MASSACHUSETTS CLEAN ENERGY CENTER

Ground-Source Heat Pump Funding & Resources

MassDEP / LSPA Meeting:

Geothermal / GSHP Application Opportunities Under the MCP

May 2015

Josh Kessler
Renewable Thermal Project Manager

MassCEC mission

- **Accelerate** clean energy technologies, companies and projects
- **Create** high-quality jobs and long-term economic growth
- **Support** municipal clean energy projects
- **Invest** in residential and commercial renewable energy installations
- **Cultivate** a robust marketplace for innovation

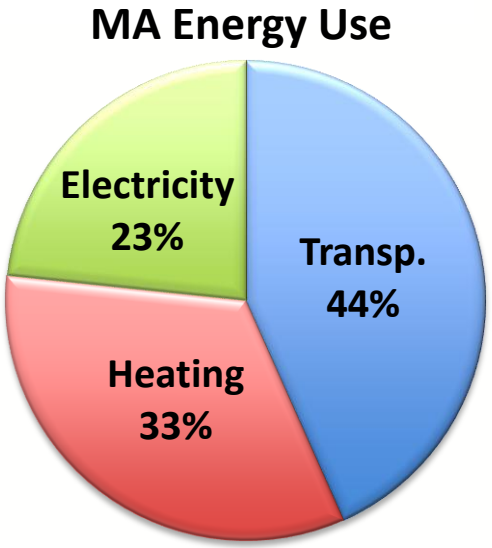
Renewable Energy Generation

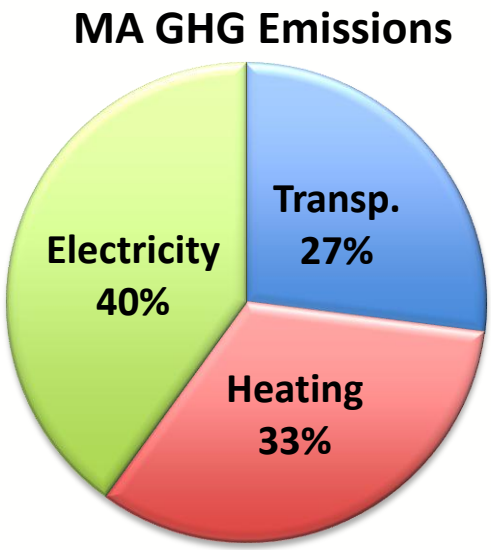
- Technologies we support:
  - **Electric:** Solar PV, Wind, Small Hydro, Anaerobic Digestion
  - **Thermal:** GSHPs, ASHPs, Biomass, District Energy, Solar Hot Water
- Support of the deployment of clean energy through:
  - Grants, rebates, and loans for installation/construction
  - Grants for early-stage project feasibility assessment
  - Technical guidance, research, market assessment
  - Marketing, outreach, training

Thermal Energy in MA

- National focus:
  - Renewables for electricity
  - Electric vehicles, biofuels
  - Limited focus on renewable heating

- Thermal energy accounts for:
  - 1/3 of MA energy use
  - 1/3 of energy-related GHG emissions





MA Heating Costs

- Average household heating cost: $1,700/yr
- 50% of homes heat use expensive fuels
  - 10% use electricity
  - 31% use fuel oil
  - 80+ towns have no access to natural gas

GSHPs reduce heating costs by about 50% vs. oil, propane, or electric resistance heat.

GSHP Opportunities & Barriers

- GSHPs provide major long-term cost and GHG savings vs. electricity and fuel oil
- Several barriers to industry growth

Barriers	Solution
High installation costs	Incentives
Limited awareness	Targeted outreach & marketing
Design & installation quality	1) Design review and project inspections 2) Installer training

MassCEC Clean Heating & Cooling Program

- Residential program that includes GSHPs, Biomass, and ASHPs
  - MassCEC has funded solar hot water through other programs since 2011
- Program timeframe
  - Pilot ran May - Oct. 2014
  - Current program launched Nov. 2014
- Residential GSHP awards to date:
  - 74 projects (35 installed; 39 more approved)
  - Awarded nearly $600,000 in grants

Commercial Pilot Program:
Renewable Thermal & District Energy Program

- **Solicitation Timeline**: Sept. 2013 - Sept. 2014
  - Funding reserved for ongoing projects
- **Grantees**: public entities, non-profits
- **Technologies**: GSHP, wood pellet boilers, district energy

Commercial-Scale Pilot Grant Structure

1. Feasibility study ($5,000)
   - Review study with CEC and technical consultants
   - Decide whether to proceed with project
2. Design & engineering ($20,000)
3. Construction ($4,000/heating ton; max. $108,000)

Lessons Learned

Program	Notable Lessons Learned
Residential Pilot	• Well-established, trained, and experienced set of installers • Equipment supply-chain is strong • Upfront installation costs are high • Existing but limited customer demand • Project design can be complex • COPs not as high as anticipated • Installation practices varied (esp. system sizing)
Commercial-Scale Pilot	• Limited availability of contractors • COPs not as high as anticipated • System sizing practices varied

Potential Commercial Program

- By July 1, we should know how much funding will be available for commercial GSHP.
  - Program launch would occur later.

- Key design considerations, if program launched
  - What to fund (feasibility studies, design/engineering, etc.)
  - Approval & contracting process
  - Outreach strategy
  - Program duration

GSHP Funding Summary

Sector	Incentive	Amount	Expires
Res	MassCEC Clean Heating and Cooling Grant	Max. $12,500	TBD
Res	Mass Save HEAT Loan	0% for 7 years; max. $25,000	TBD
Res	Federal Renewable Energy Tax Credit	30%	2016
Res	Sales Tax Exemption	100%	-
C&I	Investment Tax Credit	10%	2016

MassCEC does not currently offer GSHP funding for commercial entities. FY2016 begins July 1, and funding could be available later this year.

Resources & Training

- Installer training & certification organizations
  - New England Geothermal Professional Association (NEGPA)
  - International Ground-Source Heat Pump Association (IGSHPA)
- NEGPA/IGSHPA services
  - Directories of certified installers
  - Training for installers, project planners, customers
  - Technical guidance & standards development
  - Industry coordination

MASSACHUSETTS CLEAN ENERGY CENTER

Questions?

MASSACHUSETTS CLEAN ENERGY CENTER

Josh Kessler

Renewable Thermal Project Manager

jkessler@masscec.com

617-315-9319

Appendix: Residential Rebate Structure

Rebate per heating ton =
*Base Rebate + Efficiency Adder * (10*(Weighted Average COP – Min. COP))*

	Closed Loop		Open Loop	
	Water-to-Air	Water-to-Water	Water-to-Air	Water-to-Water
Minimum COP	3.6	3.1	4.1	3.5
Base Rebate (per 12,000 BTU/hr)	$1,500	$1,500	$1,500	$1,500
Efficiency Adder (per 0.1 COP above Minimum COP)	$100	$50	$100	$50
Maximum Rebate (per 12,000 BTU/hr)	$2,500	$2,000	$2,500	$2,000
Maximum Total Rebate (per system, based on 60,000 BTU/hr)	$12,500	$10,000	$12,500	$10,000

Appendix: Residential System Requirements

- Heat Pumps must be AHRI rated
- Designed to meet at least 98% of annual heating load
- System sized between 80% and 120% of peak load
- Vertically bored closed-loop projects must have a minimum of 150 feet per 12,000 BTU/hr of heating capacity
  - Horizontal and open loop systems will be subject to third party design review
- Closed-loop bore grouting must have a grout conductivity equal to or greater than anticipated earth conductivity of the drill site up to 1 BTU/hr-ft-°F.
- There must be at least 15 feet of separation between closed-loop bore holes.
- Open and horizontal loop projects will be required to submit the additional information listed below:
  - Open loop: method for determining pressure and flow rate
  - Horizontal loop: file from horizontal loop design software showing inputs and system design specs

MassDEP / LSPA Geothermal / GSHP Application Opportunities

Regulations for the Installation and Operation of Geothermal Heat Pump Wells

Joe Cerutti

MassDEP – Drinking Water Program

Abbreviations and Definitions

- UIC = Underground Injection Control
- GSHP = ground source heat pump = geothermal heat pump
- DX = direct exchange (ground portion of heat exchange occurs across a refrigerant loop)
- Dual use well = a well that is used as both a source of drinking water and heat pump supply
- Return flow = majority of the discharge from an open-loop heat pump
- Bleed flow = typically is 5% to 10% of the discharge from an open-loop heat pump that is not returned to the standing-column well
- gpd = gallons per day
- gpm = gallons per minute

Massachusetts Department of Environmental Protection (MassDEP)

MassDEP regulates geothermal heat pump wells, withdrawals, and discharges under the following programs:

- Underground Injection Control (UIC)
- Well Driller Certification
- Water Management Act
- Groundwater Discharge

US Environmental Protection Agency (EPA)

EPA regulates any geothermal discharges to jurisdictional surface water bodies:

- NPDES Non-Contact Cooling Water General Permit

History of UIC Requirements for Ground Source Heat Pump (GSHP) Wells

- May 1982 – MassDEP requires Underground Injection Control (UIC) registration of GSHP wells
- 1986 – EPA confirms state UIC programs' ability to regulate closed-loop (including DX) GSHP wells as Class V wells
- 2003 – MassDEP issues a GSHP fact sheet (posted on Well Driller Registration Program's web site)
- February 2009 – MassDEP adopts Guidelines for GSHP Wells
- February 2010 – elimination of registration fees and significant reduction in UIC application submittal requirements for closed-loop & DX wells
- December 2013– revisions to guidelines resolving state plumbing board issues with dual use wells

Wells Requiring UIC Registration

- Any well receiving return flow or system bleed from an open-loop system
- All closed-loop and Direct Exchange (DX) wells

Note: UIC registration is required for all of the above unless a Groundwater Discharge Permit (GDP) is required.

Wells Requiring Groundwater Discharge Permit

- Open-Loop if:
  - raw water exceeds primary drinking water Maximum Contaminant Levels (MCL) (some exceptions)
  - any chemical addition

Wells Prohibited in Massachusetts

- Open-Loop if:
  - drawing water from a Public Water System (other than make-up fluid)

Responsibilities

- Owner/Operator – properly operate and maintain system and notify UIC Program of changes to registration information
- Designer – MA PE or certified by International Ground Source Heat Pump Association (IGSHPA), Canadian Geoexchange Coalition (CGC), or the equipment manufacturer
- Installer – certified by IGSHPA, CGC, or manufacturer
- Well Driller –must be a Massachusetts Certified Well Driller

Setback Distances

If the open-loop well is also a private water supply well then all standard setback distances apply

- All others:
- 25 feet from potential sources of contamination including but not limited to:
  - septic tanks/fields
  - lagoons
  - livestock pens
  - oil or hazardous materials storage tanks
- 10 feet from property boundary (some towns require further setbacks from public road)
- 10 feet from potable water and sewer lines

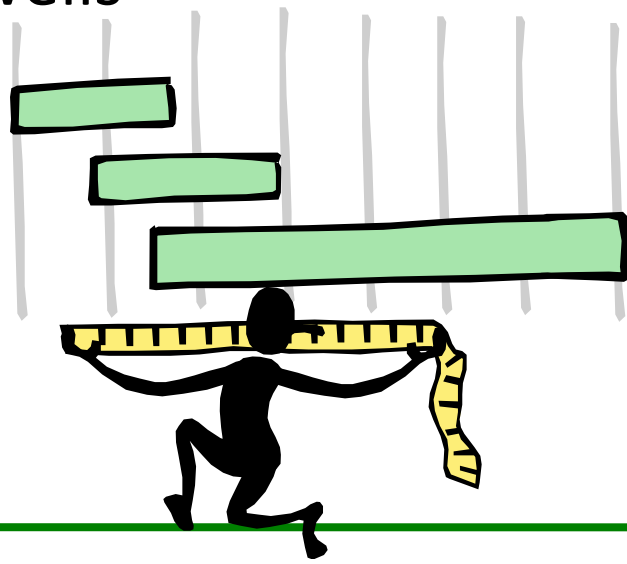
Setback Distances (continued)

Open-loop wells:

- 25 feet from private drinking water wells

Closed-loop and DX wells:

- 50 feet from private drinking water wells



Grouting Requirements

Open-loop wells should be installed per the standards established in the MassDEP Private Well Guidelines

- Bedrock Wells: casing set a minimum of 15 feet into competent bedrock and grouted in place
- Overburden Wells: grout seal across any confining layers and grout seal at or near ground surface

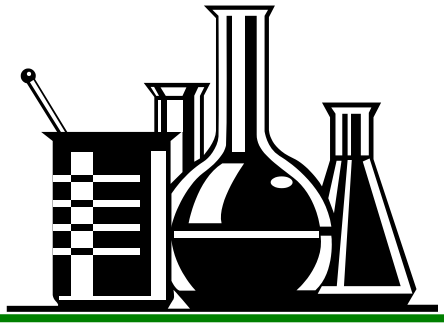
Grouting Requirements (continued)

- Closed-loop: Due to concerns associated with the expansion/contraction of plastic tubing (HDPE), high solids bentonite slurry grout required:
- DX: Same grouting requirements as closed-loop but a cement-based grout may be used in place of bentonite slurry grout

Note: sand/bentonite mixture grouts (thermal grouts) acceptable if cured grout's hydraulic conductivity does't exceed 10^{-7} centimeters per second

Allowable Additives

- Open-loop: no chemical additives currently allowed under UIC registration (permit required)
- Closed-loop:
  - Antifreeze additives: propylene glycol and ethanol
  - Ethanol denaturants: denatonium benzoate, ethyl acetate, isopropanol, pine oil, and tertiary butyl alcohol
- DX: R-22, R-407A, and R-410A refrigerants, food grade lubricating oils, and polyol ester



Other Requirements

- All GSHP wells: refrigerant leak detection and emergency shut-offs
  - For closed-loop these are required for leaks in both the water loop and the refrigerant loop
- Open-loop:
  - Discharge below the operating water level in the well
  - Backflow prevention device required on system bleed line
- DX: cathodic protection (some exceptions)

Other Requirements (continued)

- Dual use as a private drinking water well
  - Pump intake set below return line outlet in standing column wells
  - residential dual check backflow preventer prior to the heat pump
  - BOH approval for private drinking water well use
  - Requires local plumbing inspector approval
- Make-up water from public water system (PWS)
  - Approval from PWS
  - Backflow prevention device at PWS connection to building and 2nd device just prior to GSHP heat exchanger
  - MassDEP does't allow automatic feed systems

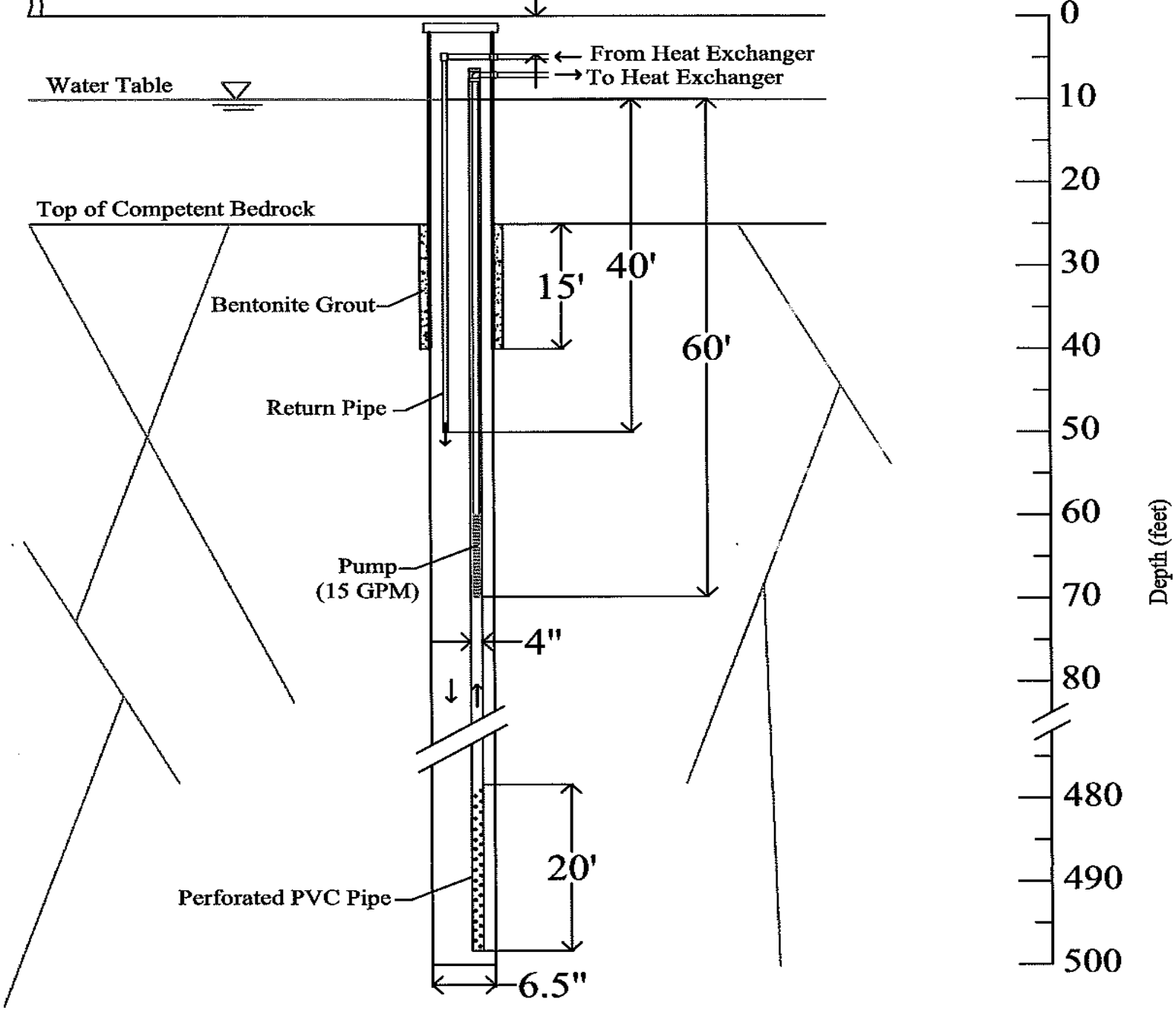
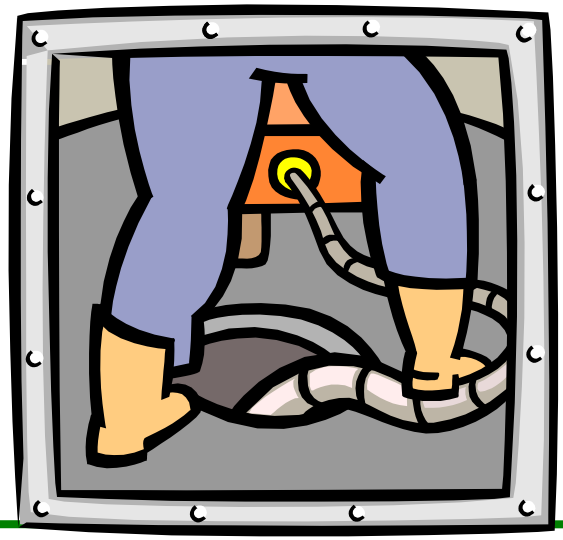


Figure copied from UIC submittal from GeoHydroCycle, Inc.

Other Requirements (continued)

- Local approval of bleed discharge to municipal sewer or stormwater (stormwater discharge may also require NPDES permit)
- Water Management Act Form I – determination of non-consumptive use required for system design rate >100,000 gpd (70 gpm)



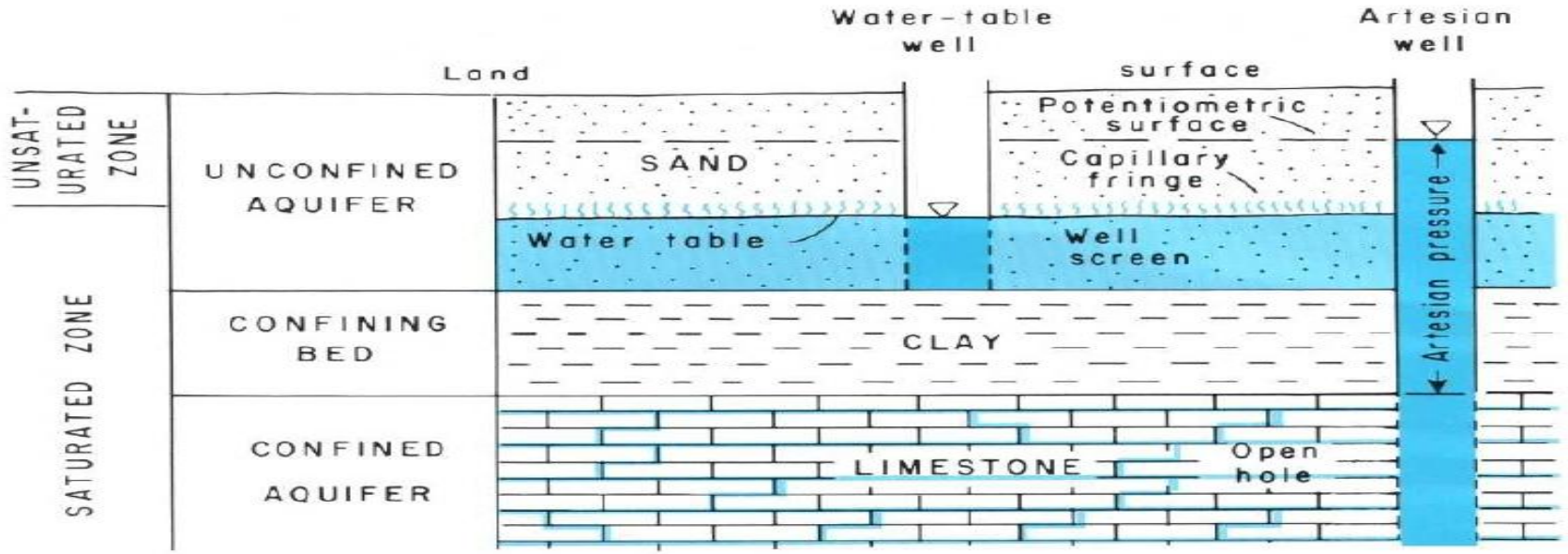
Other Requirements (continued)

- Construction Dewatering - must apply for approval (UIC registration or NPDES)
- Working within a wetland or surface water buffer (check with local Conservation Commission)
- Some BOH have adopted their own GSHP regulations and BOH drilling permit may be required for some or all GSHP well categories

Note: BOH may adopt stricter standards than MassDEP and BOH may exclude certain types of GSHP wells

Open-Transfer Well

- Open-Transfer Well: >5% of return and/or system bleed from a standing column well discharges to a different aquifer.
- These wells require the submittal of a justification statement with the UIC registration package.



Technologies Missing from Guidelines

Concentric Closed Loop

- Consists of an inner and outer well casing
  - Inner casing is essentially a drop tube open ended just above the bottom of the outer casing
- Use of experimental well casing and grout materials with better thermal conductivity values
- UIC Program treats similar to conventional closed-loop
  - Same set-back distance requirements
  - Same antifreeze solutions

Under Consideration for Future Well Driller Regulation Changes

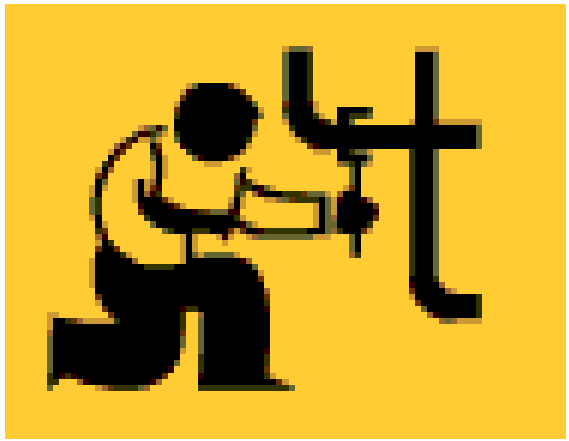
- Establish a special classification for well drillers that only install DX wells or conventional closed-loop wells

Lessons Learned Open-Loop Wells

- Unacceptable post heat pump lead and copper results
  - Water chemistry
  - Electrolysis resulting from insufficient grounding of the electrical system
  - Naturally occurring?

Lessons Learned
Open-Loop Wells (continued)

- Coastal Environments
  - Salt water intrusion and contamination of fresh water aquifers
  - Corrosion concerns for plumbing and heat pump equipment



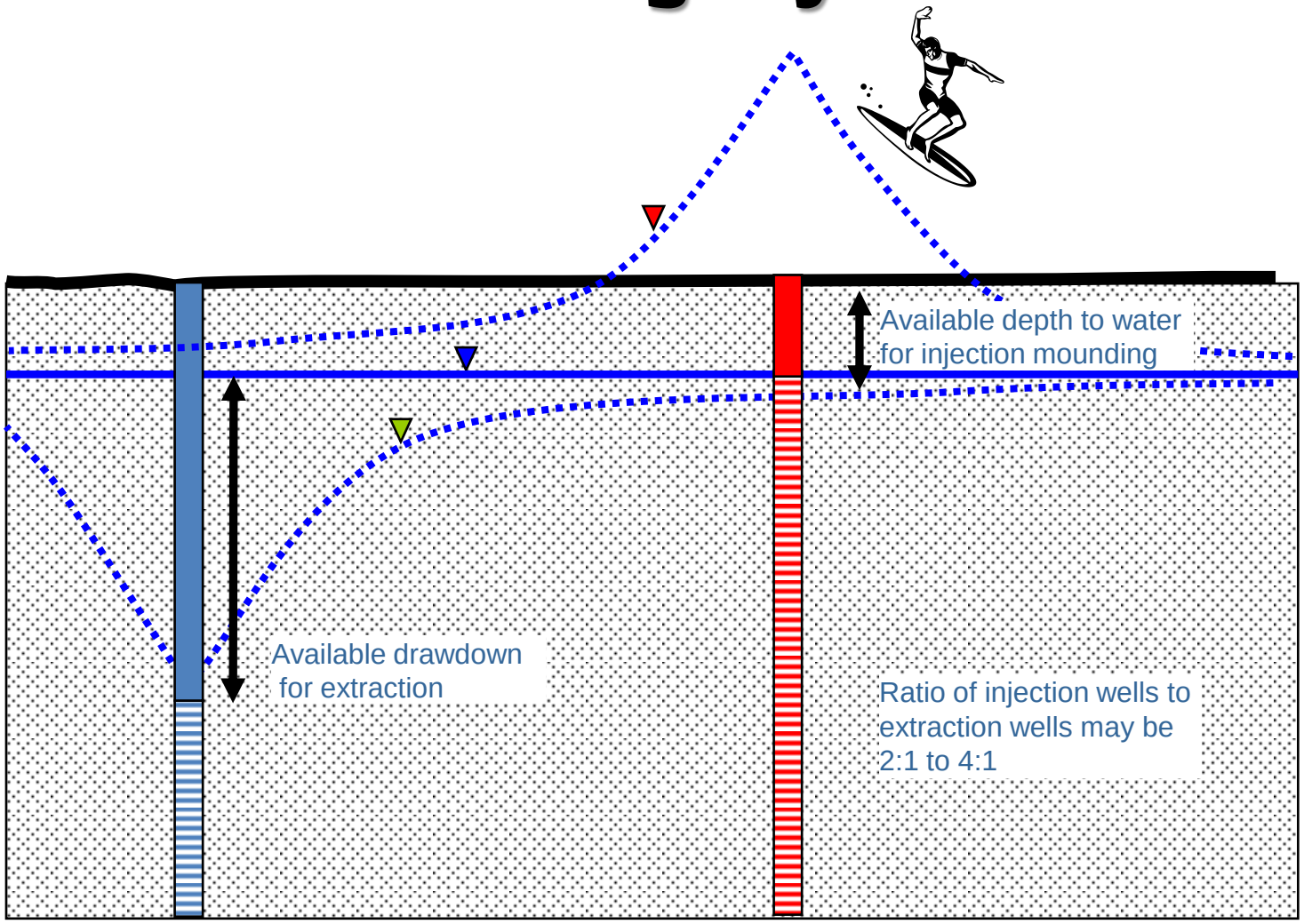
Lessons Learned
Open-Loop Wells (continued)

- Throughout Massachusetts
  - High Fe & Mn in raw water are common and can cause long term O & M costs
  - Low pH - corrosion concerns for plumbing and heat pump equipment
    - May result in failure of 90 to 120-day post start-up lead result

Lessons Learned
Open-Loop Wells (continued)

- Open doublet: pressurization of injection well
  - It's typically a lot easier to pump water from a well than it is to inject
  - 10 psi of pressure = 23 feet of water column
  - Consequences of pressurizing the injection well:
    - Break-out of ground water at ground surface resulting in flooding, erosion and the icing of walkways, roads, and driveways
    - Blow-outs or sink holes and the resulting concern for the structural integrity of nearby roads and building structures and damage to landscape features

Withdraw-Recharge Systems

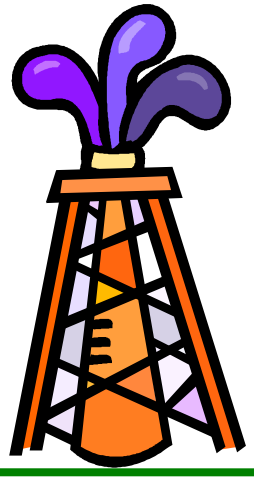


NOT TO SCALE

Original slide courtesy Haley & Aldrich, Inc.

