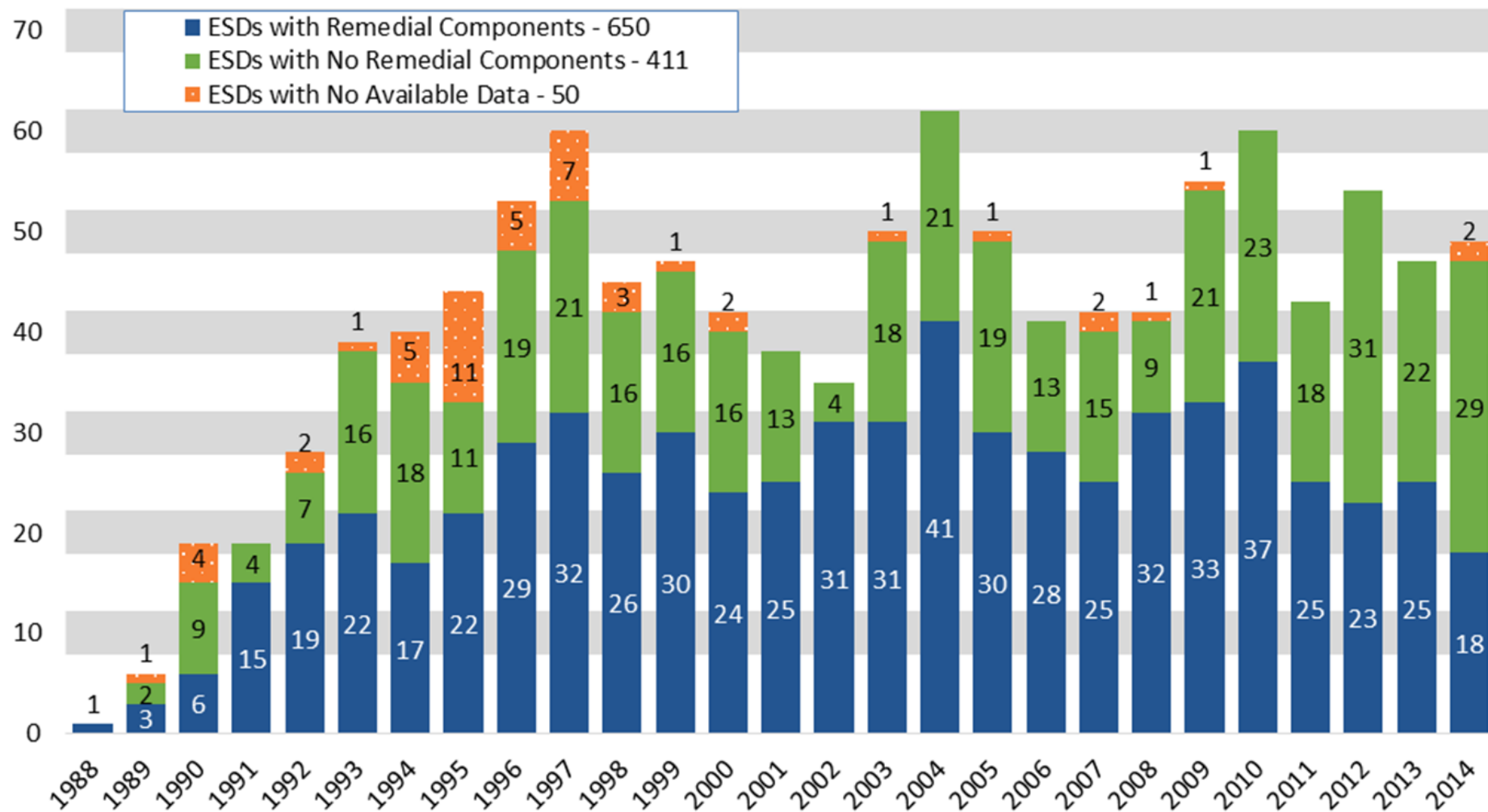
RODs and ROD Amendments per Year (FY 1981–2014)

Number of RODs and ROD Amendments = 4,086



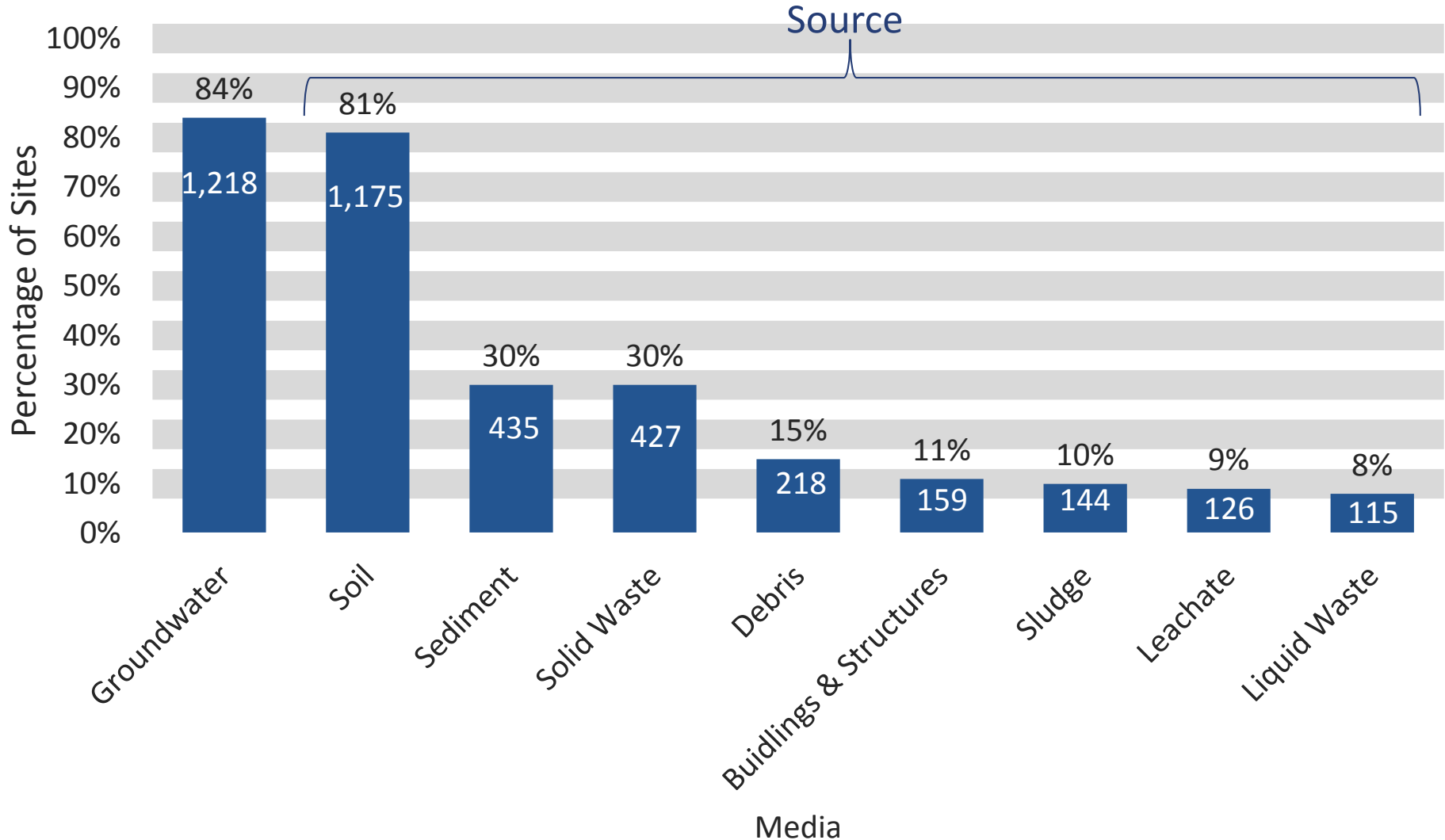
ESDs per Year (FY 1988-2014)

