APPENDICES

Central
Lake Ontario
Conservation

APPENDIX A: RESTORATION GOALS, OBJECTIVES, AND OPPORTUNITIES CHART

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK *(level of uncertainty)*	COST	BENEFIT *(potential that opportunity will help achieve objective)*
Improve Water Quality (WQ) in the marsh	Reduce salt levels in the marsh by addressing parking lot management in the watershed	CCME[a] long-term guideline of 120 mg/L	1-5	High	Review/develop best management practices for parking lot management (e.g. snow removal, salt use, employee communication)	• Will have positive WQ effects • Will help improve wildlife habitat and vegetation quality • Easy to confirm success/failure through monitoring • Opportunity to highlight corporate environmental stewardship	• May be liability constraints • May require a contract re-negotiation	Low	Low	High
	Reduce nutrient and sediment levels entering into the marsh by addressing stormwater management in the watershed	CCME[a] guidelines	1-5	High	Education and outreach to upstream residents and farmers	• Achievable • Raises awareness and may reduce phosphorus/nitrogen inputs	• Requires some money and staff /volunteer time to complete	Low	Moderate	High
					Test residential stormwater pond function and dredge if necessary	• Achievable • Will have positive WQ effects • Will help improve wildlife habitat and vegetation quality • Easy to confirm success/failure through monitoring	• Cost to City of Oshawa • Requires MOE permit	Moderate	Moderate/ High	Moderate
					Test GM/Minacs stormwater pond function and dredge if necessary	• Achievable • Will have positive WQ effects • Will help improve wildlife habitat and vegetation quality • Easy to confirm success/failure through monitoring	• Cost to GM • Requires MOE permit	Moderate	Moderate/ High	Moderate
					Review/develop best management practices for groundskeeping (e.g. fertilizing, weed control)	• May have positive WQ effects • May help improve wildlife habitat and vegetation quality • Easy to confirm success/failure through monitoring • Opportunity to highlight corporate environmental stewardship	• May require a contract re-negotiation	Low	Low	Moderate
	Reduce turbidity in the marsh by addressing impacts of carp and sediment re-suspension from wave action	Reduced turbidity values	1-5	High	Full marsh drawdown (no control structure)	• Full drawdown would temporarily eliminate carp and improve vegetation survival • Full drawdown could consolidate sediments and reduce re-suspension from wave action • Temporary removal of all turbid water	• All water would need to be pumped (very expensive) • Barrier beach may break due to Lake Ontario pressure, compromising drawdown • Permits required • Potential for vandalism	High	High	High
					Full marsh drawdown (control structure)	• *Same as above* • Control structure would enable passive drawdown (partial) and save costs on pumping remainder of water out • Control structure can be opened as needed to "flush" water from the marsh • Carp would be unable to re-enter marsh	• *Same as above except bullet #1* • Additional cost to installing control structure • Dynamic beach may shorten lifespan of structure • Potential impact to barrier beach plant community • Passive drawdown needs to be timed with low Lake Ontario levels	High	High	High
					Partial marsh drawdown (no control structure)	• Temporary removal of some turbid water (flush) • Lower risk of barrier beach breaking • Lower cost to remove only part of the water • Some sediment consolidation will occur, which will improve problem of re-suspension	• All water would need to be pumped • Carp would not be eliminated (survive in remaining water), which will impact new vegetation survival • Sediments would only be consolidated where exposed, so some re-suspension will still occur • Permits required	Moderate	High	Moderate

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK *(level of uncertainty)*	COST	BENEFIT *(potential that opportunity will help achieve objective)*
							• Potential for vandalism			
					Partial marsh drawdown (control structure)	• *Same as above* • Control structure would enable partial passive drawdown and save costs on pumping remainder of water out (and may eliminate pumping depending on water levels) • Control structure can be opened as needed to "flush" water from the marsh • Carp would be unable to re-enter marsh • Can be operated with fewer staff resources	• *Same as above* • Additional cost to installing control structure • Dynamic beach may shorten lifespan of structure • Potential impact to barrier beach plant community • Passive drawdown needs to be timed with low Lake Ontario levels	Moderate	High	Moderate
					Manual opening of the barrier beach (annually or periodically)	• Allows mixing of marsh and lake water to temporarily reduce turbidity • Some vegetation growth may occur	• Access to machinery needed • Does not address carp • Does not address sediment re-suspension from wave action	Low	Low	Low
					Creation of cells within the marsh	• Isolates sections of the marsh that can be drained or flooded as needed without impacting the entire marsh • Carp can be excluded from cells • Wave action will be reduced • Lower risk than full marsh drawdown • Little impact to user groups (depending on location)	• Improves water quality in cells, but not necessarily in entire marsh • Invasive technique requiring creation of berms in the marsh • Permits required • May be prone to vandalism	Low	High	Moderate
					Construction of islands in the marsh	• Strategically placed islands could break waves and reduce sediment re-suspension	• Does not address carp • May have negative wildlife associations (e.g. cormorant loafing) • Invasive technique requiring heavy machinery in marsh • Unknown how effective they may be • Permits required	High	High	Low
					Installation of submerged wave breaks	• Achievable	• Does not address carp • Unknown how effective they may be an reducing sediment re-suspension • May impact canoeing	Moderate	Low	Low
	Reduce marsh temperature	**TBD**	6-10	Moderate	Manual opening of the barrier beach (annually or periodically)	• Allows mixing of marsh and lake water to temporarily help moderate temperature	• Access to machinery needed	Low	Low	Moderate
					Full or partial marsh drawdown	• Removal of warm water currently in marsh	• Temporary	Moderate	High	Moderate
					Active tree planting along creek corridors	• Shade will moderate water temperatures coming into the marsh • Results will be observed more quickly	• Some cost to purchase trees • Staff/volunteer time required • May not be achievable along all creeks	Low	Low	Moderate
					Passive naturalization of creek corridors	• No materials cost • No staff/volunteer time required	• Results will not be observed for very long time (if ever)	Low	Low	Low

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK (*level of uncertainty*)	COST	BENEFIT *(potential that opportunity will help achieve objective)*
Improve vegetation quality and diversity in the marsh	Increase the amount and diversity of native emergent vegetation in the marsh	**TBD** % wetland cover in emergent vegetation	1-5	High	Improve slope along west and east shorelines, and actively plant vegetation	• Restore shoreline to natural state • Decrease erosion within the wetland and provide stable slope for vegetation growth • Increased plant habitat diversity (water depths) • Will facilitate plant migration along slope with water level changes • Increased emergent vegetation will help improve WQ over time by consolidating sediments (reduced turbidity)	• Unattractive in the short-term (1 year) • Permits required • Plantings need to be protected from carp and geese with fencing until established	Low	High	High
					Full marsh drawdown	• Expose seedbank in entire marsh to stimulate vegetation growth • Effective means of determining what areas of marsh will vegetate on their own • Full drawdown would temporarily eliminate carp and improve emergent vegetation survival (reduced root disturbance) • Increased emergent vegetation will help improve WQ over time by trapping sediments (reduce turbidity)	• More expensive than partial drawdown (more water to pump out) • Potential to increase costs if drawdown done in a drought year (need to pump some water back in) • Barrier beach may break due to Lake Ontario pressure, compromising drawdown • May not get expected vegetation in some areas • May see increase in invasive species • Permits required	High	High	High
					Partial marsh drawdown	• Expose seedbank in part of the marsh to stimulate vegetation growth • Lower risk of barrier beach breaking • Lower cost to remove only part of the water • Increased emergent vegetation will help improve WQ over time by trapping sediments (reduce turbidity)	• Carp would not be eliminated (survive in remaining water), which will impact new vegetation survival (uprooting) • Permits required • May not get expected vegetation growth in some areas • May see increase in invasive species	Moderate	High	High
					Manual opening of the barrier beach (annually or periodically)	• Some vegetation growth may occur • Allows mixing of marsh and lake water to temporarily reduce turbidity (supports vegetation growth)	• Access to machinery needed • Cannot control volume of water that will exit or enter the marsh • Cannot predict when beach will close • Water level may not reach desired target • Seedbank will not be exposed long enough in some areas to stimulate vegetation growth	Low	Low	Low
					Creation of cells within the marsh	• Isolated sections of the marsh can be drained or flooded as needed to stimulate vegetation growth without impacting the entire marsh • Carp can be excluded (increased emergent vegetation survival) • Lower risk than full marsh drawdown • Little impact to user groups (dep. on location) • Vegetation in cells acts as seed source for marsh • Smaller area, so easier to manage vegetation	• Improves vegetation quality and diversity in cells, but not necessarily in entire marsh • Invasive technique requiring creation of berms in the marsh • Permits required • May be prone to vandalism	Moderate	High	High
					Active planting	• Introduces vegetation to areas with no existing seedbank • Potential to increase plant diversity • Opportunity to engage public (volunteer planting) • Increased emergent vegetation will help improve WQ over time by trapping sediments (reduced turbidity)	• Resource intensive (staff/volunteers) • Generally low success rate due to uprooting from carp or turbidity • Need to fence off planted areas to prevent uprooting and consumption from other wildlife (difficult to do)	High	Moderate	Low