Lessons Learned
Open-Loop Wells (continued)

- Open doublet (continued)
  - Will a 500 foot deep bedrock well with a shallow depth to water table that is capable of producing 20 gpm with 300 feet of drawdown accept an injection rate of 20 gpm without pressurizing the wellhead? Probably not.



Regional System Design Considerations

- Learn from your competitors:
  - No sand & gravel aquifer available = closed-loop & open-loop standing column bedrock well
  - Medium to high yielding sand & gravel aquifer available = closed-loop & shallow open doublet

Geothermal Wells at Waste Sites

- When UIC registration is required
  - Active sites: closed-loop: registration always required
  - Open-loop: not required if tapping into a required MCP pump & treat system but when site is RAO'd, then UIC registration is required.

Geothermal Wells at Waste Sites

- Site without RAO or geothermal well installed within AUL footprint
  - Requires statement from LSP of record indicating UIC well installation & discharge activities won't exacerbate existing conditions

Geothermal Wells at Waste Sites (continued)

- Potential for exacerbation of existing contaminant plume from open-loop wells
  - System bleed from bedrock well to a shallow overburden well
  - Mixing of water in bedrock fracture zones
  - System bleed to stormwater system
  - Open-loop - open transfer (open doublet) results in a greater impact on aquifer flow directions/velocities than a standing column well

Geothermal Wells at Waste Sites (continued)

- Water quality considerations
  - Drinking Water Program's MCL vs. MCP's RCGW-2 vs. NPDES limits
  - Groundwater Discharge Permit if pre-treatment required (only if treatment is not part of MCP cleanup activities)

UIC Registration Application Process

- Closed-loop and DX: *UIC Registration Application for Closed-Loop Ground Source Heat Pump Well*
- Open loop: *BRP WS 06 UIC Registration – Open-Loop Ground Source Heat Pump Well*
  - 1 to 4 unit residential use only properties - fee exempt
  - Closed-loop regardless of land use – fee exempt
  - All others – fee applies unless facility is municipally owned

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Drinking Water Program

UIC Registration Application for Closed-Loop Ground Source Heat Pump Well

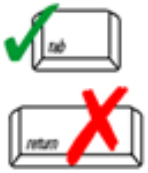
Registration Category

Registration of Underground Discharges to Injection Well(s) ☐
Modification to an Existing UIC Registration ☐

UIC Registration Fee - Exempt

For Modifications to an Existing UIC Registration

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



Check all that apply: ☐ Change of owner ☐ Change in # of discharge wells (+/-)

Enter UIC Registration Number issued by MassDEP for the initial UIC Registration (required for modifications): _____ UIC Registration#

A. Site Information

_____
Property name (enter "Private Residence" if unnamed)

_____ _____
Property Street Address City/Town

_____ _____
State Zip Code

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – drinking water program

BRP WS 06 UIC Registration

Open-Loop Ground Source Heat Pump Well

Note: this application form only applies to Open-Loop Ground Source Heat Pump Wells.

Refer to the instructions and supporting materials document that corresponds to this UIC Registration form for detailed instructions regarding the completion of this form and the required attachments.

Transmittal # (not required for 1- to 4-unit residential applications)

A. Registration Category and Fee

Registration Category

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Identify the type of registration activity you are conducting (check one):

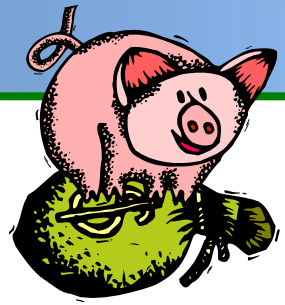
   a. Registration of a Proposed or Existing Unregistered UIC Well(s) ☐

   b. Pre-Closure of an Unregistered or Registered UIC Well(s) ☐

   c. Pre-Closure of an Unregistered or Registered UIC Well(s)and Conversion to New Well Type* ☐

   * **Note:** Conversion also requires submittal of a separate registration application for the new well type.

   d. Modification of a UIC Registration Application that is Still Under Review at MassDEP ☐



What is My Well Type & Application Fee for a BRP WS 06 Application?

five (5) or fewer wells with no well exceeding a well depth of 750 feet

- well type = 5C2 fee = $110

more than 5 wells, or one or more wells exceeding 750 feet in depth

- well type = 5C3 fee = $290

K. Additional Well-Type-Specific Information

Estimated total annual system bleed volume in gallons per year (does not typically apply to Well Type = “open doublet” or to normal consumption volume from a dual use well):

_____

System bleed discharge location (if not included in well construction information above):

☐ Stormwater ☐ Sanitary Sewer ☐ Surface Water ☐ Other (describe):

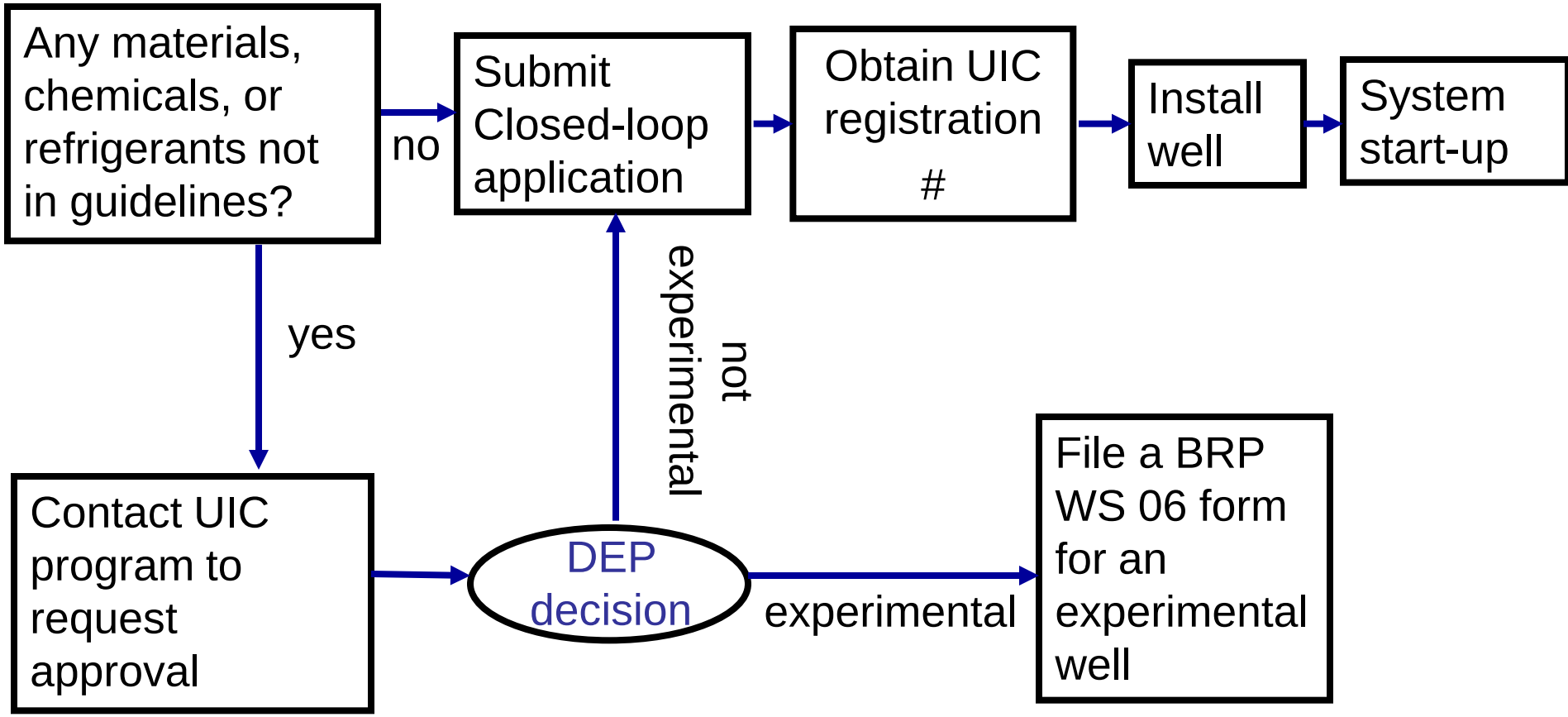
_____

Is this well(s) also being used as a water supply for other purpose(s)? ☐ Yes ☐ No

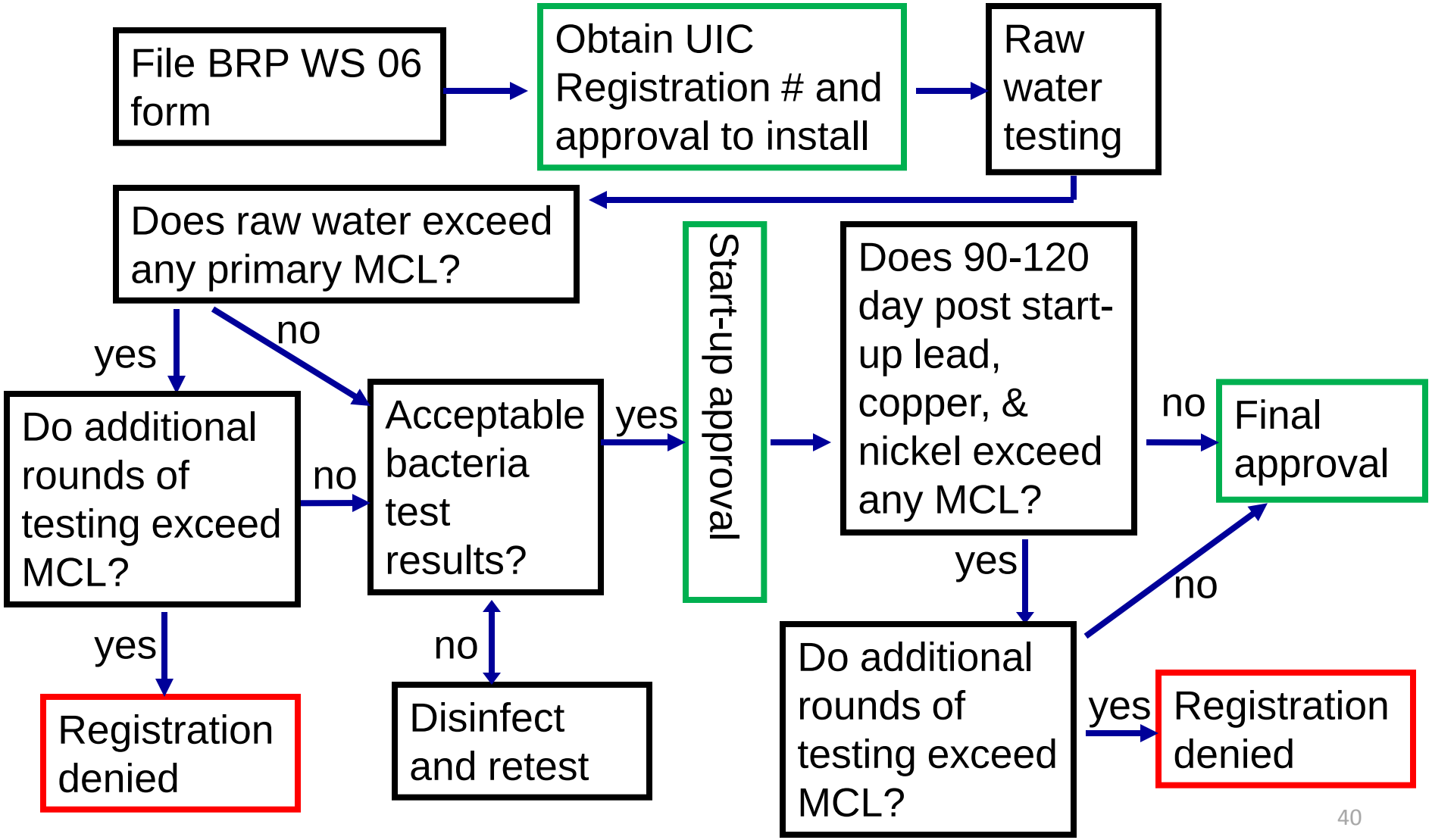
If yes, please indicate the other uses (check all that apply):

☐ Drinking Water ☐ Irrigation ☐ Process Water

UIC Application Process for Closed-Loop & DX Wells



UIC Application Process - Open-Loop Wells



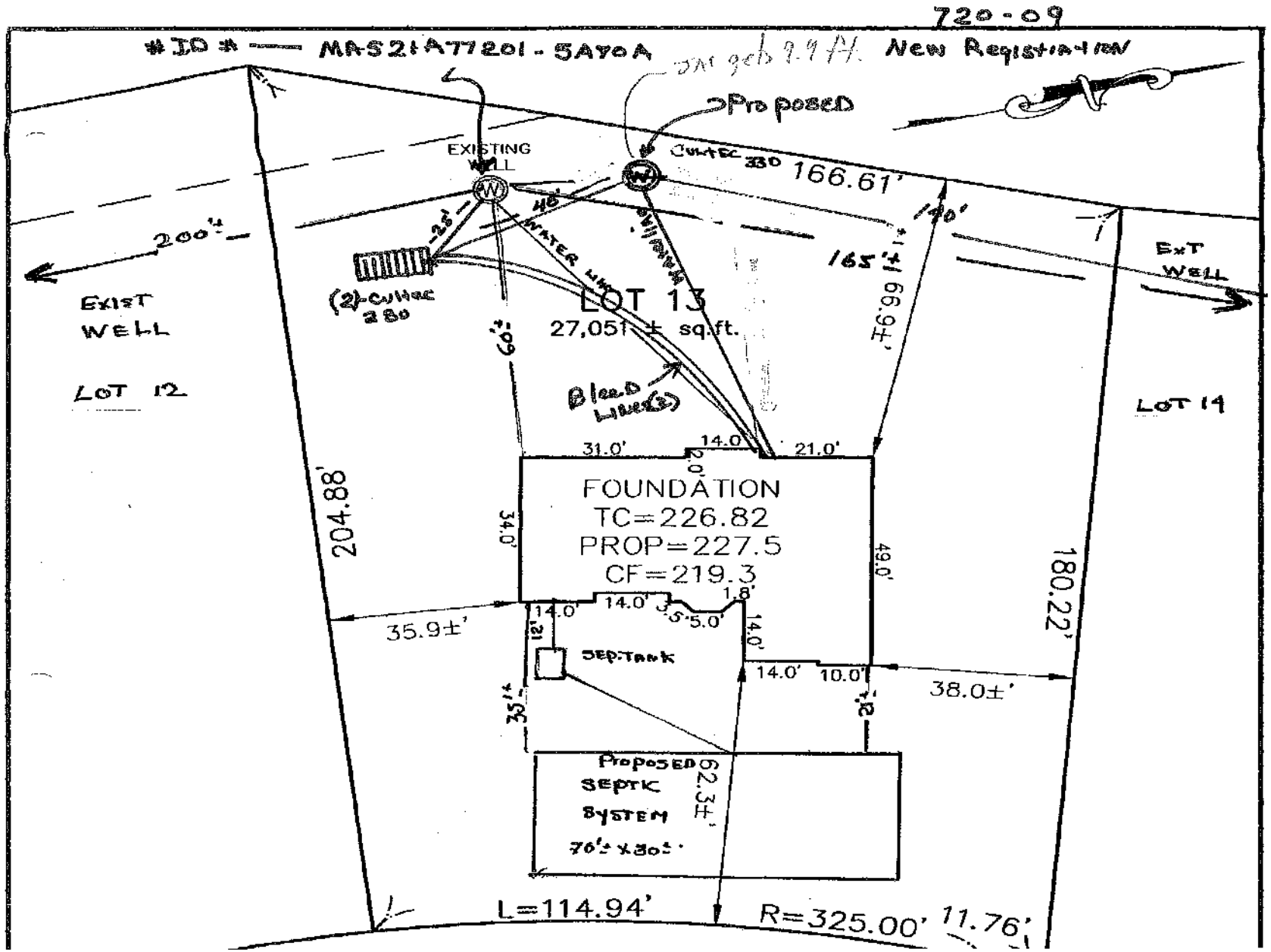
Open-Loop Application (continued)

- Site Plan
- Cross Section of GSHP well and bleed well (if applicable)

Open-Loop Application (continued)

Site Plan (Title 5 plans as base map are preferred) including:

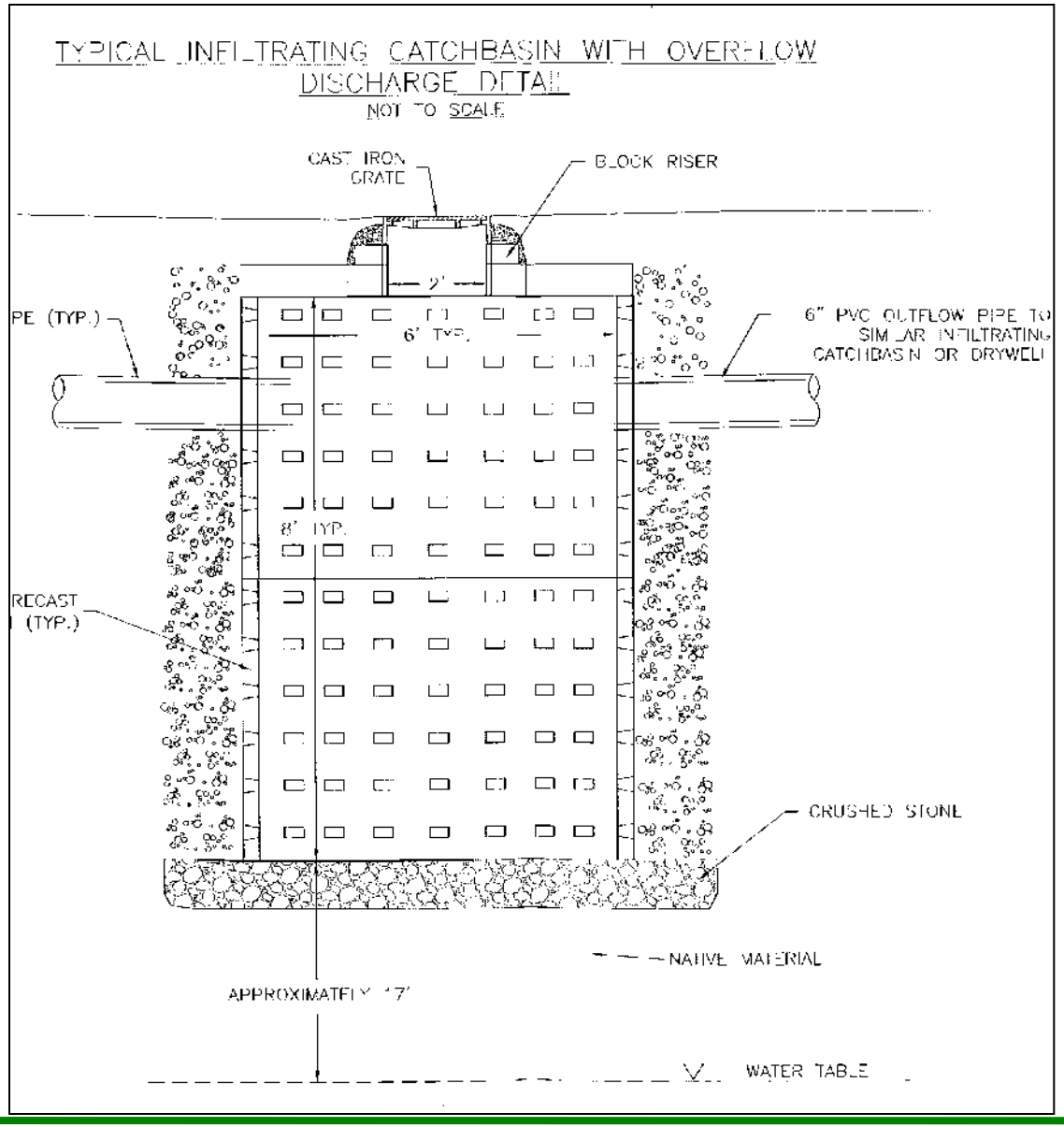
- GSHP well location
- GSHP bleed well location (if applicable)
- Location of supply and return lines
- Footprints of building structures
- Location of septic tank and leach field
- Property boundaries
- Locations of any nearby drinking water wells (including abutting properties)


720-09
#ID # — MAS21A77201-5AY0A
New Registration
Proposed
EXISTING WELL
Cultec 330
166.61'
200'±
EXIST WELL
LOT 12
(2)-Cultec 330
WATER LINE
ELECTRICAL
165'±
140'
EXT WELL
LOT 13
27,051± sq.ft.
Blend Line(s)
LOT 14
31.0'
14.0'
21.0'
FOUNDATION
TC=226.82
PROP=227.5
CF=219.3
204.88'
34.0'
49.0'
180.22'
35.9±'
14.0'
14.0'
1.8'
5.0'
14.0'
DEP:TANK
14.0'
10.0'
38.0±'
Proposed SEPTIC SYSTEM
70'± x 30'±
62.3±'
L=114.94'
R=325.00'
11.76'

Open-Loop Application (continued)

Cross section of proposed well construction including:

- Well depth
- Boring diameter
- Tubing diameter & material
- Grout interval
- Grout material
- Include cross section of bleed well (if applicable)


TYPICAL INFILTRATING CATCHBASIN WITH OVERFLOW DISCHARGE DETAIL
NOT TO SCALE
CAST IRON GRATE
BLOCK RISER
2'
6" PVC OUTFLOW PIPE TO SIMILAR INFILTRATING CATCHBASIN OR DRYWELL
PE (TYP.)
6' TYP.
8' TYP.
RECAST (TYP.)
CRUSHED STONE
NATIVE MATERIAL
APPROXIMATELY 17'
WATER TABLE

Open-Loop Application (continued)

Raw water analytical requirements:

- VOCs (EPA Method 524 + MTBE)
- arsenic
- nitrate (As N)
- nitrite (As N)
- gross alpha radiation
- radium (226 + 228)
- lead
- copper
- nickel
- uranium
- sodium
- chloride
- corrosivity
- iron
- manganese
- pH

Notes: Radiologicals not required in overburden wells on Cape, Islands, and Plymouth-Carver Aquifer (per August 2010 revisions)

Radium(226 +228) only required if gross alpha =/> 5 pCi/L

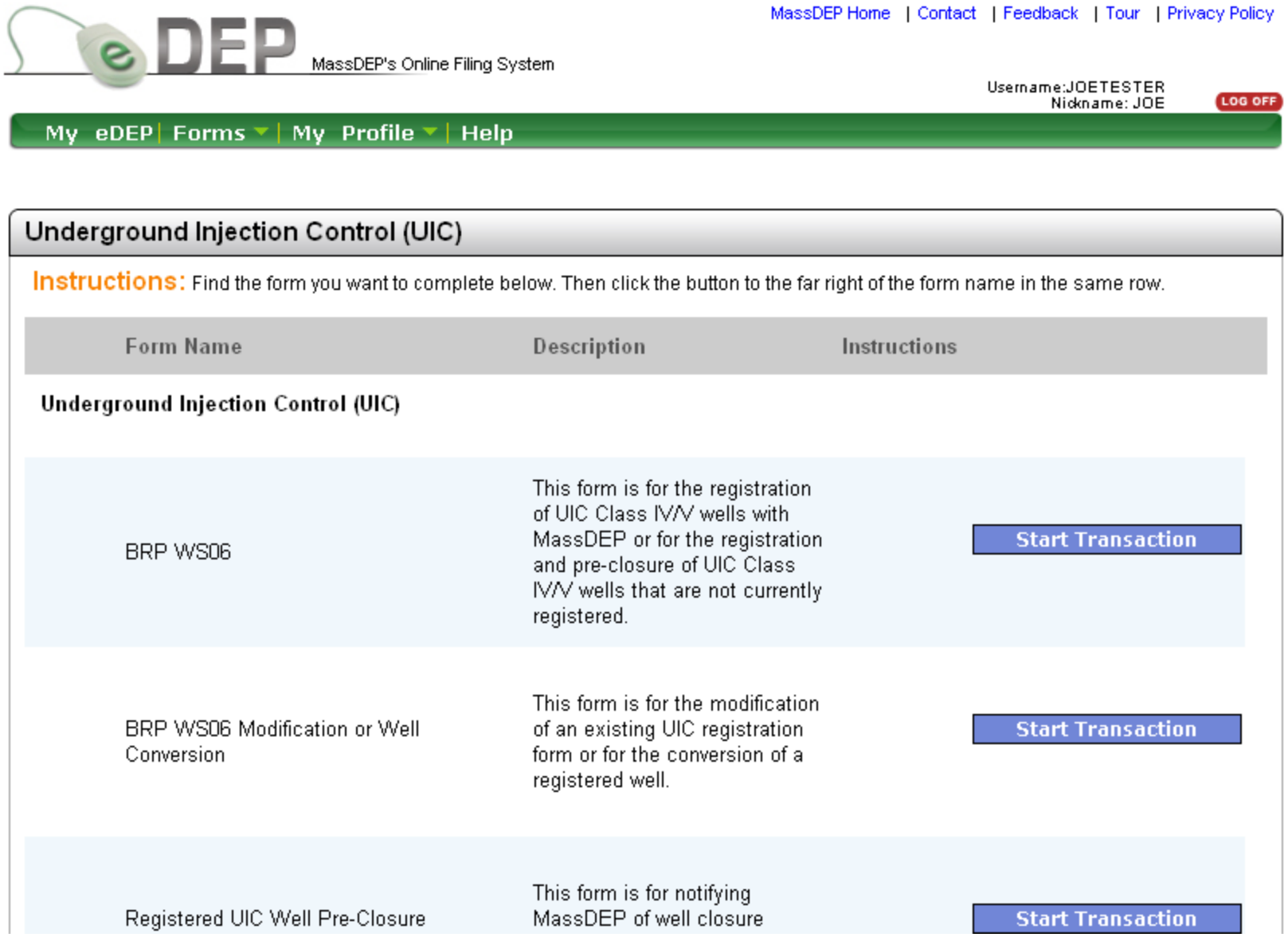
Uranium only required if gross alpha =/> 15 pCi/L

