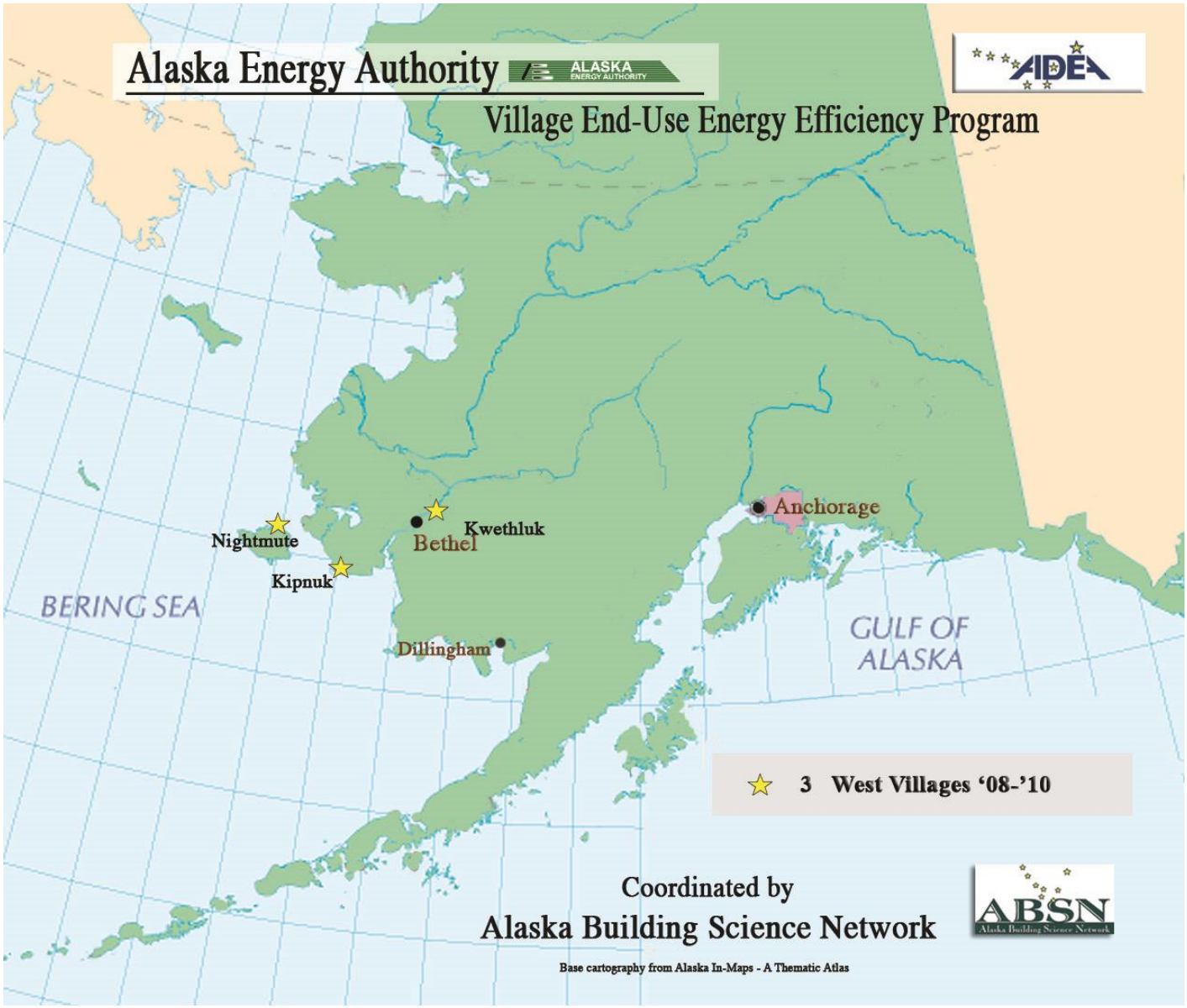
# FINAL REPORT

## AEA Grant # 2195234




## West Region
## 2008 – 2010

Prepared for:

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August 2010

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## ABSN's Mission Is:

*To provide building science information, comprehensive public education, advocacy, and hands on training in building and maintaining safe, healthy, energy efficient, durable, and sustainable homes and buildings in rural and urban Alaska*