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK *(level of uncertainty)*	COST	BENEFIT *(potential that opportunity will help achieve objective)*
	Increase the amount of submerged aquatic vegetation (SAV) in the marsh by reducing turbidity	Improved SAV IBI	1-5	High	Full marsh drawdown	• Expose seedbank in entire marsh to stimulate vegetation growth • Effective means of determining what areas of marsh will vegetate on their own • Full drawdown would temporarily eliminate carp and improve SAV survival (reduced root disturbance and lower turbidity) • Full drawdown would remove turbid water • Full drawdown would consolidate sediments and reduce re-suspension from wave action, thereby improving SAV survival (lower turbidity) • Increased SAV will help improve WQ	• More expensive than partial drawdown (more water to pump out) • Potential to increase costs if drawdown done in a drought year (need to pump some water back in) • Barrier beach may break due to Lake Ontario pressure, compromising drawdown • May not get expected vegetation growth in some areas • SAV growth will not be sustained unless turbidity issues are dealt with • Permits required • May see increase in invasive species	High	High	High
					Partial marsh drawdown	• Expose seedbank in part of the marsh to stimulate vegetation growth • Lower risk of barrier beach breaking • Lower cost to remove only part of the water • Temporary removal of some turbid water (flush) may improve SAV growing conditions • Some sediment consolidation will occur, which will improve problem of re-suspension • Increased SAV will help improve WQ	• Carp would not be eliminated (survive in remaining water), which will impact new SAV survival (uprooting and increased turbidity) • Permits required • May not get expected vegetation in some areas • Sediments consolidated only where exposed, so re-suspension will occur • May see increase in invasive species	Moderate	High	High
					Manual opening of the barrier beach (annually or periodically)	• Some SAV growth may occur • Allows mixing of marsh and lake water to temporarily reduce turbidity (supports SAV growth)	• Access to machinery needed • Cannot control volume of water that will exit or enter the marsh • Cannot predict when beach will close • Water level may not reach target • Seedbank will not be exposed long enough in some areas to stimulate SAV growth	Low	Low	Low
					Creation of cells within the marsh	• Isolated sections of the marsh can be drained or flooded as needed to stimulate SAV growth without impacting the entire marsh • Carp can be excluded (increased SAV survival) • Wave action will be reduced so turbidity will be lower (increased SAV survival) • Lower risk than full marsh drawdown • Little impact to user groups (dep. on location) • Vegetation in cells acts as seed source for marsh • Smaller area, so easier to manage vegetation	• Improves vegetation quality and diversity in cells, but not necessarily in entire marsh • Invasive technique requiring creation of berms in the marsh • Permits required • May be prone to vandalism	Moderate	High	High
					Active planting	• Introduces vegetation to areas with no existing seedbank • Potential to increase plant diversity • Opportunity to engage public (volunteer plantings) • Increased SAV will help improve WQ	• Resource intensive (staff/volunteers) • Generally low success due to uprooting from carp • Need to fence off planted areas to prevent uprooting and consumption from other wildlife (difficult to do)	High	Moderate	Low
	Reduce impact of invasive plant species in the marsh through active management	Decrease in current invasive plant populations	11-15	Moderate	Active removal in affected areas	• Engage public and raise awareness about invasives • Reduces competition for resources for native wetland species • Improve wildlife habitat	• Time intensive • May require use of herbicides • Removal techniques not always effective and will require continued effort	Moderate	Moderate	Moderate

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK *(level of uncertainty)*	COST	BENEFIT *(potential that opportunity will help achieve objective)*
Improve wildlife habitat in the marsh	Improve habitat for SAR via overall improvement and/or specific actions targeted at SAR	Observe an increase in abundance of SAR in wetland	6-10	Moderate	*Restoration opportunities that may positively impact SAR in the marsh have been highlighted with an asterisk (*)*					
	Increase fish spawning habitat by restoring marsh shorelines	Improved fish IBI	1-5	High	Improve slope, vegetation, and add structure along west and east shorelines	• Restore shoreline to natural state • Decrease erosion within the wetland • Potential for materials to be donated (no cost) • Consistent with CLOCA FMP recommendation to "restore degraded in-stream habitat to enhance productivity of fishery and fish habitat"	• Unattractive in the short-term (1 year) • Permits required • Active planting required	Low	High	High
					Create backwater lagoons along shoreline	• Increase in spawning habitat diversity • Can be done in conjunction with shoreline restoration activities to reduce disturbance	• *Same as above* • Additional cost to include in shoreline restoration action	Low	High	High
	Increase amount of veg in the marsh for reptiles, amphibians, fish, birds, and invertebrates	Improved fish, bird, amphibian, and macro-invertebrate IBIs	1-5	High	See *Improve vegetation quality and diversity in the marsh* for specific restoration opportunities	• Emergent and submergent vegetation provide cover/protection, feeding grounds, and nesting habitat for all wildlife • Helps improve WQ, which in turn improves habitat for wildlife.	• Depending on method – vegetation type achieved may be unwanted (invasives, i.e. phragmites)	Low	Low-High (depending on restoration opportunity)	High
	Improve water quality for amphibians, reptiles, fish, birds, and inverts	Water Quality Index (WQI)	1-5	High	See *Improve water quality in the marsh* for specific restoration options	• Reduced toxicity to wildlife • Improved growing conditions, thereby providing habitat and food to support wildlife • Improved feeding conditions (clarity)	•	Low	Low-High (depending on restoration opportunity)	High
	Provide nesting habitat for birds	3 nesting structures installed	6-10	Low	Build and install osprey platform(s)	• Increase nesting bird diversity in marsh • Eat carp	• Existing platform on GM property • May not be compatible with tern rafts • May not attract osprey (go unused)	Moderate	Moderate	Low
					Build and install tern nesting raft(s)	• Known to be successful at attracting terns • Relatively inexpensive	• Will need replacement (5-10 years) • May attract predators (e.g. mink) • Would require signage for boaters	Low	Low	Moderate
	Improve underwater cover for fish by installing root wads, boulders, and/or crib structures throughout marsh	**TBD**	1-5	High	Construct and install fish cribs	• Inexpensive • Simple to construct • Consistent with CLOCA FMP recommendation to "restore degraded in-stream habitat to enhance productivity of fishery and fish habitat"	• Must be done on ice in winter (some risk) • Could interfere with canoeing activities depending on location	Low	Low	Moderate
					Deposit root wads, logs, and boulders throughout marsh	• Potential for materials to be donated (no cost) • Consistent with CLOCA FMP recommendation to "restore degraded in-stream habitat to enhance productivity of fishery and fish habitat"	• Could interfere with canoeing activities depending on location	Low	Low	Moderate
	Improve turtle habitat	Observe increase in turtle abundance in the marsh	6-10	Low	Construct nesting habitat*	• Increase number of nesting options for turtles • Opportunity to engage park users (monitor site and install nest protection structures) • Will benefit Blanding's turtle (SAR)	• Shoreline may provide sufficient nesting habitat already • Ongoing maintenance required to remove vegetation growth	Low	Low	Low
					Install basking logs*	• Can be done in conjunction with shoreline restoration • Will benefit Blanding's turtle (SAR)	•	Low	Low	Moderate
	Improve woodland frog habitat	Improved amphibian IBI	6-10	Moderate	Create backwater lagoons along shoreline	• Specialized habitat for woodland amphibians • Increase in habitat diversity within wetland • Can be done in conjunction with shoreline restoration activities	• Additional cost to include in shoreline restoration action	Moderate	High	Moderate
					Create vernal pools within existing upland forests/swamps	• Specialized habitat for woodland amphibians • Increase in habitat diversity within wetland	• Disturbance to existing habitat • May promote spread of invasive species	Low	Moderate	Moderate

GOAL	OBJECTIVE	TARGET	TIMEFRAME TO BEGIN ACTION *(years)*	PRIORITY	RESTORATION OPPORTUNITIES	PROS	CONS	RISK *(level of uncertainty)*	COST	BENEFIT *(potential that opportunity will help achieve objective)*
Improve recreation opportunities in the marsh	Increase vegetation and improve habitat for wildlife to improve hunting, fishing, canoeing, and nature appreciation activities	Increase in user satisfaction (survey) and/or user rates for each activity	1-5	High	See *Improve vegetation quality and diversity in the marsh* and *Improve wildlife habitat in the marsh* for specific restoration opportunities	• Increased vegetation will support a wider diversity of wildlife species, which will enhance the canoeing and nature appreciation experiences • Increased vegetation and improved fish habitat will positively impact the fishing experience in the marsh • Improved habitat will attract waterfowl, which will enhance the hunting experience • Improved habitat will draw more visitors to the park which may result in increased revenue generation • Osprey and tern nesting platforms will attract birders to marsh • Increased opportunity to raise awareness about wetlands and wildlife for urban visitors	• Drawdown to stimulate vegetation growth will temporarily impact canoeing and fishing opportunities (1 spring/summer), and will result in loss of revenue for that year • Constructed wildlife habitats may act as obstacles to boaters in some locations of the marsh and signage may be required • Some open water in shallow areas of the marsh (around edges) will be lost due to vegetation growth, which may impact canoeing activities, but will not eliminate them • Increased cost to pump water back into marsh in the fall to accommodate fall waterfowl hunt	Low	Low-High (depending on restoration opportunity)	High
	Improve water quality for improved fishing and canoeing experience	Increase in user satisfaction (survey) and/or user rates for each activity	1-5	High	See *Improve water quality in the marsh* specific restoration opportunities	• Clearer water will be more aesthetically pleasing to all marsh user groups • Reduced turbidity will improve fish habitat quality and result in healthier fish populations (better for consumption – **pending MOE test results**) • Improved water quality poses a lower health risk to users of the marsh (**pending Durham Health**) • Better water quality will support vegetation and wildlife, which in turn attracts marsh visitors	• Drawdown will temporarily impact canoeing and fishing opportunities (1 spring/summer), and will result in loss of revenue for that year	Low	Low-High (depending on restoration opportunity)	High
	Improve fishing access and enhance nature appreciation	Increase in user satisfaction (survey) and/or user rates for each activity	6-10	Moderate	Install fishing groynes	• Directs users to specific locations for fishing and nature appreciation, which reduces impacts of ad hoc trail creation (e.g. soil compaction, increased bank erosion, wildlife disturbance) • Provides opportunities for educational signage with maximum exposure • Improves fishing experience by providing access to a wider diversity of fish habitats • Consistent with CLOCA FMP recommendation to "restore degraded in-stream habitat to enhance productivity of fishery and fish habitat" • Can be constructed in conjunction with shoreline restoration works (less disturbance)	• May not be used by some fishermen if they have other preferred locations	Low	Moderate	High
					Construct boardwalk* (likely on east side at existing boat launch area)	• May attract visitors to the park • Provides access to the shoreline while minimizing disturbance to shoreline habitat • Can be used as fishing platform • Boardwalk may provide nesting structure for Barn Swallows (SAR) • Provides opportunities for educational signage with maximum exposure • Acts as additional cover for fish	• Potential for vandalism • Maintenance over time will be required (depending on design)	Low	High	High
					Install viewing platform(s)	• Enables birders and other users to see farther into the marsh • Provides opportunity for educational signage and/or nature talks • Attracts birders to the marsh	• Potential for vandalism (depending on design)	Low	Moderate	High

APPENDIX B: SAMPLE COST ANALYSIS FOR A McLAUGHLIN BAY DRAWDOWN

UNDERTAKING A COST ANALYSIS

Pumping water from a large body of water, such as McLaughlin Bay, is expensive and time consuming. As is outlined in section 2.1, there are many factors to consider, and an accurate cost analysis for a partial drawdown, without professional advice, is difficult to undertake, and is beyond the scope of this report. However, cost is a driving factor in choosing which pumping option to implement, so it is important to try to gain some insight into the relative costs.

This appendix contains a sample analysis for a 1 m partial drawdown of McLaughlin Bay. A 6-inch diameter pump has been used in the analysis for all of the options to make comparing them easier, but it must be recognized there are many pumps that can be considered, including larger-sized diameter pumps, which would increase the water removal rate. This analysis does not account for those variables as information on purchase prices, power supply, rental costs, etc., are difficult to obtain. Appendix D contains the spec sheets for a Gormann – Rupp portable diesel pump, and those specifications have been applied to the analysis.

