SOLAR REUSE ASSESSMENT

Yeoman Creek Landfill Site in Waukegan, Illinois

FINAL
NOVEMBER 2013

OVERVIEW

Cleanup is complete at the Yeoman Creek Landfill Superfund site, in Waukegan, Illinois. Today, site owners, the City of Waukegan and the Yeoman Creek Remediation Group (YCRG) are interested in redeveloping portions of the 72-acre site into a solar renewable energy facility. The Waukegan Community School District owns the majority of the site and is a member of the YCRG, along with the City of Waukegan and two private corporations.

The EPA Region 5 Superfund Redevelopment Initiative sponsored a solar reuse assessment to support stakeholders in evaluating solar energy reuse options for the site.

REUSE GOALS

In 2010, the Waukegan Community School District, which owns the majority of the site and YCRG, formally endorsed solar energy development as a desirable future use of the site and identified the following reuse goals:

- Site reuse should provide a positive benefit to YCRG and the community;
- Public access to the site is not desirable due to security concerns;
- Solar energy development at a secure site can provide benefits such as meeting on-site electricity needs, generating revenue to defray site operation and maintenance costs and power costs for the community, reducing carbon fuel use and creating jobs.

This solar reuse assessment provides a summary of the following topics:

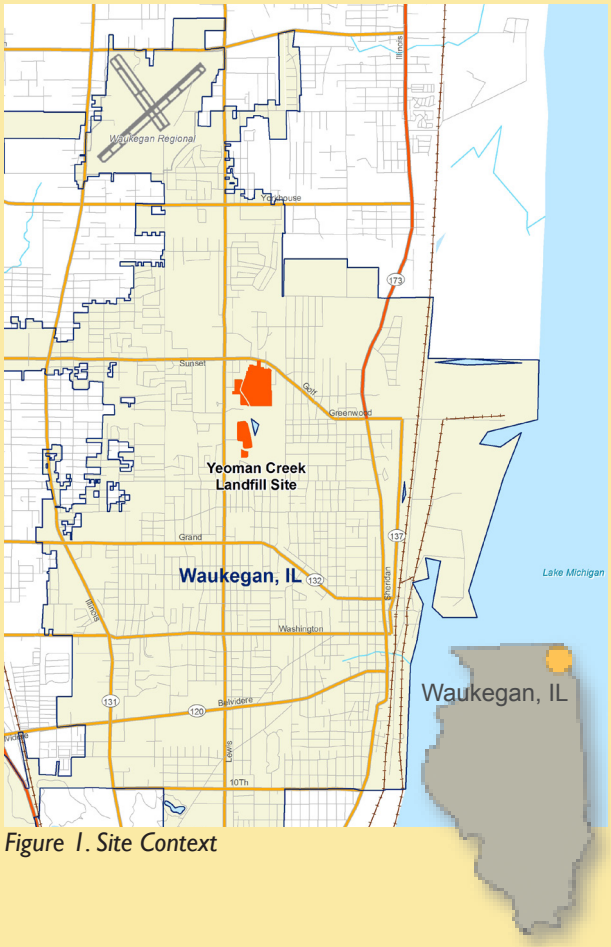


Figure 1. Site Context

Region 5 Renewable Energy Reuse Assessments

For over 10 years, the U.S. Environmental Protection Agency (EPA) Superfund Redevelopment Initiative has been working with communities nationwide to improve the process of returning Superfund sites to beneficial uses. As part of this program, EPA Region 5 has provided resources to evaluate potential for renewable energy generation at select Superfund sites.

Sponsored by the EPA Region 5 Superfund Redevelopment Initiative

The most important requirements for a renewable energy project are the availability of a suitable renewable energy resource, site suitability (such as relatively flat land) and transmission access. This section describes the suitability of the Yeoman Creek Landfill site for solar generation.

RESOURCE AVAILABILITY

The Yeoman Creek site is located in an area well-suited for solar power generation. The National Renewable Energy Laboratory (NREL) solar radiation estimates indicate that the state of Illinois has a relatively good solar resource. Solar irrandiance levels of 4.25 kWh/m^2/day are found across the central and southern portions of the state. Solar irradiance levels of 6 kWh/m^2/day are considered excellent. Altitude, latitude, time of day, time of year and local weather conditions all affect the available solar radiation levels at a location. Based on the available solar resources in this area, it is likely that the Yeoman Creek site is suitable for solar generation.