Number of ESDs = 1,111



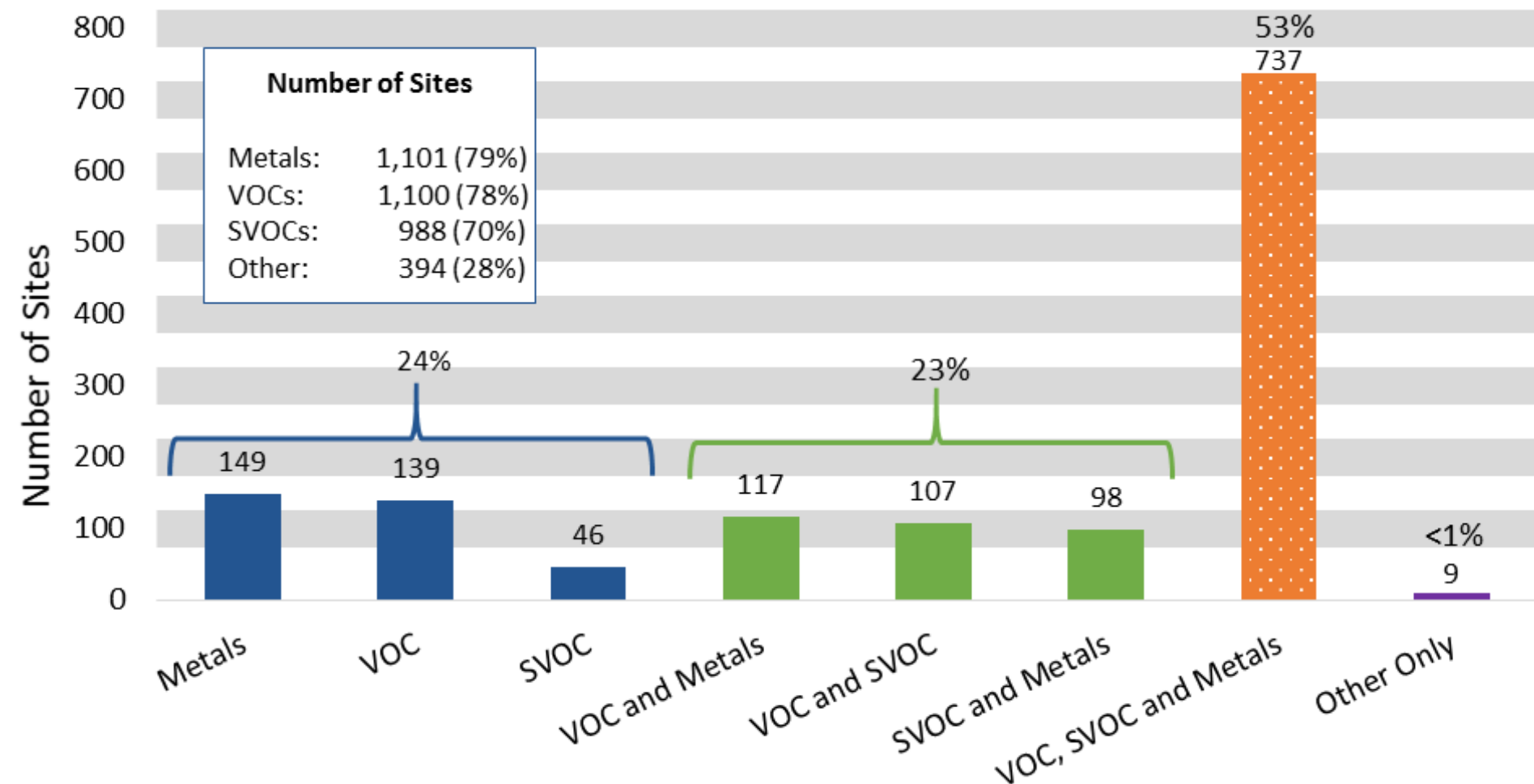
Media Addressed at Superfund Sites with Remedies (FY 1982-2014)