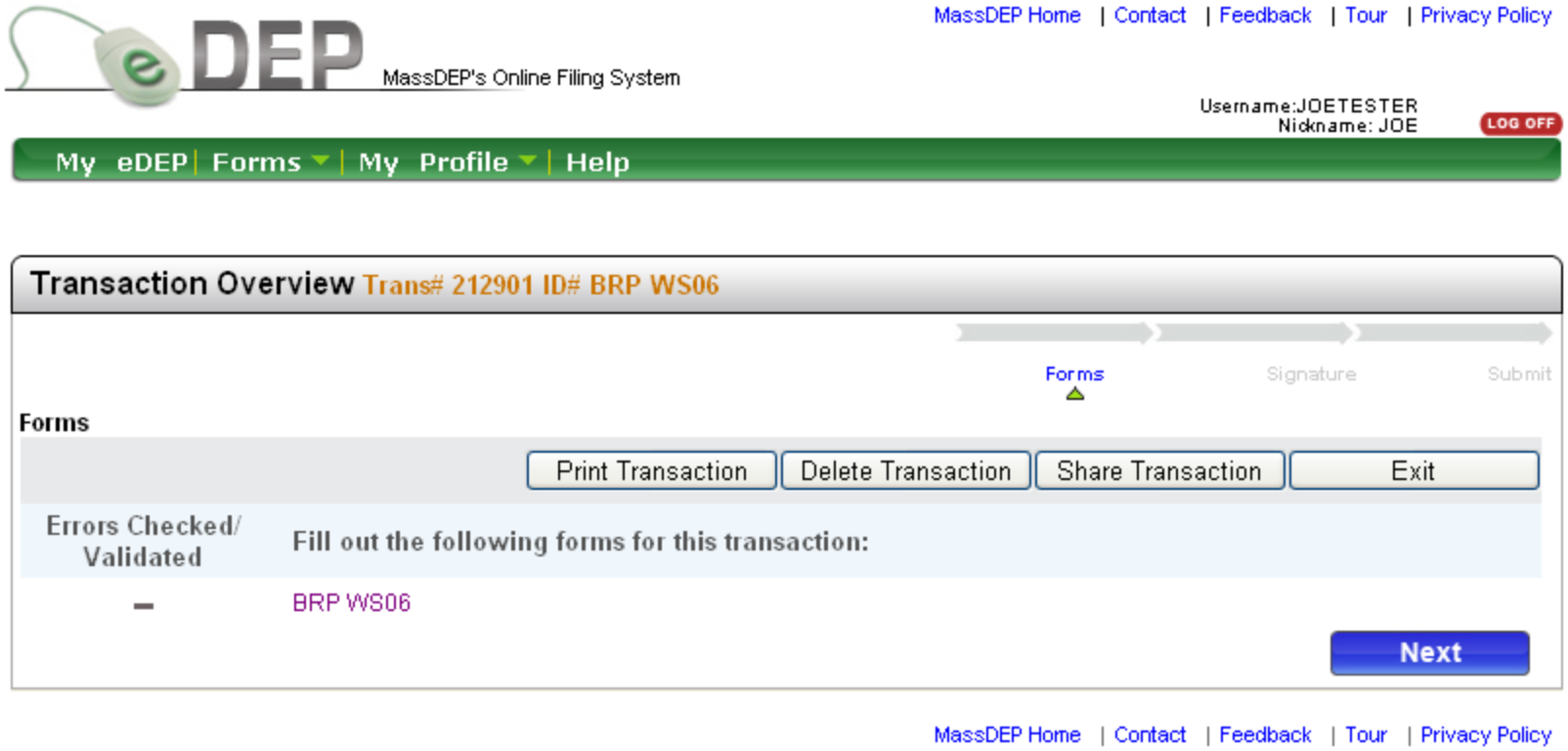
MassDEP raw water testing requirements typically exceed local BOH

Electronic Filing of UIC Registration Applications

- Electronic filing is available through eDEP


eDEP
MassDEP's Online Filing System
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help
Air & Climate
Business Sectors
Cleanup of Sites & Spills
Drinking Water
Service Centers
Toxics & Hazards
Underground Injection Control (UIC)
Waste & Recycling
Wastewater
Wetlands
All Forms
Recent Forms
My eDEP
Show Filter
Trans#
ID
Status
Last Update
Download to Print
212886
WORK IN PROGRESS
02/04/2010
Download
212882
SUBMITTED
02/04/2010
Download


eDEP
MassDEP's Online Filing System
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help
Underground Injection Control (UIC)
Instructions: Find the form you want to complete below. Then click the button to the far right of the form name in the same row.
Form Name
Description
Instructions
Underground Injection Control (UIC)
BRP WS06
This form is for the registration of UIC Class IV/V wells with MassDEP or for the registration and pre-closure of UIC Class IV/V wells that are not currently registered.
Start Transaction
BRP WS06 Modification or Well Conversion
This form is for the modification of an existing UIC registration form or for the conversion of a registered well.
Start Transaction
Registered UIC Well Pre-Closure
This form is for notifying MassDEP of well closure
Start Transaction


MassDEP Home | Contact | Feedback | Tour | Privacy Policy
eDEP
MassDEP's Online Filing System
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help
Transaction Overview Trans# 212901 ID# BRP WS06
Forms
Signature
Submit
Forms
Print Transaction
Delete Transaction
Share Transaction
Exit
Errors Checked/ Validated
Fill out the following forms for this transaction:
–
BRP WS06
Next
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
MassDEP's Online Filing System ver.9.2.4.0© 2010 MassDEP

BRP WS06 - Transaction #212901

Error Check | Save | Print | Exit

Section 1
Section 2
Section 3
Section 4

BRP WS06 - Transaction #212901 - UIC Registration # N/A

A. General Question

You may only register one type of discharge (well type) per registration application even if you are registering one well for multiple types of discharges. If you are registering for more than one type of well discharge you should start another application form after completing this form.

A1. What well type do you wish to register at this time?

Well Category: Ground Source Heat Pump Well Type: open-loop - standing column

A2. Are there any well additives?

○ Yes ◉ No

A3. Is the design injection rate greater than or equal to 100,000 gpd?

◉ Yes ○ No

A4. Is the source of your injection water from a public water system?

○ Yes ◉ No

A5. Is the source of your injection water already registered/permitted with the Water Management Act Program (WMAP) or has it already received a determination of non-consumptive use from WMAP?

○ Yes ◉ No

A6. Does the well construction or closure activity involve a drilled well?

◉ Yes ○ No

A7. Is the registration a result of the closure or conversion activity of a previously unregistered well?

○ Yes ◉ No

A8. Is the facility serviced by the well for 4 residential units or fewer?

○ Yes ◉ No

H. Registered Well Driller (if applicable)

First Name | Last Name

Company Name | Phone # | Massachusetts Well Driller Registration #

Email

I. Site Information

Water Supply: ○ Public ○ Private Sewer: ○ Public ○ Private

Are there any other current or proposed discharges on site?

○ Yes ○ No

Check any of the following that apply to this site

a. ☐ Bureau of Waste Site Cleanup Priority Site If yes, File Number

b. ☐ Bureau of Waste Site Cleanup Waiver Site If yes, File Number

c. ☐ Superfund Site If yes, Federal ID #

If the site is currently being regulated by the Bureau of Waste Site Cleanup, check any of the following that apply

☐ Incident Response ☐ Short Term Measure ☐ Activity and use limitations

Confirm that the applicant has checked that the site does not have any activity restrictions with respect to limiting discharges on the site.

○ Restrictions ○ No Restrictions

Only enter the location of wells that will be used for the following well type: ***open-loop - standing column***

Location of Well, Latitude & Longitude are no longer optional data:

Add Row

Identify the method used for locating the latitude/longitude coordinates for the UIC Class V well(s):

a. Type

○ Approximate location of point of UIC Class V well(s)

I. Site Information

Water Supply: ○ Public ○ Private Sewer: ○ Public ○ Private

Are there any other current or proposed discharges on site?

○ Yes ○ No

Check any of the following that apply to this site

a. ☐ Bureau of Waste Site Cleanup Priority Site If yes, File Number

b. ☐ Bureau of Waste Site Cleanup Waiver Site If yes, File Number

c. ☐ Superfund Site If yes, Federal ID #

If the site is currently being regulated by the Bureau of Waste Site Cleanup, check any of the following that apply

☐ Incident Response ☐ Short Term Measure ☐ Activity and use limitations

Confirm that the applicant has checked that the site does not have any activity restrictions with respect to limiting discharges on the site.

○ Restrictions ○ No Restrictions

Only enter the location of wells that will be used for the following well type: ***open-loop - standing column***

Location of Well, Latitude & Longitude are no longer optional data:

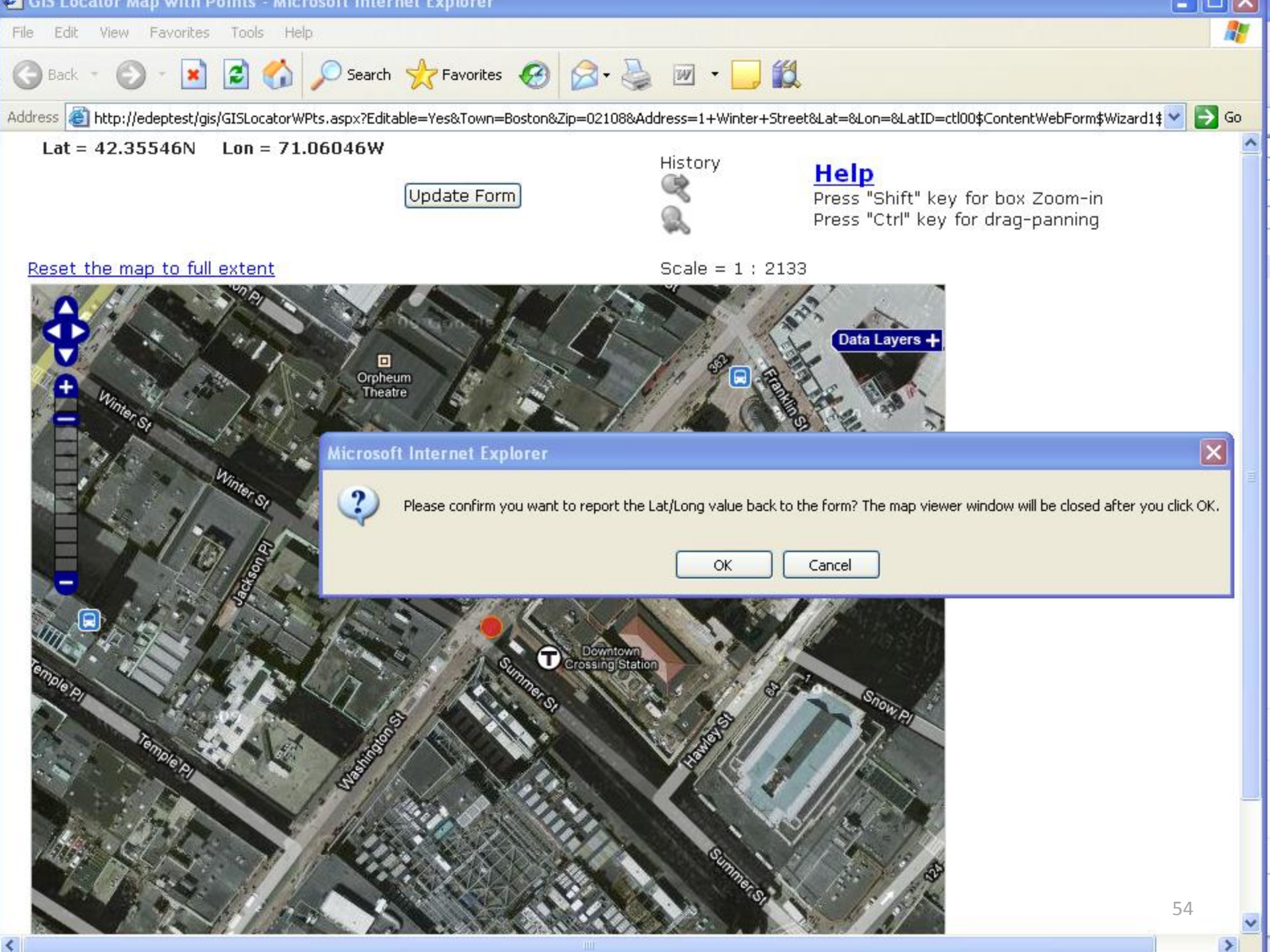
Well Identification Number	Latitude	Longitude	Locating Wells	
	N (e.g. 42.355767)	W (Do not enter (-) sign in front of value, e.g. 71.060996)	Locating Wells	Delete
			Add Row	

Identify the method used for locating the latitude/longitude coordinates for the UIC Class V well(s):

a. Type

○ Approximate location of point of UIC Class V well(s)

○ Approximate center of drainfield(s)


GIS Locator Map with Points - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://edeptest/gis/GISLocatorWPts.aspx?Editable=Yes&Town=Boston&Zip=02108&Address=1+Winter+Street&Lat=&Lon=&LatID=ctl00$ContentWebForm$Wizard1$
Go
Lat = 42.35546N Lon = 71.06046W
Update Form
History
Help
Press "Shift" key for box Zoom-in
Press "Ctrl" key for drag-panning
Reset the map to full extent
Scale = 1 : 2133
Data Layers
Orpheum Theatre
Winter St
Winter St
Franklin St
Jackson Pl
Temple Pl
Temple Pl
Washington St
Summer St
Downtown Crossing Station
Hawley St
Snow Pl
Summer St
Microsoft Internet Explorer
Please confirm you want to report the Lat/Long value back to the form? The map viewer window will be closed after you click OK.
OK
Cancel

I. Site Information

Water Supply: ○ Public ○ Private Sewer: ○ Public ○ Private

Are there any other current or proposed discharges on site?

○ Yes ○ No

Check any of the following that apply to this site

a. ☐ Bureau of Waste Site Cleanup Priority Site _____ If yes, File Number

b. ☐ Bureau of Waste Site Cleanup Waiver Site _____ If yes, File Number

c. ☐ Superfund Site _____ If yes, Federal ID #

If the site is currently being regulated by the Bureau of Waste Site Cleanup, check any of the following that apply

☐ Incident Response ☐ Short Term Measure ☐ Activity and use limitations _____

Confirm that the applicant has checked that the site does not have any activity restrictions with respect to limiting discharges on the site.

○ Restrictions ○ No Restrictions

Only enter the location of wells that will be used for the following well type: ***open-loop - standing column***

Location of Well, Latitude & Longitude are no longer optional data:

Well Identification Number	Latitude	Longitude	Locating Wells	
Well #1	42.35546 N (e.g. 42.355767)	71.06046 W (Do not enter (-) sign in front of value, e.g. 71.060996)	Locating Wells	Delete
			Add Row	

Identify the method used for locating the latitude/longitude coordinates for the UIC Class V well(s):

a. Type

○ Approximate location of point of UIC Class V well(s)

○ Approximate center of drainfield(s)

○ Approximate location of center of wellfield(s)

MassDEP's Online Filing System

BRP WS06 - Transaction #640150

Error Check | Save | Print | Exit

Section 1
Section 2
Section 3
Section 4

BRP WS06 - Transaction #640150 - UIC Registration # N/A

J. Injection Well Information (include information for wells being registered for closure)

Well Category: ***Ground Source Heat Pump*** Well Types: ***open-loop - standing column***

Registration: ○ Individual ◉ Area (multiple wells with same well codes)

Number of Wells: 2 Maximum Well Depth (feet): 1,500

UIC Well(s) Construction Date (for existing wells):

Well Construction (check all that apply)

- ☑ Drywell
- ☑ Drilled Well
- ☐ Septic Tank
- ☐ Dug Well
- ☐ Improved Sinkhole
- ☐ Drainfield/Leachfield
- ☐ Trench Drain
- ☐ Dustwater onto the ground
- ☐ Horizontal (only applies to certain ground source heat pump wells)
- ☐ Other (describe)

Type of Well Seal (if applicable): CEMENT/BENTO Well Seal Grout Material:

Source of injection fluid and Potential contaminant

Add Injection Fluid

Maximum total rate of injection (gallons per minute): 100 Average discharge rate (gallons per day): 20,000

Number of entry points to existing system

1

Total Number of entry points for proposed system (include entry points for both new and existing wells)

1

Distance to nearest wetland or water body (feet);
enter N/A if distance is greater than 200 feet

N/A

Distance to nearest septic system (feet);
enter N/A if distance is greater than 200 feet

100

Distance to nearest building foundation (existing or proposed)(feet);
enter N/A if distance is greater than 25 feet

N/A

Distance to nearest property line (feet);
enter N/A if distance is greater than 25 feet

15

List any treatment devices, process equipment, or heat pumps in place or proposed prior to the injection point (attach specification sheets and include treatment devices in a cross section):

1 PLATE AND FRAME HEAT EXCHANGER

Depth to water table (feet)

Depth to bedrock (feet)

Soil type(s) at side - e.g., fill, sandy till, gravel, sand

Distance to nearest private drinking water well (existing or proposed) (feet);
enter N/A if distance is greater than 1,250 feet

Distance to nearest Public Water Supply (feet);
enter N/A if distance is greater than 2,500 feet

N/A

K. Additional Information Required for Specific Well Types

Estimated total annual system bleed volume in gallons per year (Does not include normal water consumption volume from a dual use well) 200,000

System bleed discharge location (if not included in well construction information above):

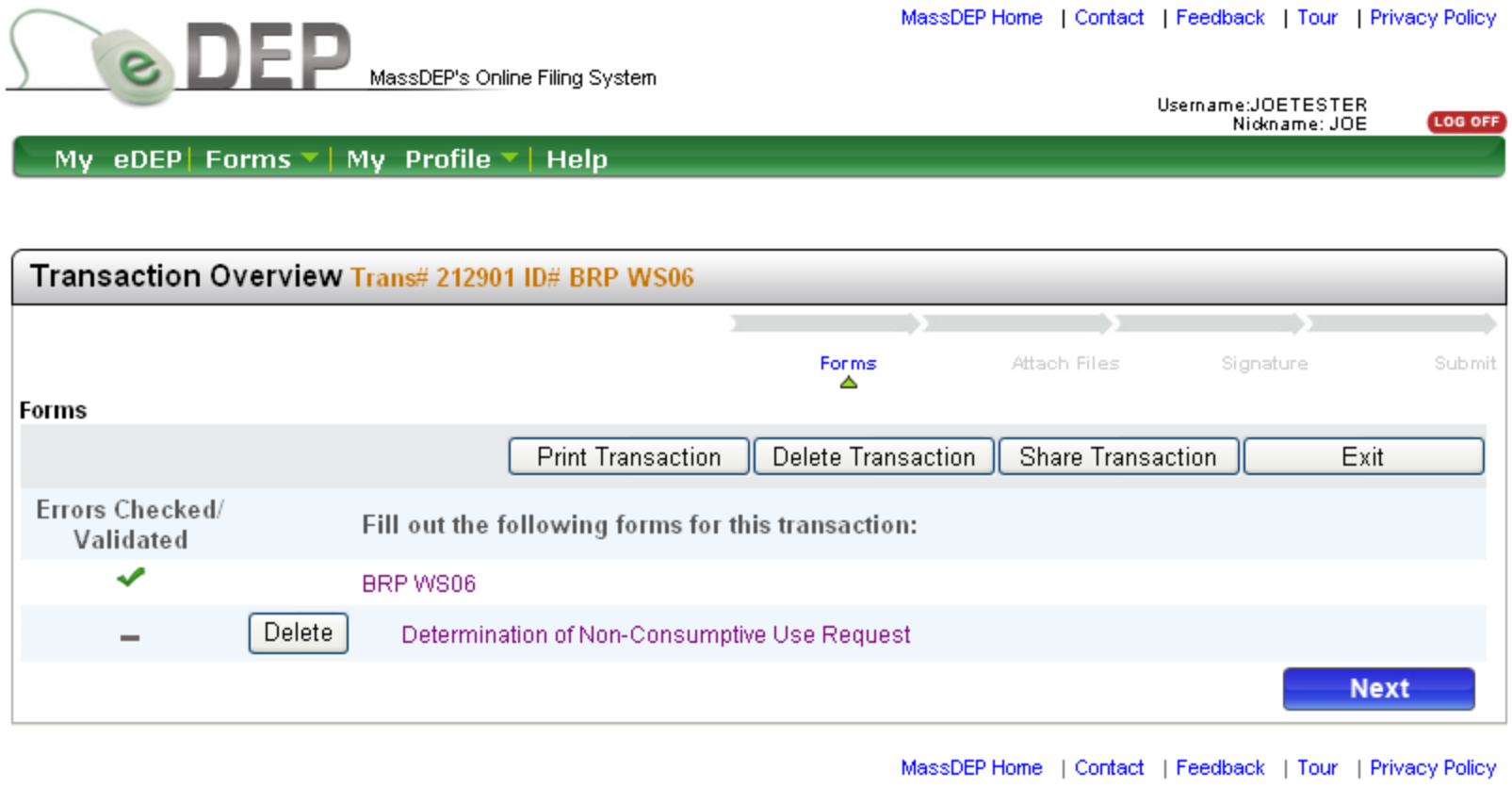
☐ Stormwater ☐ Sanitary Sewer ☐ Surface Water ☐ Other (describe)

Is this well(s) also being used as a water supply for other purposes?

◉ Yes ○ No

If yes, please indicate the other use(s) (check all that apply):

☐ Drinking Water ☐ Irrigation ☑ Process Water



MassDEP's Online Filing System

Determination of Non-Consumptive Use Request - Transaction #212901

Error Check | Save | Print | Exit

Determination of Non-Consumptive Use Request - Transaction #212901 - UIC Registration # N/A

A. Facility Information

Facility Name

Address

City/Town | State | Zip Code

Facility Contact Person:

First Name | Last Name

Email (optional)

B. Withdrawal Information

1. Design maximum daily withdrawal volume: 200,000 gallons per day

2. Existing or proposed maximum number of days per year of withdrawal (days of operation): 200 days per year

3. Existing or proposed average daily withdrawal volume (based upon number of days of operation per year): 25,000 gallons per day

4. Attach a copy of a USGS Quadrangle Map showing the location of the withdrawal point(s) (WP) and discharge point(s) (DP) and system bleed point(s) (BP) (if applicable).

5. Attach a schematic drawing indicating WP, DP and BP and distances between (in feet).

6. In the following table indicate the depth interval of the WP, DP, and BP and type of aquifer or surface water (i.e. sand & gravel, confined sand & gravel, bedrock, river, stream, lake, stormwater, shallow infiltration, etc.). Note: For a groundwater WP, DP, or BP, the depth interval should be the well screen interval (for confined and unconfined sand and gravel aquifers) or the interval of open borehole beneath the protective surface casing (for bedrock aquifers). If the WP and DP are in the same well and are open to the identical depth interval then enter "same" under the depth interval column for the DP location.

Location	Depth or depth interval of withdrawal or discharge (feet below ground or water surface)	Type of aquifer or surface water
WP	75 - 1,500	bedrock
DP	same	bedrock
BP (if applicable)	4 - 8	overburden

7. What is the proposed or existing use of this water?

standing column ground source heat pump

8. Is there an existing or planned system bleed point (BP) that is not the same location as the DP (Note: typical Title 5 or MassDEP permitted discharges of sanitary wastewater that may be generated from a dual purpose WP are not considered system bleed)?

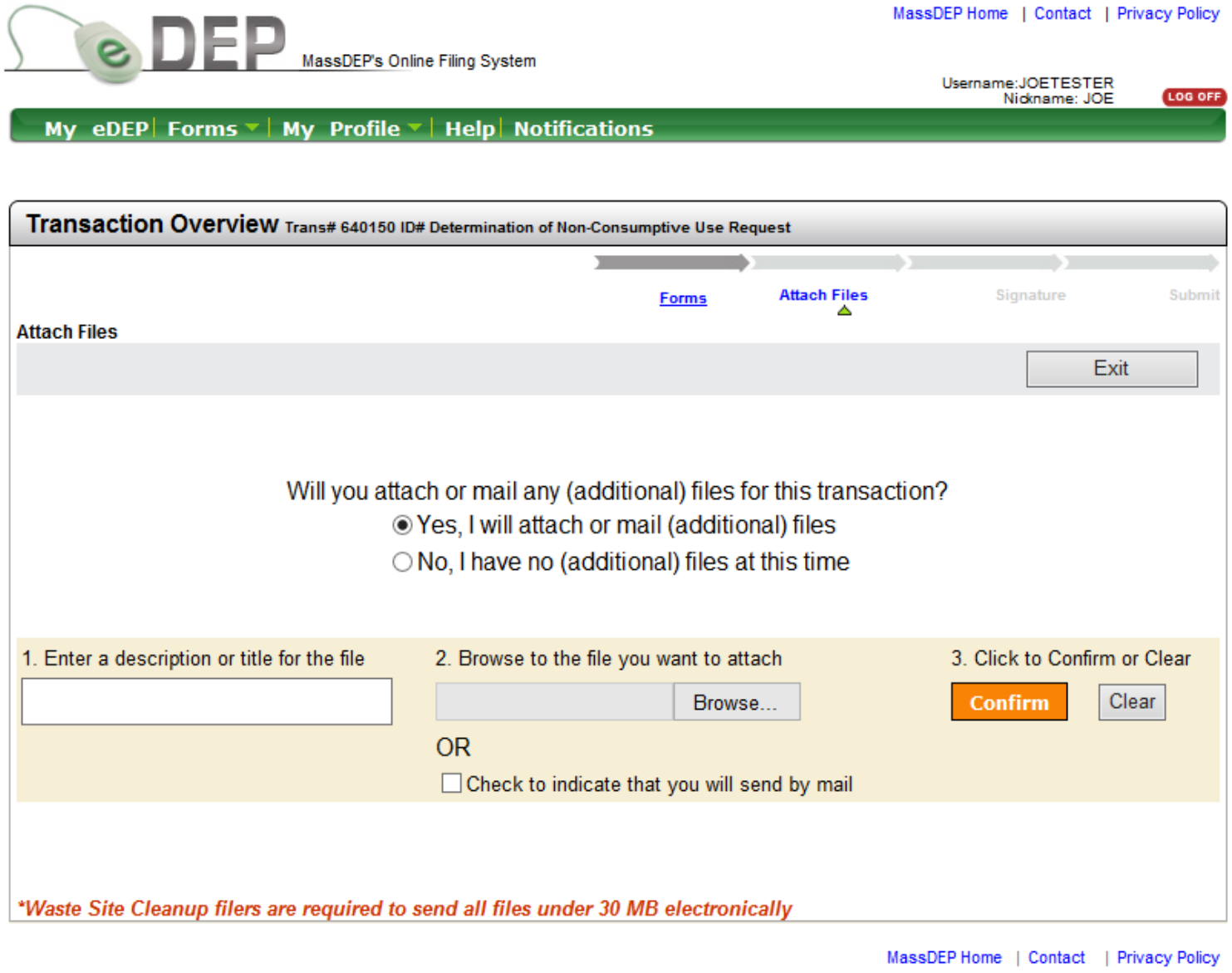
(•) Yes ( ) No

9. If there is an existing or proposed BP, answer the following questions:

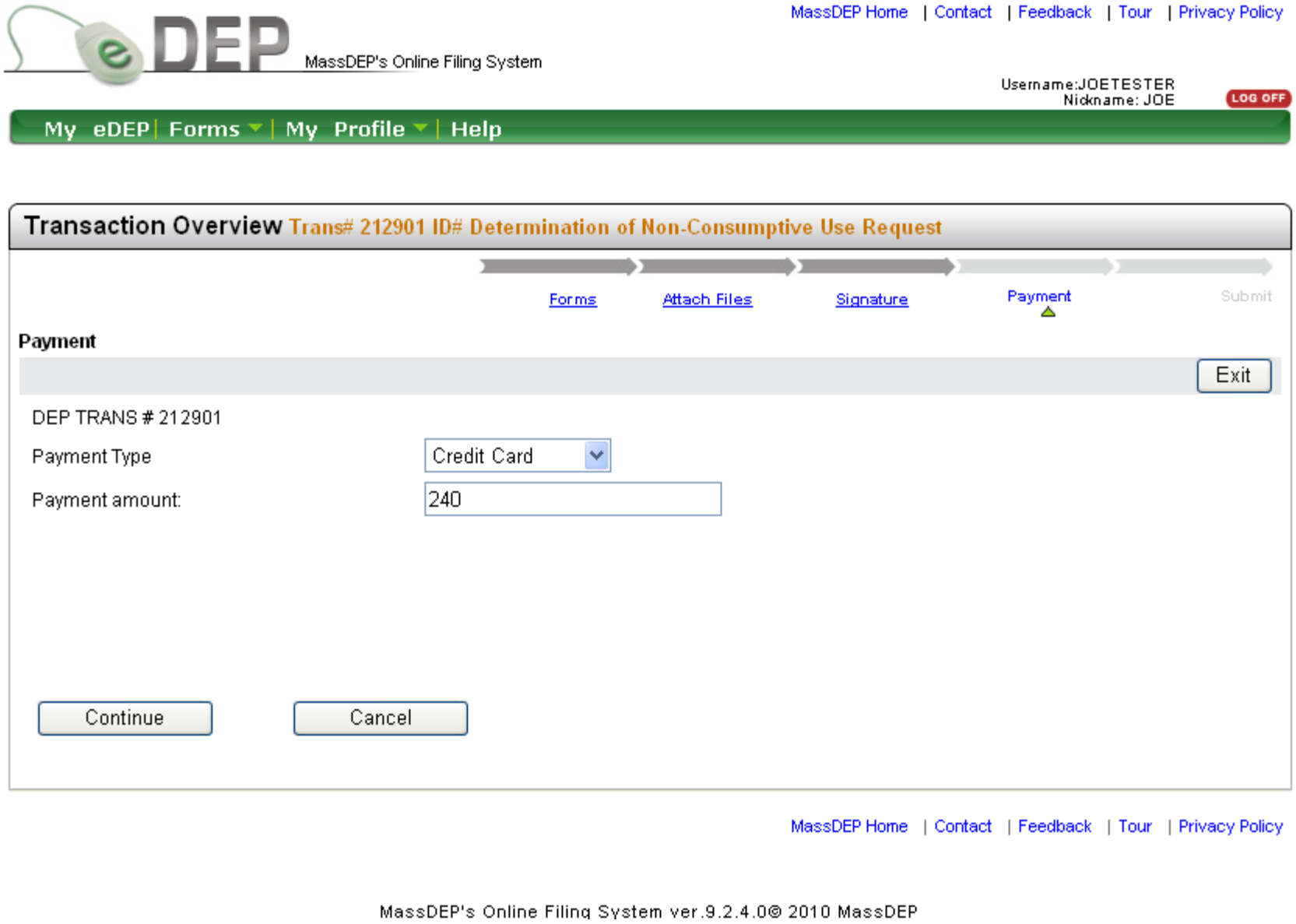
a. Design maximum daily bleed volume: 5,000 gallons per day

b. Maximum number of days per year system will be bled: 25 days

10. Attach copy of laboratory reports on water quality test results (standard analyses) for WP and DP waters (temperature is a critical submittal).