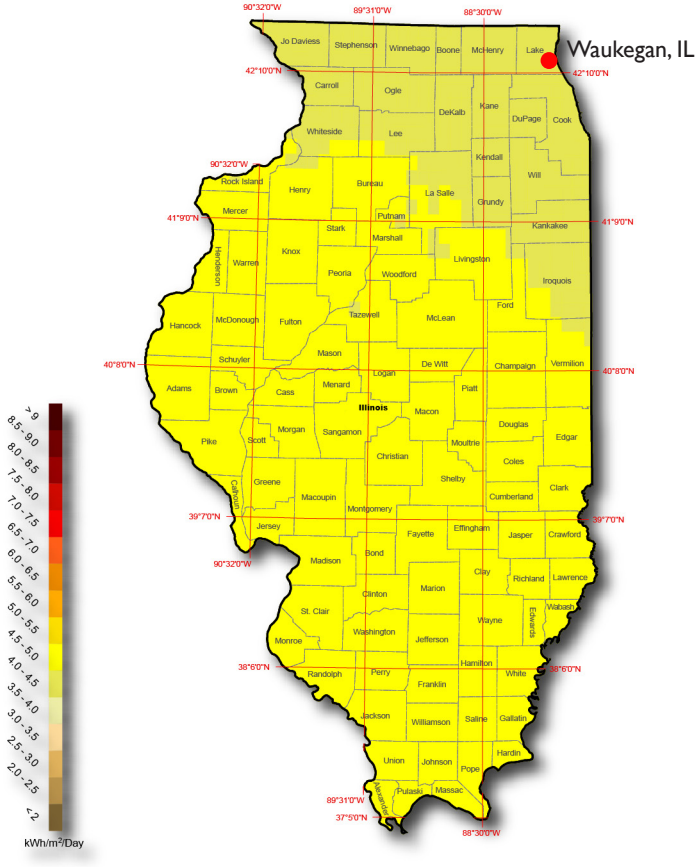
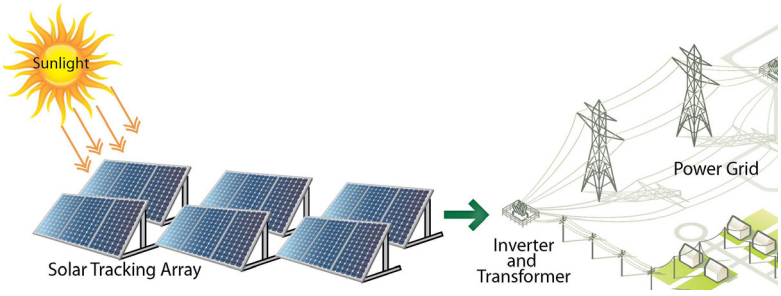


Figure 2. Illinois Solar Radiation Map
(Source: U.S. DOE, NREL, September 2007)

INFRASTRUCTURE

Access to infrastrucuture is a key factor in determining the viability of a solar project. Proximity to an electric substation and transmission lines are important location-based considerations.

The electric utility, Commonwealth Edison, operates a substation and transmission lines in the vicinity of the site. An active substation is located on Lewis Street, approximately 500 feet west of the Yeoman Creek Landfill. The utility's high voltage transmission lines run west-east across the site, separating the Yeoman Creek and Edwards Field Landfill Units (see Figure 3).



Utility-scale solar PV systems generate electricity that is distributed via transmission grid. These systems require access to a substation and transformer to step up the voltage for distribution via high-voltage transmission lines.

Commmonwealth Edison Substation on Lewis Avenue

LANDFILL UNITS

The Yeoman Creek Landfill site consists of five non-contiguous landfill units, including:

- Yeoman Creek Landfill – East (44 acres)
- Yeoman Creek Landfill – West (7.5 acres)
- Edwards Field (10 acres)
- North Rubloff (2.5 acres)
- South Rubloff (2 acres)

PARCELS AND OWNERSHIP

The site is primarily owned by public entities; the Waukegan School District and Waukegan Parks District collectively own 60 acres at the site. Parcel configurations are fragmented by the Commonwealth-Edison transmission corridor.