Sites with a Remedy = 1,447



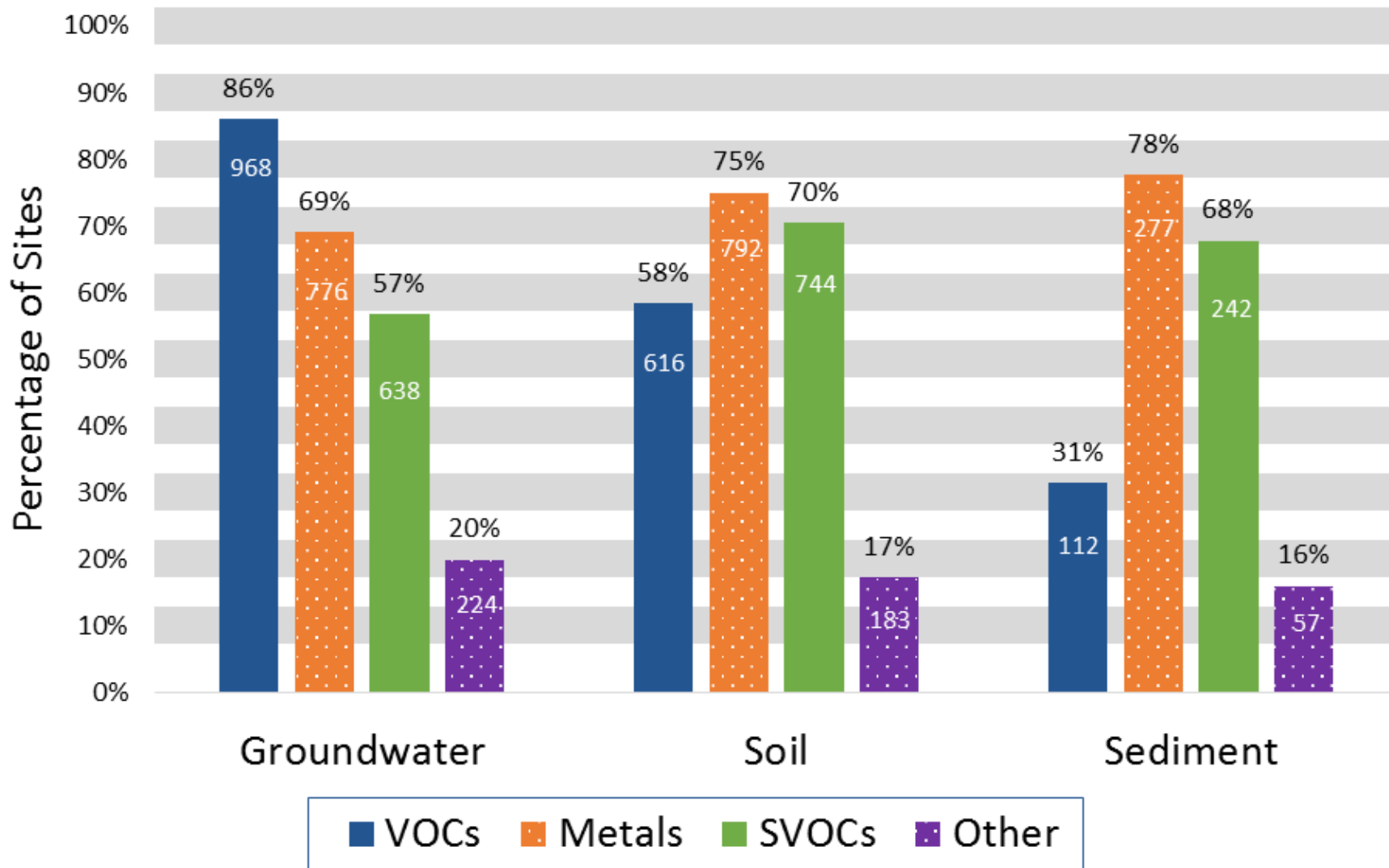
COCs at Superfund Sites (FY 1982-2014)

Sites with a COC and a Remedy = 1,402



"Other" COCs may also be present at sites with metals, VOCs and/or SVOCs. At 9 sites they are the only COCs. Examples include cyanide, nitrate, sulfate and asbestos.

COCs by Media at Superfund Sites (FY 1982-2014)



Types of Remedies

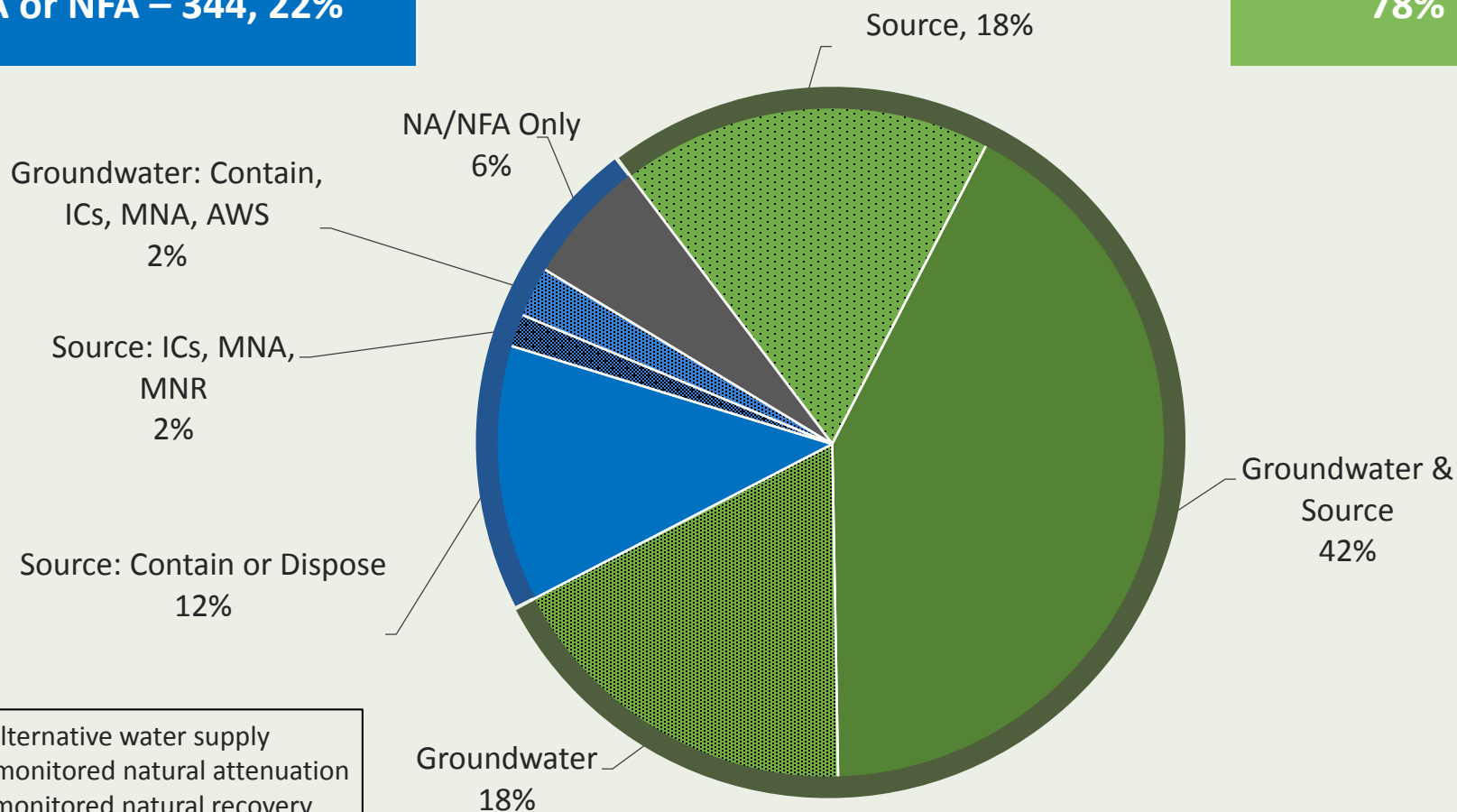
- ◆ **Treatment** (*“reduction of toxicity, mobility or volume”*)
 - » Ex situ (above ground)
 - » In situ (below ground)
- ◆ **Containment**
 - » Capping of soil or landfills
- ◆ **Off-site Disposal**
 - » Excavation/removal of soil or waste & offsite disposal in permitted landfill
- ◆ **Others**
 - » Monitored Natural Attenuation
 - » Monitored/Engineered Natural Recovery (sediments)
 - » Institutional Controls
 - » Alternative Water Supply