eDEP
MassDEP's Online Filing System
MassDEP Home | Contact | Privacy Policy
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help | Notifications
Transaction Overview Trans# 640150 ID# Determination of Non-Consumptive Use Request
Forms
Attach Files
Signature
Submit
Attach Files
Exit
Will you attach or mail any (additional) files for this transaction?
Yes, I will attach or mail (additional) files
No, I have no (additional) files at this time
1. Enter a description or title for the file
2. Browse to the file you want to attach
Browse...
OR
Check to indicate that you will send by mail
3. Click to Confirm or Clear
Confirm
Clear
*Waste Site Cleanup filers are required to send all files under 30 MB electronically
MassDEP Home | Contact | Privacy Policy


eDEP
MassDEP's Online Filing System
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help
Transaction Overview Trans# 212901 ID# Determination of Non-Consumptive Use Request
Forms
Attach Files
Signature
Payment
Submit
Forms
Print Transaction
Delete Transaction
Share Transaction
Exit
Errors Checked/ Validated
Fill out the following forms for this transaction:
BRP WS06
Determination of Non-Consumptive Use Request
Next
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
MassDEP's Online Filing System ver.9.2.4.0© 2010 MassDEP


MassDEP Home | Contact | Feedback | Tour | Privacy Policy
eDEP
MassDEP's Online Filing System
Username:JOETESTER
Nickname: JOE
LOG OFF
My eDEP | Forms | My Profile | Help
Transaction Overview Trans# 212901 ID# Determination of Non-Consumptive Use Request
Forms
Attach Files
Signature
Payment
Submit
Payment
Exit
DEP TRANS # 212901
Payment Type
Credit Card
Payment amount:
240
Continue
Cancel
MassDEP Home | Contact | Feedback | Tour | Privacy Policy
MassDEP's Online Filing System ver.9.2.4.0© 2010 MassDEP

MassDEP UIC Information & Contact

Guidelines for Ground Source Heat Pump Wells & UIC forms and instructions available on MassDEP's UIC Web page:

http://www.mass.gov/eea/agencies/massdep/water/drinking/underground-injection-control.html

For GSHP UIC Registration:

Joe Cerutti – 617-292-5859

joseph.cerutti@state.ma.us

Geothermal/Ground-Source Heat Pump Application Opportunities Under the MCP

MassDEP/LSPA Training Course

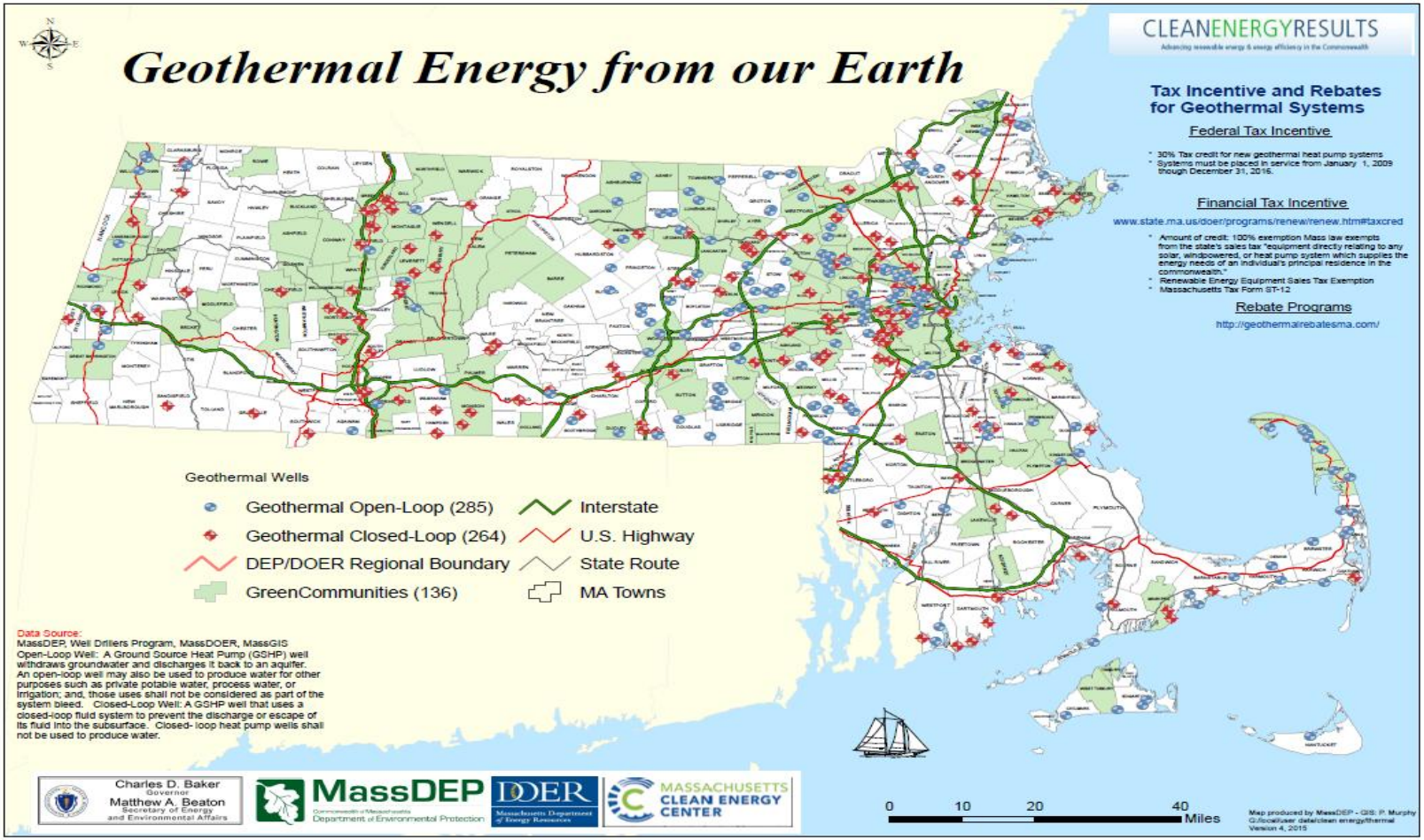
Tuesday, May 5th — Westborough, MA

Thursday, May 7th — Taunton, MA

Thomas M. Potter, Clean Energy Development Coordinator

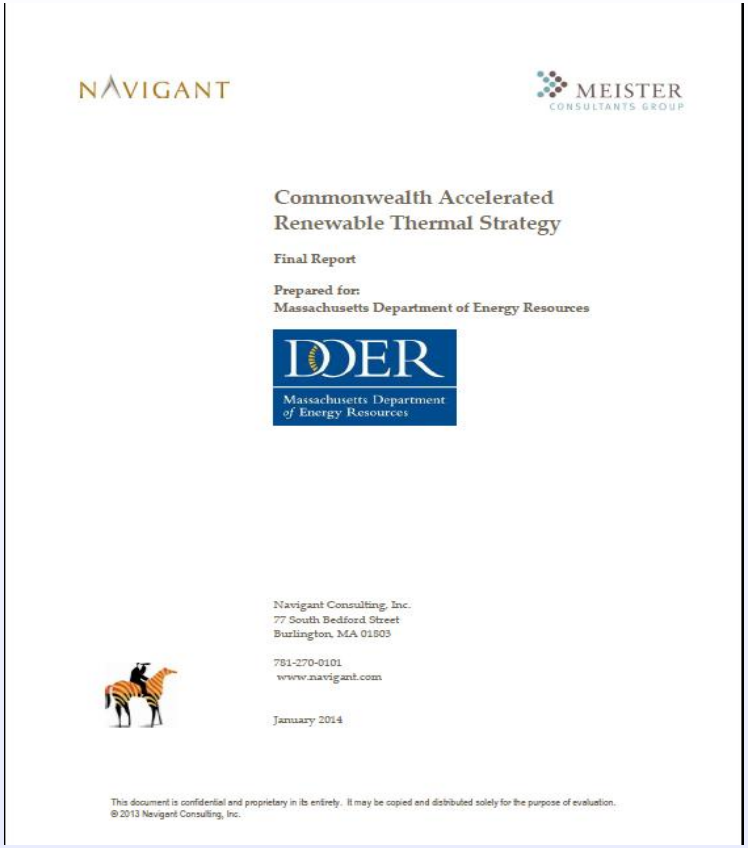
Geothermal In Massachusetts

(Open Loop 285 | Closed Loop 264)



OPPORTUNITY:
Commonwealth Accelerated Renewable Thermal Strategy (CARTS)

- **January 2014 Study**
- **Objectives:**
  - Reduce GHG emissions
  - Expand economic development opportunities
  - Reduce heating and cooling costs for consumers
- **Main Opportunities:**
  - Efficient Heat Pumps (air/ground) in residential applications
  - Clean biomass (pellets/chips) in commercial buildings


NAVIGANT

MEISTER CONSULTANTS GROUP

Commonwealth Accelerated Renewable Thermal Strategy

Final Report

Prepared for:
Massachusetts Department of Energy Resources

DOER
Massachusetts Department of Energy Resources

Navigant Consulting, Inc.
77 South Bedford Street
Burlington, MA 01803

781-270-0101
www.navigant.com

January 2014

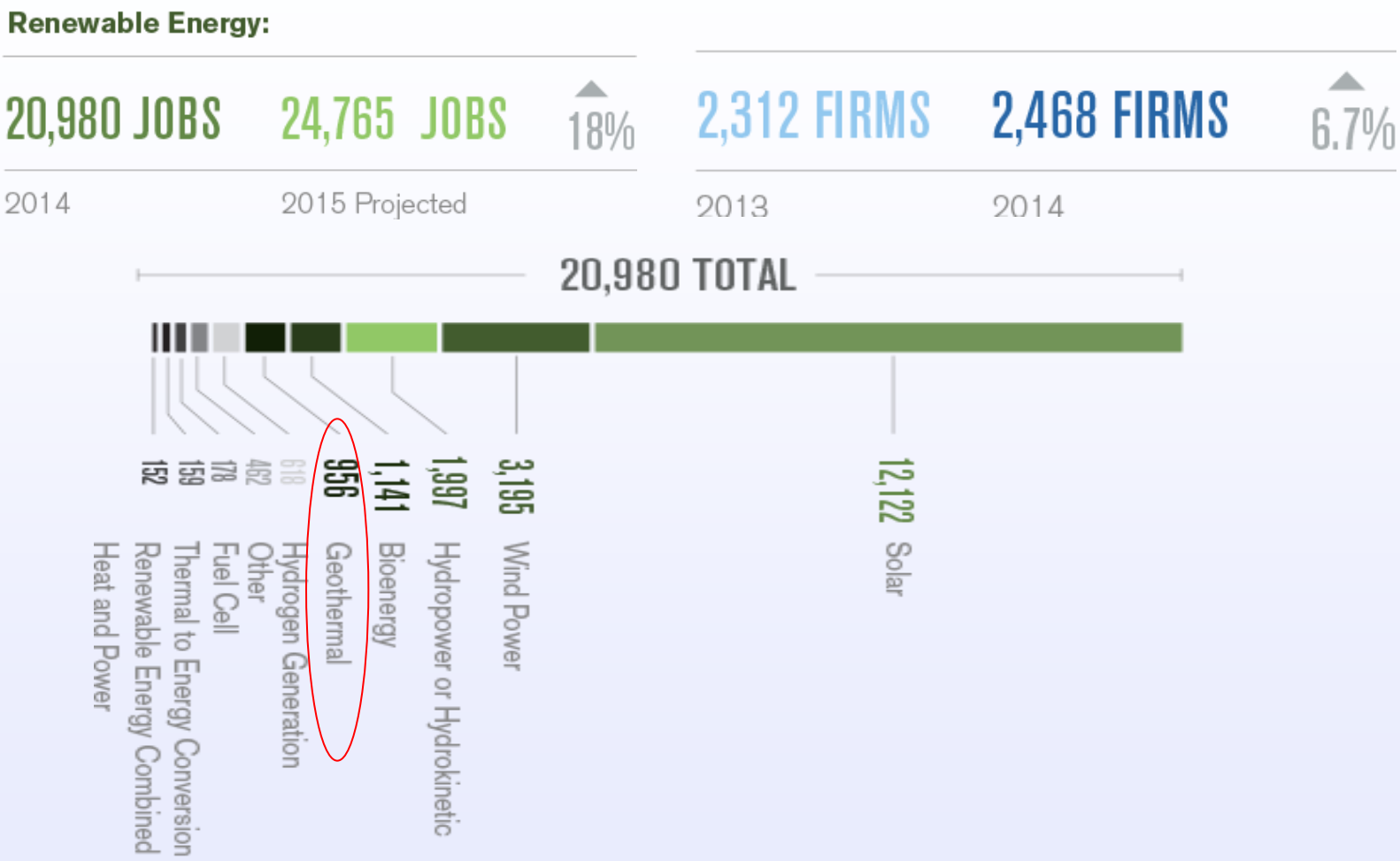
This document is confidential and proprietary in its entirety. It may be copied and distributed solely for the purpose of evaluation.
© 2013 Navigant Consulting, Inc.

CARTS (cont.)

Market:

- Commercial, Large Buildings, Using Fuel Oil / Electricity
- Residential, High Income, Using Fuel Oil
- Residential, Low Income, Using Fuel Oil / Electric
- "Priority customers will likely be living in areas not served by natural gas utilities, outside of gas service areas, or a long distance from gas distribution. Currently about 1.2 million households in Massachusetts are not using natural gas for space heating"

2014 Renewable Energy Jobs



Why Licensed Site Professionals?

LSP's have the professional credentials that align with GSHP applications

- Geologists
- Hydrogeologists
- Engineers
- Environmental Scientists

AGENDA

1. Renewable Thermal Technologies & Greener Cleanups Nexus

2. MCP Considerations for Ground-Source Heat Pump Applications to:

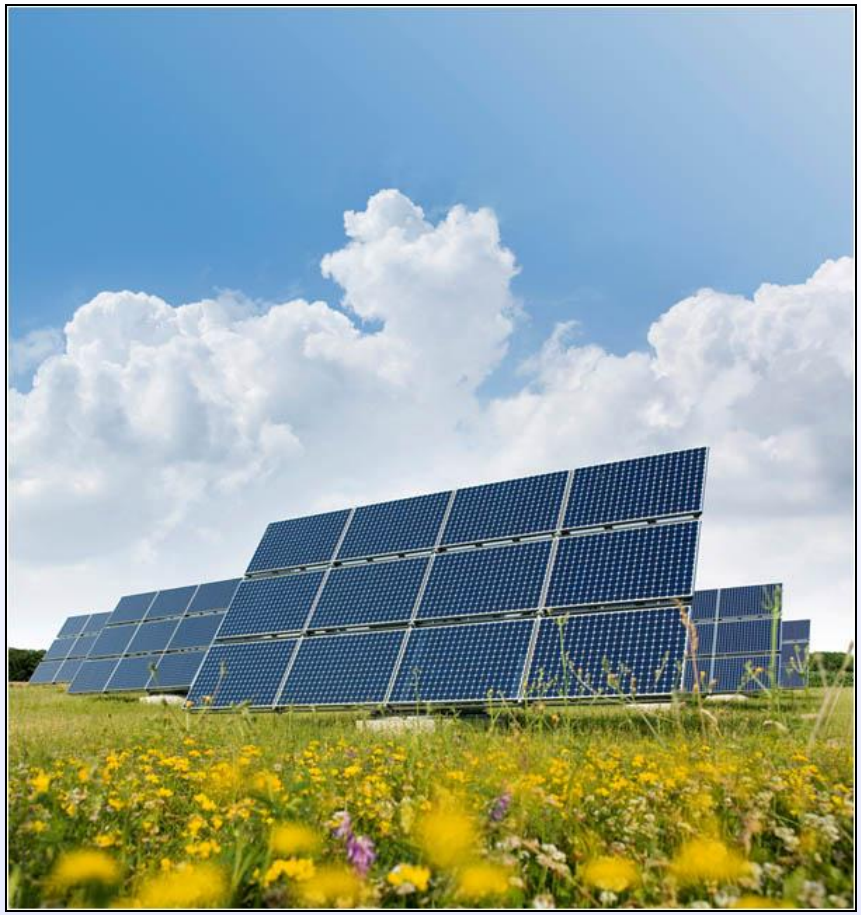
    a. Site Redevelopment
    b. Remedial Response
    c. Remedy Repurposing

Massachusetts Clean Energy Efforts

- 2007 established **Executive Office of Energy & Environmental Affairs**
- 2008 **Green Communities Act (GCA)**
  - Supports Development of Clean Energy Resources
  - Expands Efforts to Promote Energy Efficiency
  - Increased the Renewable Energy Portfolio Standard (RPS) to 1% per year.
  - **Goal of 15% "New Sources" by 2020 (currently 9%)**
- 2008 **Global Warming Solutions Act**
  - Comprehensive Program -> Climate Change
  - Goal 25 % Below 1990 GHG levels by 2020

CLEANENERGYRESULTS

- Launched 2011
- **Promotes Clean and Efficient Sources of Energy at MassDEP Regulated Sites (where we have authority or control)**
- Maximizes MassDEP's Unique Expertise to Overcome Permitting & Siting Obstacles
- **Create economic growth and employment opportunities**



CLEANENERGYRESULTS

RPS/APS Projects including:

- Solar Photovoltaic
- Wind
- Anaerobic Digestion
- Renewable Thermal Technologies
  - Solar space & domestic hot water heating
  - Biomass pellets 7 chips
  - Heat Pumps (ground, water, air)
  - Biogas (renewable gas)
  - Advanced biofuels

CLEANENERGYRESULTS

- *"Promote the use of Green Remediation/Greener Cleanups at state and federally regulated contaminated sites"*

- *Promote use of Renewable Thermal Technologies - specifically Ground-Source Heat Pumps*

310 CMR 40.0191
Response Action Performance Standard (RAPs)

- (3) The application of RAPS shall be protective of health, safety, public welfare and the environment and shall include, without limitation, in the context of meeting the requirements of this Contingency Plan, consideration of the following:
  - *(e) eliminating or reducing, to the extent practicable and consistent with response action requirements and objectives, total energy use, air pollutant emissions, greenhouse gases, water use, materials consumption, and ecosystem and water resources impacts resulting from the performance of response actions through energy efficiency, renewable energy use, materials management, waste reduction, land management, and ecosystem protection.*

Greener Cleanups Guidance (WSC #14 – 150)

- DRAFT
  - May 2014
- COMMENTS
  - July 2014
- FINAL EFFECTIVE
  - October 2014

MassDEP
Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs
Department of Environmental Protection
One Winter Street Boston, MA 02108 • 617-292-5500

DEVAL L. PATRICK
Governor

RICHARD K. SULLIVAN JR.
Secretary

DAVID W. CASH
Commissioner

GREENER CLEANUPS GUIDANCE
WSC #14 – 150

This document provides guidance in support of 310 CMR 40.0191 and 310 CMR 40.0858 on recommended approaches that maximize the net environmental benefit when conducting response actions at disposal sites regulated under the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000. Recommended approaches include adherence to available industry standards and guidance as described further in this document.

This document is intended solely as guidance. It is not a regulation, rule or requirement, and should not be construed as mandatory. It does not create any substantive or procedural rights, and is not enforceable by any party in any administrative proceeding with the Commonwealth. This document provides guidance on approaches MassDEP considers acceptable for meeting the general requirements set forth in the MCP. Parties using this guidance should be aware that other acceptable alternatives may be available for achieving and documenting compliance with the applicable regulatory requirements and performance standards of the MCP.

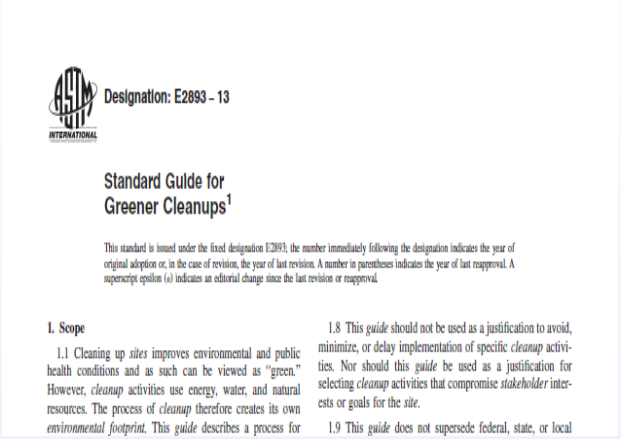
Benjamin J. Ericson
Assistant Commissioner
Bureau of Waste Site Cleanup

October 20, 2014

This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5751. TDD# 1-866-539-7622 or 1-617-574-6868
MassDEP Website: www.mass.gov/dep
Printed on Recycled Paper

MassDEP Recommendation

MassDEP strongly recommends use of the *ASTM Standard Guide for Greener Cleanups* ("the ASTM Guide") (Designation: ASTM E2893-13, November 2013)



Designation: E2893 – 13

Standard Guide for Greener Cleanups[1]

This standard is issued under the fixed designation E2893; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 Cleaning up *sites* improves environmental and public health conditions and as such can be viewed as "green." However, *cleanup* activities use energy, water, and natural resources. The process of *cleanup* therefore creates its own *environmental footprint*. This *guide* describes a process for

1.8 This *guide* should not be used as a justification to avoid, minimize, or delay implementation of specific *cleanup* activities. Nor should this *guide* be used as a justification for selecting *cleanup* activities that compromise *stakeholder* interests or goals for the *site*.

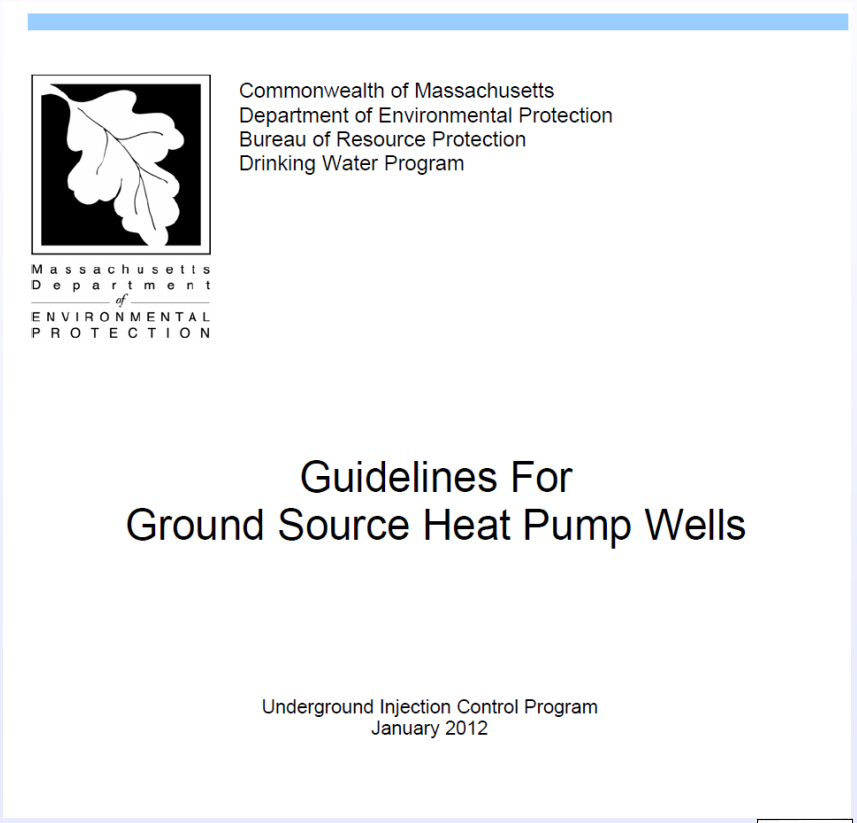
1.9 This *guide* does not supersede federal, state, or local

Compliance Through Available Industry Standards & Guidance

- **USEPA, CLU-IN**, Green Remediation Focus (http://cluin.org/greenremediation/)
- **ASTM** International, November 2013, *Standard Guide for Greener Cleanups*, E2893-13
- **ITRC**, November 2011, *Technical/Regulatory Guidance, Green and Sustainable Remediation: A Practical Framework* (GSR-2).

Guidelines For
Ground Source Heat Pump Wells

- MassDEP Bureau of Water Resources (BWR) regulates GSHP installations
- BWSC working with BWR on contaminated site applications



SITE REDEVELOPMENT

MCP Regulatory Considerations

GSHP Opportunities

Former Brownfield ...