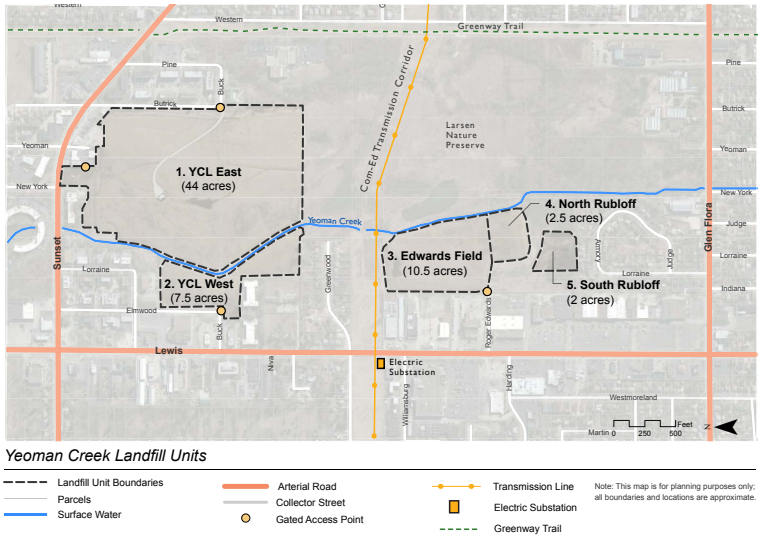


Figure 3. Landfill Units Map

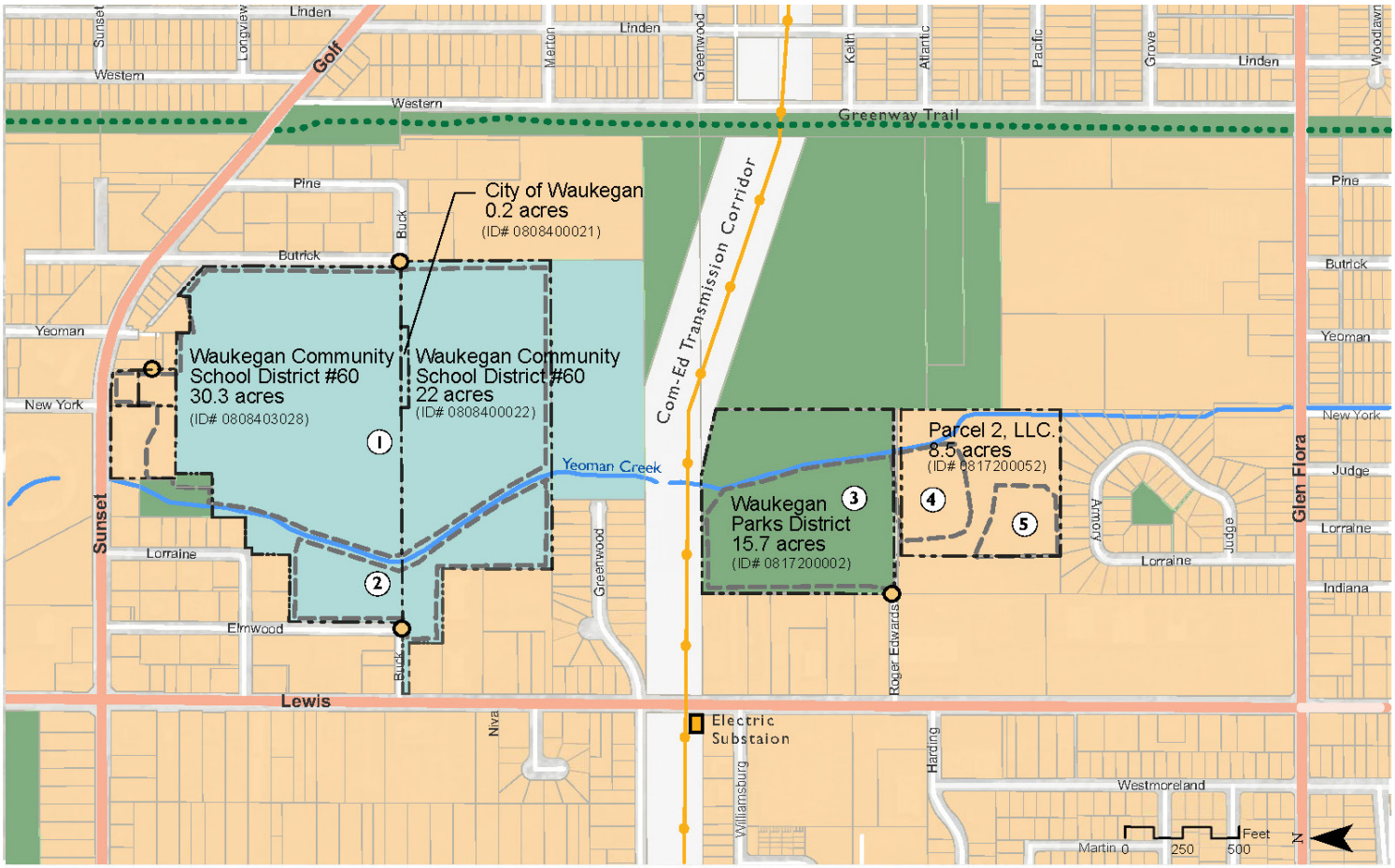


Figure 4. Property Ownership Map

REMEDIAL FEATURES

Potential solar renewable energy development at the site will need to take into account the site's existing remedy. The landfill cover and remedial systems constructed in 2005, include: Landfill Cover System; Landfill Gas Collection System; Leachate monitoring wells; Ground water monitoring wells; and Fencing. The landfill cap (depth, composition and grading) and gas collection system are key factors that influence the size and location of a potential solar PV system.

Cap

The site's five landfill units have capped cover systems consisting of:

- Vegetative cover over a 3-foot frost protection layer
- Tire chip drainage layer
- Polyethylene liner over a 2-3 ft. compacted clay liner
- Tire chip gas ventilation layer

Gas Collection System

Two types of landfill gas collection (LFG) systems are in place at the site:

- Active LFG system in place at YCL East & West landfill units
- Passive LFG system in place at Edwards Field & North Rubloff landfill.