DRAWDOWN VOLUME

The first variable that can be fairly accurately estimated is the volume of water that needs to be removed. This can be done because the bathymetry of the Bay has been modeled, and water levels have been documented at the wetland since 2004. Because a drawdown will occur in the spring, the average water level in the Bay for the month of May over the past 8 years was used, which is 75.5 m IGLD. It is also known that the average water level difference between Lake Ontario and McLaughlin Bay over that time period is +60 cm in McLaughlin Bay; therefore, water levels can be passively drawn down to 74.9 m IGLD if a control structure were to be installed. Finally, a 1 m drawdown has been recommended to expose the wetland substrates typically under 0 – 1 m of water, so the elevation to draw water levels down to is 74.5 m IGLD.

Using the wetland bathymetry data, the volume of water contained within the basin can be calculated using ArcGIS. The volumes are listed in the table below.

WATER LEVEL (m)	WETLAND VOLUME (USG)	DRAWDOWN VOLUME (USG)
75.5	160,741,529	0
74.9	95,477,308	65,264,221
74.5	58,128,648	102,612,881

DRAWDOWN TIMING

Using these volumes, additional calculations can be done to estimate the time that it will take to drawdown water levels. The first scenario calculates the drawdown time if a stop log control structure was installed, i.e. some passive water removal would occur, and the second calculates the timing as if no control structure was present. Note that the drawdown time assumes a flow rate of 1510 USG/min as stated in the spec sheet in Appendix D, and that the time in days assumes that the pump would run 24 hours a day.

WATER LEVEL (m)	DRAWDOWN VOLUME (USG)	DRAWDOWN TIME (HOURS)	DRAWDOWN TIME (DAYS)
74.9 – 74.5	37,348,661	412	17
75.5 – 74.5	102,612,881	1133	47

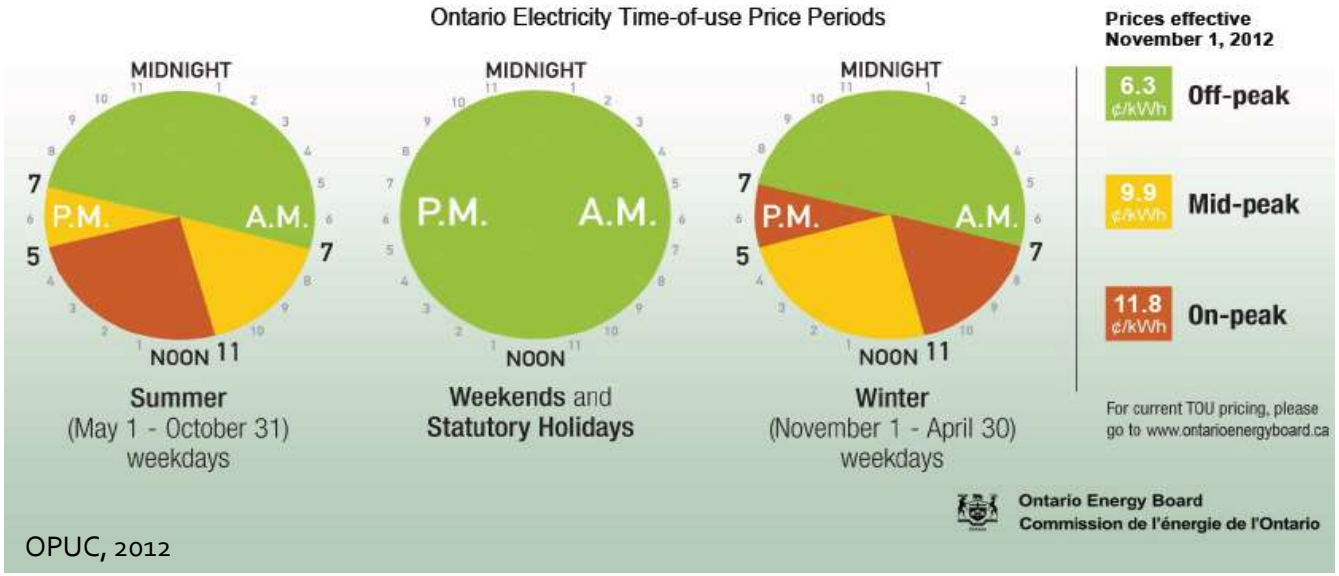
The intended drawdown completion date is no later than the first week of June, so in the first scenario, a drawdown could be initiated anytime in May; in the second scenario pumping would have to begin by the first or second week of April. Because a control structure has not been recommended as an option for McLaughlin Bay (see section 4), the second timeline is the most accurate. As April is typically a wet month, which may lead to a higher than expected volume of water to remove, it is probably prudent to investigate alternative pump sizes to shorten the drawdown window. Alternative pumps have not been considered in this analysis, but one option may be to conduct the cost assessment using 2 pumps.

ESTIMATING COSTS

Some costs can be estimated, such as operating costs and human resource needs, while others, such as the cost to install an electric pump, cannot, at least not without professional guidance. Consequently, the potential for error in the following tables ranges from moderate to high, and the assessment presented below should be viewed as an example rather than a true account of the cost of implementing one pump option over another.

Predicting fuel costs, in this case electricity and diesel, is fairly straightforward, though they are also extremely variable over time. The average time-of-use rates as posted by the Oshawa Public Utilities Commission (OPUC) for November 2012 is ¢8/kWh, and has been used in this cost assessment as it is expected that a pump would run 24 hours a day, 7 days a week during a drawdown. The diesel price used in the following tables is based on the average diesel price in Toronto East for 2012 from the Ontario Ministry of Energy website (http://www.energy.gov.on.ca/en/fuel-prices/fuel-price-data/?fuel=dsl&yr=2012). It lists the average price at $1.243/L, which is equal to $4.70/USG.

Additional pump-specific information is needed to evaluate operating costs, including the voltage and current of the electric pump, which are required to determine kW, as well as the fuel tank volume and run-time per tank to determine fuel consumption rates. For the electric pump, these parameters were estimated with the assistance of an electrician, and for the diesel pump, the



OPUC, 2012

specifications from the Gormann – Rupp portable pump in Appendix D were used. The results of the fuel assessment are shown in the table below.

As with the previous table, the costs of drawing down water levels with a control structure and without a control structure have been included for comparison.

WATER LEVEL (m)	DRAWDOWN VOLUME (USG)	DRAWDOWN TIME (hours)	ELECTRIC PUMP			DIESEL PUMP	
			kW[1]	¢/kWh	COST	CONSUMPTION ($/hr)[2]	COST
74.9 – 74.5	37,348,661	412	10	8	**$320**	12.80	**$5,277**
75.5 – 74.5	102,612,881	1133	10	8	**$898**	12.80	**$14,498**

From this chart, it is clear that the current cost of diesel fuel is significantly higher than the current cost of electricity, and that it is financially advantageous to install an electric pump in terms of operating costs.

The human resource costs between the electric and diesel pumps are also noteworthy. It unknown exactly how many times an electric pump installed at McLaughlin Bay would need to be visited: it is probably realistic to assume that a check to ensure that everything is running properly would be conducted every 2-3 days. The diesel pump highlighted in Appendix D has a tank capacity of 88 USG, and an estimated run-time of 32.3 hours, so it is expected that the pump would need to be visited for refueling every day, including weekends. Added to that is the time required to drive to the gas station, add fuel to a fuel transfer tank, drive to the pump site, transfer the fuel, and return home. Conservatively, it costs $1,400, including mileage, for 1 person to operate an electric pump, assuming it takes an hour to complete each visit and the site is visited twice a week. By comparison, it costs over $6,000 for 1 person to operate a diesel pump (assuming it takes 2 hours to complete a daily visit).

One factor that does factor significantly into the cost of an electric pump is connecting electricity to the desired pump site. As discussed in section 4.1, there are two locations at McLaughlin Bay where a pump would most likely be installed: at the southwest and southeast corners. The estimated distance of running wire from the north is 1 km, whereas the distance from the east is somewhere between 200 and 500 m. Among other things, as travel distance increases, the gauge of wire needed becomes higher, in turn increasing the expense of the wire. Online voltage drop calculators, such as the one featured at www.southwire.com, are useful tools for estimating wiring needs and costs.

Additional factors that influence the cost of installing electricity, but which cannot be adequately determined in this report, include:

- Whether wire can be buried directly, or if hydro poles need to be erected. The latter is much more expensive.
- What phase of power is required and whether additional elements, such as a transformer, will need to be installed.
- What sort of panel is required at the pump site.
- The cost of installation, i.e., hiring an electrician. These costs may or may not include Hydro One's layout approval fee, which is around $1,500.

[1] Assumed specs of 230 V and 50 A
[2] 88 USG gas tank and 32.3 hour run-time (Gorman-Rupp Company spec sheet)

COMPARING THE OPTIONS

It is clear from the previous discussion, that there are financial benefits and drawbacks for both electric and diesel pumps. The following table endeavours to clarify the merits of each option.

For diesel pumps, there is also the question of whether it makes sense to purchase a pump or rent it. 2012 quotes from Battlefield Equipment Rentals show that renting a portable diesel pump costs $334/day, $1,200/week, and $2,040/month. Given the drawdown timeframe of 6.7 weeks, a 2 month rental would be the least expensive option. Overall, the cost of renting a portable pump (as shown in Appendix D), is around $4,600. An additional $1,200 (1 week) was added to the price to account for the potential need to rent a pump in the fall in order to pump water back into the marsh if water levels are too low for the fall waterfowl hunt to occur. To purchase the same pump and trailer totals almost $50,000. In

		WITHOUT A CONTROL STRUCTURE			WITH A CONTROL STRUCTURE		
		ELECTRIC PUMP	DIESEL PUMP (BUY)	DIESEL PUMP (RENT)	ELECTRIC PUMP	DIESEL PUMP (BUY)	DIESEL PUMP (RENT)
DRAWDOWN	Level passively removed (m)	0	0	0	75.5 – 74.9	75.5 – 74.9	75.5 – 74.9
	Volume passively removed (USG)	0	0	0	65,264,221	65,264,221	65,264,221
	Level pumped out (m)	75.5 – 74.5	75.5 – 74.5	75.5 – 74.5	74.9 – 74.5	74.9 – 74.5	74.9 – 74.5
	Volume pumped out (USG)	**102,612,881**	**102,612,881**	**102,612,881**	**37,348,661**	**37,348,661**	**37,348,661**
CAPITAL COSTS	Stop Log Control Structure ($)	0	0	0	150,000	150,000	150,000
	Pump/Installation ($)	100,000	49,756	0	100,000	49,756	0
	Fuel Transfer Tank ($)	0	1400	1400	0	1400	1400
VARIABLE COSTS	Rental Fee ($)	0	0	5,966	0	0	5,966
	Hydro ($)	898	0	0	320	0	0
	Fuel ($)	0	14,498	14,498	0	5,277	5,277
	Human Resource ($)	674	4,719	4,719	245	1,717	1,717
	Mileage ($)	750	1,500	1,500	273	546	546
	TOTAL	$102,322	$71,874	$28,085	$250,838	$208,697	$164,907
COST PER US GALLON	Cost (¢/USG) for 1st drawdown	0.099	0.070	0.027	0.672	0.558	0.442
	Cost (¢/USG) for subsequent drawdowns	0.0023	0.020	0.026	0.0022	0.020	0.036
	Average cost per drawdown (¢/USG) after 3 drawdowns	**0.0133**	**0.0163**	**0.0132**	**0.0848**	**0.0774**	**0.0688**
	RANK	2	3	1	6	5	4

either case, a fuel transfer tank would also need to be purchased and installed in a pickup truck in order to enable the pump to be refueled daily. A 100 gallon tank costs approximately $800, and accessories, such as a fuel transfer pump, cost close to $500 (see Appendix E).