Treatment at Superfund Sites (FY 1982-2014)

Number of Sites = 1,540

**Non-Treatment,
NA or NFA – 344, 22%**

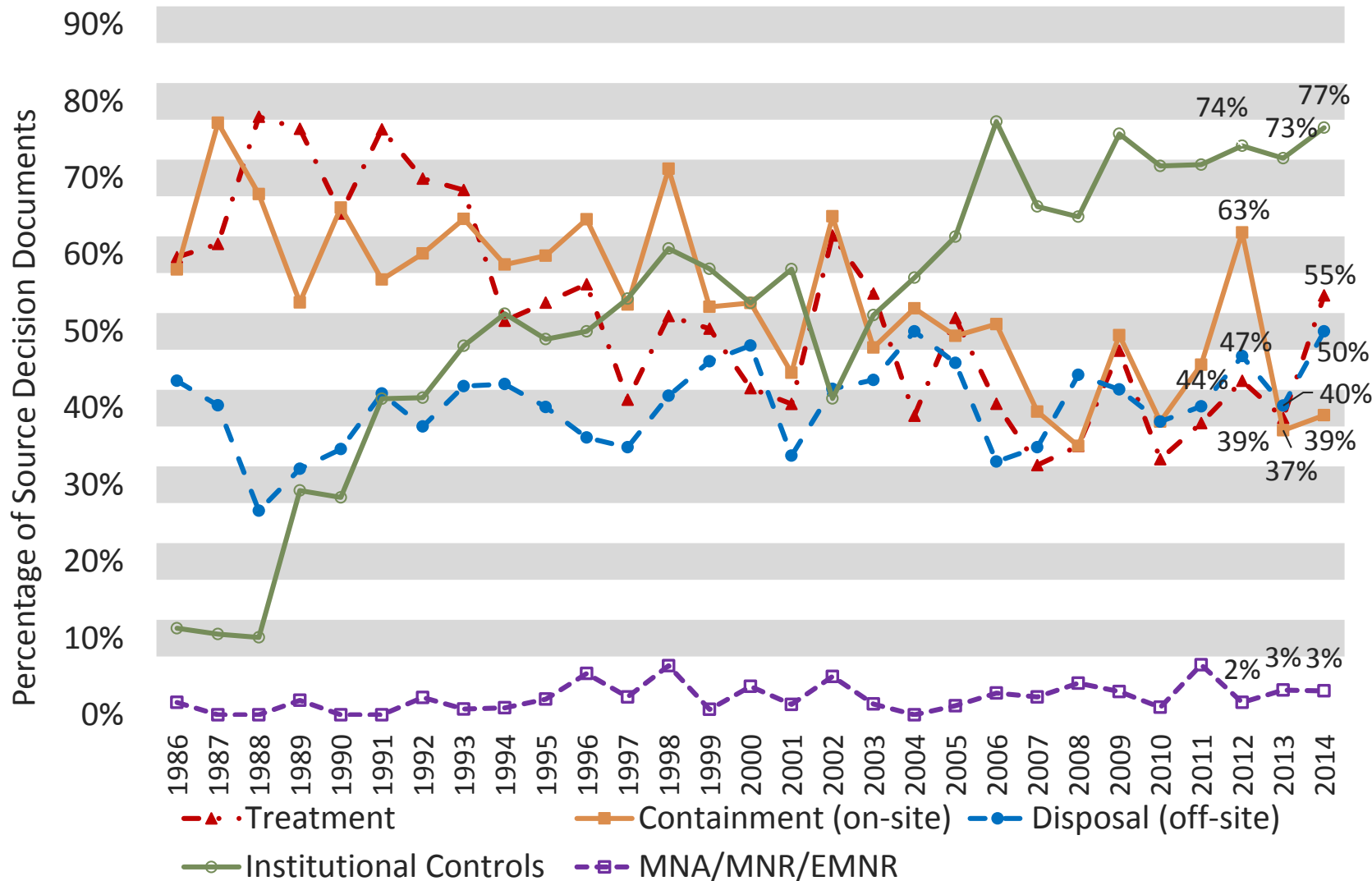
**Treatment – 1,196
78%**



AWS = alternative water supply
MNA = monitored natural attenuation
MNR = monitored natural recovery
NA = No action
NFA = No Further Action

Selection Trends for Decision Documents with Source Remedies (FY 1986-2014)