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# Village End Use Energy Efficiency Measures Program 2008 – 2010
## AEA Grant # 2195234 Administered by Alaska Building Science Network

## Final Report - Executive Summary: West

- By ABSN Project Manager Geoff Butler, August, 2010

From February 2008 – February 2010 the following 3 rural Alaska villages received energy efficiency upgrades to community buildings:

**Kipnuk, Kwethluk, Nightmute**

Total program grant funds: $112,500 Grant funds averaged per village: $37,500 ($112,500/3)

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The goal of these grant projects is to facilitate energy efficiency upgrades to community buildings that deliver the greatest energy savings with the most rapid payback rate on grant funds. Energy efficient lighting upgrades are the first measures undertaken. The first section of this report details results of our lighting program in all three villages region-wide. Following this section and the reports for Kipnuk and Kwethluk is our Nightmute final report which details energy efficiency lighting and weatherization upgrades in 13 community buildings and 4 teacher-housing units in Nightmute, Alaska. These energy retrofits took place as part of a "Whole Village" energy efficiency retrofit project spearheaded by The Alaska Energy Authority, with the Alaska Building Science Network (ABSN) completing community building upgrades from Feb. '08 through Feb. 2010. This project was an effort to maximize energy savings to Nightmute in the wake of the highest oil price spike in world history - with a barrel of oil topping $150 during the summer of 2008.

ABSN provides project development, coordination, training, technical assistance, materials and logistical support to facilitate these projects. For this grant cycle, to advance technology transfer and provide rural employment and skills training, we partnered directly with 16 rural village entities region-wide and provided lighting and weatherization retrofit training to approximately 31 local maintenance staff who completed lighting and other energy upgrades in their buildings. Region-wide, 50 community buildings and 18 teacher-housing units operated by rural school districts received energy efficiency improvements.

Concerning the lighting portion of these projects, at the inception of these grants in 2002, original energy audits for these projects estimated light fixture (replacement) at a cost of $355 per fixture. Within this scenario, the 670 linear fluorescent light fixtures retrofitted region-wide, alone, would have cost $237,850 to complete. With ABSN's methods, when we deduct materials costs of T5/HO lighting (~$2,500) and CFLs (~$2,000) lighting materials grant-wide, our cost for linear fluorescent retrofits is ~$160 per fixture. During phases 1 and 2 of these projects: '05 – '08 our average number of light fixtures per village in all regions was 185. During Phase 3 for the West region with Kipnuk and Kwethluk having large lighting scopes, our fixture average went to 223 fixtures /village.

ABSN's approach of partnering with local city, tribal governments, village corporations and rural school districts, coupled with the substantial in-kind contributions arising from these partnerships also facilitated the completion of a larger lighting scope than our previous averages. ABSN's approach provides skills training and employment for rural maintenance staff at greatly reduced costs compared with original audit estimates for these projects.

**Primary Accomplishments of this Grant Region-wide for total lighting budget of $112,500:**

- 670 linear fluorescent lighting retrofits
- 522 Compact fluorescent light bulb installations
- 2, T5 light fixture upgrades in school gym facilities
- Installed two programmable thermostats for added fuel savings
- Acquired $ 20,939 matching grant resources associated with lighting projects – extending the capacity of AEA grant funding for lighting by ~ 19%

## Grant funds payback and fuel saving measures

Savings from heating measures and corresponding grant expenditures are not included in payback calculations for the lighting section of this report. Our region-wide payback estimate of 1.60 years reflects the total lighting grant funds of $112,500.