As has been already stated, only one pump size has been priced out, so the purchase costs presented will be different for larger-sized pumps, and this may or may not affect the per gallon cost of each drawdown. Similarly, the cost of the electric pump is estimated at $100,000, which is based on the price of installing an electric pump at Oshawa Second Marsh. At best, this is a guess, as no information is available about the feasibility of connecting the pump site(s) to their nearest respective outlets.

The table also compares the costs of each option with and without a control structure so that its value can be quantified.

Disregarding the potential inaccuracies, when all of the variables are considered, it is clear that the least expensive option, both initially (¢0.027/USG) and after 3 drawdowns (¢0.0132), is renting a portable diesel pump, but not by much. If the assumed cost of installing an electric pump is accurate, which is unknown at this time, then the cost of pumping water out over 3 drawdowns is comparable at ¢0.0133/USG. This is due entirely to the difference in price for electricity versus diesel. Of course, it cannot be estimated what the relative costs of fuel will be in 30 years, nor is it known what the pump rental rates will be in the future, so these costs over time could be wrong, but assuming that these variables stay constant for the next few decades, installing an electric pump and renting a diesel pump are virtually the same price.

In all scenarios, purchasing a diesel pump is not a good financial decision. It is also clear from the table that for McLaughlin Bay, adding a control structure is not financially advantageous, even over 30 years, as the per gallon cost of pumping water is significantly higher.

While this analysis is useful, and reinforces the recommendation in the report to conduct the first drawdown with a temporary portable pump, it is an example only, as there are numerous other options that may be added to this analysis, and which may change the outcome. Furthermore, such an analysis should be undertaken as close to the desired drawdown year as possible, because many of the variables are prone to changing, e.g., fuel prices, and may not relevant if done too far in advance.

APPENDIX C: SAMPLE INSTRUCTIONS FOR CONSTRUCTING WILDLIFE HABITAT

BUILDING NESTING PLATFORMS FOR OSPREYS (MINISTRY OF NATURAL RESOURCES, 1999)

EXTENSION NOTES

Ontario

BUILDING NESTING PLATFORMS FOR OSPREYS

Although they were once scarce in Ontario, ospreys have made a striking comeback in recent years. Thanks to concerned people working together to build and install special nesting platforms, these large brown and white fish hawks are now a familiar sight along many waterways.

This Extension Note provides information on how to construct and install two types of nesting structures — the single-poled platform and the quadropod platform.

THE OSPREY STORY

Ospreys are found across Canada and in most parts of the world. In Ontario, they nest in regions as far north as Algonquin Park.

During the 1950s and '60s, osprey populations dropped dramatically in the province. Pollutants, such as the insecticide DDT, had contaminated many waterways and were accumulating in fish. Because fish are an important source of food for ospreys, they too were affected. Fortunately, the use of DDT was banned in Ontario in 1974.

Today, ospreys are returning, but only to face another obstacle. Ospreys generally build their nests in tall, isolated trees that are close to shallow bodies of water. During their 20-year absence, many of these natural nesting sites were destroyed, forcing some ospreys to nest on hazardous structures such as hydro poles and television towers.

For the past few years, the Ministry of Natural Resources, along with groups of concerned citizens from Georgian Bay to the St. Lawrence River, have embarked on a campaign to build nesting structures specially designed for ospreys.

BEFORE YOU START

Erecting platforms in lakes and rivers may require a permit. Before you begin, contact the Ministry of Natural Resources for more information. Other agencies, such as Parks Canada and local conservation authorities, may also have to be informed.

NESTING PLATFORMS

There are different types of nesting platforms for different site conditions. The quadropod is designed to be placed directly in the water, while the single-poled structure is designed for use on land.

When choosing a site for a nesting platform, consider the following:

- Ospreys feed almost exclusively on fish. Sites should be no more than three kilometres from shallow bodies of water — 50 metres is ideal.
- Platforms should be erected in open areas, giving the osprey room to build a nest as well as to protect it from predators, such as raccoons and owls.
- Sites should be sheltered from prevailing winds and major ice movement. They should also be at least 100 metres from human activity.
- When building several nesting platforms on one site, they should be placed at least 300 metres apart.

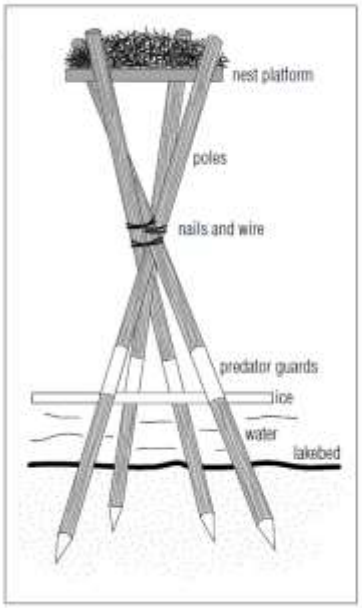
THE QUADROPOD PLATFORM

As the name implies, this platform has a four-legged base. Because it's left in the water year-round, it's important to choose a location where it won't be a hazard to boaters, and where winter ice won't disrupt it. Good locations include quiet bays or isolated marshes.

Install the quadropod during winter months when ice conditions make it easier to get around. You'll need three or four people to carry equipment, position poles and erect the platform.

EQUIPMENT

- four cedar poles, six metres in length (sharpen thick end)
- 1.2 by 1.2 metre skid or pallet
- eight-inch ice auger
- 2 eight-inch spikes
- 30 two-inch roofing nails
- 12 four-inch spiral spikes/nails
- 12 six-inch spiral spikes/nails
- six metres of black fencing wire
- pliers, claw hammer, sledge hammer, saw and ice pick
- four pieces of one-metre-square sheet metal or children's plastic roll-up toboggans for predator guards
- 1.2 metres of chain
- hardwood block (about 10 x 10 x 25 centimetres)
- five-metre ladder



Quadropod platforms are designed for use in water. Quiet bays and marshes are ideal locations.

INSTALLATION

Follow these steps to install the quadropod platform.

1. Drill four holes into the ice at a 45 degree angle. The holes should be approximately two metres apart, forming a square.
2. Ram the sharpened poles down into the ice holes and then use the sledge hammer to knock them at least one metre into the ground below the ice. To make the job of hammering easier, attach the block of hardwood to the side of each pole using a length of chain. To hold the chain in position, notch a small V into the pole using the saw (see Figure 1).
3. Place the wood pallet or skid in a level position between the tops of the poles. The platform should be at least 2.4 metres above the ice. Using the six-inch spikes, nail and wire the platform to the poles.
4. Wire and nail the poles together using the eight-inch spikes where they cross near the centre of the structure.
5. Wrap the predator guards (sheet metal or plastic toboggans) around each leg of the structure. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.
6. Wire a few "starter" sticks onto the bottom of the platform to attract an osprey. An extra perch can be installed off to the side or above the platform. This provides a place for the male to roost during the nesting season.

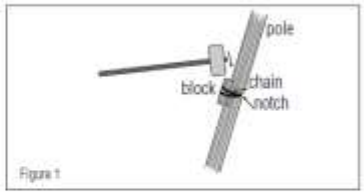


Figure 1

SINGLE-POLED PLATFORM

The single-poled platform is better suited for use on land. It's adaptable to areas with deep soil, as well as areas with no soil. Your first challenge may be to find a long and sturdy pole. Old hydro poles are ideal. Try contacting your local utility company or Bell Canada office to inquire about obtaining poles for this purpose.

EQUIPMENT

- one pole, six to nine metres in length
- 1.2 by 1.2 metre skid or pallet with 10-inch high retaining fence
- four wood or metal braces
- power auger (for deep soil sites)
- rock drill and mounting set (for rocky sites)
- six-inch spikes
- two-inch roofing nails
- steel guy wire
- four eye bolts (minimum two-inch thread)
- cement
- pliers, claw hammer and sledge hammer
- one piece of one-metre square sheet metal or children's plastic roll-up toboggans


The single-poled platform is designed for use on land. It can be erected in deep soil or on rock.

DEEP SOIL

Follow these steps to install a single-poled platform in deep soil:

1. Attach the nesting platform (skid or pallet) to the pole. Wire a few "starter" sticks to the platform.
2. Use the power auger to drill a hole one to two metres deep.
3. Place the pole in the hole and secure it with cement, sand or rock.
4. If necessary, attach guy wires to add extra support.
5. Wrap the predator guards (sheet metal or roll-up toboggans) around the pole. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.

ROCK

While a little more involved, it is still easy to erect nesting poles in rocky areas. The most difficult piece of equipment to come across may be the rock drill and mounting sets used by utility companies. Follow these steps to install a single-poled platform on rock.

1. Attach the nesting platform (skid or pallet) to the pole. Wire a few starter sticks to the platform.
2. Use the rock drill to make the holes to accommodate the mounting set.
3. Set the bracket inside the holes. Pour in cement for additional support.
4. Raise and anchor the pole in place using the mounting set.
5. If necessary, attach guy wires prior to raising the pole to add extra support.
6. Wrap the predator guards (sheet metal) around the pole. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.


The pole is anchored with a mounting set.

MAINTENANCE

Inspect the nesting platform at least once a year. If the material in the nest is more than half a metre deep, remove a layer of sticks. Ospreys add material to the nest at the beginning and at the end of the nesting season. Although nests look sturdy, they are not. When nests become too large, windstorms can blow them down.

Further reading:

- Ewins, P.J. 1994. *Artificial Nest Structures for Ospreys — A Construction Manual.* Environment Canada. Toronto, Ontario. 41p.