Sustainable Property Development (e.g. LEED)

Massachusetts Department of ENVIRONMENTAL PROTECTION

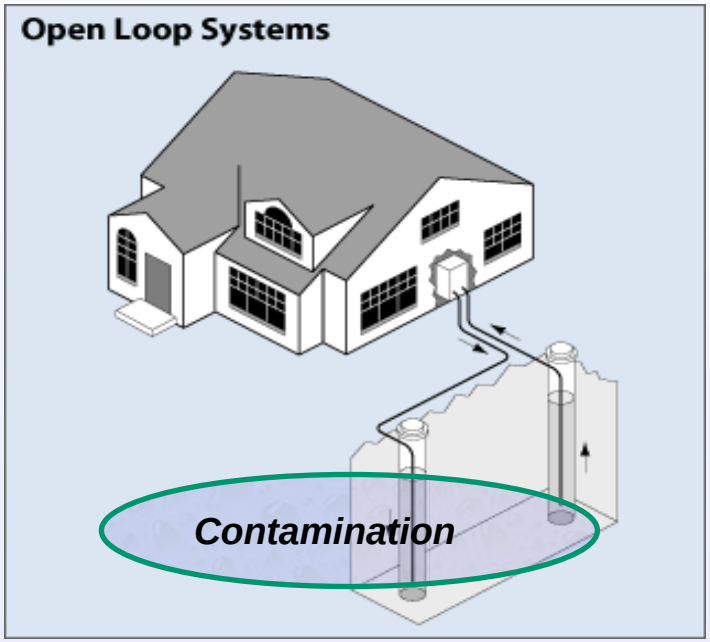
Prior to GSHP Installation

- History
- Environmental Condition
- Groundwater quality
  - Open Loop vs.
  - Closed Loop

If the Site is "OPEN" or Not a Reported Site
(Preliminary/Comprehensive Response Actions)

OPEN Loop Systems

- For UIC Registration of open loop systems, groundwater conditions must not exceed one or more Maximum Contaminant Level (MCL) drinking water limits as prescribed by the Bureau of Water Resources, and/or
- If groundwater conditions also exceed RCGW-1 per 310 CMR 40.0300 (you must report)
- Open Loop system may only proceed on a case by case basis with exempt conditions

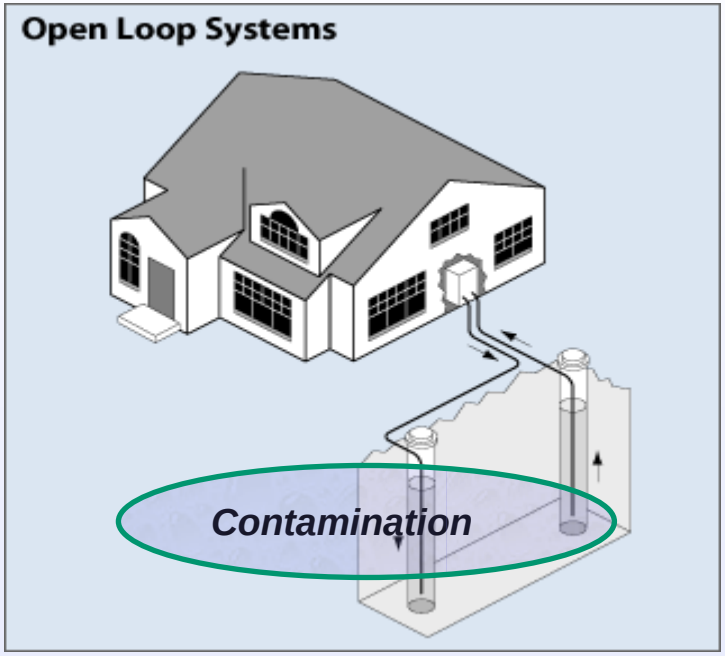


Exempt Conditions

Release Exemptions per 310 CMR 40.0317:

(20) releases of chloroform in groundwater attributable to naturally-occurring ecological processes . . .

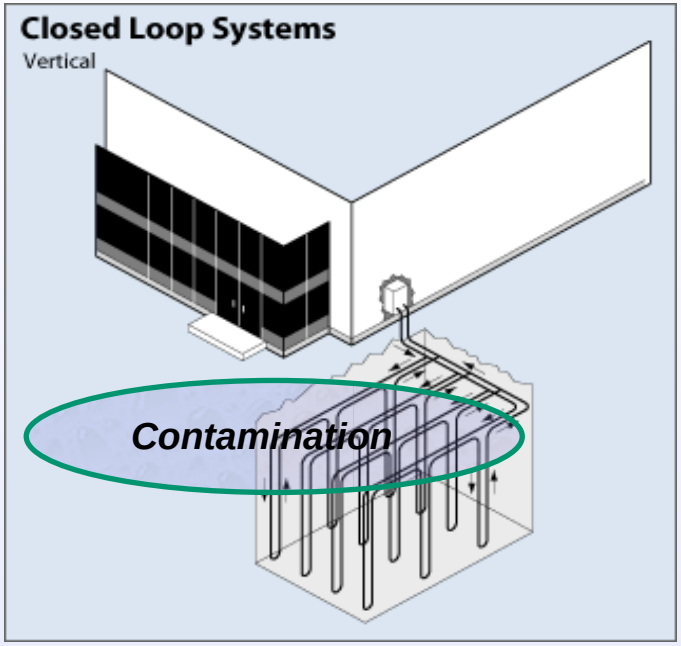
(22) arsenic, beryllium or nickel in Boston Blue Clay or arsenic in an area documented by the U.S. Geological Survey or in other scientific literature as an area of elevated arsenic measured in soil or groundwater . . .



If the Site is "OPEN" or Not a Reported Site
(Preliminary/Comprehensive Response Actions)

CLOSED Loop Systems

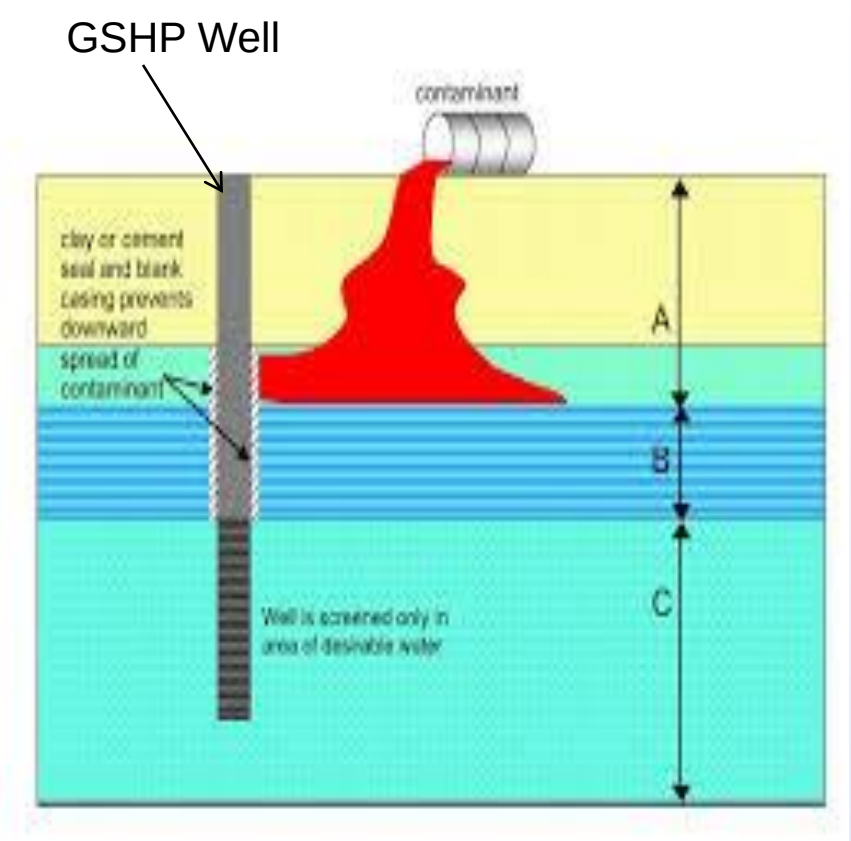
- Option when . . .
- Contamination is present above MCLs, is reportable through the MCP
- For UIC Registration – need a statement that GSHP installation will not exacerbate the contamination



Contamination Exacerbation

- Well installations and operations must ensure the prevention of vertical migration of contamination

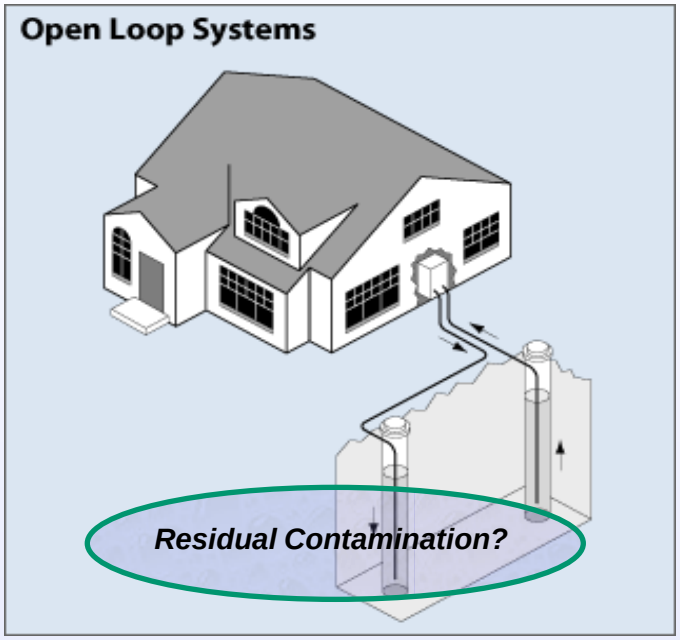
- All excavated soils must be handled in accordance with 310 CMR 40.0030



If the Site is "CLOSED"
(Permanent Solution/Permanent Solution with Conditions)

OPEN Loop Systems

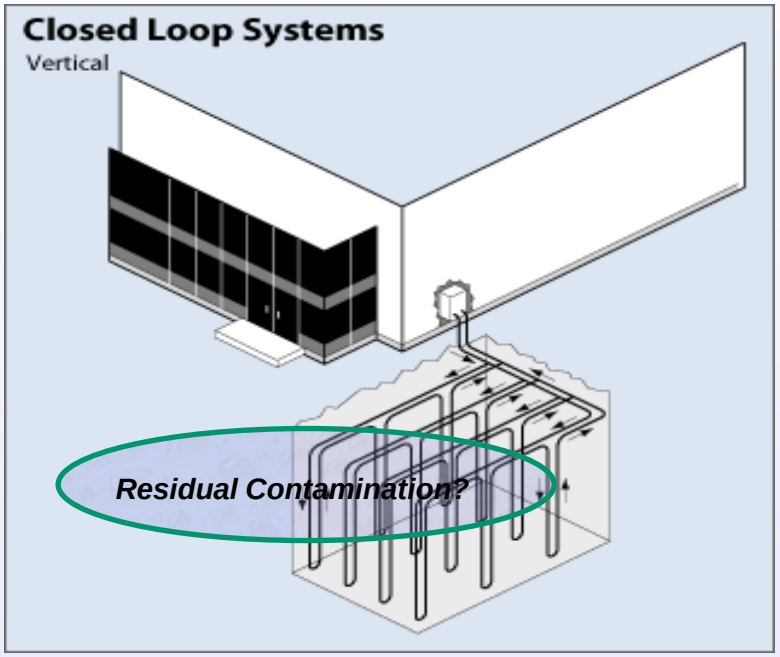
- Consider baseline water quality conditions
- Open loop system not applicable at or above MCLs (with exemptions)



If the Site is "CLOSED"
(Permanent Solution/Permanent Solution with Conditions)

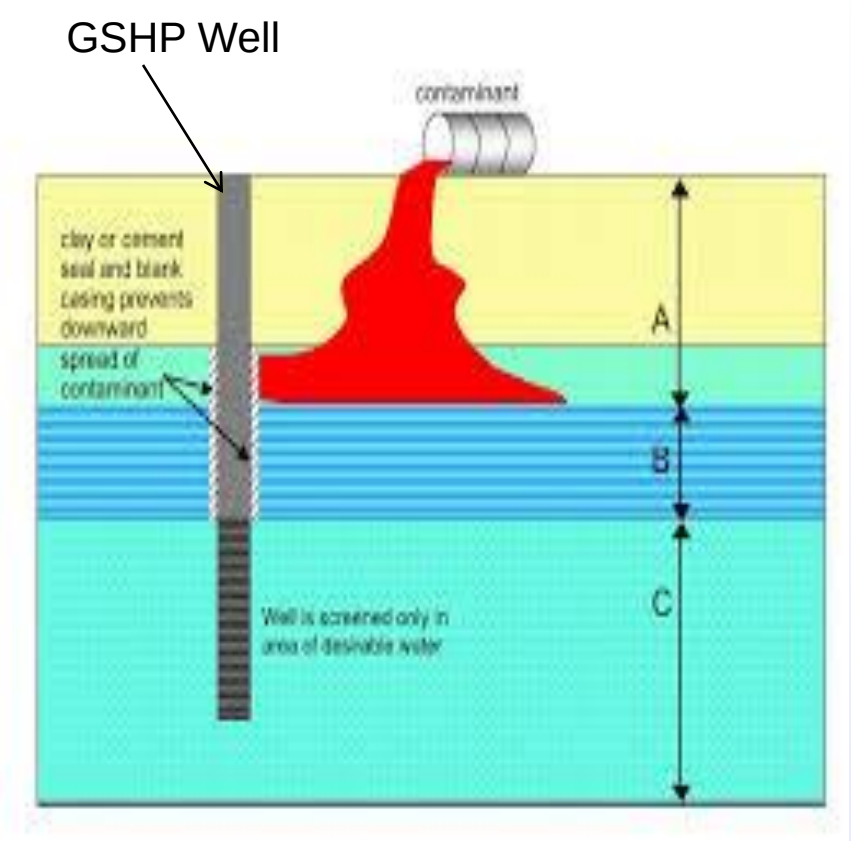
CLOSED Loop Systems

- Consider baseline water quality conditions
- For UIC Registration – need a statement that GSHP installation will not exacerbate the contamination



Contamination Exacerbation

- Well installations and operations must ensure the prevention of vertical migration of contamination
- All excavated soils must be handled in accordance with 310 CMR 40.0030
- Must adhere to any AUL conditions



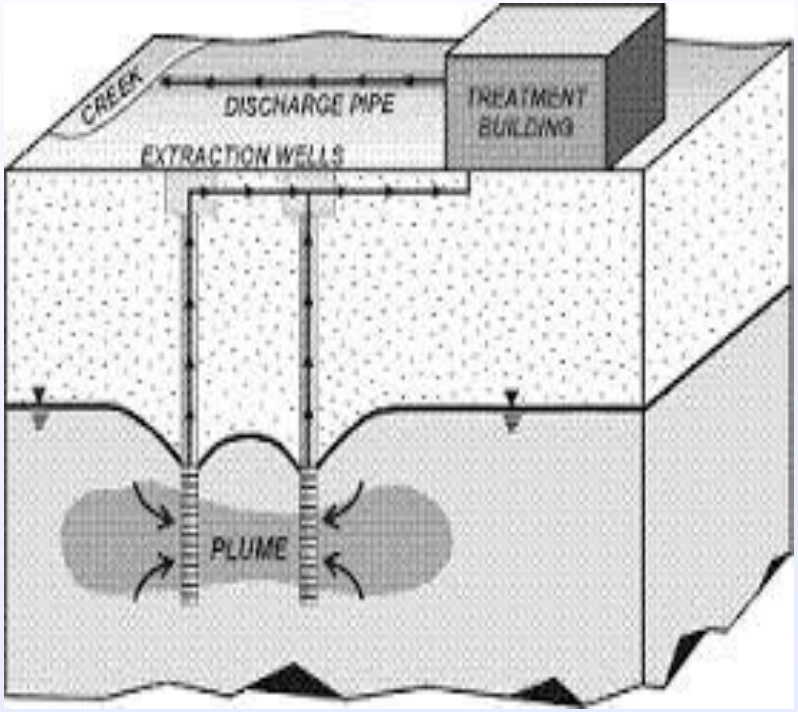
REMEDIAL RESPONSE(S)

MCP Regulatory Considerations

GSHP Opportunities

Field Excavations/Remedy Installations

Groundwater Recovery & Treatment Systems (a.k.a. P&T)

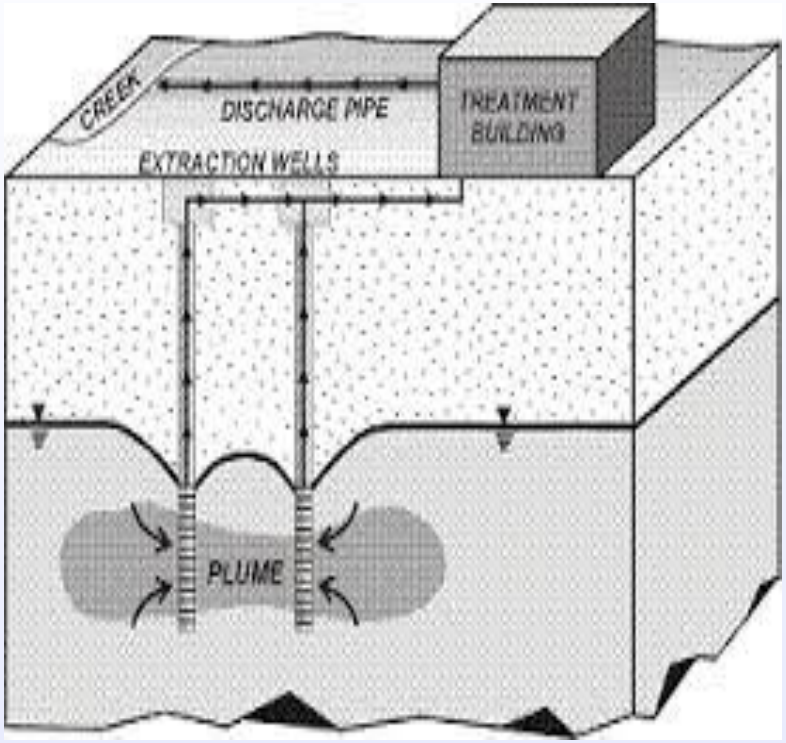


Field Excavations/Remedy Installations

- Remedial activities that include soil excavation provide opportunities for GSHP installations
  - LUST
  - Source Area Removal
  - Etc.

Groundwater Recovery & Treatment Systems (a.k.a. Pump & Treat)

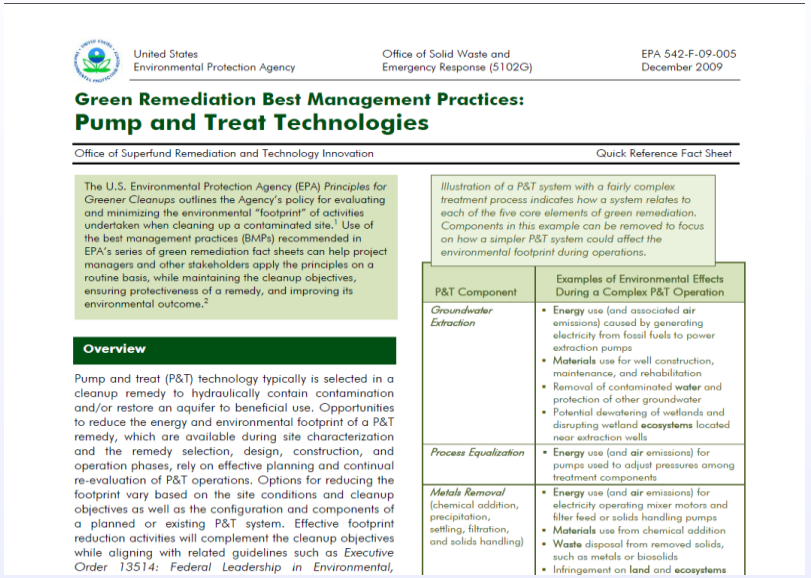
- ~ 140 P&T Systems installed in MA
- The remedial selection and/or existing operation of P&T systems provides opportunities for GSHP installations



Best Management Practices (BMP's): Pump & Treat Technologies

Ground Source Heat Pump Greener Cleanup Applications/Opportunities:

- Use of GSHP generated heat for the treatment processes
- Use of GSHP to provide space heating and cooling for treatment system housing and/or nearby buildings
- Re-evaluating the potential for renewable energy application at long-term remedies as new technologies and incentives become available such as GSHP's



United States Environmental Protection Agency | Office of Solid Waste and Emergency Response (5102G) | EPA 542-F-09-005 December 2009

Green Remediation Best Management Practices: Pump and Treat Technologies

Office of Superfund Remediation and Technology Innovation | Quick Reference Fact Sheet

The U.S. Environmental Protection Agency (EPA) *Principles for Greener Cleanups* outlines the Agency's policy for evaluating and minimizing the environmental "footprint" of activities undertaken when cleaning up a contaminated site.[1] Use of the best management practices (BMPs) recommended in EPA's series of green remediation fact sheets can help project managers and other stakeholders apply the principles on a routine basis, while maintaining the cleanup objectives, ensuring protectiveness of a remedy, and improving its environmental outcome.[2]

Illustration of a P&T system with a fairly complex treatment process indicates how a system relates to each of the five core elements of green remediation. Components in this example can be removed to focus on how a simpler P&T system could affect the environmental footprint during operations.

P&T Component	Examples of Environmental Effects During a Complex P&T Operation
Groundwater Extraction	• **Energy** use (and associated **air** emissions) caused by generating electricity from fossil fuels to power extraction pumps • **Materials** use for well construction, maintenance, and rehabilitation • Removal of contaminated **water** and protection of other groundwater • Potential dewatering of wetlands and disrupting wetland **ecosystems** located near extraction wells
Process Equalization	• **Energy** use (and **air** emissions) for pumps used to adjust pressures among treatment components
Metals Removal (chemical addition, precipitation, settling, filtration, and solids handling)	• **Energy** use (and **air** emissions) for electricity operating mixer motors and filter feed or solids handling pumps • **Materials** use from chemical addition • **Waste** disposal from removed solids, such as metals or biosolids • Infringement on **land** and **ecosystems**

Overview

Pump and treat (P&T) technology typically is selected in a cleanup remedy to hydraulically contain contamination and/or restore an aquifer to beneficial use. Opportunities to reduce the energy and environmental footprint of a P&T remedy, which are available during site characterization and the remedy selection, design, construction, and operation phases, rely on effective planning and continual re-evaluation of P&T operations. Options for reducing the footprint vary based on the site conditions and cleanup objectives as well as the configuration and components of a planned or existing P&T system. Effective footprint reduction activities will complement the cleanup objectives while aligning with related guidelines such as *Executive Order 13514: Federal Leadership in Environmental,*

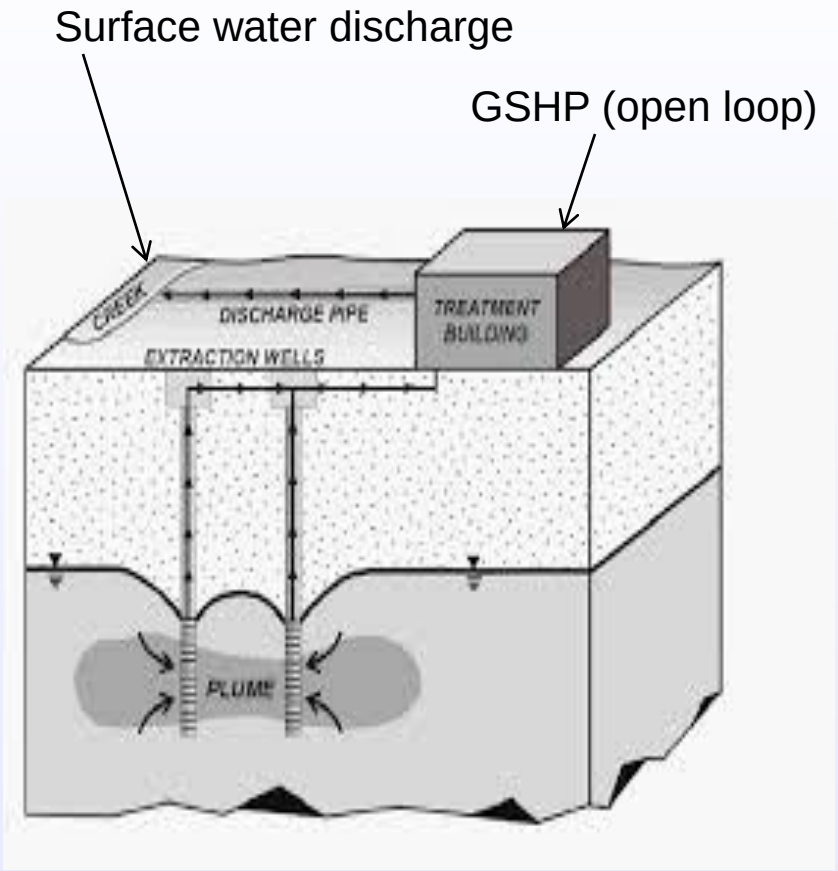
http://www.clu-in.org/greenremediation/docs/GR_Fact_Sheet_P&T_12-31-2009.pdf

Renewable Thermal/Geothermal
Best Management Practices (BMP's)

			Core Element Addressed			Remediation Technology		
		Best Management Practice	Energy	Air	Water	Soil Vapor Extraction	Air Sparging	Pump and Treat
9	Buildings	** Use non "natural conditions" methods for energy conservation (for example, choosing Energy Star qualified boilers or heat pumps) . . . for energy efficient heating and cooling into new buildings . . (follows #8)	X			X	X	X
49	Power and Fuel	Capture on-site waste heat such as treatment plant effluent, excess plant steam, ground-source heat pumps, mobile waste-to-heat generators, and furnaces/air conditioners operating with recycled oil to power cleanup activities. For example, integrate a CHP system powered by natural gas or cleaner diesel to generate electricity while capturing waste heat to be used to condition air inside buildings, for vapor treatment, or for other onsite operations	X	X		X	X	X
62	Power and Fuel	** Use heat pumps or solar heating in place of electrical resistive heating when preheated extracted groundwater is required prior to treatment	X					X

Remedial System Discharge

- P&T systems utilize "open loop" GSHP systems that discharge to:
  - Surface Waters
  - POTWs
  - Groundwater



Remedial System Discharge (cont.)

MCP "control"

- UIC Registration is not necessary for a GSHP that's are operating as part of an MCP response action conducted under the direction of a LSP

- UIC Registration is required once MCP remedial Response Actions end

MCP Discharge Considerations

- **Surface Water** (310 CMR 40.0042)
- **POTW** (310 CMR 40.0043 & 40.0044)
- **Groundwater** (310 CMR 40.0045)
  - Downgradient, 40.0045(3)
  - Upgradient, 40.0045(4)

Additional GSHP Opportunity Considerations

- Is there a nearby building/facility with heating cooling needs?
- Could the open loop P&T system provide a benefit?
- Is it cost effective?