Source Decision Documents = 2,944

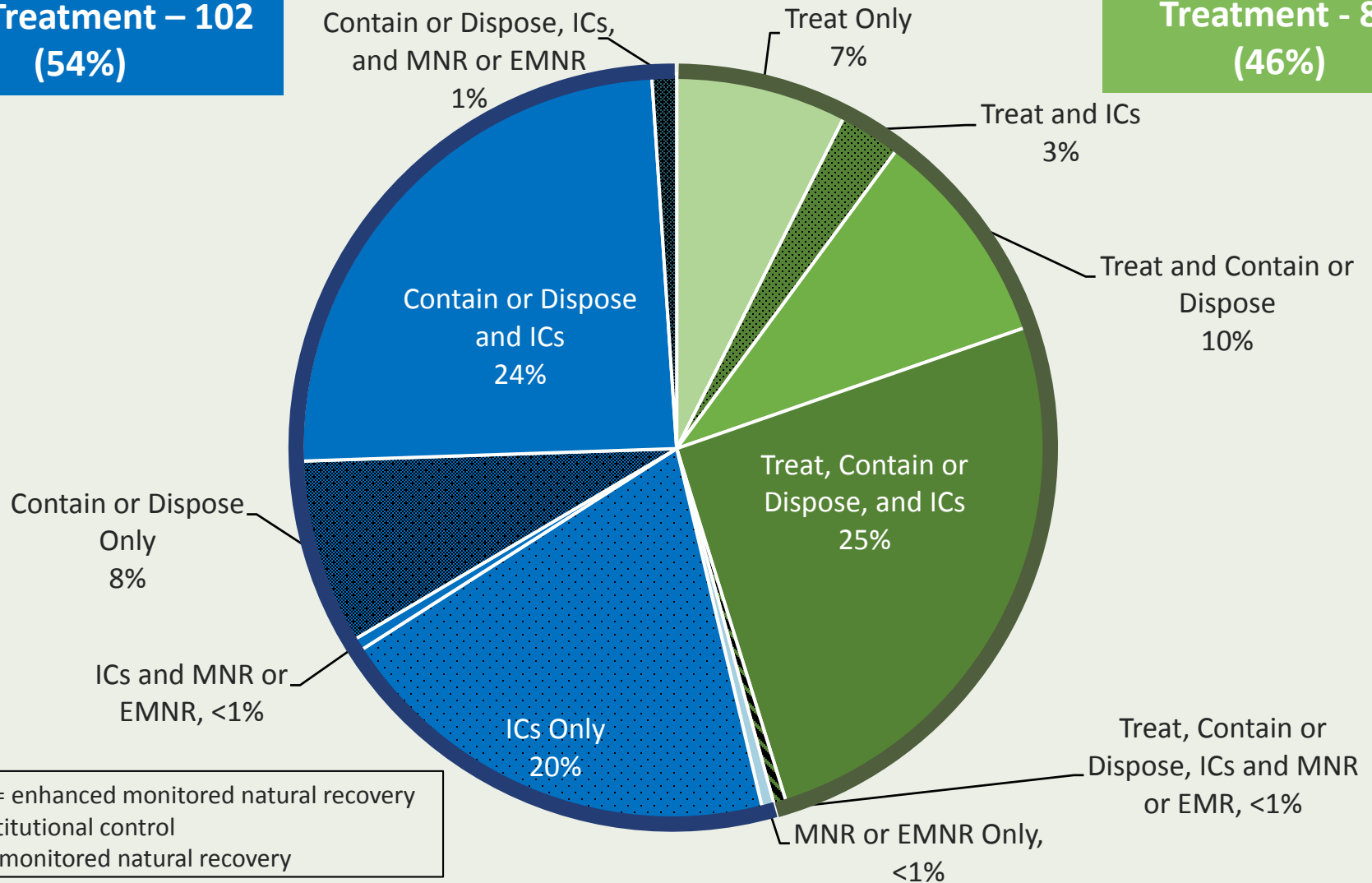


Combinations of Recent Source Remedies (FY 2012-2014)

Source Decision Documents = 188

**Non-Treatment – 102
(54%)**

**Treatment - 86
(46%)**



Source Remedies Selected in Recent Decision Documents (FY 2012-2014)

Source Decision Documents = 188

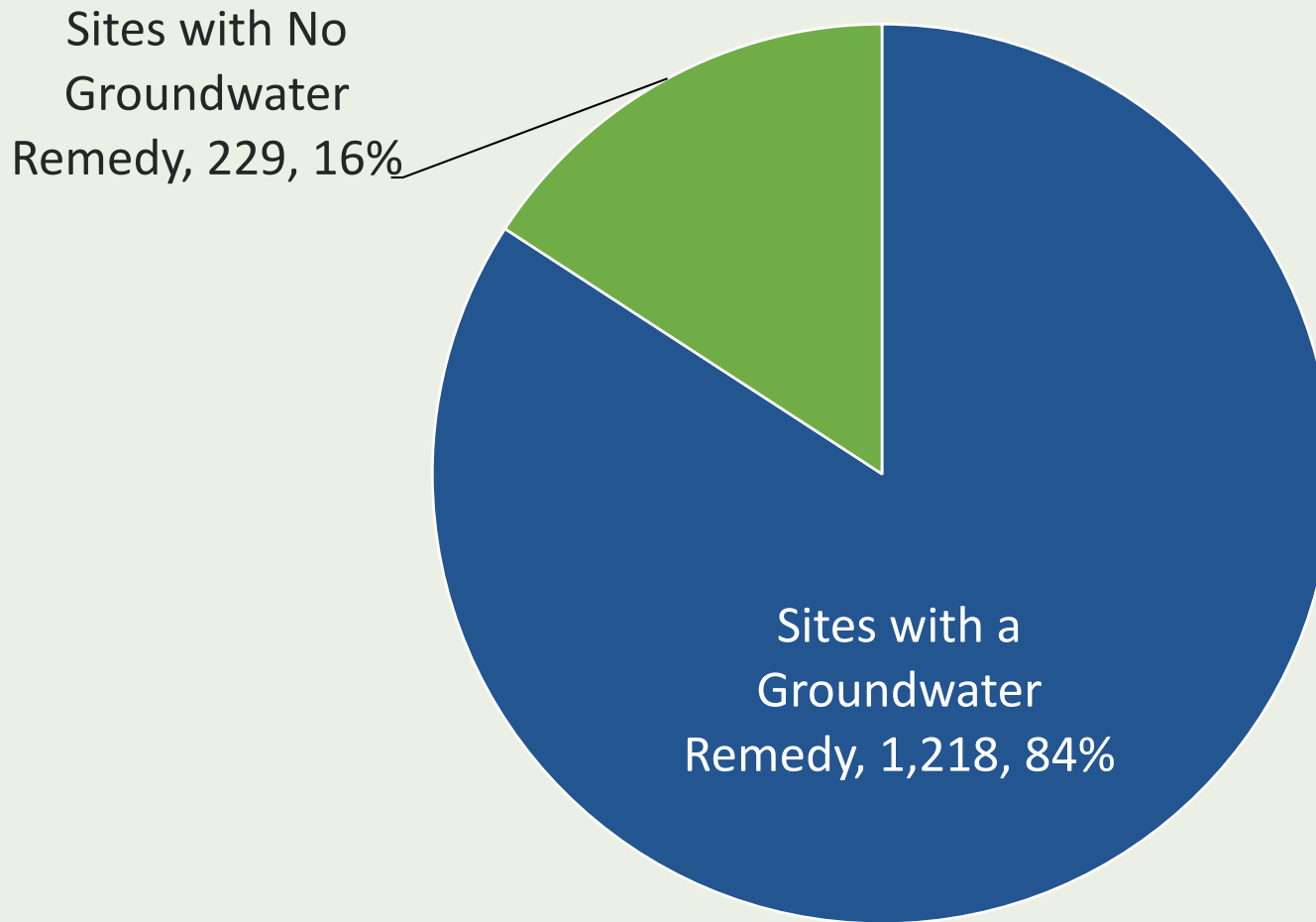
Technology	Total (FY12-14)	Percent Source Decision Documents
In Situ Treatment	44	23%
Soil vapor extraction	14	7%
Chemical treatment	12	6%
Thermal treatment	10	5%
Bioremediation	7	4%
Solidification/stabilization	7	4%
Cap (amended, in situ)	3	2%
Soil amendments	2	1%
Fracturing	1	1%
Multi-phase extraction	1	1%
Phytoremediation	1	1%