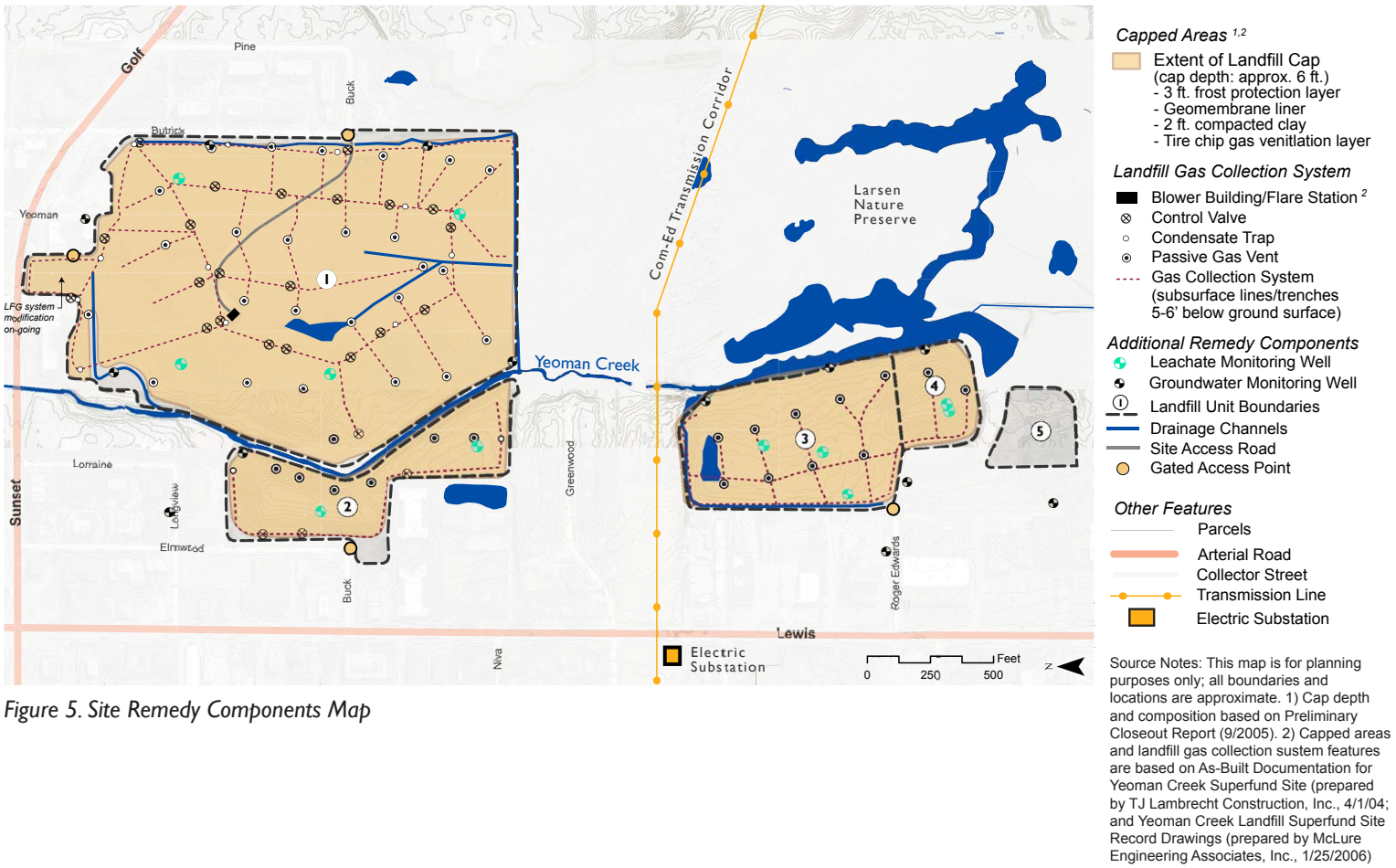


Figure 5. Site Remedy Components Map

Source Notes: This map is for planning purposes only; all boundaries and locations are approximate. 1) Cap depth and composition based on Preliminary Closeout Report (9/2005). 2) Capped areas and landfill gas collection sustem features are based on As-Built Documentation for Yeoman Creek Superfund Site (prepared by TJ Lambrecht Construction, Inc., 4/1/04; and Yeoman Creek Landfill Superfund Site Record Drawings (prepared by McLure Engineering Associates, Inc., 1/25/2006)

Active landfill gas vent

Drainage swale

Capped area

GRADES

Topography and aspect (slope direction) are also key factors that will influence the location and size of a solar PV system. Grades of 10 percent or less are generally considered suitable for solar PV. Figure 6 characterizes the site's grades into three categories: 3-5 percent, 5-10 percent and greater than 10 percent.