## Region-Wide Lighting Retrofit Summary

**For all linear fluorescent, compact fluorescent bulb and T5 lighting retrofits and installations**:

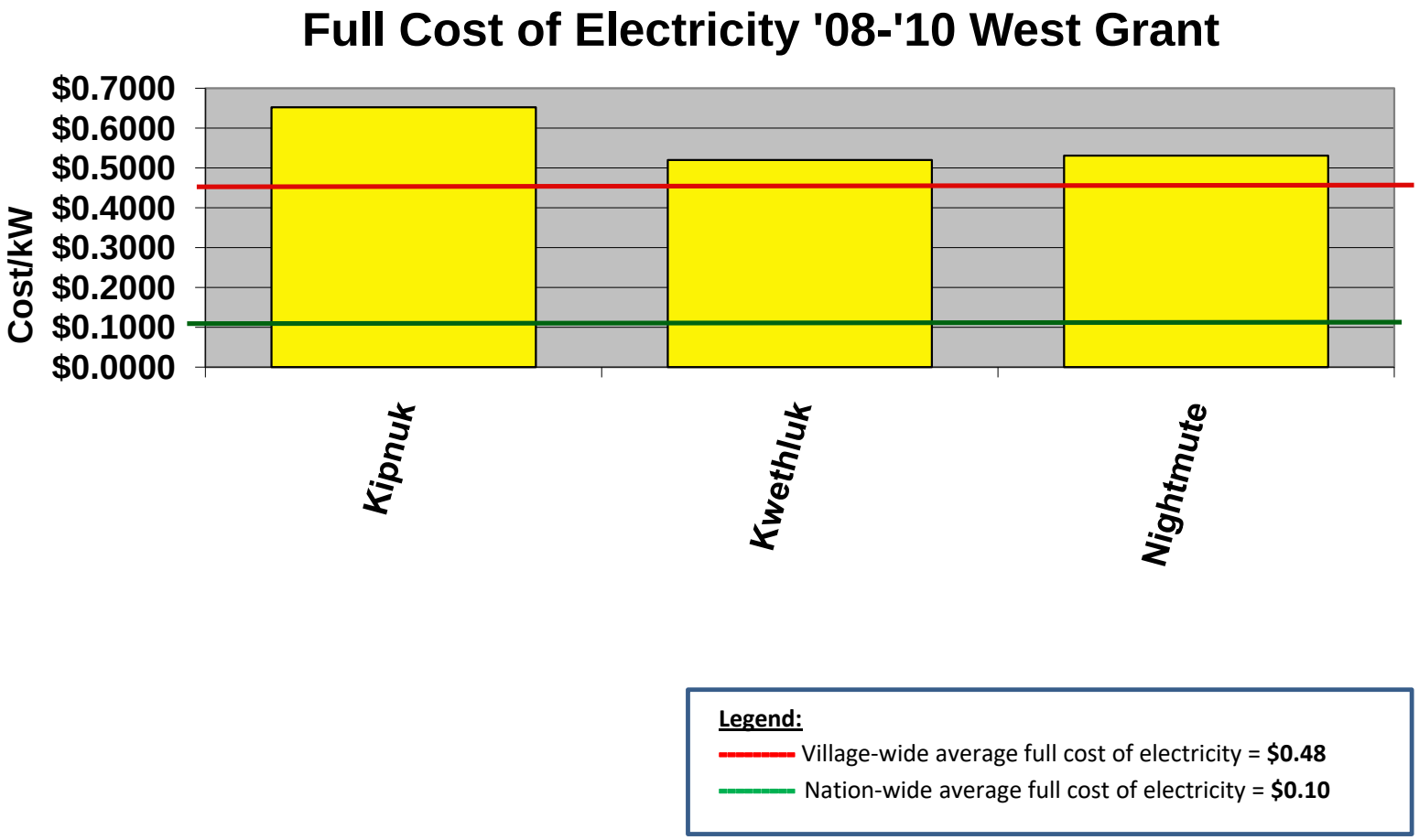
- Pre-retrofit energy use for all lighting: 122.29 kW
- Post-retrofit energy use for all lighting: 51.62 kW
- Energy savings from all lighting upgrades: 70.67 kW
- **Pre-retrofit to post retrofit energy reduction: 58 %**