Source Remedies Selected in Recent Decision Documents (FY 2012-2014) (cont'd)

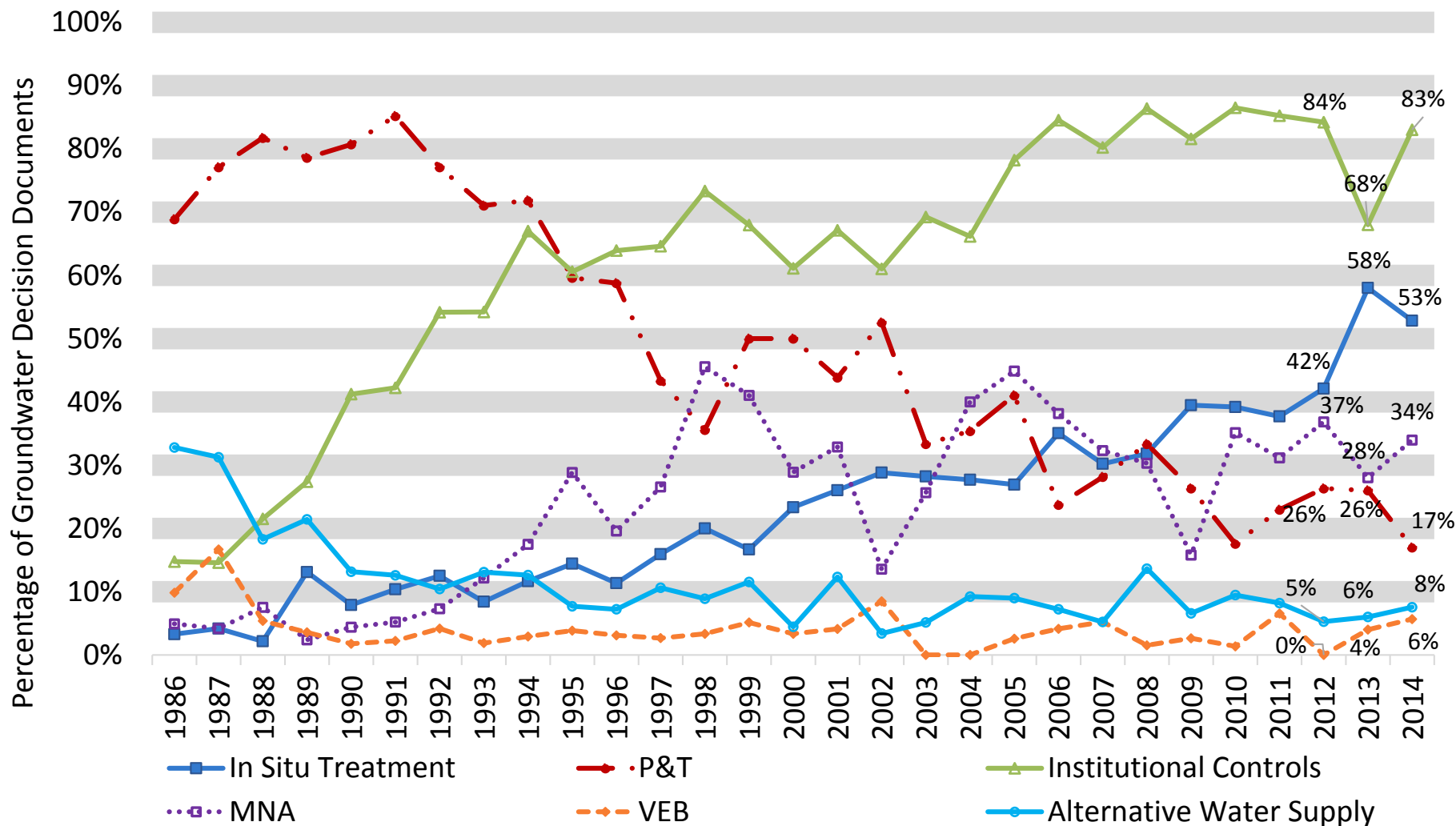
Technology	Total (FY12-14)	Percent Source Decision Documents
Ex Situ Treatment	55	29%
Physical separation	27	14%
Recycling	12	6%
Solidification/stabilization	5	3%
Thermal treatment	4	2%
Chemical treatment	3	2%
Source P&T (leachate)	3	2%
Bioremediation	1	1%
Constructed treatment wetland	1	1%
Soil vapor extraction	1	1%
Unspecified ex situ treatment (off-site)	7	4%
Unspecified ex situ treatment (on-site)	6	3%