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BUILDING TERN NESTING RAFTS (TORONTO REGION CONSERVATION AUTHORITY AND ENVIRONMENT CANADA, 1996)

REEFRAFTS FOR COMMON TERNS AND FISH

GUIDELINES FOR DESIGN, CONSTRUCTION AND OPERATION

metropolitan toronto and region conservation authority

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

GREAT LAKES 2000 CLEANUP FUND / FONDS D'ASSAINISSEMENT DES GRANDS LACS 2000

Introduction

Common terns are small colonial waterbirds that are declining in numbers throughout the lower Great Lakes due to predators, human disturbance, and competition for nesting habitat by ring-billed gulls. Small colonies of these birds can be managed effectively by providing habitat in the form of wooden nesting rafts placed in suitable, safe areas. Since floating structures have also been known to provide habitat for fish, this tern management technique has provided an opportunity to enhance fish habitat in the form of a "reef" structure suspended beneath the raft. The installation of a "reefraft," a combination of a nesting raft and a fish reef, can provide habitat features for these birds and a variety of fish species.

Common terns are not very fussy in their choice of nesting habitat. They prefer to nest on small islands to prevent depredations by ground predators. Islands should be of sufficient elevation (so that their nests will not be washed out by storm waves) and have little vegetation (so that they have good visibility and can readily take off, land and move about on their short legs). However, Common terns also use artificial nesting sites including break walls, dredge spoil islands and various offshore structures. Thus, it is not surprising that they will readily take to reefrafts as well.

Reefrafts are relatively inexpensive compared to the costs associated with constructing artificial islands and can be readily moved to other locations if necessary. They have been used with great success at two sites on the Toronto waterfront and have application potential at other locations, such as in embayments and small lakes.

These guidelines are designed to provide you with information on the design specifications, construction, installation, and management of reefrafts. However, this information should not be considered the definitive word on the subject. Other approaches/designs are possible and you can make your own modifications as you see fit.

A video demonstrating the use of "reefrafts" is available from The Metropolitan Toronto and Region Conservation Authority and the Canadian Wildlife Service.

2

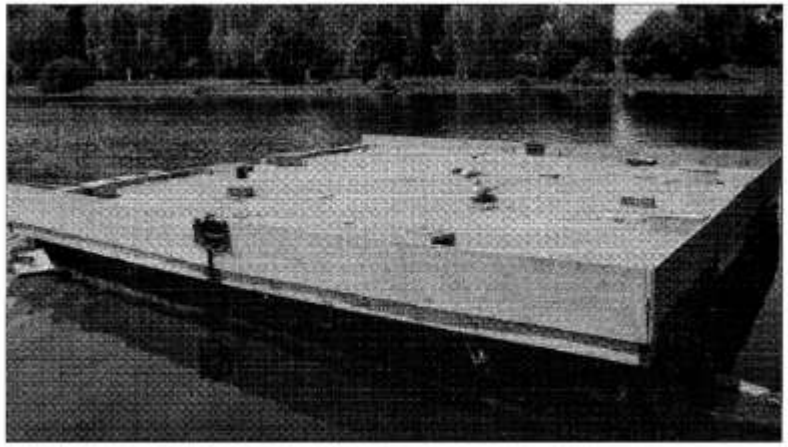
Identifying Good Places to Install a Reefraft

Common terns normally nest in lakes, ponds, rivers, and other water bodies of many different shapes and sizes. A good reefraft location would be a water body that meets the following criteria: sufficient size (probably a minimum of 2 acres or about 1 hectare); no or very little boat traffic or other human disturbance; and near a good foraging area (i.e. a sizeable water body with a good supply of fish - the main food of Common terns). If your selected area already has suitable Common tern habitat such as several small, sparsely vegetated islands, then a reefraft is most likely NOT going to attract colonizing Common terns. However, in areas where suitable natural nesting habitats are scarce or where existing locations are fully occupied by nesting gulls, the chances for success are much better.

Quiet, out-of-the-way locations are best in order to reduce potential disturbance by boaters and to ensure that the rafts themselves do not pose a threat to the safety of boaters. The reefraft itself should be at least a stone's throw away from the shoreline to prevent damage by vandals or predators.

Before considering the installation of a reefraft, make sure that you have permission from the owner of the waterlot and make sure you are not creating a hazard to boat traffic. Local authorities and the Coast Guard should be contacted to determine if special navigational lighting or signage is required, and your local government wildlife office should be consulted during the early planning stage, to check that there are no other sensitive wildlife interests at the proposed site.

If you have had terns nesting in your area in the past, hanging around during the summer, or leisurely moving through during the fall, chances are good that terns would colonize a reefraft in your area if it were properly installed, equipped, maintained, and operated.



Design, Construction and Assembly of Reefrafts

Design of the reefraft was based on the need for a semi-permanent structure that could remain in the water over the winter in protected areas. The wooden platform of the raft was designed to stay above the water line in order to prevent water-logging and rotting. It also incorporated the use of standard lumber sizes where possible to minimize cutting. Ice proof dock floats were selected in order to prevent winter ice damage. The floats that were used were the "Enviro Float" design, and the size and shape of these floats dictated the design of the support frame. Therefore, modifications may be required if floatation devices other than the Enviro Float are used.

The reefraft is constructed in two sections and is joined by four hinge brackets. Steel corner brackets are used to connect and stabilize the frame. The entire frame is constructed with 2x8 "stringers" except for 2x4 "cross members" used to support the plywood deck seams. Cedar or pressure-treated wood can be used for the frame. Pressure-treated lumber is cheaper; however, the possibility of some leaching of the wood preservative into water courses might not be acceptable in some areas.

Earlier versions of the raft were constructed using lighter weight material; however, this required that the rafts be removed from the water in the fall and be reinstalled in the spring. This task was found to be very time-consuming and labour intensive.

Due to the size and weight of the raft, it is easier to construct and assemble the raft on flat ground near the water's edge, and preferably, as close to the raft's final location as possible. Although heavy, each raft section can be handled by a crew of four or five people. Depending on the availability of electricity, cordless power tools or the use of a gas-powered generator may be required.

MATERIALS NEEDED TO CONSTRUCT A REEFRAFT

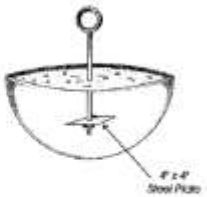
ITEM	QUANTITY	ITEM	QUANTITY
Raft Components		Reef Components	
4 x 8 x ⅛ in. (8.5mm) plywood underlay	1	dark green snowfence	1-2 rolls
4 x 8 x ⅝ in. (14mm) sanded fir plywood GIS	10	½ in. rebar	16 feet
2 x 4 x 16 foot cross members	2	steel wire	
2 x 8 x 16 foot stringers	12	1 in. wood screws	1 box
ice proof dock floats	16	⅜in. flat washers	1 box
steel corner brackets	32		
heavy duty steel dock hinges	4		
backer plates (for hinges)	4	Anchors	
6 in. lag screws	64		
reinforcing "T" plates	16	sakrete or concrete mix	8 bags
2 x 4 joist hangers	28	⅝16 in. chain	
2½ in. by ⅜ in. carriage bolts	272	8 10 in. heavy duty eye bolts	4
⅜ in. nuts	272	⅝ in. quick links	8
⅜ in. washers	336	4 x 4 in. steel plate	4
1½ in. galvanized screws	2 boxes		
2 x 4 in. galvanized hinges	2		
Waterseal	6 litres		
6 in. angle brackets	16		

Approximate Total Cost: $2,500 - $3,000

Construction and Assembly

The following are step-by-step guidelines to build a reefraft:

Figure 1: *Anchor design*

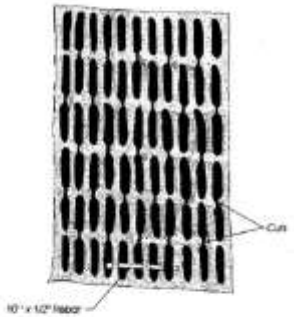


- Four anchors are constructed by pouring ready-mix concrete or stone mix into a suitable mould such as the end of a 45-gallon plastic barrel. Mix concrete as per instructions on bag, using two bags per anchor. Place a large heavy duty eye-bolt or dock ring in the concrete to attach anchor chain. Other materials such as concrete blocks can be used; however, the anchors must be heavy enough to secure the heavy rafts during strong wind and shifting ice conditions. We recommend four anchors per raft.

- Cut two 4 x 8 x ⅝ sheets of plywood into a total of eight 12-inch by 96-inch boards for the raft sides. Cut the single sheet of 4 x 8 x ⅜ plywood underlay into three 18-inch by 96-inch boards. Apply waterseal to these plywood pieces and the remaining 8 sheets of plywood using a paint roller. Randomly drill a number of ¾-inch drainage holes in the 8 sheets of plywood decking, 12-18 inches apart.

- Cut dark green plastic snowfence to length, based on the water depth at the desired raft location. Wire a 10 to 12 inch piece of ½ inch rebar to one end of cut pieces to act as a weight. The number of pieces needed will depend on the desired density of the structure (probably 12-16 per raft). Using scissors or a sharp knife, cut every other panel in the snowfence in order to expand the mesh size. This was undertaken in order to prevent the snowfence from acting like a "gill net" and trapping fish. Re-roll individual pieces from the weighted end and set aside.

Figure 2: *Fish habitat section constructed from snowfence.*



NOTE: The fish-reef component of the raft described in this manual was constructed using dark green plastic snowfence hung beneath the raft in strips in order to simulate macrophyte beds. Other forms of submerged habitat structure (i.e. brush, logs, Christmas trees, etc.) could be substituted.

- After laying out and cutting the 2x8 "stringers" to length, assemble the frame with the steel corner brackets using 2½ inch carriage bolts with washers. Be sure that the distance between the outer stringers is 24 inches O/C in order to accommodate the width of the Enviro Float. Note: If using a floatation cell other than the Enviro Float design, measure or use the float as a template to ensure the proper fit.