- **Estimated Annual Savings Range:**

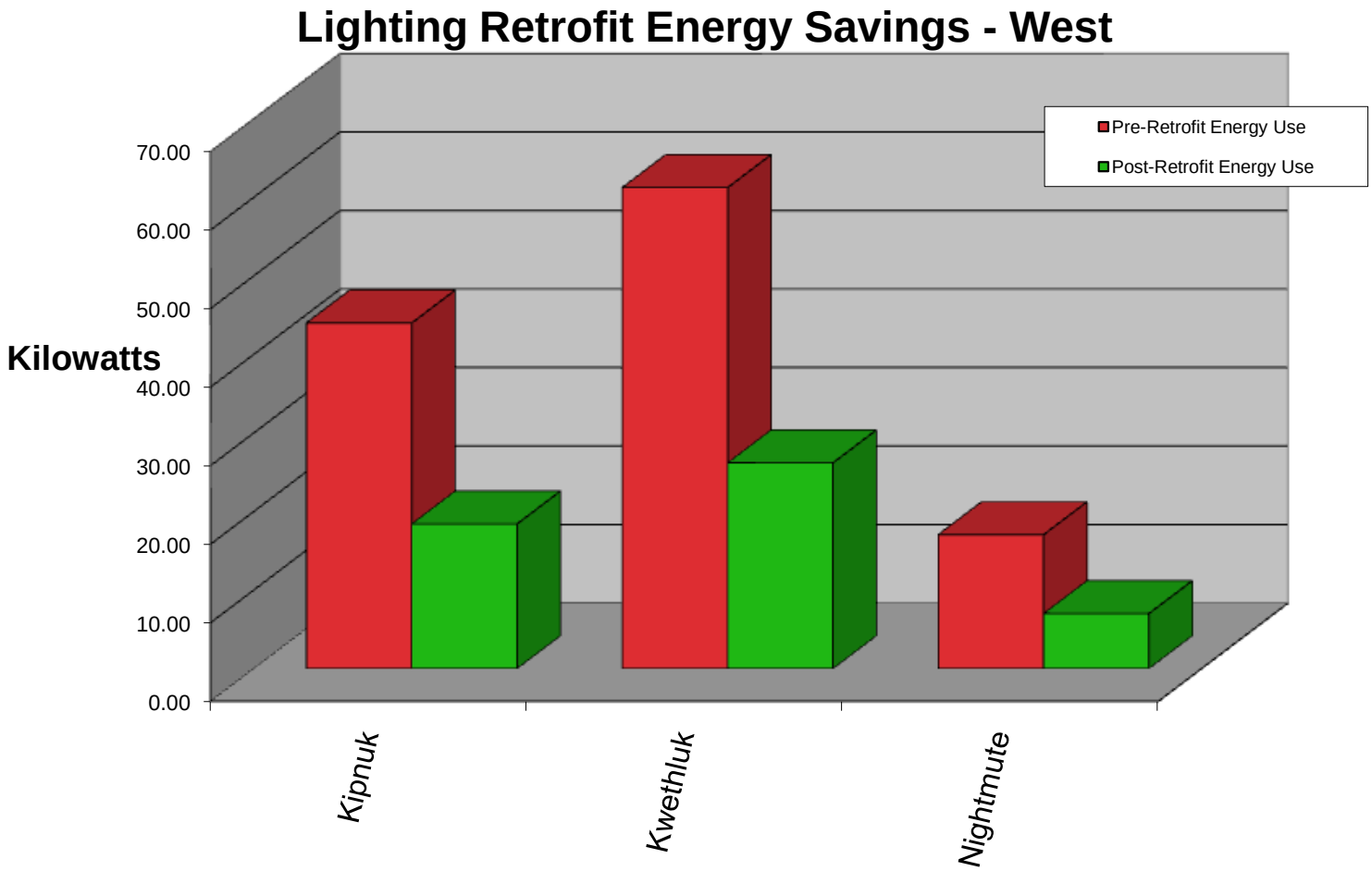
| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use (gallons) | Avoided Diesel Costs | Payback Est. (yrs) |
|---|---|---|---|---|
| 4 Hours | $ 33,523 | 6,021 | $ 18,188 | 3.36 |
| 7 Hours | $ 70,444 | 10,964 | $ 37,456 | 1.60 |
| 10 Hours | $ 83,807 | 15,052 | $ 45,469 | 1.34 |

- Total grant funds for all energy efficiency measures: $ 112,500
- Simple mean payback (All grant funds, but accounting for lighting savings only) 1.60 Years