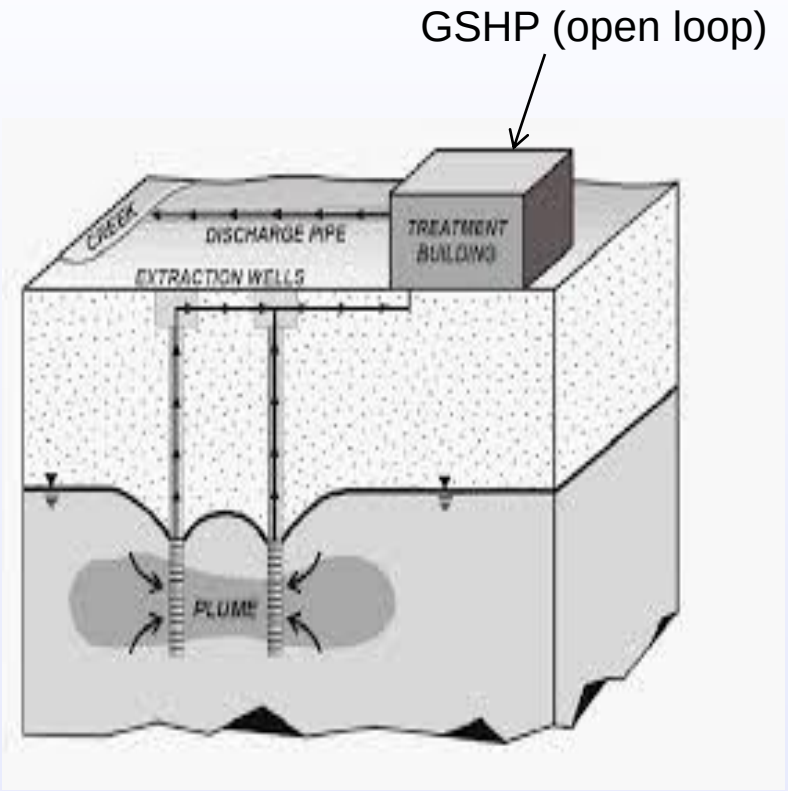
REMEDY REPURPOSING

MCP Regulatory Considerations

Repurposing Former P&T Systems

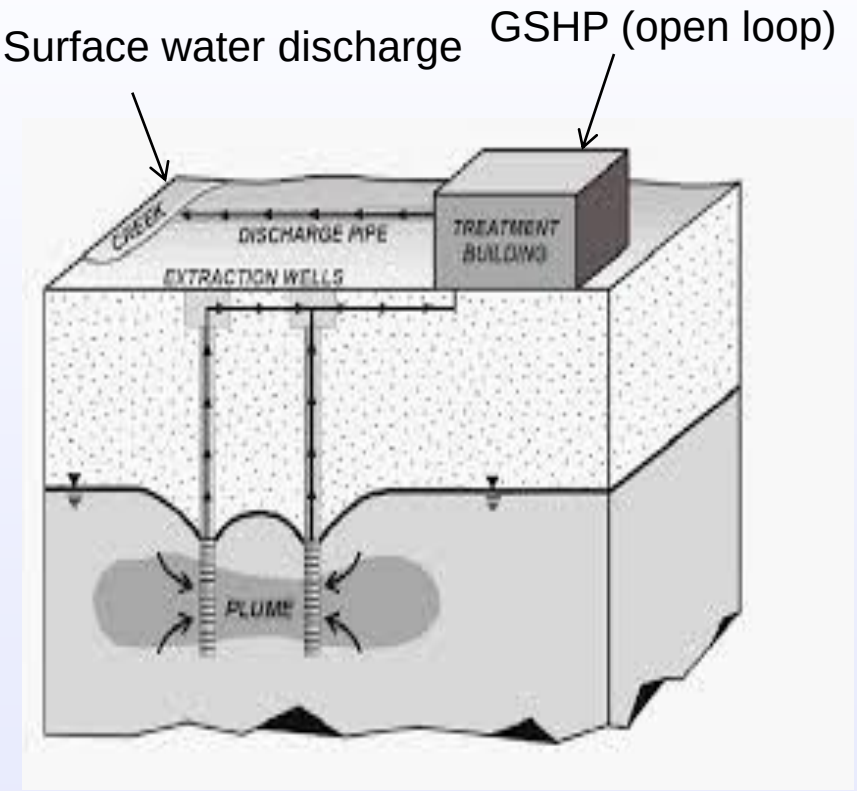
- Consider GSHP Benefit
  - Nearby heating load?

- Existing infrastructure
  - Standing column groundwater extraction wells
  - Extraction Pumps
  - Piping, flow meters and valves
  - Treatment system housing
  - Dedicated electrical meter



Repurposing Former P&T Systems (cont.)

- Groundwater quality?
  - Would treatment be necessary? (e.g. above MCLs)
- Regulatory Authority?
  - The system would no longer be operating as a remedial remedy under the MCP
  - Any associated “open loop” GSHP would be regulated by BWR’s UIC program and would require UIC registration



COMING SOON!

FACT SHEET: *"RENEWABLE THERMAL TECHNOLOGY APPLICATIONS AT CONTAMINATED PROPERTIES IN MASSACHUSETTS: GROUND-SOURCE HEAT PUMPS"*

---

http://www.mass.gov/eea/agencies/massdep/cleanup/reports/site-cleanup-news-and-updates.html

Thank You!

Thomas M. Potter

Clean Energy Development Coordinator

MassDEP Bureau of Waste Site Cleanup

One Winter Street, 6th Floor

Boston, MA 02108

617-292-5628

Thomas.Potter@state.ma.us

Clean Energy Results Program Website:

http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/

Using Thermal Technologies to Lower the Carbon Footprint at Pump and Treat Projects

Based on EPA OSRTI/GeoTrans Study 2009
Baird&McGuire Superfund Site

Dorothy Allen, MA Department of Environmental Protection

Introduction

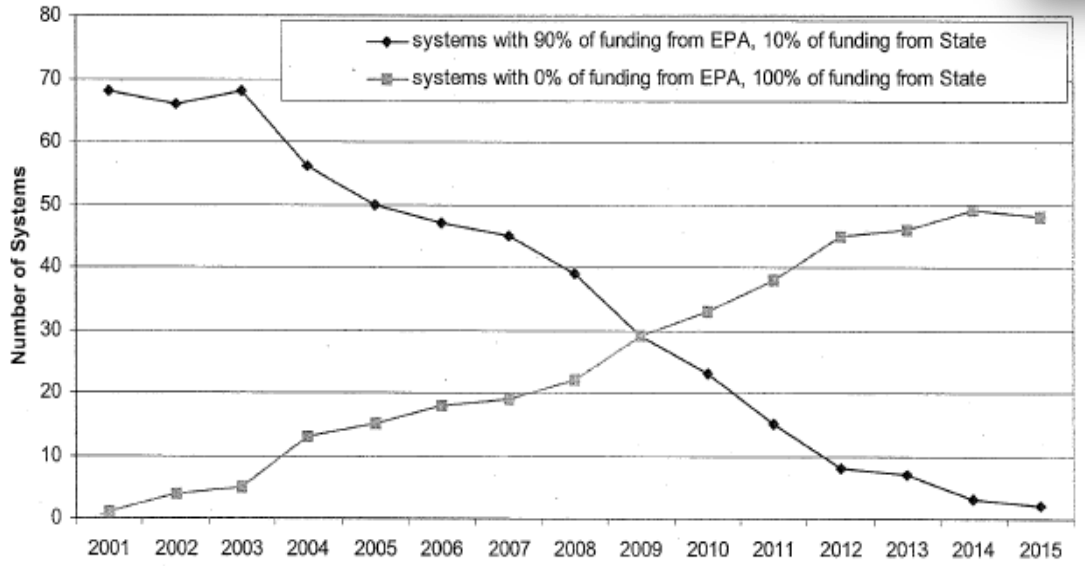
- Superfund Sites – large contaminated areas – required to meet substantive not administrative requirements
- 2009 Study planed to consider CHP and evolved into GWSHP
- FS level evaluation – performance of unit operations, heat and energy requirements, financial and GHG emissions assessments
- Presentation Content
  - Reasons for Study
  - Site and Treatment System Features
  - Modifications
    - CHP
    - CHP with GWSHP
    - GWSHP only for process or heating
  - Conclusions

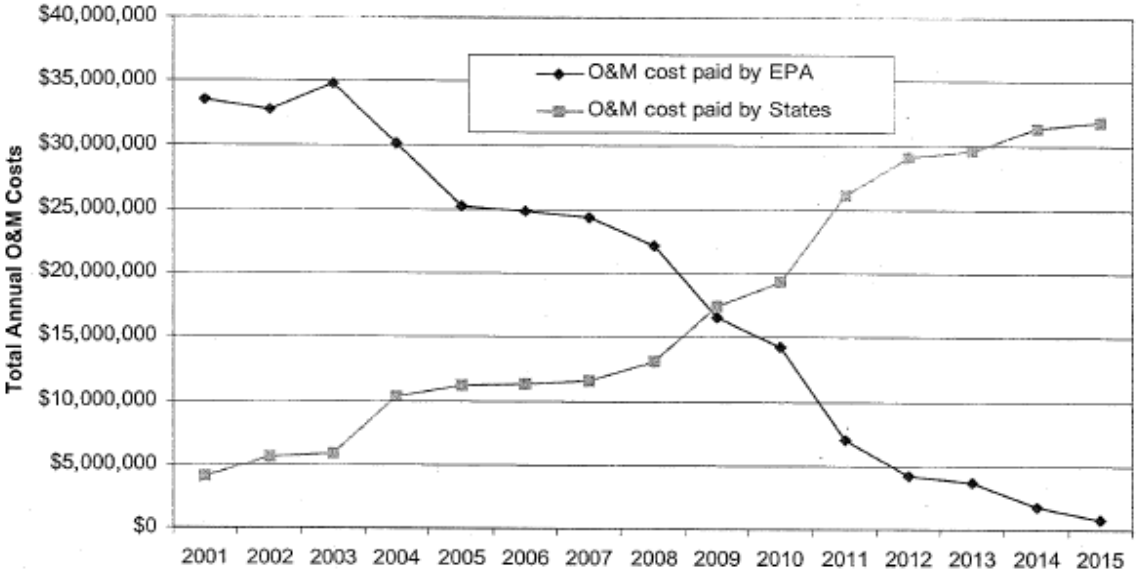
The Challenge: Carbon & Energy Footprints of Superfund Cleanup Technologies

Technology	Estimated Energy *Annual Average* (kWh*10^3)	Total Estimated Energy Use *in 2008-2030* (kWh*10^3)
Pump & Treat	489,607	11,260,969
Thermal Desorption	92,919	2,137,126
Multi-Phase Extraction	18,679	429,625
Air Sparging	10,156	233,599
Soil Vapor Extraction	6,734	154,890
Technology Total	*618,095*	*14,216,209*

	Annual Carbon Footprint (MT CO_2)
Sum of 5 Technologies	404,411

State Lead Groundwater Pump and Treat Systems





Source: Groundwater Pump and Treat Systems: Summary of Selected Cost and Performance Information at Superfund-Financed Sites, 2001

EPA Interest in Lowering Remediation Environmental Footprint

Green Remediation Metrics

ASTM Standard Guide for Greener Cleanups →

Core Element	Metric		Unit of Measure	Metric Value
Materials & Waste	M&W-1	Refined materials used on site	tons	
	M&W-2	Percent of refined materials from recycled or waste material	percent	
	M&W-3	Unrefined materials used on site	tons	
	M&W-4	Percent of unrefined materials from recycled or waste material	percent	
	M&W-5	Onsite hazardous waste generated	tons	
	M&W-6	Onsite non-hazardous waste generated	tons	
	M&W-7	Percent of total potential onsite waste that is recycled or reused	percent	
Water		Onsite water use (by source)		
	W-1	- Source, use, fate combination #1	millions of gals	
	W-2	- Source, use, fate combination #2	millions of gals	
	W-3	- Source, use, fate combination #3	millions of gals	
	W-4	- Source, use, fate combination #4	millions of gals	
Energy	E-1	Total energy use	MMBtu	
	E-2	Total energy voluntarily derived from renewable resources		
	E-2A	- Onsite generation or use and biodiesel use	MMBtu	
	E-2B	- Voluntary purchase of renewable electricity	MWh	
	E-2C	- Voluntary purchase of RECs	MWh	
Air	A-1	Onsite NOx, SOx, and PM10 emissions	lbs	
	A-2	Onsite HAP emissions	lbs	
	A-3	Total NOx, SOx, and PM10 emissions	lbs	
	A-4	Total HAP emissions	lbs	
	A-5	Total GHG emissions	tons CO_2e	
Land & Ecosystems	Qualitative description			

Source: USEPA OSWER OSRTI Methodology for Understanding and Reducing a Project's Environmental Footprint, 2011

EPA Interest in Lowering Remediation Environmental Footprint Cont.- CO2 eq Emissions

Item or Service Used	Unit	Energy Used MMBtu	CO_2e Emitted lbs	NOx Emitted lbs	SOx Emitted lbs	PM Emitted lbs	HAPs Emitted lbs	Reference
		Suggested Conversion Factors: Parameters Used, Extracted, Emitted, or Generated						
Construction Materials								
Cement	Dry-lb	0.0021	0.9	0.0018	0.00105	0.0000032	0.000029	5
Concrete	lb	0.00041	0.171	0.00035	0.00021	0.00001	0.00001	6
Gravel/sand/clay	lb	0.000028	0.0034	0.000017	0.000015	0.0000020	2.1E-10	7
HDPE	lb	0.031	1.9	0.0032	0.0041	0.00064	0.0000034	8
Photovoltaic system (installed)	Watt	0.034	4.5	0.015	0.032	0.00063	0.0000029	9
PVC	lb	0.022	2.6	0.0048	0.0076	0.0012	0.00047	10
Stainless Steel	lb	0.012	3.4	0.0075	0.012	0.0044	0.00014	11
Steel	lb	0.0044	1.1	0.0014	0.0017	0.00056	0.000067	12
Other refined construction materials	lb	0.014	1.9					
Other unrefined construction materials	lb	0.000028	0.003					

Item or Service Used	Unit	Energy Used MMBtu	CO_2e Emitted lbs	NO x Emitted lbs	SO x Emitted lbs	PM Emitted lbs	HAPs Emitted lbs	Reference
		Suggested Conversion Factors: Parameters Used, Extracted, Emitted, or Generated						
Treatment Materials and Chemicals								
Cheese Whey	lb	0.0025	0.031	0.000062	0.000033	0.000002	NP	15
Emulsified vegetable oil	lb	0.0077	3.44	0.0066	0.0019	0.000033	NP	16
Molasses	lb	0.0044	0.48	0.0011	0.00024	0.0000041	NP	17
Treatment materials and chemicals	lb	0.015	1.7	0.003	0.0065	0.00061	0.000016	18
Virgin GAC (coal based)	lb	0.015	8.5	0.014	0.034	0.00078	0.0012	19
Fuel Processing								
Biodiesel Produced	gal	0.029	-16.8	0.018	0.033	0.00082	NP	1
Diesel Produced	gal	0.019	2.7	0.0064	0.013	0.00034	0.00012	20
Gasoline Produced	gal	0.021	4.4	0.008	0.019	0.00052	0.00016	21
Natural Gas Produced	ccf	0.0052	2.2	0.0037	0.0046	0.000072	0.0000061	22
Public water	gal x 1000	0.0092	5	0.0097	0.0059	0.016	0.0000150	23

Source: USEPA OSWER OSRTI Methodology for Understanding and Reducing a Project's Environmental Footprint, 2011

MassDEP Tracks Its GHG Emissions in Climate Registry Information System – RGGI Requirement

CRIS: Climate Registry Information System

Entity Emissions Detailed Report

Massachusetts Department of Environmental Protection

(Public)

3/12/2012 17:10:10 EDT

Operational Control: National - US

DIRECT EMISSIONS (metric tons)	CO2e	CO2	CH4	N2O	HFCs (CO2e)	PFCs (CO2e)	SF6
Stationary Combustion - Scope 1	986.92748	981.37796	0.0169	0.01682	0	0	0
Mobile Combustion - Scope 1	384.97583	382.37707	0.01119	0.00756	0	0	0
Process - Scope 1	0	0	0	0	0	0	0
Fugitive - Scope 1	31.11343	0.06804	0.00607	0	30.9179	0	0
TOTAL DIRECT EMISSIONS	1,403.01674	1,363.82307					

INDIRECT EMISSIONS (metric tons)	CO2e	CO2
Purchased Electricity - Scope 2	1,969.4736	1,954.50859
Purchased Heating - Scope 2	0	0
Purchased Cooling - Scope 2	0	0
Purchased Steam - Scope 2	0	0
TOTAL INDIRECT EMISSIONS	1,969.4736	1,954.50859

Baird & McGuire 10% of all MassDEP emissions CO2 eq

CRIS: Climate Registry Information System

Entity Emissions Detailed Report

Massachusetts Department of Environmental Protection

(Public)

3/12/2012 17:10:10 EDT

TOTAL EMISSIONS: MassDEP - 21E site - Baird & McGuire

Does the Entity control the Facility's emissions? Yes

Equity Share (%) N/A

DIRECT EMISSIONS (metric tons)	CO2e	CO2	CH4	N2O	HFCs (CO2e)	PFCs (CO2e)
Stationary Combustion - Scope 1	90.33748	89.83166	0.0016	0.00152	0	0
Mobile Combustion - Scope 1	0	0	0	0	0	0
Process - Scope 1	0	0	0	0	0	0
Fugitive - Scope 1	0	0	0	0	0	0
TOTAL DIRECT EMISSIONS	90.33748	89.83166	0.0016	0.00152	0	0

INDIRECT EMISSIONS (metric tons)	CO2e	CO2	CH4	N2O	HFCs (CO2e)	PFCs (CO2e)
Purchased Electricity - Scope 2	246.58	244.71067	0.02282	0.00449	0	0
Purchased Heating - Scope 2	0	0	0	0	0	0
Purchased Cooling - Scope 2	0	0	0	0	0	0
Purchased Steam - Scope 2	0	0	0	0	0	0
TOTAL INDIRECT EMISSIONS	246.58	244.71067	0.02282	0.00449	0	0

Source: MassDEP 2008 Report GHG Emissions Report

Current Site Features

32 Acres, Holbrook, MA

A) Treatment plant
B) Cochato River
C) Infiltration basins
D) Restored wetland
E) Lake Holbrook
F) South Street wells

Initial Conditions and Impacts

- Listed on NPL in 1983
- Direct discharge from lagoons and landfilling to soil, river and wetlands
- Soil, groundwater, and river sediment contamination with metals, SVOCs, VOCs, PAHs, and pesticides
- EPA completed RI/FS in 1983-1986
- ROD signed 1986

Remedial Action Components

- Incineration of soils and river sediments (250K $yd^{3)}$
  - Began incineration in 1995 and completed in 1998
  - Excavated soil on 12.5 Acres
  - Buried residual ash onsite (300 yd^3 stabilized)

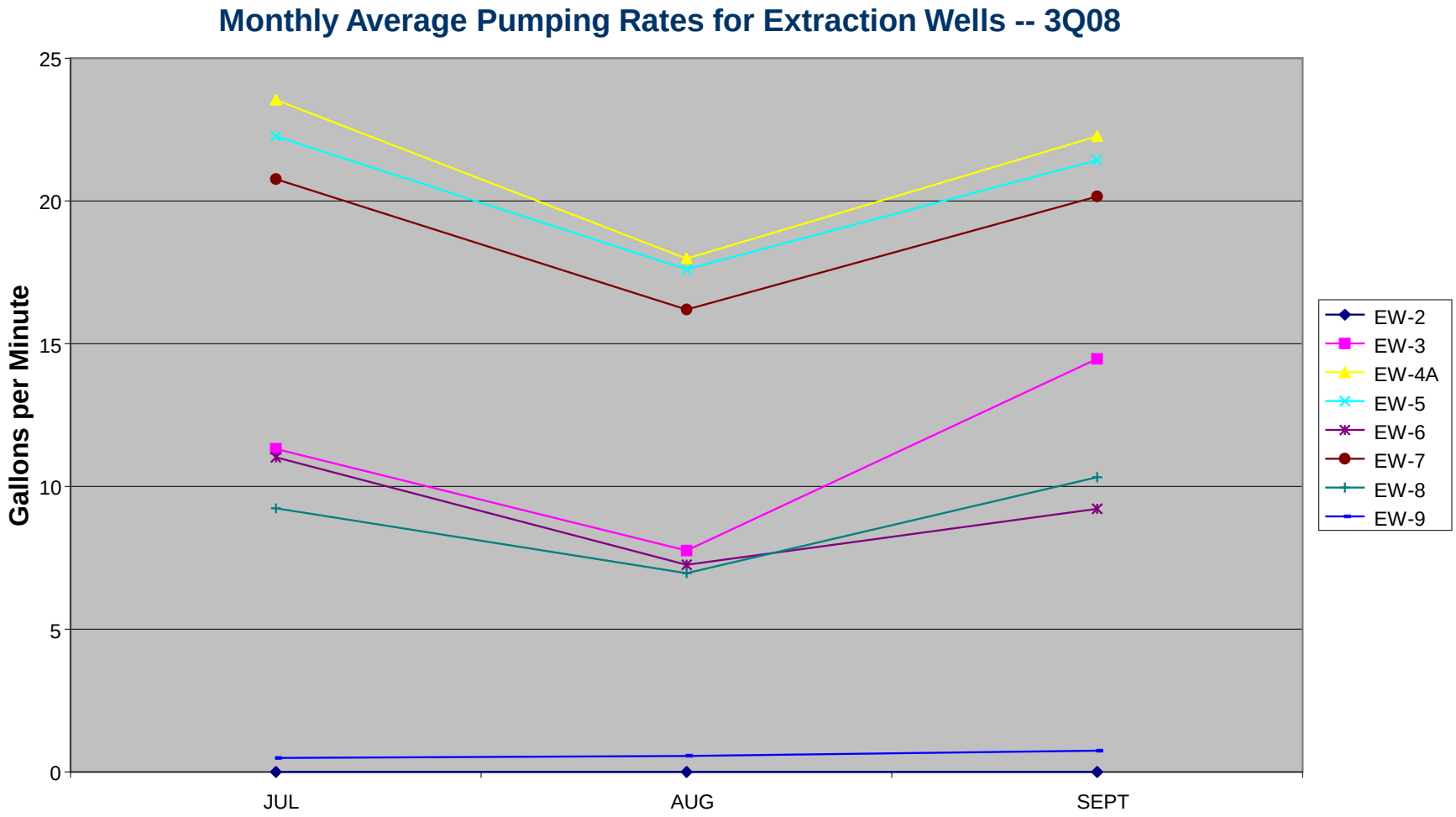
- P&T system for contaminated groundwater
  - Started in 1993
  - Initially served to treat incineration dewatering and process flows
  - Used from 1998 to the present for treatment of groundwater
  - Discharges effluent to infiltration basins

Remediation – 1996 to 2006

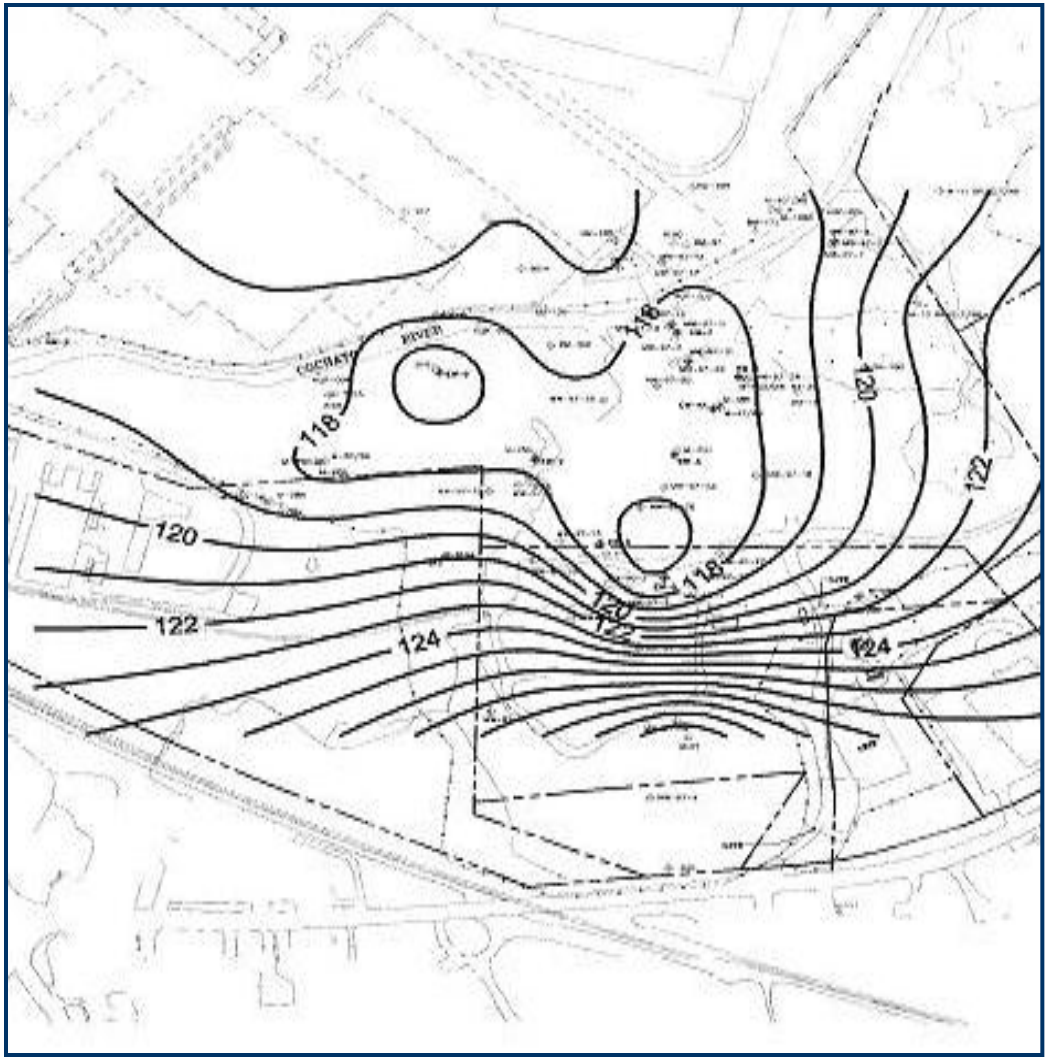
A) Incinerator & restored wetland
B) Groundwater treatment plant
C) Bauer, Inc.
D) Excavation
E) Backfilled incinerated ash
F) Cochato River
G) Infiltration Basins