Figure 3: *Plan diagram of raft frame showing dimensions and float and hardware placement.*

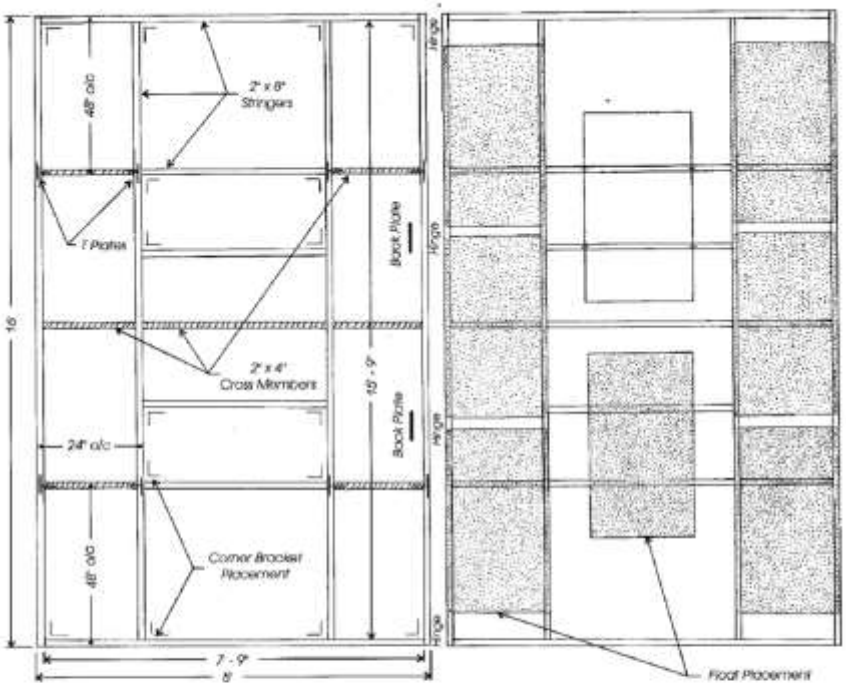
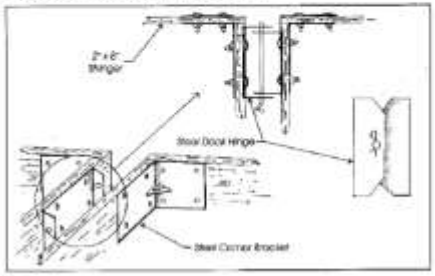


Figure 4: *Corner bracket and hinge assembly*



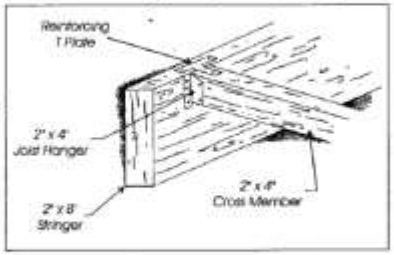
- Bolt the two outer hinges to the frame with the same bolts used to attach the corner brackets at this location. Next, in conjunction with the steel backer plates, bolt the two inner hinges using 2½ carriage bolts and washers.

HINT: Once the hinges have been attached to one section, line up the first precut 2x8 stringer from the second section and mark the holes for the hinges. This will ensure that the hinge placements are aligned and that the two raft sections can be easily joined at a later time.

- Cut and assemble the second section of the raft starting with the hinge stringer referenced earlier. As with the first half, use the same carriage bolts to attach the corner brackets and outer hinges, and use backer plates with the inner hinges.

- Cut and install the 2x4 "cross members" using joist hangers and galvanized deck screws. Use reinforcing "T" plates to secure the 2x4 cross members to the 2x8 frame in order to provide additional support and reinforcement along the hinged sides of the raft sections.

Figure 5: *Placement of joist hanger and reinforcing T plate.*



- Flip frames over. Make a 22 inch by 2 cutout in the 2x8 cross member to accommodate the top of the centre Enviro Floats. Note: depending on the type of float used, this cutout may not be required.

HINT: This cutout is easily undertaken with the use of a reciprocating saw.

- Place floats into the frame and secure to the stringers using 6 inch lag screws with washers. Be sure that the floats are not touching any of the bolts used in the frame assembly. Note: using a float as a template, mark the hole locations and pre-drill ¼-inch pilot holes in the 2x8 stringers in order to keep the lag screws straight and prevent the stringers from splitting.

Figure 6: *Centre float placement.*

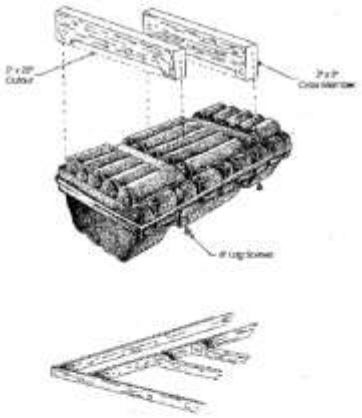
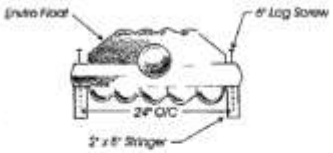


Figure 7: *Side float placement between stringers.*



- Use quick links to attach two anchor chains to each section at the outside corners (opposite the hinged side). Drill a ½-inch hole in the steel corner bracket to attach the quick-link if necessary.

- Once the floats are secured in place each section is flipped over into the water.

HINT: Place the side of the section with the anchor chains nearest to the water's edge and secure the chains to the shore. This will prevent the lower side of the section from floating out away from you as it is flipped over into the water.

Due to the weight of the raft section, caution must be exercised during this step to avoid personal injury.

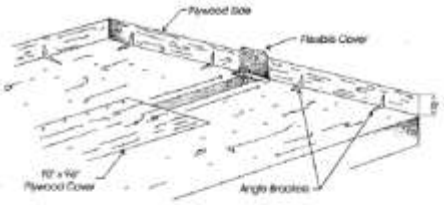
Figure 8: *Flipping raft section into water.*

- Before installing the plywood decking, lower the precut snowfence through the open raft frame and attach to the inside of the wooden stringers with galvanized screws and small washers.

- Install the 4x8 plywood decking (good side up) and secure with galvanized deck screws. Once the decking is in place, join the two sections (raft halves) at the hinges using the hinge pins.

- Using two pieces of 18-inch by 96-inch plywood, cover the gap between the two raft sections. Use galvanized deck screws to attach the plywood covers to one half of the raft only. This will allow the raft to pivot at the hinge and prevent the screws from pulling out.

Figure 9: *Raft deck showing plywood gap cover, sides and angle brackets.*



- Screw the 12-inch by 96-inch plywood sides to the outside stringers. The top of the sides should be 8 inches above the deck and the sides should meet at the corners without a crack. Cover the gap between the side panels at the raft hinge with rubber tire tubing or other suitably flexible material in order to prevent tern chicks from falling out, while maintaining movement by the two raft halves at this location. Steel angle brackets can be screwed to the raft sides and deck as necessary to provide additional support.

- Place an even base of nesting substrate (sand/gravel mix) on the deck to a depth of 2-3 inches. Add driftwood, brick, or pieces of rubble as relief objects and place two or three pairs of tern decoys on the raft to attract prospecting terns.

HINT: A wheelbarrow and ramp can be used to add the substrate material to the raft. Make sure that the raft is not resting on the bottom while the substrate is being added. The extra weight will make the raft difficult to move if it is not floating freely.

Installation of Completed Reefraft in Chosen Location

- Place one anchor on top of the raft at each of the outside corners and attach to anchor chains with quick-links. Tow raft to desired location and drop anchors. Due to the weight of the completed reefraft, the use of a boat and motor will be required, particularly if installing the raft during windy conditions. In shallow ponds or embayments it may be possible for two or three people to drag the raft into place using chest-waders.

  When completed, the top of the reefraft should resemble a deserted beach with pieces of driftwood and debris. These relief objects are used since terns prefer to nest right next to them. The substrate on the raft should drain water. If water pools on the raft, additional drainage holes in the plywood deck must be added.

HINT: By first dropping two anchors off one side and then pulling the raft away from these anchors before dropping the other two, ensures that the anchors are spread further apart.

Operation and Maintenance

The rafts are designed to be left in the water permanently and should withstand typical ice and weather conditions in protected embayments and small lakes; however, periodic maintenance is recommended and may be required.

In order to maintain an even base of nesting substrate, the sand/gravel mixture should be raked on an annual basis and some fill may need to be added to replace losses due to wind and rain erosion. Raking the substrate also helps to evenly distribute the weight of the material on the raft.

Rafts must be monitored and action must be taken to prevent birds such as gulls and Canada geese from nesting on the rafts in the spring. This monitoring must commence when the ring-billed gulls start their breeding activities (typically mid to late March in the Toronto area) and should continue until the rafts are colonized by terns. The use of bird scaring shell crackers; frequent inspection; and, if necessary, nest removal (under CWS permit) should be sufficient to prevent nesting by non-target species.

Chick shelters are necessary in order to protect young chicks from predators as well as wind, rain, and sun exposure. Shelters can be constructed from wood as three-sided boxes approximately 6x6x12 inches in size or clay drainage tile or white ABS pipe 4-6 inches in diameter. The chick shelters should be added to the raft once the terns are well into incubation.

Once the tern chicks are almost ready to fledge, a ramp must be provided on the raft to allow any chicks in the water to return to the raft. A ramp can be constructed using the remaining piece of 18 by 96-inch plywood. Attach two gate hinges to the one end and tie or secure suitable floatation to the other. The ramp should be attached to the top of a raft side in order to allow fledged young to return to the raft while continuing to prevent young chicks from getting out. "Loafing logs" are small pieces of floating driftwood that can be tied to the side of the raft at the same time that the ramp is installed. These floating structures provide resting areas for adult and juvenile terns next to the raft.

Annual Maintenance:

The following is a typical operation and maintenance schedule for a reefraft:

SPRING (April 1-30)

- Add nesting substrate (sand/gravel) and rake as required
- Undertake gull/goose control prior to arrival of terns if necessary
- Inspect rafts including the floatation cells, anchor chains, and sides and make minor repairs
- Ensure that any gaps or cracks in the raft sides are repaired or covered
- Place tern decoys on raft if necessary

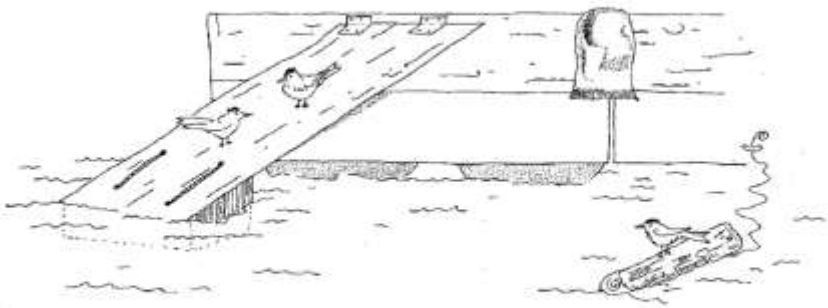
SUMMER (June 1)

- Place chick shelters on raft once tern chicks are visible
- Attach ramp to raft prior to chicks fledging from raft
- Tie pieces of floating driftwood to sides/corners of raft as loafing structures for newly fledged chicks

FALL (late September)

- Rake and distribute material
- Inspect floats and anchors
- Remove and store chick shelters, decoys, and ramp
- Collect and dispose of any tern carcasses or dead fish that may be present on raft

Figure 10: *Floating ramp placement and "loafing log"*

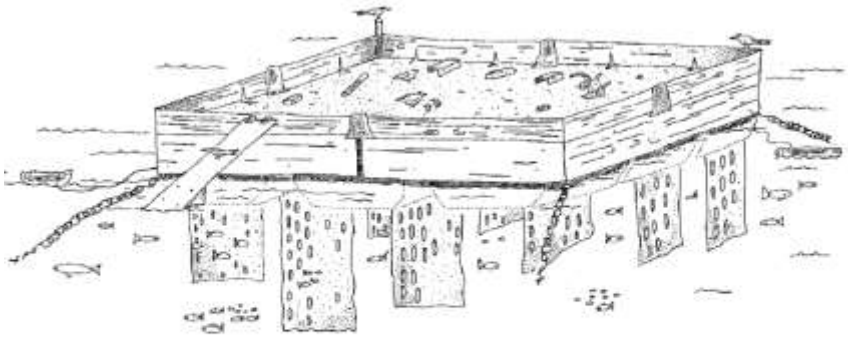


Evaluating the Effectiveness of Reefrafts

Reefrafts provide an excellent opportunity for a number of monitoring programs related to Common terns and fish. Data collection in the form of *observational monitoring* and *nest counts* can be undertaken throughout the nesting season and in many cases can be accomplished from shore with the use of binoculars or a spotting scope. Monitoring of the fish communities using the reef structure and raft for protection can be monitored through *electrofishing* on a seasonal basis.