Slopes at the YCL East (1) ,YCL West (2) and Edwards Field (3) landfill units are generally less than 10 percent. Level areas located away from structures or trees at these landfill units are well-suited for solar PV.

Drainage features including Yeoman Creek and internal drainage channels for stormwater control are not suitable for solar PV.

Figure 6. Site Grades Map

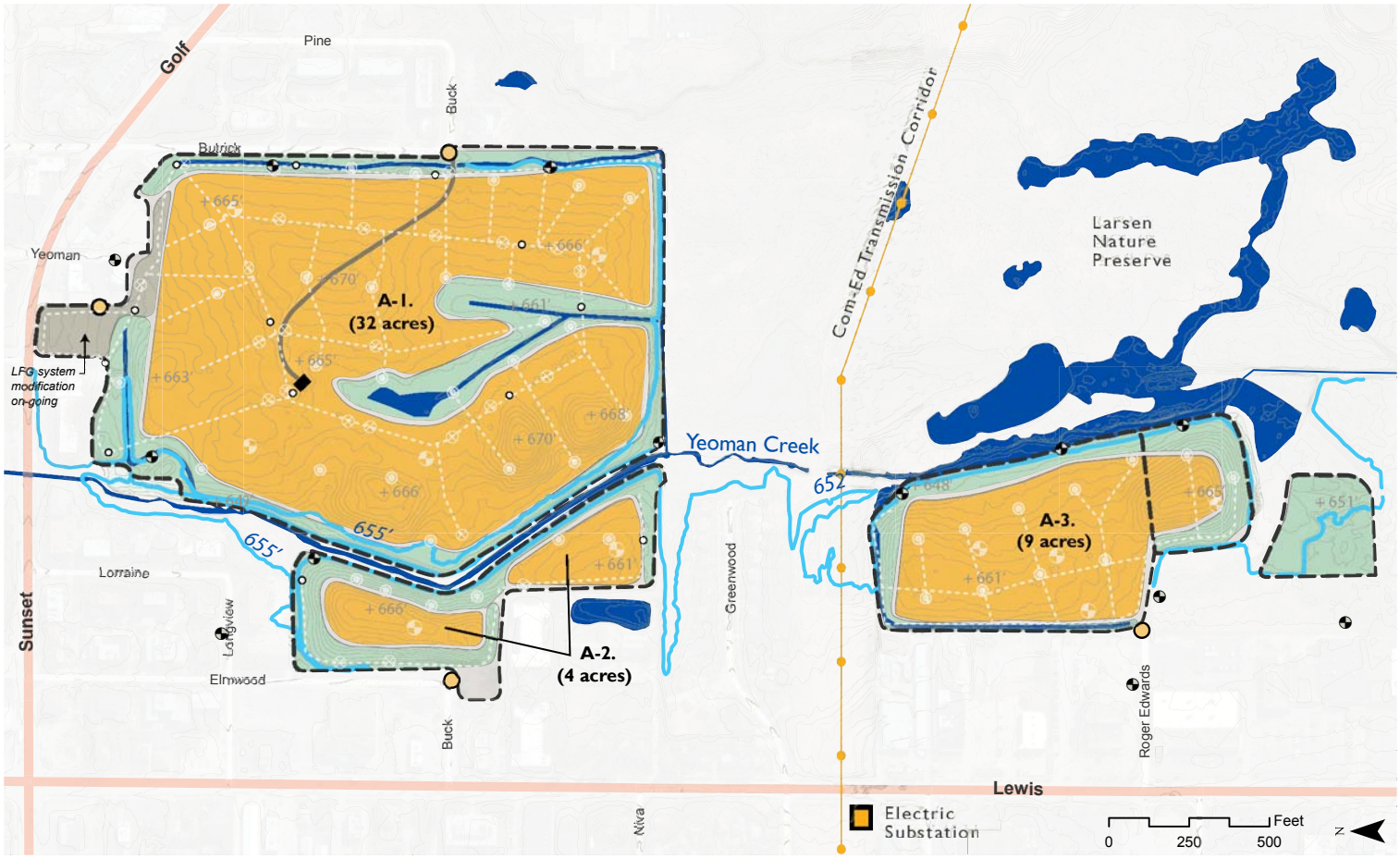
Note: This map is for planning purposes only; all boundaries and locations are approximate. 1-foot Contours based on LiDar elevation survey; provided by Lake County GIS (2007);

Interior portions of landfill units are generally flat with moderate slopes around perimeter

View of level area at Edwards Field (Landfill Unit 3) from North Rubloff (Landfill Unit 4)

SOLAR SUITABILITY

The solar reuse zones on Figure 7 identify several opportunities for solar development at the Yeoman Creek site. Areas suitable for solar reuse (A-1, A-2 and A-3) encompass approximately 45 non-contiguous acres. Areas with remedial or physical limitations cover approximately 23 acres that are not likely suitable for solar reuse.