Treatment goal: groundwater and effluent at MCLs drinking water standards

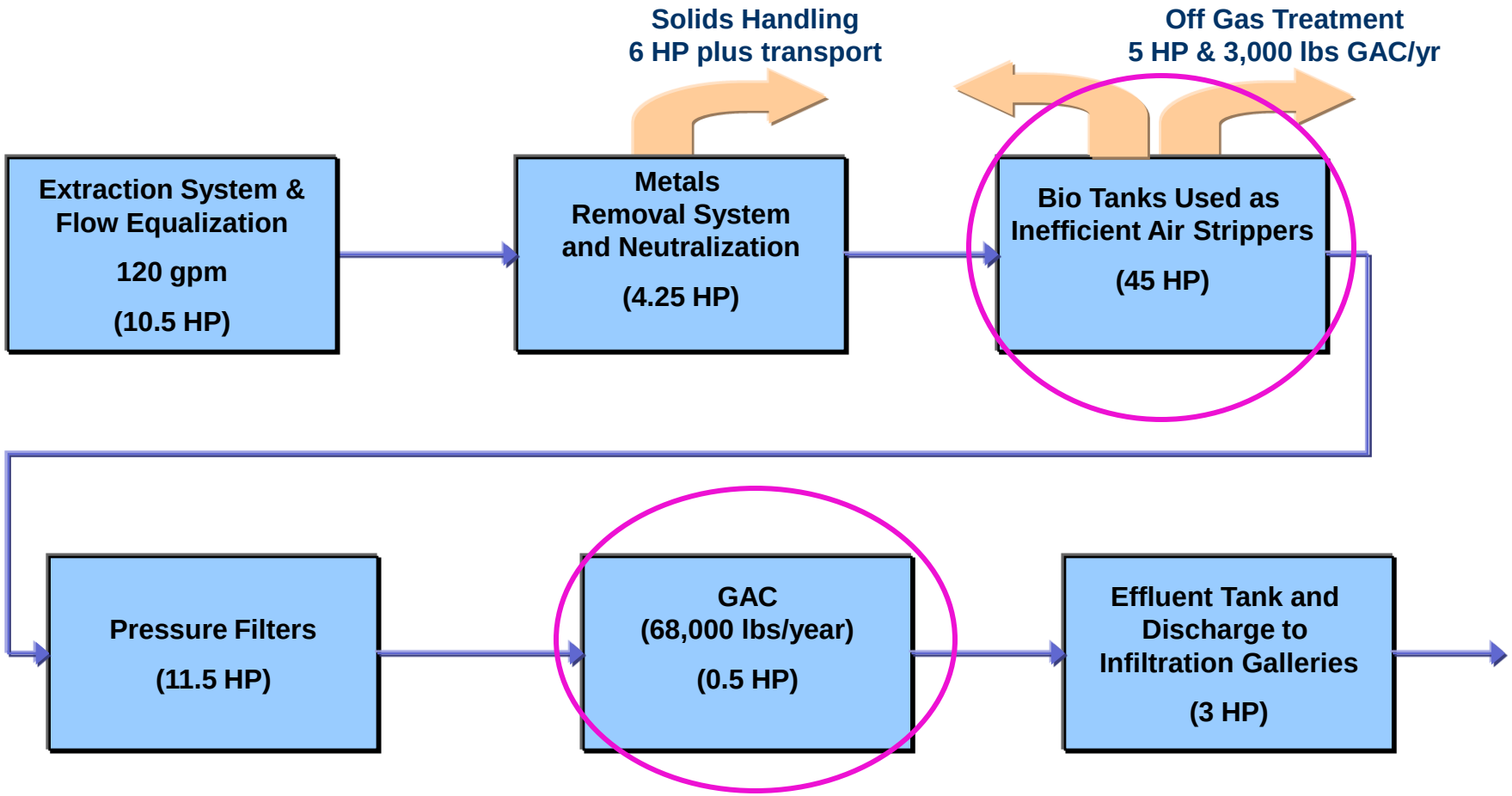
Pumping Rates: 75 – 140 gpm



Groundwater Contours Indicating Plume Capture



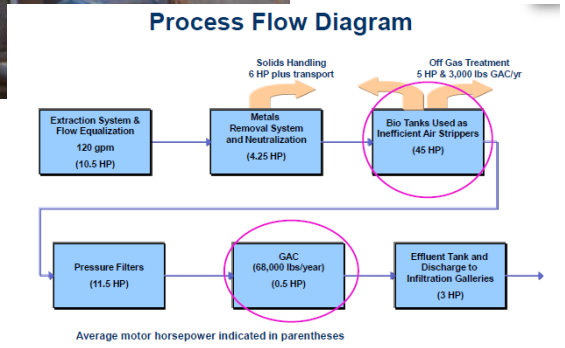
Process Flow Diagram



Average motor horsepower indicated in parentheses

Bio Tanks

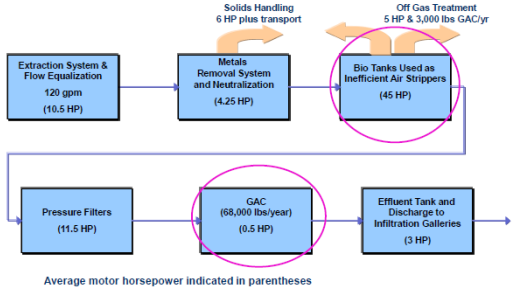
- Size: 172,458 gal
- Detention time: 28 hours at 100 gpm



Granular Activated Carbon

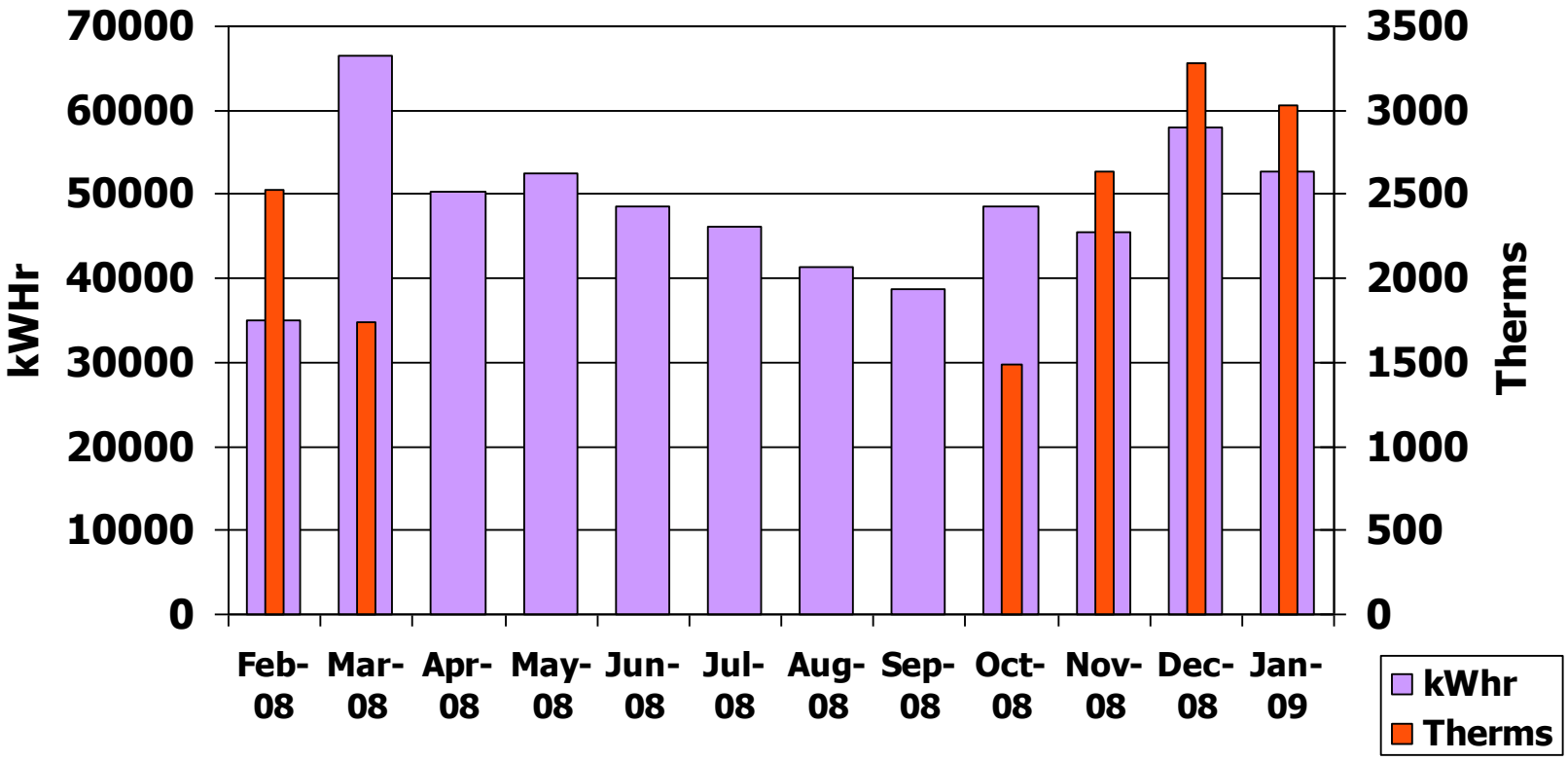
GAC A	GAC B	COMMENTS
		Filtersorb 300 pH recommended
	4/23/2004	
6/15/2004		
	9/29/2004	Filtersorb 300 pH
11/4/2004		Carbsorb 30pH
	1/19/2005	Carbsorb 30pH
3/2/2005		Carbsorb 30pH
	5/9/2005-	Carbsorb 30pH
7/21/2005		RX-pH POOL
	9/28/2005	RX-pH POOL
11/3/2005		RX-pH POOL
	2/1/2006	RX-pH POOL
3/9/2006		RX-pH POOL
	5/3/2006	RX-pH POOL
6/14/2006		RX-pH POOL
	9/14/2006	RX-pH POOL
10/11/2006		RX-pH POOL
12/7/2006	12/7/2006	RX-pH POOL
3/2/2007		RX-pH POOL
	3/13/2007	RX-pH POOL
6/8/2007		RX-pH POOL
	06/20/07	RX-pH POOL
10/04/07		DSRA React carbon, pH increase
	11/16/07	DSRA React carbon, pH increase
01/31/08		DSRA React carbon, pH increase
	02/28/08	DSRA React carbon, pH increase
04/22/08		DSRA React carbon, pH increase
	07/08/08	DSRA React carbon, pH increase
9/23/2008		DSRA React carbon, pH increase
	10/23/2008	DSRA React carbon, pH increase
12/10/2008		DSRA React carbon, pH increase
	2/13/2009	DSRA React carbon, pH increase

Process Flow Diagram



- GACs require 8,000 to 8,500 lbs filter media per change-out

Monthly Energy Usage



Improvements and Annual Costs

- Extraction well redevelopment
- Replacement of pressure filter media (investigation of greensand and bag filters)
- Utility audits: installation of more efficient lighting, motion sensors (58 MWhr/yr), VFDs for extraction, influent and pressure filter pumps (23 MWhr/yr) resulting in 7 MWhr/mo reduction (5 tons CO_2/mo – 62 tons CO_2/yr)
- Staff: $635,000 for operations, site sampling, consulting, and reporting
- Direct costs: $294,000 for materials and laboratory analysis (GAC – $65,000 for 8 x 8,000 lbs at $1/lb)
- Energy: electricity $100,000 (50 MWhr/mo at $0.17 kWhr) and natural gas $23,000 (15,000 therms/year at $1.5/therm)

Plans for Long Term Treatment

- Removal of arsenic and naphthalene (some other organics) to achieve site restoration at drinking water standards (MCLs)
- Effluent at MCLs and GW1 to prevent contamination of infiltration basins
- Optimize plant/site operations
  - Replacement or elimination of Bio Tanks and clarifier modifications
  - Improve GAC operations
  - Establish extraction well redevelopment/replacement plan
  - Optimize extraction well pumping
  - Residual LNAPL investigation
- Minimize energy use and reduce emission of GHG
- Investigate additional remedies

Conceptual Investigation of Thermal Technologies (CHP and GWSHP)

- Lower energy and GHG emissions from
  - GACs (change-outs 6.45 lbs CO_2/lb GAC)
  - Bio Tanks (high energy requirements)
- Elimination of Bio Tanks and GAC units
- Addition of air stripping at elevated temperature
- Addition of CHP turbine to provide heat and power
- Use of GWSHP to optimize CHP performance
- Provide for maximum heat recovery

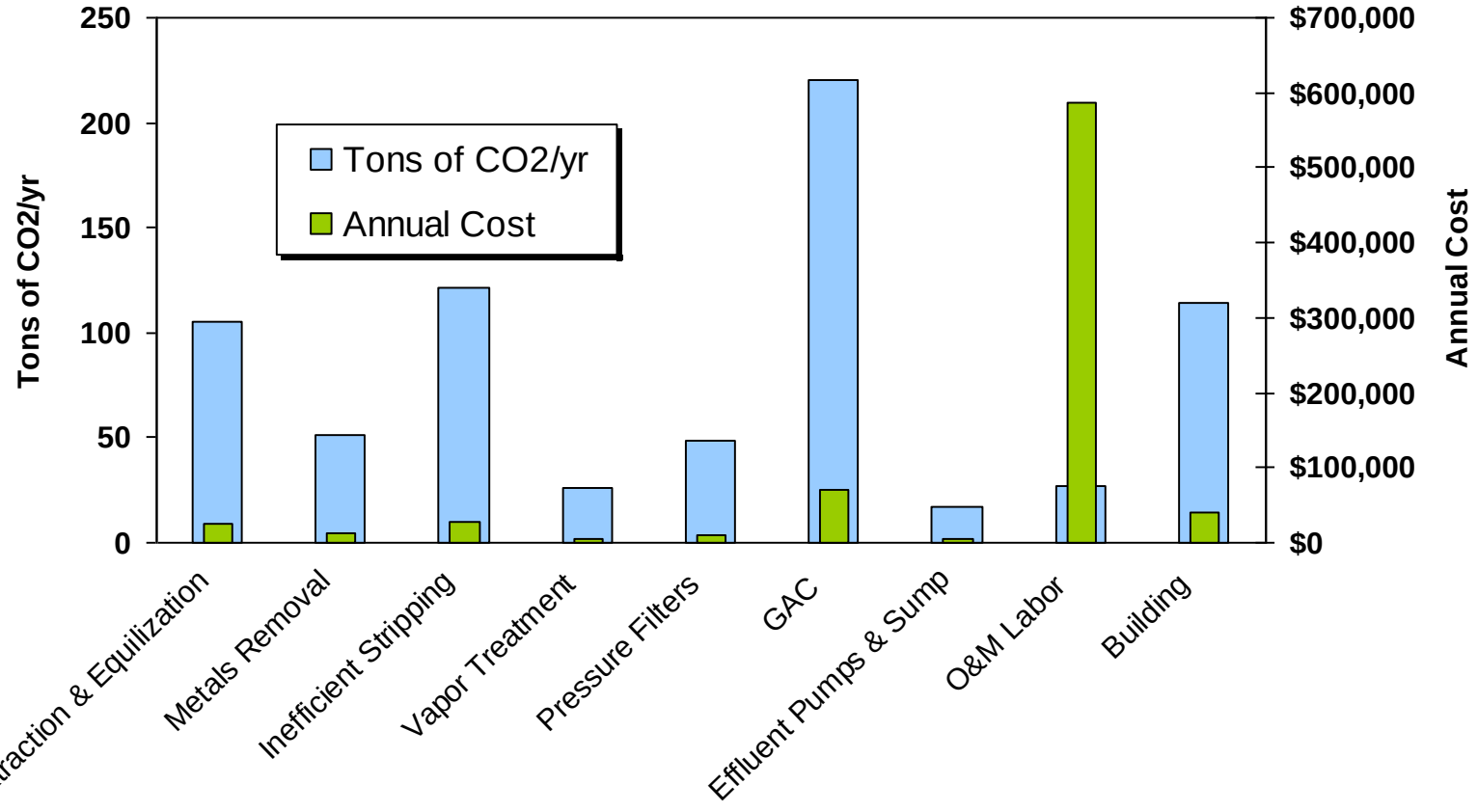
Parameters for the Study

- Carbon parameters
  - Electricity: 1.48 lbs of CO_2 per kWh (GRID 2005 for MA)
  - Natural gas: 12.2 lbs of CO_2 per therm (www.nrel.gov/lci)
  - GAC: 6.45 lbs of CO_2 per pound of GAC (discussion point)
  - Travel: 40 lbs of CO_2 per site visit (based on approximately 2 gallons of gas per visit)
- Cost parameters
  - Electricity: $0.17/kWh (bills)
  - Natural gas: $1.50/therm (bills)
  - GAC: $1.04/lb (contract estimate)
  - Service tech visit: $450 per visit

Breakdown of Current Carbon Footprint and O&M Cost

Total O&M Cost: $784,000 per year

Total Carbon Footprint: 787 tons of CO_2 per year



Preliminary Analysis

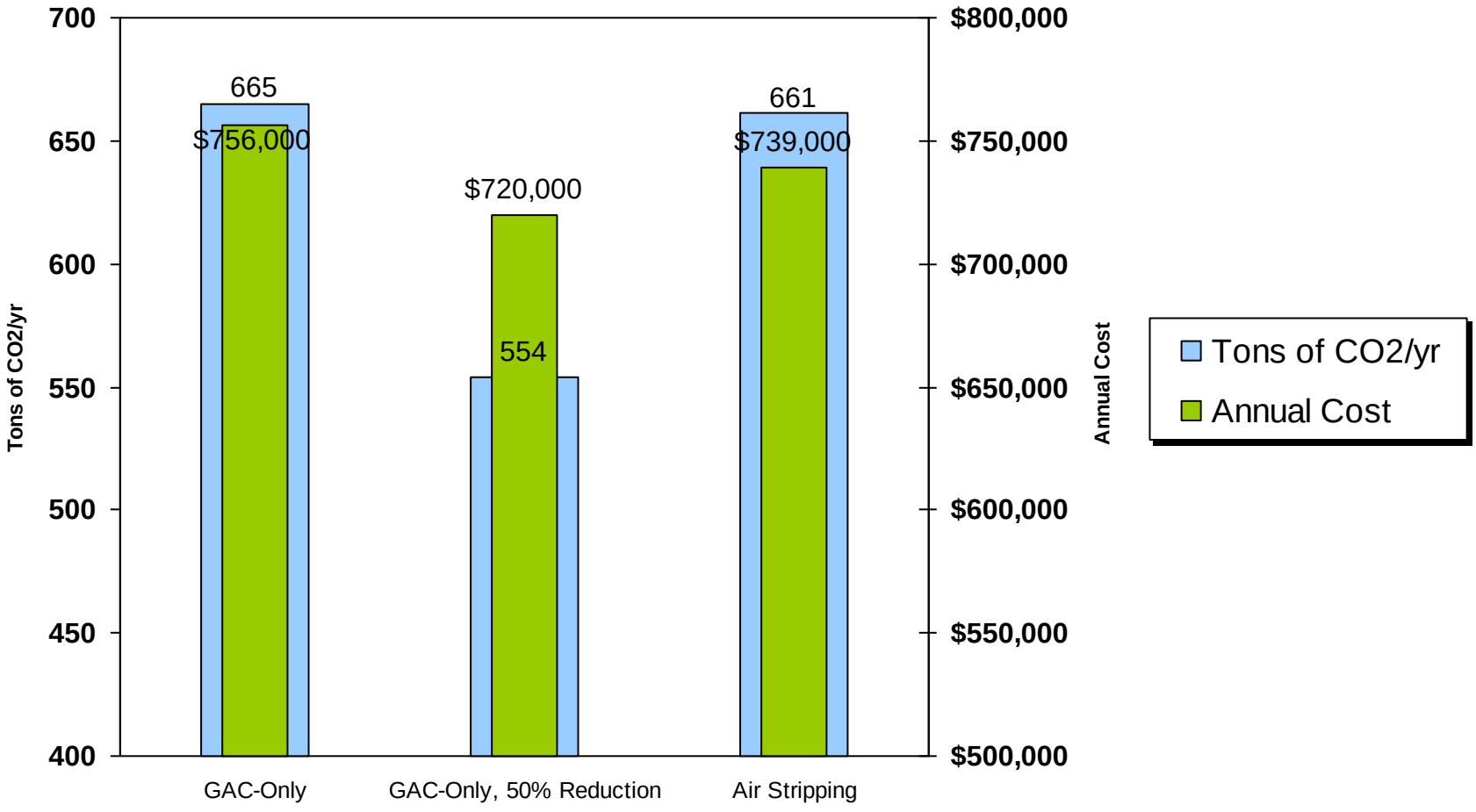
- The GAC has a high carbon footprint and a high cost (largely due to frequent change-outs)
- Inefficient air stripping has a substantial footprint
- Building footprint is also significant (18,700 therms of NG for heating, 75,000 kWh per year for ventilation, lighting, etc.)
- Previous evaluations suggest capture is adequate but not much room for reducing extraction rates. VFD's on pumps, so assumption is that there is little room for reducing energy usage for extraction
- O&M labor costs are high, but the carbon footprint is relatively low

Options

- Eliminate stripping and go to GAC-only for treatment of organics
- Attempt to decrease GAC change-out frequency
- Eliminate GAC and go with stripping only

- Enhance stripping with waste heat from a combined heat and power unit (or GWSHP)
- Consider GWSHP for building heating/cooling

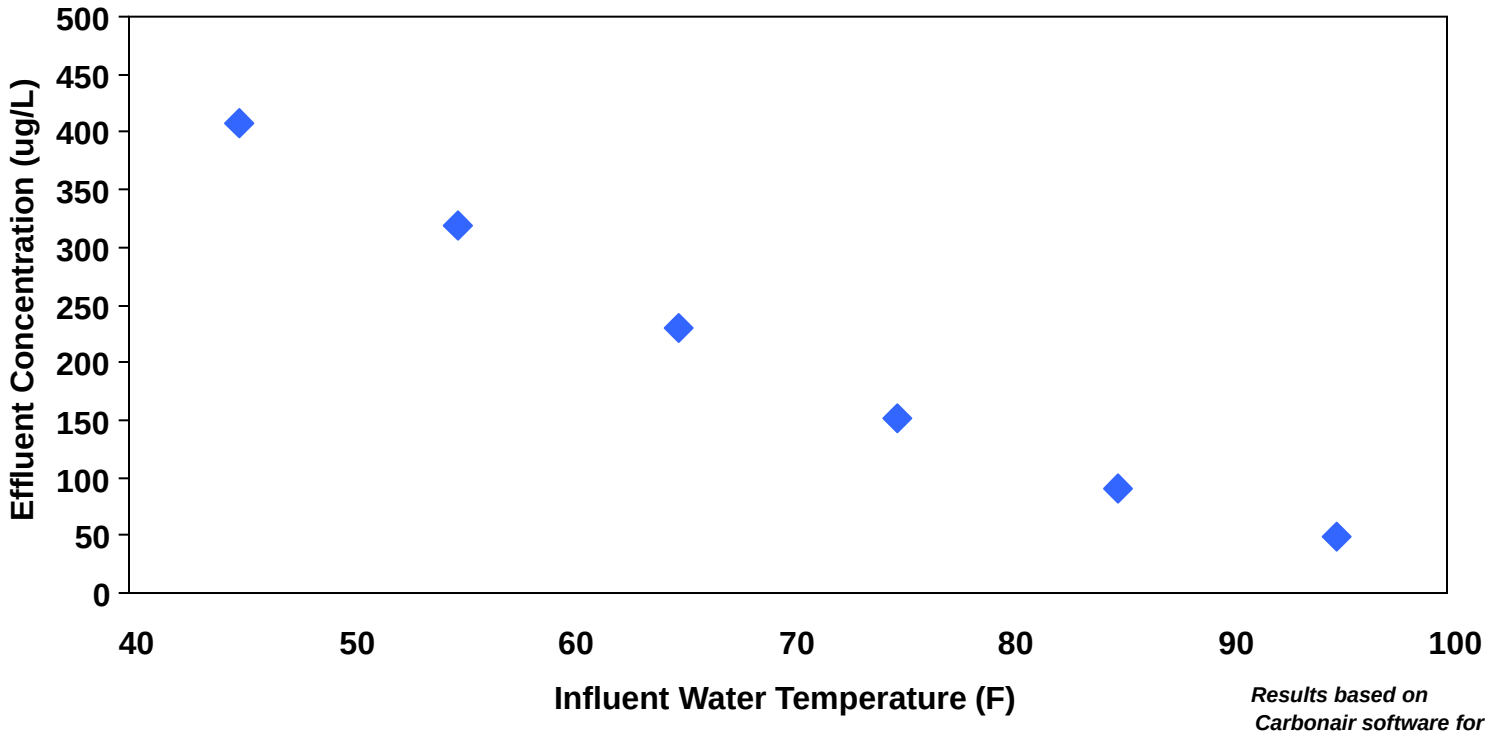
Breakdown for Various Options



Total Carbon Footprint: 787 tons of CO_2 per year
Total O&M Cost: $784,000 per year

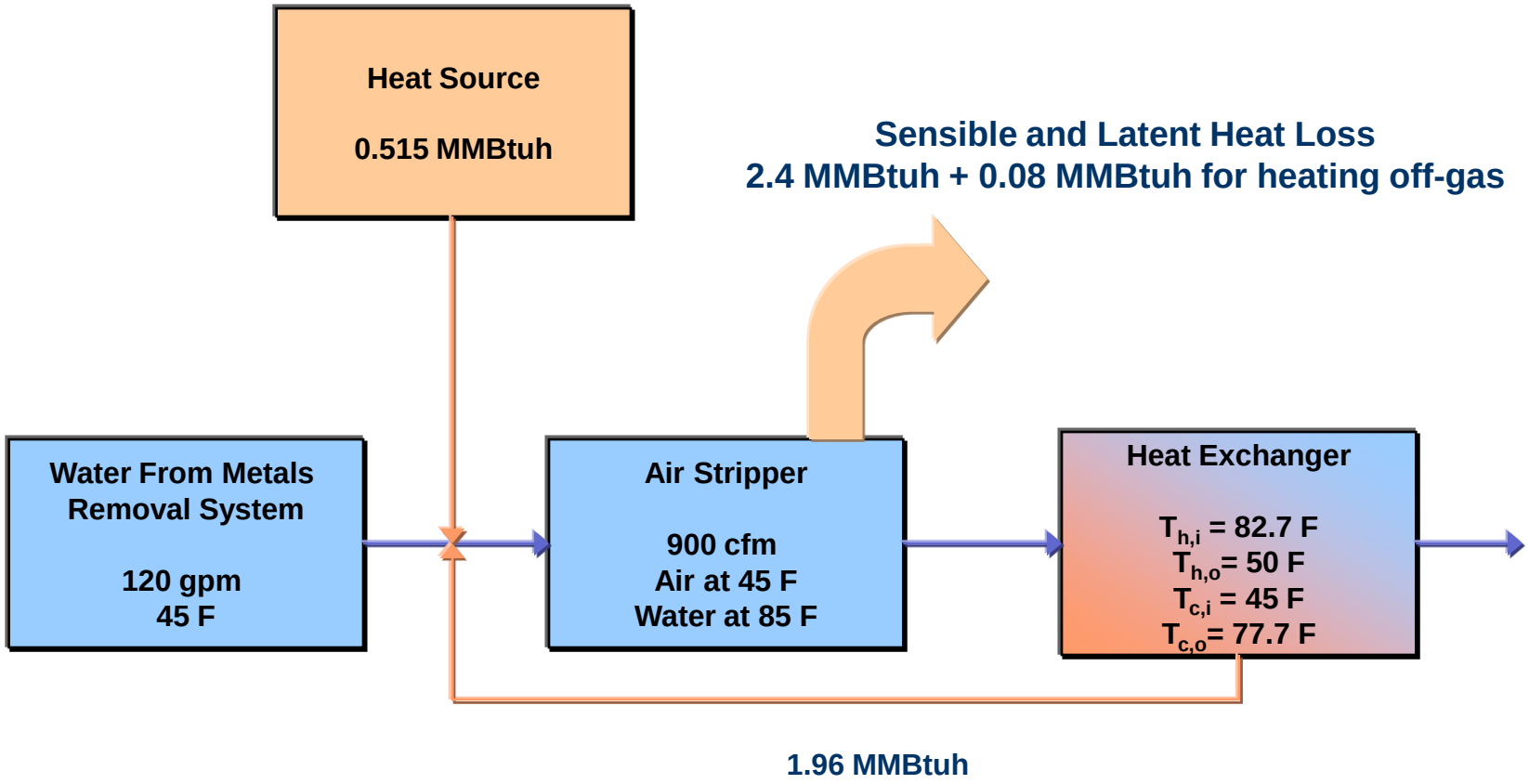
Stripping Effectiveness and Water Temperature

Naphthalene Effluent Concentration vs. Water Temperature with Water Flow of 120 gpm, Air Flow of 900 cfm, 6 Trays, and an Influent Concentration of 800 ug/L