Although direct monitoring activities such as nest and egg counts are useful, the birds should be left alone as much as possible during the first few years. Occasional human disturbance in order to carry out this monitoring will be less disruptive once the nesting colony is well established. Please note that there may not be nesting success in the first year. Do not be discouraged, since the raft may have been observed by prospecting terns that could return to use it the following year.

Figure 11: *Completed reefraft with suspended fish habitat.*



Further Reading

Dunlop, C. L., H. Blokpoel and S. Jarvie. 1991. Nesting Rafts as a Management Tool for a Declining Common Tern (Sterna hirundo) Colony. Colonial Waterbirds 14: 116-120.

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Great Lakes 2000 Cleanup Fund Fact Sheet. Caspian Tern Nesting Raft in Hamilton Harbour, 1993-1995.

Acknowledgments

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Environment Canada

Canada

CONSTRUCTING FISH CRIBS (EHOW.COM, 2011)

How to make fish cribs out of wood pallets

By Steve Silverman, eHow Contributor , last updated November 07, 2011

A fish crib can be unloaded from the side of a fishing boat. Fish cribs can be an important tool to a fishery because they provide an excellent habitat for fish on the bottom of any body of water. Fish cribs are often constructed from wooden pallets. In building the cribs, you have to weigh them down so they will sink to the bottom of the body of water when deployed. Once fish cribs are prepared and loaded onto a boat, they can be put into position quickly.

1. Cut the wood pallets down to the desired size, then layer the pallets, separating each pallet with four cinder blocks. Place a pallet on the ground and place four cinder blocks on it, one in each of the corners. Place another pallet on top of the cinder blocks, then four more cinder blocks on top of that pallet. Then add another pallet on top.

2. Strap the pallets and the cinder blocks together. They should be tightly lashed in several places so they will not come apart. Use clips to keep the lashing in place.

3. Stuff the pallets with brush. This will provide the environment that will appeal to the fish and draw them to the pallet. Fill the pallets with as much brush as possible.

4. Load the fish cribs onto flat pontoon boats or other suitable boats, and drop them off in the selected locations.

APPENDIX D: SPEC SHEET FOR A GORMANN – RUPP PORTABLE DIESEL PUMP

Specification Data | Diesel Engine Driven | Sec. 45 | PAGE 1561 | MARCH 2010

ACDEU

Self Priming Centrifugal Pump
w/Autostart

Super TSERIES
VARIOUS PATENTS APPLY

Model T6A60S-4045T
Size 6" x 6"

70 MT

Total Head P.S.I.	Total Head Feet	Capacity of Pump in U.S. Gallons per Minute (GPM) at Continuous Performance			
59.0	136	400	400	400	400
52.0	120	730	760	760	760
43.3	100	750	1050	1170	1170
34.7	80	760	1060	1290	1460
26.0	60	770	1070	1300	1500
17.3	40	780	1080	1310	1510
Suction Lift		25'	20'	15'	10'

PUMP SPECIFICATIONS

Size: 6" x 6" NPT (152 mm x 152 mm) - Female.
Casing: Gray Iron 30. Maximum Operating Pressure 98 psi (675 kPa).*
Semi-Open Type, Two Vane Impeller: Ductile Iron 6545-12. Handles 3" (76.2 mm) Diameter Spherical Solids.
Impeller Shaft: Stainless Steel 17-4 PH.
Replaceable Wear Plate: Carbon Steel 1015.
Removable Adjustable Cover Plate: Gray Iron 30; 50 lbs. (23 kg).
Flap Valve: Neoprene */Steel Reinforcing.
Seal Plate: Gray Iron 30.
Shaft Sleeve: Alloy Steel 4130.
Seal: Cartridge Type, Mechanical, Oil-Lubricated, Double Floating, Self-Aligning, Silicon Carbide Rotating and Stationary Faces. Stainless Steel 316 Stationary Seat. Fluorocarbon Elastomers (DuPont Viton® or Equivalent). Stainless Steel 18-8 Cage and Spring. Maximum Temperature of Liquid Pumped 160°F (71°C).*
Bearing Housing: Gray Iron 30.
Radial Bearing: Open Single Ball.
Thrust Bearing: Open Double Ball.
Bearing and Seal Cavity Lubrication: SAE 30 Non-Detergent Oil.
Flanges: 125# Gray Iron 30.
Gaskets: Buna-N, Compressed Synthetic Fibers, PTFE, Vegetable Fiber, Cork, and Rubber.
O-Rings: Buna-N.
Hardware: Standard Plated Steel.
Brass Pressure Relief Valve.
Bearing and Seal Cavity Oil Level Sight Gauges.
*Consult Factory for Applications Exceeding Maximum Pressure and/or Temperature Indicated.
Standard Equipment: Hoisting Ball. 90° Discharge Elbow. Strainer. Single Level Actuated (Microswitch) Type Liquid Level Control System.**
Optional Equipment: Battery. G-R Hard Iron Impeller and Seal Plate. Hard-ened Steel Wear Plate. High Speed (55 MPH/89 KM/H) Single Axle Pneu-matic-Tired Wheel Kit */$_{NC}$. DOT-Approved Lights and Electric Brakes. Over-the-Road Trailer (Meets DOT Requirements) Available */Either Elec-tric or Hydraulic Surge Brakes, Running Lights, Jack Stands and Safety Cables. EPS */Submersible Transducer Liquid Level Sensor (50 Ft. [15M] Cable Standard, Alternate Lengths Available).
**50 Ft. (15 m) Standard Length; Dual Switches and Alternate Cable Lengths Available From the Factory.

WARNING!
Do not use in explosive atmosphere or for pump-ing volatile flammable liquids.

ENGINE SPECIFICATIONS

Model: John Deere 4045T.
Type: Four Cylinder, Four Cycle, Turbocharged, Liquid Cooled Diesel Engine.
Displacement: 276 Cu. In. (4.5 liters).
Governor: Mechanical.
Lubrication: Forced Circulation.
Air Cleaner: Dry Type.
Oil Reservoir: 17.5 U.S. Qts. (16.6 liters) Dry; 15.5 U.S. Qts. (14.7 liters) Refill.
Fuel Tank: 88 U.S. Gals. (330 liters).
Full Load Operating Time: 30.1 Hrs.
Starter: 12V Electric.
Standard Features: Low Oil Pressure and High Coolant Temperature Safety Shut Down Switches/Indicators. Autostart Instrument Panel Includes: Tachometer, Voltmeter, Hourmeter, Coolant Temperature Gauge, Oil Pressure Gauge, Manual/Stop/Auto Key Switch, 10 Amp Pushbutton Circuit Breaker, Audible Startup Warning Delay. Muffler */Guard and Weather Cap. Throttle Control.

JOHN DEERE PUBLISHED PERFORMANCE:
Maximum Gross Continuous BHP (Industrial)
72 (54 kW) @ 2400 RPM

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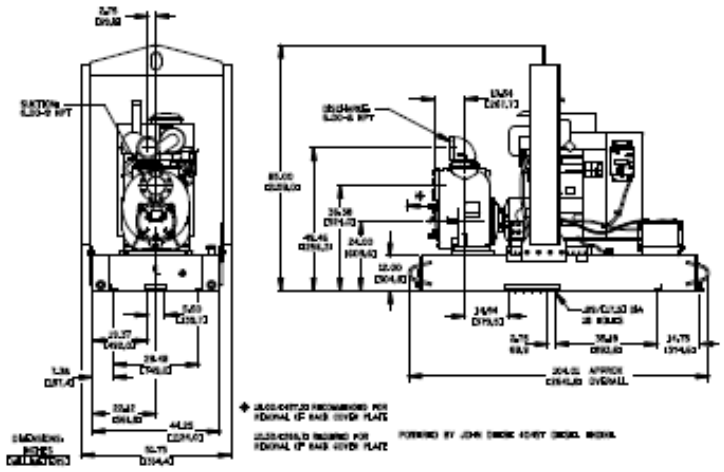
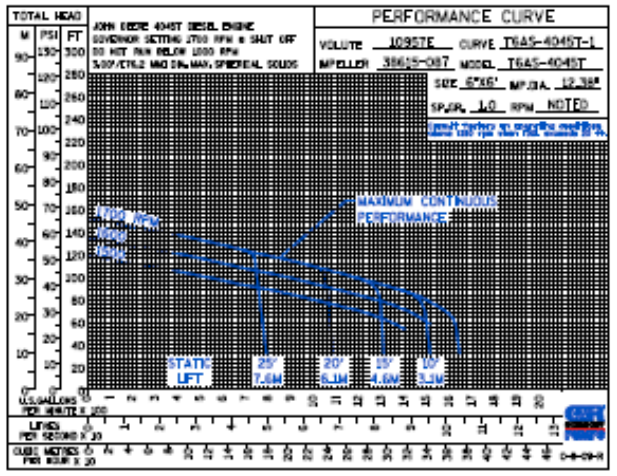
Specification Data
SECTION 45, PAGE 1561

APPROXIMATE DIMENSIONS and WEIGHTS

	SKID BASE	2-WHEEL
NET WEIGHT:	3395 LBS. (1540 KG.)	3905 LBS. (1771 KG.)
SHIPPING WEIGHT:	3630 LBS. (1646 KG.)	3905 LBS. (1771 KG.)
EXPORT CRATE SIZE:	273 CU. FT. (7,7 CU. M.)	