Key

Solar Reuse Suitability

- **A** **Areas suitable for solar reuse** (45 acres)
  - Grades <10%
  - Above base flood elevation
  - Good access
  - Remedy, ICs, O&M considerations
- **B** **Remedial limitatations** (1.5 acres)
  - Remedy modification on-going
- **C** **Areas with physical limiations** (20.5 acres)
  - Grades >10%
  - Riparian areas, flood zones, drainage channels

+ 663′ Spot Elevations

655′ Base Flood Elevation Contour (100-yr Flood Zone)

Transmission Line

Electric Substation

Site Remedy Components

- Blower Building/Flare Station
- Control Valve
- Condensate Trap
- Passive Gas Vent
- Gas Collection System (subsurface lines/trenches 5-6' below groun surface)
- Leachate Monitoring Well
- Groundwater Monitoring Well
- Landfill Unit Boundaries
- Drainage Channels
- Site Access Road
- Gated Access Point
- Arterial Road
- Collector Street

Figure 7. Solar Suitability Zones Map

REMEDY COMPATIBILITY

Any future development will need to be consistent with the site's remedy and institutional controls to ensure the long-term protectiveness of the site's remedy. Table 1 provides an overview of remedy compatibility and solar reuse considerations that would need to be addressed in order to ensure protectiveness of the site's remedy. Development activities at the site should be consistent with remedial documents and done in coordination with EPA and YCRG.

Reuse Zone	Site Remedy Considerations
Zone A (45 acres) Areas suitable for solar PV development	• Maintain integrity of cap, landfill gas collection lines and extraction wells. • Maintain drainage features to manage stormwater runoff and prevent ponding or erosion of cap. • Ensure long-term access to above ground remedy components for operation & maintenance (O&M). • Consider ballasted anchoring system that uses above grade footings for solar PV arrays to protect existing cap and ensure compatibility with O&M requirements and institutional controls.
Zone B (1.5 acres) Areas with remedial limitations	• The on-going modification of the landfill gas collection system at Lovinger property may preclude solar reuse opportunities.
Zone C (20 acres) Areas with physical limitations	• The protective measures in place for erosion prevention (e.g., rip rap) would likely prevent solar reuse.

Table 1. Solar Reuse and Remedy Compatibility Considerations

A Solar PV project in place at the East Hampton Landfill in western Massachusetts is an example of a solar project designed for compatibility with an existing remedy. Solar PV arrays are mounted on ballasted foundations that rest on top of the landfill cover system (above left); the configuration of the site's solar PV network is designed to allow for access to existing remedy components, such as landfill gas collection wells (above right).

POTENTIAL SOLAR PV GENERATION AND COST CONSIDERATIONS

Based on remedy components, physical features and grades, approximately 45 acres at the site are potentially suitable for solar PV. Reuse Zones A-1 (YCL-East), A-2 (YCL-West) and A-3 (Edwards Field) highlighted in orange on Figure 7 are likely well-suited for solar PV development. A range of potential solar PV system size, generation and cost estimates corresponding to these zones are listed in Table 2 below. The estimated installed costs do not factor in potential incentives or solar PV system ownership and financing options but are intended to provide a baseline overview of the upfront capital costs associated with designing and building various sized systems that may be feasible at the site.

Reuse Zone	Available Acreage	Estimated Project Size	Estimated Output	Installed Costs
Zone A1 (YCL - East)	32	5 MW – 6 MW	5,850 MWh – 7,050 MWh	$17.5 M – $20 M
Zone A2 (YCL - West)	4	0.65 MW – 0.8 MW	725 MWh – 925 MWh	$2.3 M – $3.3 M
Zone A3 (Edwards Field)	9	1.5 MW – 1.7 MW	1,750 MWh – 1,950 MWh	$5.2 M – $7.5 M
Assumptions System Costs:$3.50 - $5.00/Watt installed O&M Costs: $10/kW/Year Area needed: 5-6 acres / MW MWh=1000 kilowatthours (kWh) Output estimates based on average crystalline silicon PV system Costs do not include potential incentives				

Table 2. Potential Solar PV System Size and Cost Estimates

INCENTIVES AND FINANCING OPPORTUNITIES

Identifying and leveraging applicable incentives and grants is an important part of making PV systems cost effective. Incentives are available at the state and federal level and include both policy-based incentives (e.g., renewable portfolio standards) and financial incentives (e.g., tax credits and rebates). A number of policies and incentives, such as those outlined below, could help facilitate the development of larger scale solar energy projects.

Renewable Portfolio Standard (RPS)

- Under the state's RPS, 25 percent of the state's power production must come from renewable resources by 2025. Renewable generation goals will be met with yearly phase-in targets out to 2025.
- In addition, the RPS contains a solar carve out - 1.5 percent of electricity must come from solar systems by 2025.

Solar Renewable Energy Credits

- The solar requirements of the state's RPS will be met through solar renewable energy credits (SREC). Each SREC represents the environmental attributes associated with 1 megawatt-hour of energy.
- SREC rates are negotiated with Commonwealth Edison (ComEd) based on their procurement processes.