Superfund Sites with Groundwater Remedies (FY 1982–2014)

Sites with a Remedy = 1,447



Selection Trends for Decision Documents with Groundwater Remedies (FY 1986-2014)



Summary of Groundwater P&T Remedies (FY 1982-2014)

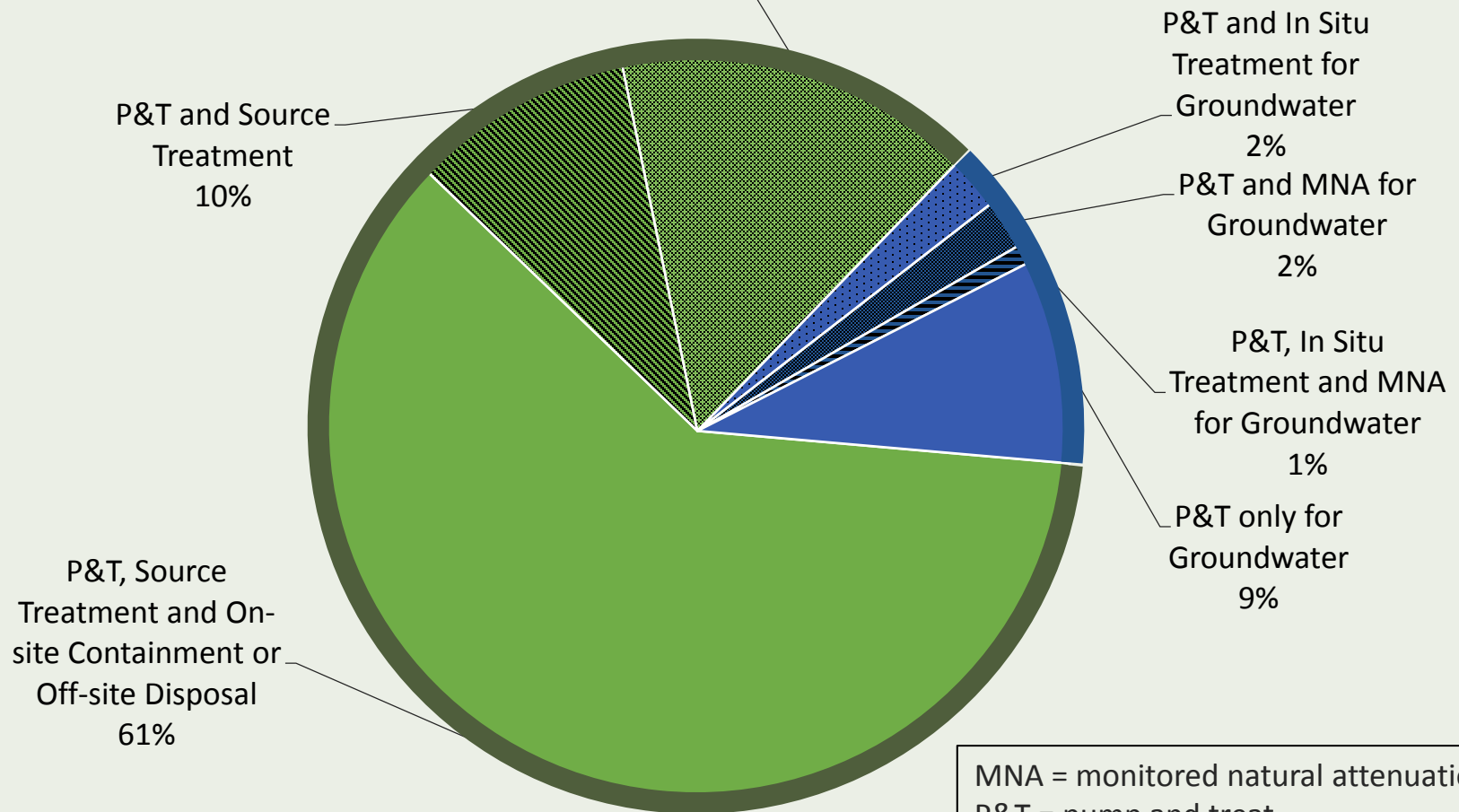
P&T Sites = 834 (70% of GW Sites with a Remedy)

**P&T with Source Control – 716
(86%)**

P&T with Source Containment
or Disposal

15%

**P&T with no Source Control – 118
(14%)**



MNA = monitored natural attenuation
P&T = pump and treat

Groundwater Remedies Selected in Recent Decision Documents (FY 2012–2014)