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Specification Data	Sec. 10	PAGE 1540 SEPTEMBER 2011

ACDEU

Tandem Axle Over-the-Road Trailers

(Satisfy U.S. and Canada D.O.T. Requirements)

29313– Models

SHOWN WITH SAFETY CABLES

WARNING!

Make trailer selection based on the pump unit weight and maximum load capacity of the trailer. The weight of the pump unit and/or any ancillary equipment loaded onto the trailer must not exceed the maximum load capacity of the trailer. Otherwise, an unsafe towing condition will occur, resulting in damage to the trailer and pump unit, and severe injury or death to personnel.

The maximum safe towing speed for the trailer is 55 MPH (88 kph).

TRAILER SPECIFICATIONS

Frame: Fabricated Structural Steel.
Floor: Diamond Tread Steel Plate.

2-5/16" Ball Hitch w/Surge Brakes: -011 and -012 Models.
2-5/16" Ball Hitch w/Electric Brakes*: -015 and -016 Models.
3" I.D. Lunette Eye w/Surge Brakes: -013 and -014 Models.
3" I.D. Lunette Eye w/Electric Brakes*: -017 and -018 Models.
Maximum Load Capacity (GVRW): 7,000 Lb. (3175 Kg.).
Two 3500 Lb. (1588 Kg.) Leaf Spring Axles. ST205/75 D15 Bias Tires. 200 Lb. (91 Kg.) Maximum Tongue Weight.

2-5/16" Ball Hitch w/Surge Brakes: -023 and -024 Models.
2-5/16" Ball Hitch w/Electric Brakes*: -019 and -020 Models.
3" I.D. Lunette Eye w/Surge Brakes: -025 and -026 Models.
3" I.D. Lunette Eye w/Electric Brakes*: -021 and -022 Models.
Maximum Load Capacity (GVRW): 12,000 Lb. (5443 Kg.).
Two 6000 Lb. (2722 Kg.) Leaf Spring Axles. ST235/80 R16 Radial Tires. 218 Lb. (99 Kg.) Maximum Tongue Weight.

2-5/16" Ball Hitch w/Electric Brakes*: -027 Model.
3" I.D. Lunette Eye w/Electric Brakes*: -028 Model.
Maximum Load Capacity (GVRW): 14,000 Lb. (6350 Kg.).
Two 7000 Lb. (3175 Kg.) Leaf Spring Axles. ST235/80 R16 Radial Tires. 218 Lb. (99 Kg.) Maximum Tongue Weight.

Standard Equipment (All Models): Adjustable Pump Positioning for Proper Weight Distribution. 12 Volt Electrical System ᵂ/Tail, Brake, Turn Signal, Clearance, License Plate Light. Trailer Connector Plug for Towing Vehicle. Emergency Breakaway Safety Cable ᵂ/Hook (Automatically Applies Brakes if Trailer Breaks Away From Tow Vehicle). Steel Fenders ᵂ/Non-Skid Step Pads. Safety Reflectors. Safety Cables/Chains ᵂ/Hooks. Rear Jack Stands. Front Jack Stand or Dolly Wheel (See Dimensional Drawings).

**12 Volt Recharging Backup Battery Supplied ᵂ/Trailer. Requires Electric Brake Control in Tow Vehicle.*

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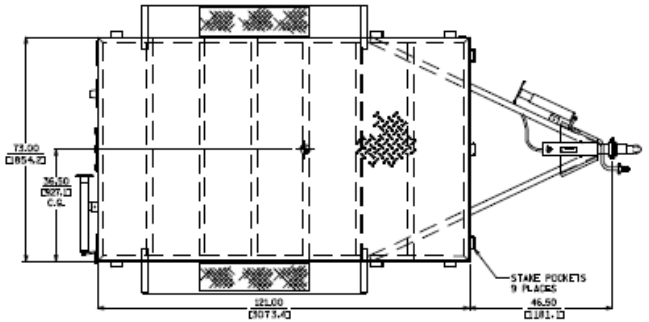
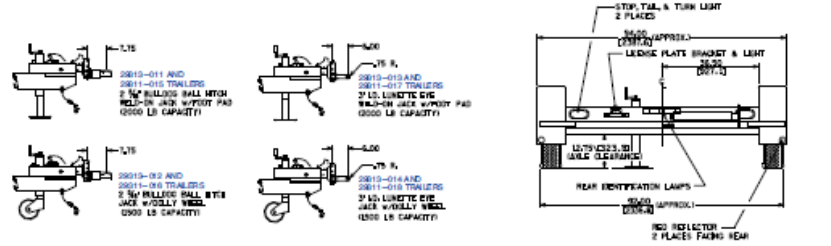
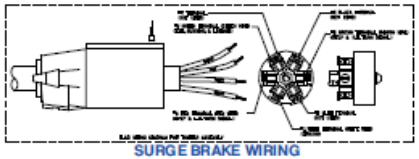
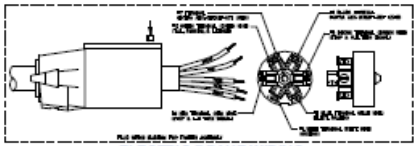
Specification Data	TRAILER MODEL DIMENSIONS 29313-011 THROUGH 29313-018	TRAILER WEIGHT
SECTION 10, PAGE 1540	DIMENSIONS AND WEIGHT APPROXIMATE	1355 LB. (615 KG.)







SURGE BRAKE WIRING



ELECTRIC BRAKE WIRING

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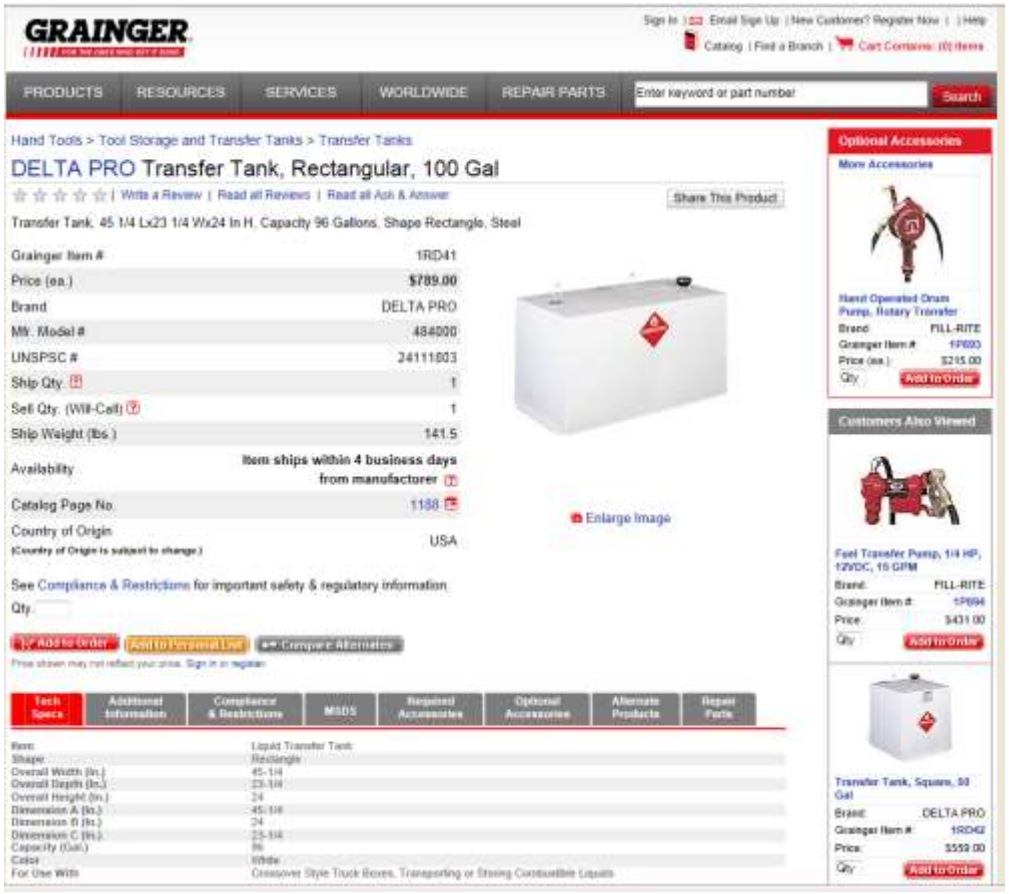
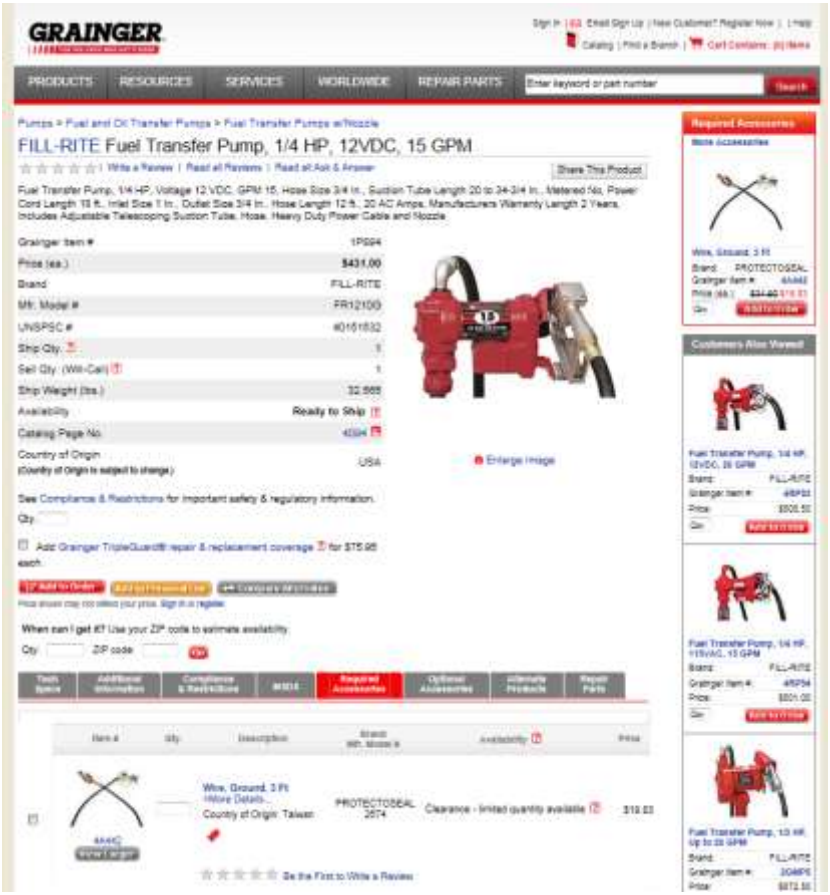
APPENDIX E: SAMPLE DIESEL PUMP ACCESSORIES





From www.grainger.com (accessed February 11, 2013)

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