Solar and Wind Energy Rebate Program

- Funded through the State's Renewable Energy Resources Program (RERP), the rebate is designed to encourage utilization of smaller-scale solar projects. Projects must be at least 1 kW in size.
- RERP offers a solar panel rebate of $2.50/Watt up to 30 percent of project costs, with a maximum incentive of $30,000 for governmental entities.

Community Solar and Wind Grant Program

- Offered by the Illinois Department of Commerce and Economic Opportunity (DCEO), this grant is designed to support the development of community scale solar projects. Solar systems must be new and have over $100,000 in totals costs to be eligible. Preference is given to projects that have an innovative design, technology or financing approach.
- DCEO offers a solar panel grant of $2.60/Watt up to 40 percent of project costs, with a maximum incentive of $250,000 for governmental entities.

Renewable Energy and Energy Efficiency Project Financing

- The Illinois Finance Authority (IFA) is an issuer of tax-exempt bonds and credit enhancement in Illinois.
- IFA is authorized to provide funding via issuance of tax-exempt bonds for renewable energy projects.
- Host entities must meet strict eligibility criteria and demonstrate that projects will provide a significant public benefit.

Net Metering

- Investor-owned utilities in Illinois are required to offer net metering under state law. In Illinois, an electricity provider may choose to allow meter aggregation for community-owned solar projects. Com-Ed does not currently allow for net meter aggregation.
- For systems up to 40 kW in size, net metering credits would be a one-to-one retail rate credit. For systems bigger than 40 kW up to 2 MW in size, net metering credits would be equal to the utility's avoided cost for excess generation.

The financial viability of a renewable energy project at the Yeoman Creek Landfill site will depend on the ability of the project to take advantage of as many of these funding opportunities as possible either directly as a project owner/developer or through partnerships or other financial arrangements reached with potential solar energy developers who are eligible for the incentives listed above.

OWNERSHIP AND PROJECT DEVELOPMENT OPTIONS

In addition to capital costs and available incentives, the type of solar PV project and arrangement between the land owner or host, project developer, investor and utility can have a significant impact on the financial viability of a project. Table 3 below outlines the benefits and limitations of three ownership options identified by the City of Waukegan and School District as the most desirable scenarios for municipal entity to host a solar project at the site.

Key Ownership and Financial Considerations

- ***Land Lease:*** A land lease approach would be expected to provide the least amount of financial risk to a public entity. A solar developer will be responsible for all aspects of project development, assume financial risk and claim project revenue. The value of the land lease will vary by developer and site, so having clear revenue goals under a land lease scenario will be important during project negotiation.
- ***Third-Party Power Purchase Agreement (PPA):*** A third-party ownership PPA may be the most viable way for a system to be financed and installed on a site. Private financing and ownership of a solar system can be a hedge against long-term electricity prices and will generally be economically viable if a project can be developed with a PPA price that is competitive with utility electricity rates (current rates; projected rate increases).
- ***Ownership Flip:*** A variation on the Third-Party PPA with an option to purchase may offer an opportunity for a public entity to acquire the system at a discount. The viability of an ownership flip approach will depend on the final negotiated "fair market value" of a system and whether the public entity will continue to be able to sell output from the system once it assumes ownership.

Solar PV Project Ownership Scenarios

Scenario	Overview	Benefits	Limitations
Land Lease	In a land lease scenario, a public entity selects a developer to design, finance, build, own, operate and maintain a system at a municipally owned site. The developer is responsible for all aspects of project development, assumes all risks, and claims most project revenue and owns project RECs. In exchange, the project developer/owner negotiates a land lease with the host municipality. The value of the land lease will vary by developer and project site. In some cases, a PPA may also be negotiated with the host, separate from the lease payment, or lease included as part of a PPA. Lease payments can be fixed ($X per acre or PV system size) or based on revenue generation from the system.	• A fixed lease payment approach can be a low-risk option – payment is generally made to the public entity regardless of whether a PV system operates or not. • Project developer is responsible for all aspects of financing, building and operating a system and assumes project risk. • No need to select equipment or work with vendors. • Project developer claims most (if not all) project revenue. • Bundling lease with a PPA can lower the price of electricity purchased by a public entity from a project.	• A revenue-based lease structure will fluctuate based on the amount of power actually generated by the system. • Ongoing site access required for system operation and maintenance. • Project developer or owner owns the RECs. • Lease payments generally made only once a power purchase agreement has been negotiated.