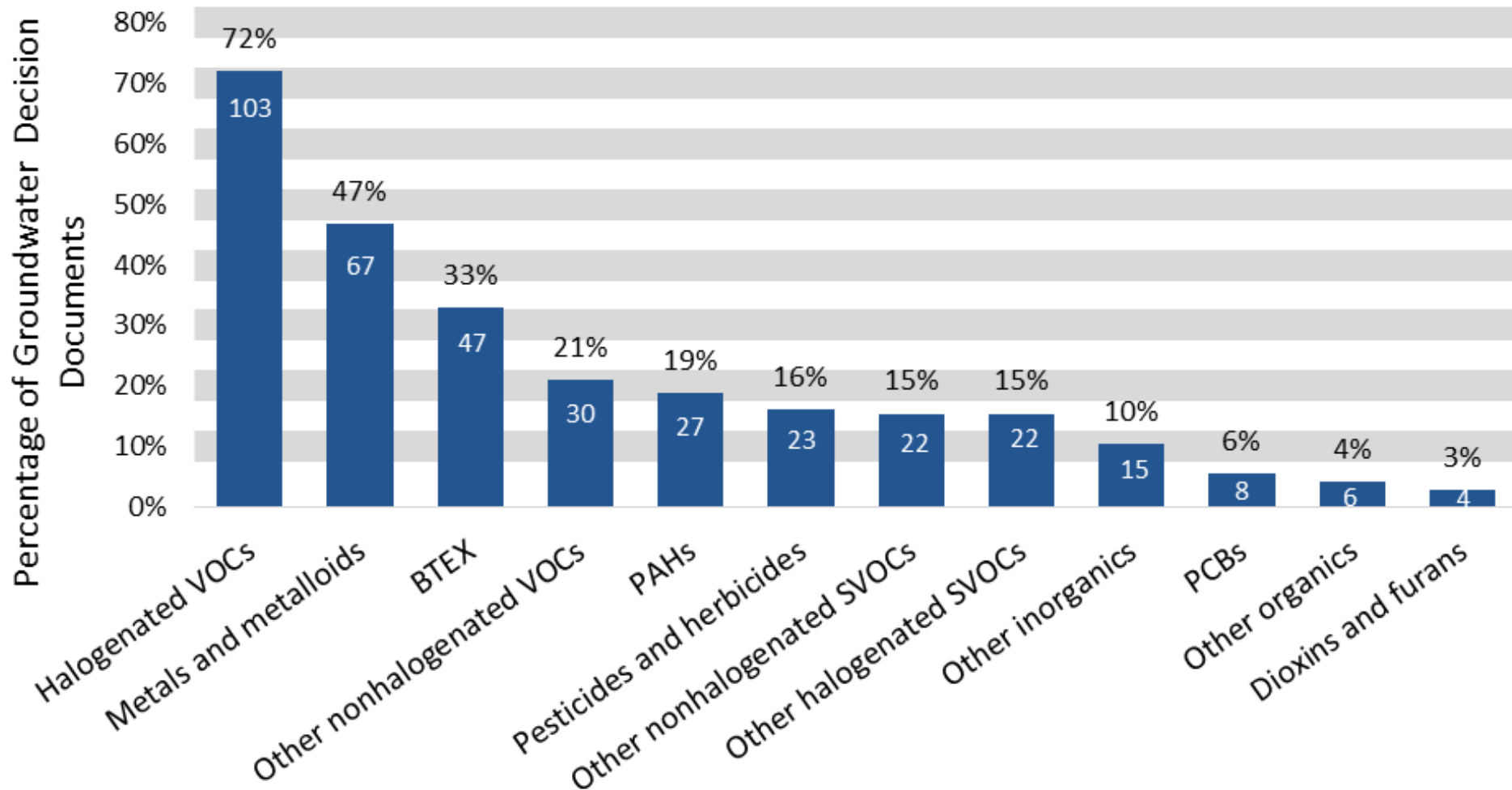
Groundwater Decision Documents = 160

Remedy	Total (FY12-14)	Percent Groundwater Decision Documents
Ex Situ Treatment (P&T)	37	23%
In Situ Treatment	81	51%
Bioremediation	46	29%
Chemical treatment	37	23%
Permeable reactive barrier	7	4%
Air sparging	5	3%
Thermal treatment	4	3%
Fracturing	3	2%
In-well air stripping	2	1%
Multi-phase extraction	2	1%
Phytoremediation	2	1%
Flushing	1	1%
Unspecified in situ treatment	3	2%

In Situ Bioremediation and Chemical Treatment Techniques Selected in Recent Groundwater Decision Documents (FY 2012-2014)

Technology	2012	2013	2014	Total
Bioremediation	13	17	16	46
Anaerobic bioremediation	8	10	11	29
Bioremediation (unspecified)	5	5	5	15
Bioaugmentation	2	2	5	9
Aerobic bioremediation	0	2	1	3
Chemical Treatment	16	9	13	38
In situ chemical oxidation	9	5	8	22
In situ chemical reduction	4	3	6	13
In situ chemical treatment (unspecified)	1	1	1	3
Neutralization	0	1	0	1
In situ chemical oxidation/reduction	1	0	0	1

Detailed COCs in Decision Documents with Groundwater Remedies (FY 2012-2014)



Vapor Intrusion Remedies Selected in Decision Documents (FY 2009-2014)

- ◆ VI decision documents over 6 years
- ◆ 24 have VI mitigation for existing structures
- ◆ 56 have ICs for existing structures or future development

Remedy	2009	2010	2011	2012	2013	2014	Total
Vapor Intrusion Mitigation at Existing Structures	1	8	6	3	3	3	24
Active depressurization technology	0	6	3	1	0	3	13
Vapor intrusion mitigation (unspecified)	1	2	2	2	2	1	10
Sealing cracks and openings	0	4	1	0	0	0	5
Interior ventilation	0	4	0	0	0	0	4
Passive barrier (impermeable membrane)	0	0	1	1	1	0	3
Soil pressurization	0	3	0	0	0	0	3
Sub-slab ventilation	0	0	0	1	1	0	2
Institutional Controls	0	11	11	6	6	22	56
Future construction	0	9	7	4	5	16	41
Existing structures	0	6	6	3	2	6	23

Combined Remedies and Optimization Impacts

- ◆ Identified some sites with combined remedies in the FY 2012-14 decision documents.
- ◆ Also identified some ARODs and ESDs that were informed, in part, by a prior optimization event.

Combined Remedies Highlights

◆ **Williams Air Force Base, AZ, AROD 9/28/13**

- » Groundwater, contaminated with benzene, toluene, naphthalene, LNAPL
- » Phased approach
- » **Steam enhanced extraction followed by in situ bioremediation**

◆ **Alameda Naval Air Station, CA, ROD 4/29/14**

- » Groundwater contaminated with chlorinated VOCs (vinyl chloride and trichloroethene)
- » Spatial approach
- » **ISCO for higher concentrations in groundwater**
- » **In situ bioremediation for more dilute plume areas**

Conclusions

- ◆ Superfund sites address multiple media and types of contaminants with multiple remedial approaches.
- ◆ Most site remedies include treatment of source, groundwater or both.
- ◆ Many recent decision documents include in situ treatment
 - » Source: SVE, chemical treatment & ISTT most frequently
 - » GW: Bioremediation and chemical oxidation/reduction most frequent
 - » P&T: Usually combined with source control
- ◆ Selected remedies combined using both a spatial and phased approach, or were informed by optimization reviews.

Report available June 2017 at:

[http://www.epa.gov/remedytech/
superfund-remedy-report](http://www.epa.gov/remedytech/superfund-remedy-report)

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