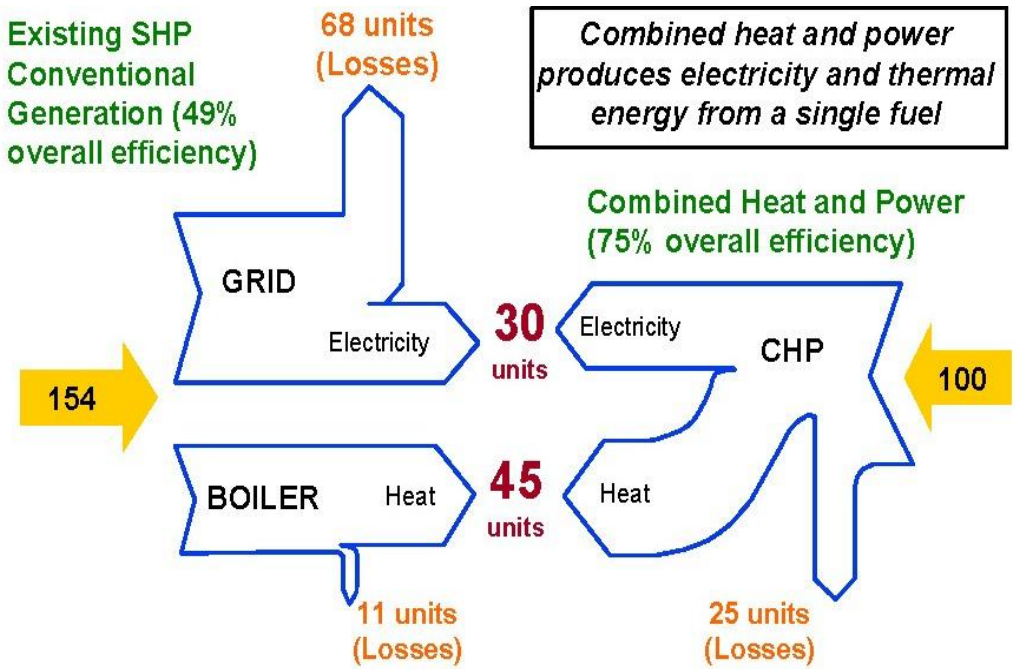
Results based on Carbonair software for STAT 180 unit

Heat-Enhanced Air Stripping

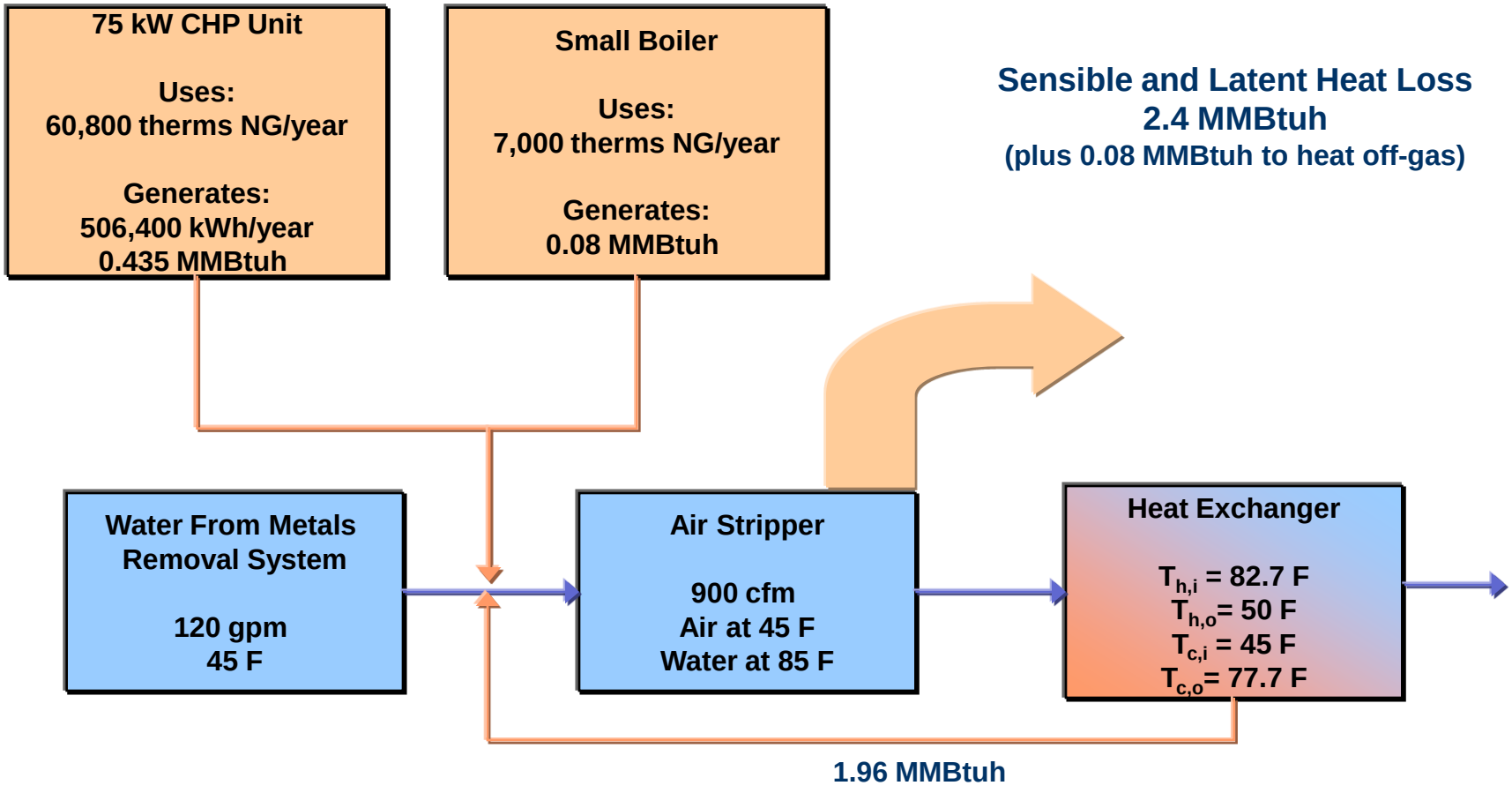


Combined Heat and Power

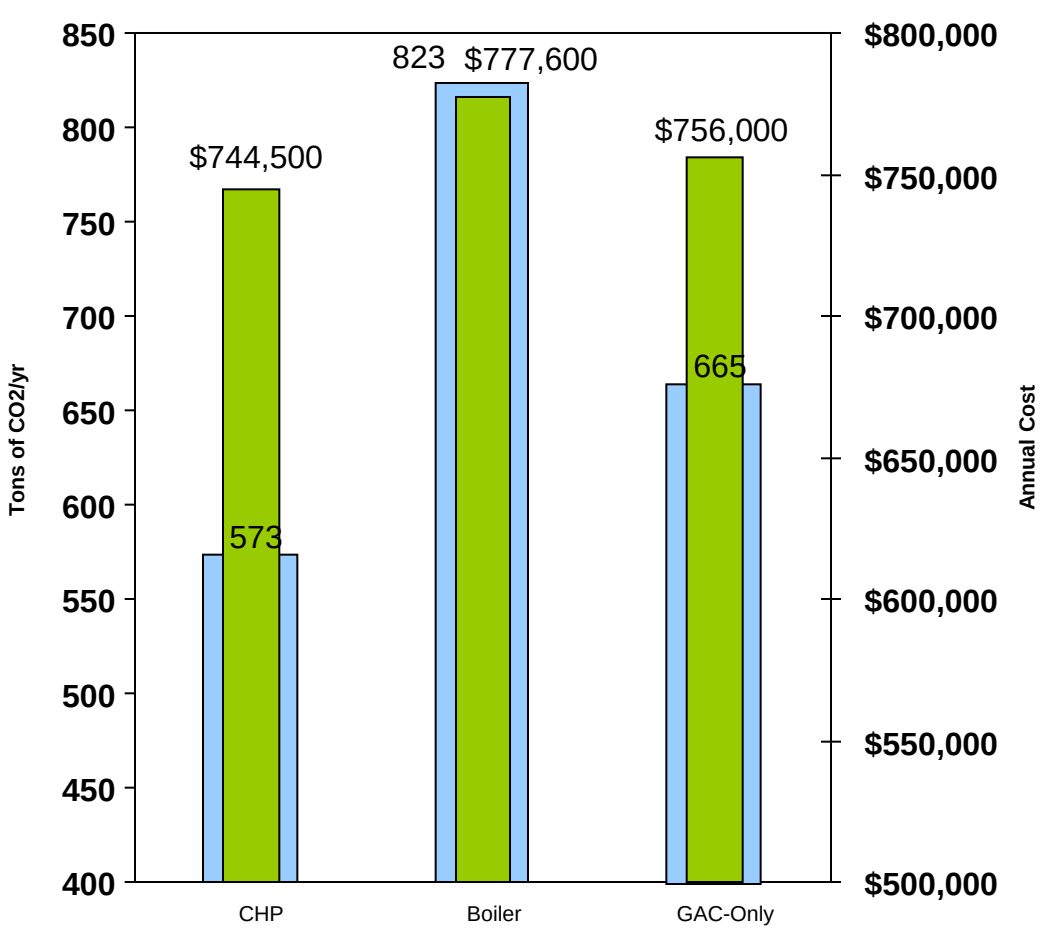
- Generate electricity on-site with a natural gas powered generator
- Rather than discharge heat to the atmosphere, use it for beneficial use
- Results in increased overall efficiency
- Only makes sense if electrical demand and heating demand are present and appropriate

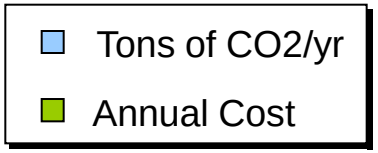


CHP Heat-Enhanced Air Stripping



CHP Option vs. Boiler Option





CHP Option Uses:

- 60,800 therms of NG per year

CHP Generates:

- 506,400 kWh per year
- 0.435 MMBtuh
  (a boiler supplies additional 0.08 MMBtuh)

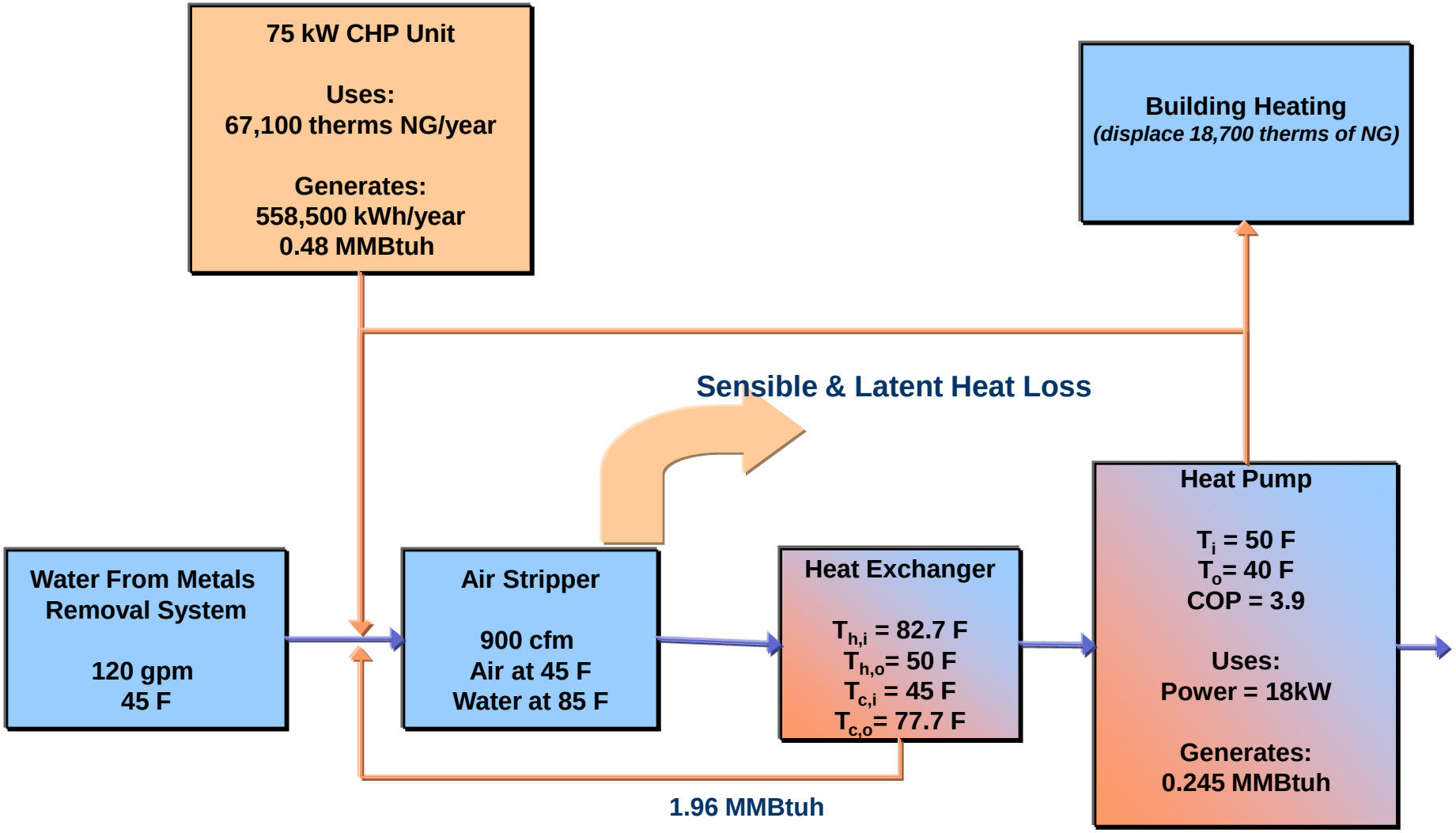
Boiler Option Uses:

- 47,500 therms of NG per year

Boiler Generates:

- 0.51 MMBtuh

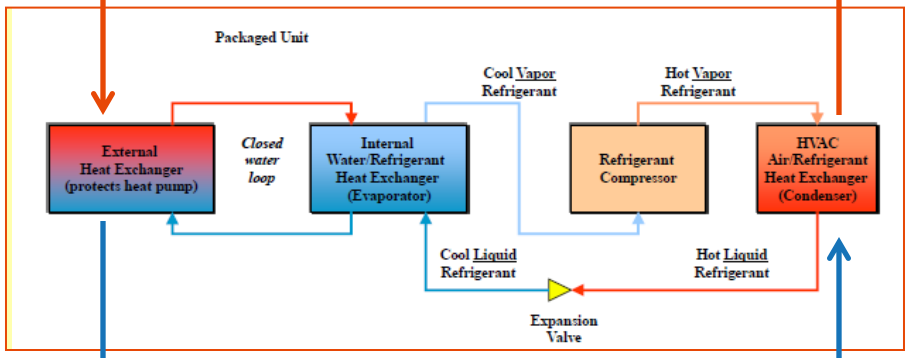
CHP & Heat Pump



Groundwater Source Heat Pump in Heating Mode

- Similar concept to air conditioner or refrigerator but
  - Heats instead of cools air
  - Uses water not air as the heat source
- Heat from water vaporizes refrigerant
- Heat from condensing refrigerant is transferred to building via HVAC system
- Heat is transferred via vaporization/condensation of refrigerant

Extracted groundwater after metals removal and HX

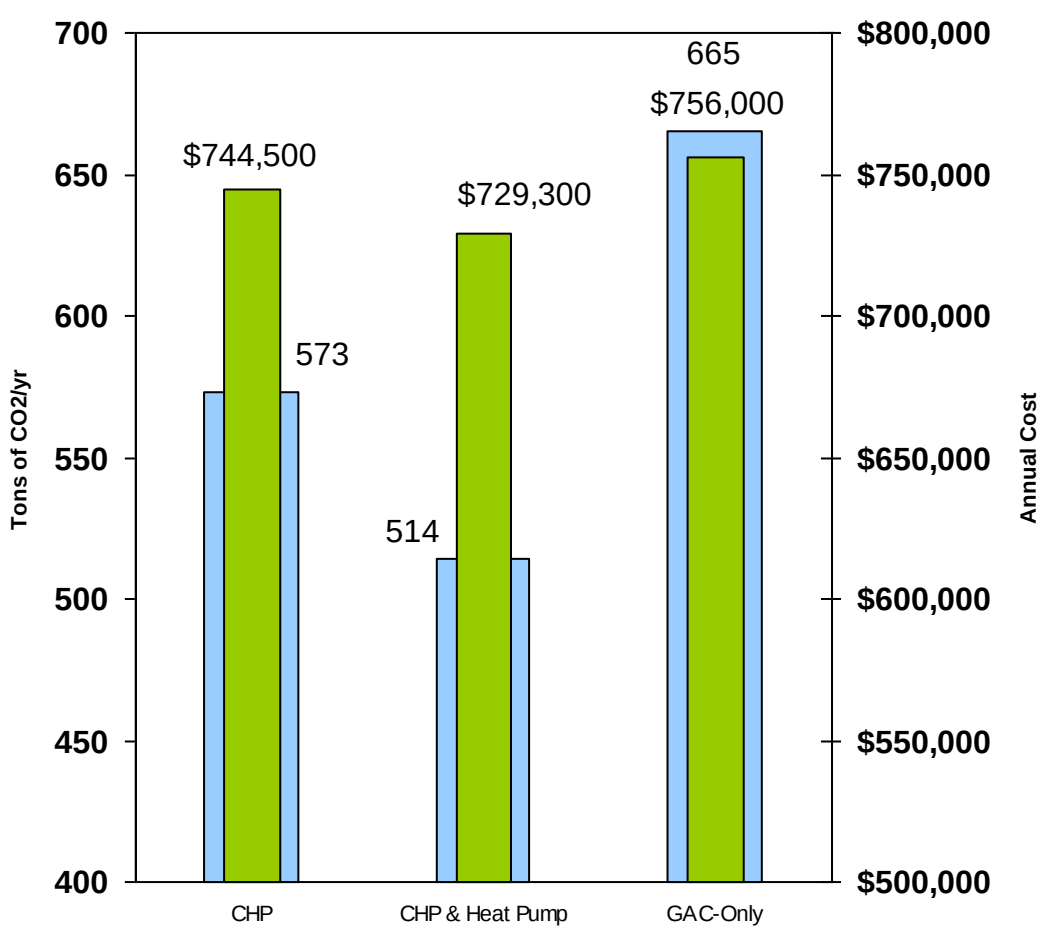


Hot water to distribution system (or stripper influent)

Treated groundwater < MCLs discharged to infiltration basins

Return water from the heating system (preheated gwtr from HX)

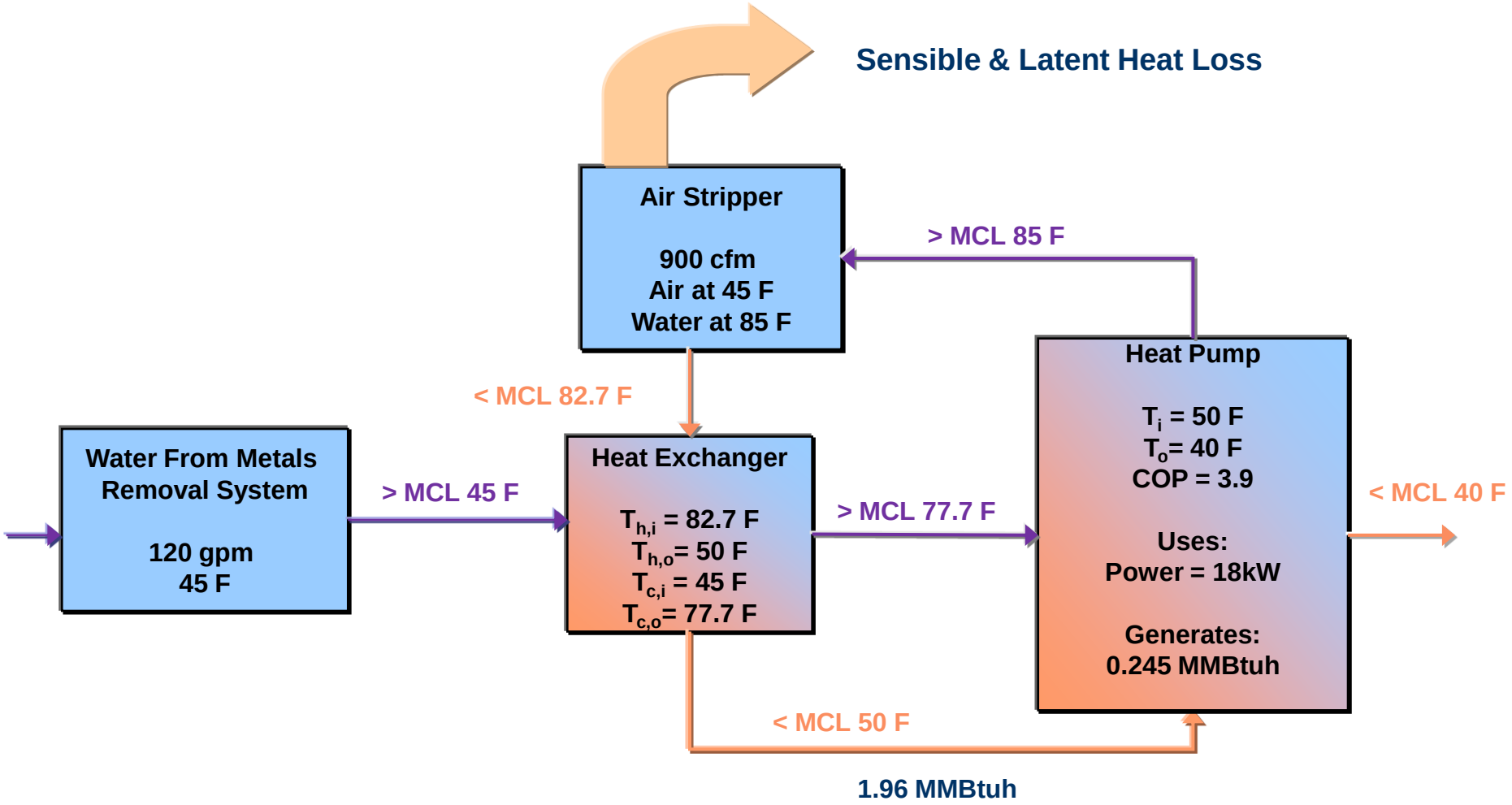
CHP Option
With and Without Heat Pump



Heat Pump:

- Adds electrical load so that CHP unit operates at full load
- Displaces 18,700 therms of NG/yr
- Reduces carbon footprint for heating building by about 30 tons of CO_2/yr

Heat Pump for Heating Groundwater in Treatment



GHG Heating with GSHP or NG Heater

GHG Savings =
Heating Load [(FI/FEx1000kg/ton)-(EI/COPx3600sec/hr)]

Heating Load = .23 MMBtuh (2,164 GJ/yr)
Fuel Intensity NG = 50 kg (CO_2)/GJ
Emission Intensity = 590 ton/GWhr
Furnace Efficiency = 85%
Coefficient of Performance (COP) = 3.9

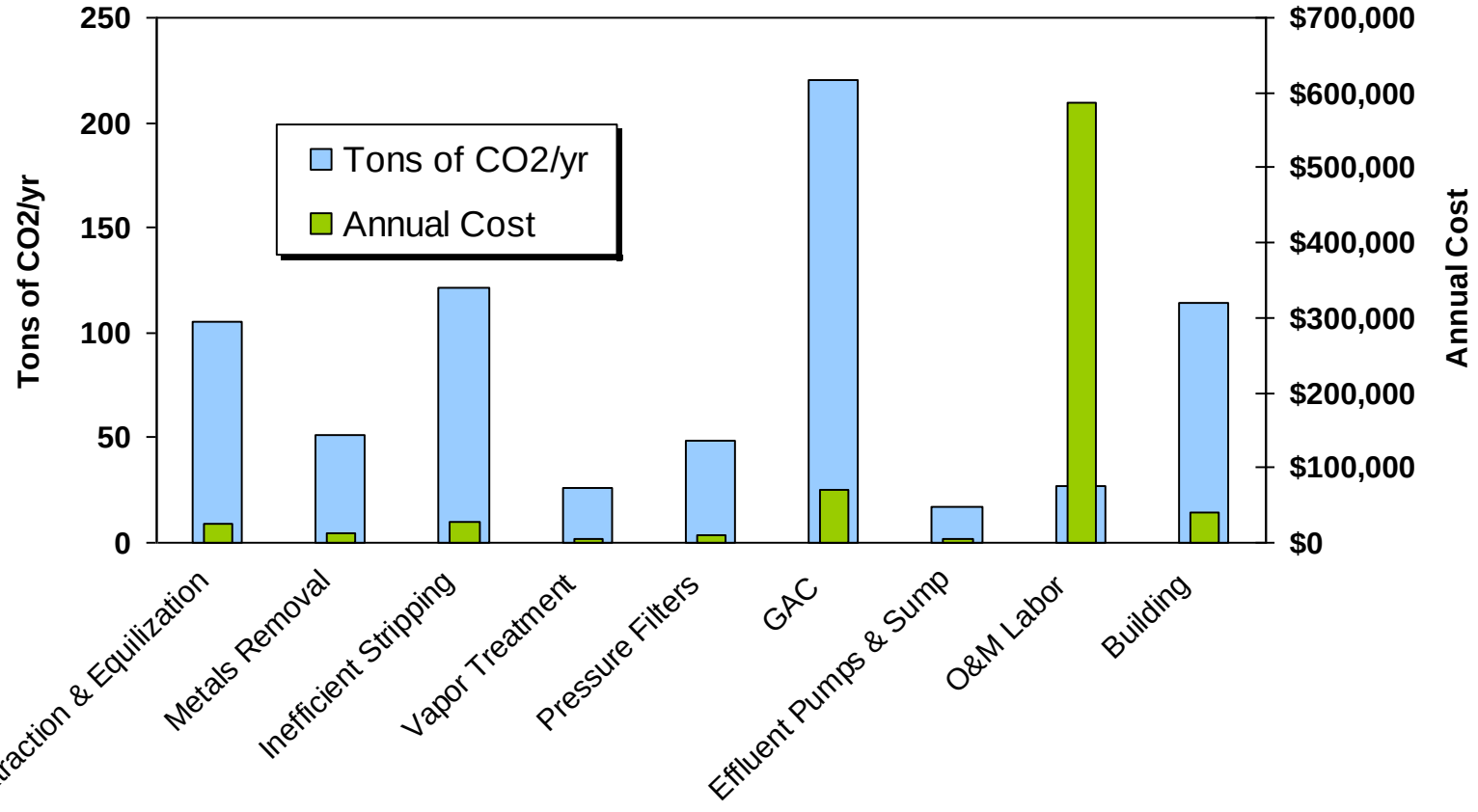
36.7 tons/yr
787 tons of CO_2 per year for P&T

Solar array of 140 kW and CF of 0.13 could provide necessary power for the GWSHP

Breakdown of Current Carbon Footprint and O&M Cost

Total O&M Cost: $784,000 per year

Total Carbon Footprint: 787 tons of CO_2 per year



Conclusions Regarding Site

- Investigate GAC performance
  - Clarifier sizing
  - Metals removal chemistry
  - Filter effectiveness
  - Backwashing effectiveness
- Depending on GAC results pilot air stripping with and without heating
- Depending on pilot results consider CHP with GWSHP option but concern regarding potential future reduced standards for naphthalene
- Consider GWSHP for building heat regardless especially with solar PV

Conclusions Regarding Technological Applications

- CHP (combined with heat exchangers and GWSHP) is a carbon and energy efficient method of heating process water
  - May be beneficial to some biological treatment systems
  - Enhances stripping efficiency
  - In-situ remedies (?)
- Optimize traditional treatment components when comparing to new or more complex treatment approaches
- Heat enhanced stripping may be more appropriate for contaminants such as MTBE that are difficult to remove via stripping and GAC
- Appropriately consider disadvantages associated with heating water before implementing a treatment approach that requires heating
  - Increased potential for fouling
  - System has to “come up to temperature” before effective treatment can begin
- Heat pumps for building heating and cooling may be appropriate at many P&T sites