Table 3. PV Project Ownership Scenarios

Solar PV Project Ownership Options (continued)

Scenario	Overview	Benefits	Limitations
Third-Party Power Purchase Agreement (PPA)	A public entity (municipality) hosts and purchases power from a PV system but does not own it. The "third party" ownership model is a long-term contract that requires a separate, taxable entity (i.e., the investor / owner of the PV system) to finance and sometimes build and operate the system on a site owned by the host. The system owner is often a third-party investor who provides investment capital for the project in return for tax benefits. Developers are separate legal entities from investors. Developers will develop and operate solar projects using their experience and sources of tax equity financing and debt capital. Typically, the developer will sell electricity to the site host or the local utility via a long-term contract (a PPA).	• No/low up-front cost to public entity. • Public entity can avoid dealing with complex system design and permitting processes. • No PV system operation and maintenance responsibilities or costs. • Public entity can benefit by either receiving competitively priced electricity via a PPA or land lease revenues for making the site available to the solar developer via a lease payment: • Predetermined and predictable cost of electricity with a PPA.	• PPA negotiation can be lengthy and costly. • Limited control over project design and operation. • Legal expertise and contracting experience needed to ensure municipality's interests are well represented. • Ongoing site access required for system operation and maintenance. • Typically, project developer or investor owns the RECs. • Some PPAs require host to purchase the system at end of contract if PPA term is less than the useful life of the system.
Ownership Flip	A variation of the third party ownership model, where ownership of the PV system would "flip" to the developer (or a public entity) after the investor has fully monetized the tax benefits of a project (typically five or six years, but can be longer). This type of flip arrangement is typically negotiated up front and the terms of a flip included in a PPA. The public entity (host) would have the option to buy out all or most of the owner's interest in a project at the fair market value of the PV system. If an ownership transfer model is desirable, it should be considered during the Request for Information (RFI) development phase.	• Similar benefits to third party PPA in terms of pre-flip benefits. • A public entity could have the option to purchase the system and take full ownership after RECs and depreciation are realized by the investor. • Potential opportunity, upon owning the system, for the public entity to continue to sell electricity and/or RECs to a utility or replace electricity purchased from the grid.	• Similar limitations to third party PPA in terms of pre-flip challenges. • Model often implemented as a partnership-flip, where developer and lender create a partnership in the form of a special purpose entity (SPE) and then share pre-negotiated percentages of the income, incentives and depreciation of the system.

Table 3. PV Project Ownership Scenarios

RESOURCES

Region 5 Superfund Redevelopment
www.epa.gov/region5superfund/redevelop

Superfund Redevelopment Initiative
http://www.epa.gov/superfund/programs/recycle

Re-Powering America Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills
http://www.epa.gov/renewableenergyland/docs/best_practices_siting_solar_photovoltaic_final.pdf

Re-Powering America Renewable Energy Interactive Mapping Tool
http://epa.gov/renewableenergyland/mapping_tool.htm

Siting Clean and Renewable Energy on Contaminated Lands and Mining Sites
U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. September 2008.

Solar Energy Industries Association
http://www.seia.org

Database of State Incentives for Renewables & Efficiency (DSIRE)
http://www.dsireusa.org

DOE Solar Energy Technologies Program
http://www1.eere.energy.gov/solar

National Renewable Energy Lab (NREL) Solar Research
http://www.nrel.gov/solar

NREL Renewable Energy Resource Maps
http://www.nrel.gov/renewable_resources

NREL Solar Advisor Model
https://www.nrel.gov/analysis/sam

SOLAR REUSE CONSIDERATIONS

Solar Reuse Suitability

The site offers 45 acres suitable for direct use and utility-scale solar PV development. With suitable acreage divided among three landfill units, the site offers the flexibility to accommodate system sizes ranging from 0.65 MW to 6 MW.

Remedy Compatibility

Solar PV development is likely compatible with the existing remedy. PV arrays would need to be configured around remedy features, PV array installation using a ballasted anchoring system could ensure minimal disturbance of the cap surface. Modifications to certain institutional controls in the form of restrictive covenants at Edwards Field may be needed to allow for solar PV development.

Phasing

Solar PV arrays could be installed in phases at the site. 9 acres at Edwards Field can accommodate a 1.5 to 2 MW solar project. Located in close proximity to an existing substation with few physical and remedial constraints, this area is likely well-suited for an initial phase of solar development. 32 acres at YCL-East could support a 5-6 MW project in a later phase. A phased approach would offer the opportunity to test remedy compatibility at a small scale.

Ownership and Development Options

The City and School District are evaluating a range of potential ownership options for a solar project including: 1) Direct Ownership, 2) Land lease, and 3) Third-party PPA. The land lease option presents the least financial risk to the School District and City of Waukegan.

Engaging Renewable Energy Developers

As an initial step, the City of Waukegan and School District could issue a Request for Information (RFI) to determine whether sufficient renewable energy developer interest exists to support the desired range of project development scenarios under consideration.

ACKNOWLEDGMENTS

The following organizations and entities contributed to the findings of the Yeoman Creek Solar Reuse Assessment:

- Yeoman Creek Remediation Group
- Waukegan School District
- City of Waukegan
- EPA Region 5

Reuse assessment prepared by Skeo Solutions

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