**Additional Energy Efficiency Measures:** See Nightmute final report weatherization measures

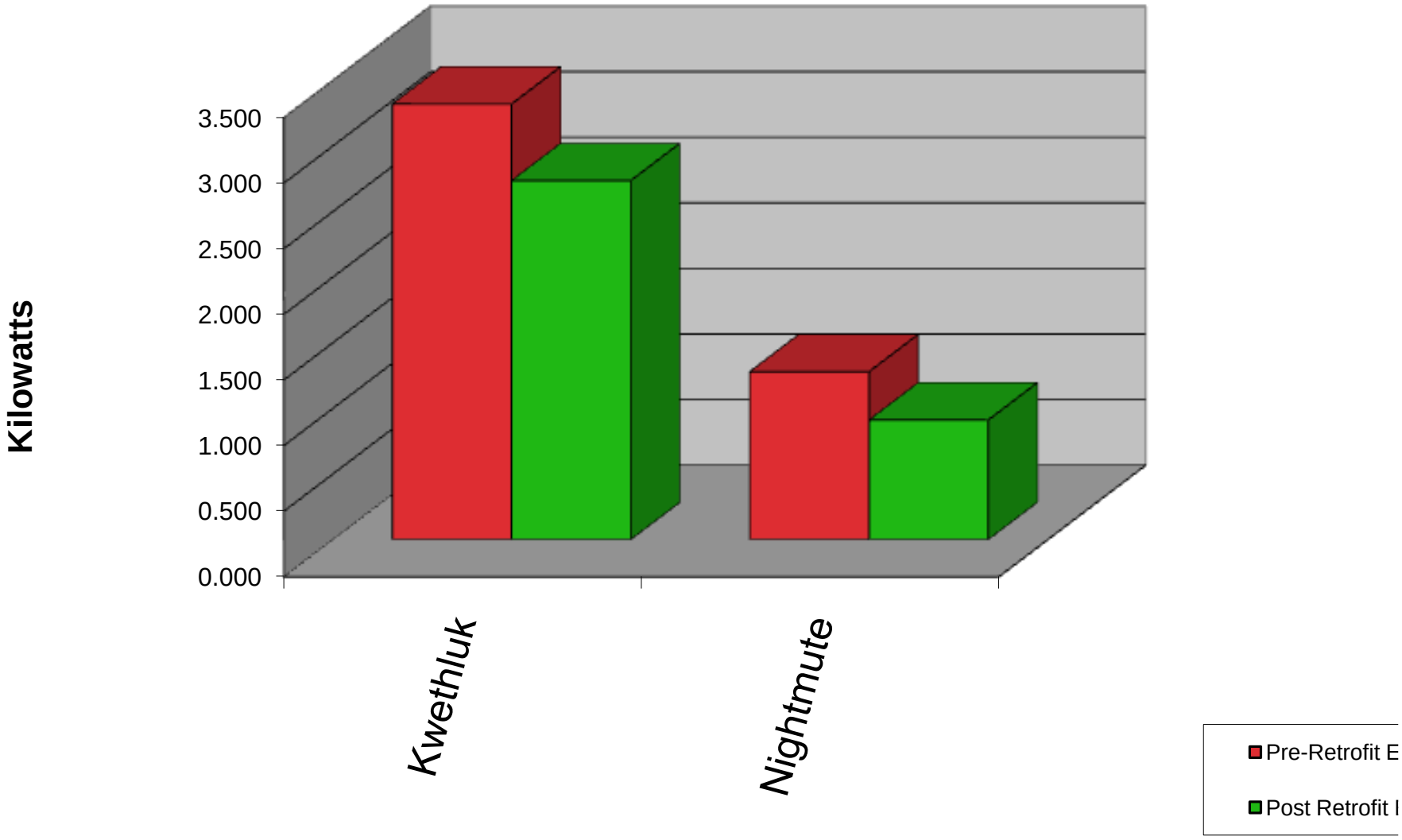



**AEA Village End Use Energy Efficiency Progam '08-'10**




**AEA Village End Use Energy Efficiency Program '08-'10**

# T5 Gym & Common Area Lighting Upgrad



## AEA Lighting Retrofit Project – Summary of Savings For '08-'10 Grant Activities With Building Use Estimates of 7 hrs / Day, 250 days/year:

| VILLAGES | Pre-retrofit Energy Use (watts) (By Grant =Total) | Pre-retrofit Energy Use (KW) (By Grant =Total) | Post-retrofit Energy Use (watts) (By Grant =Total) | Post-retrofit Energy Use (KW) (By Grant =Total) | Percent Wattage Reduction Pre to Post retrofit (By Grant =Total) | Energy Use Savings (watts) (By Grant =Total) | Energy Use Savings (kW) (By Grant =Total) | Lighting / Building Use (hrs/day) (By Grant =Ave) | Lighting / Building Use (days/yr) (By Grant =Ave) |
|---|---|---|---|---|---|---|---|---|---|
| **Kipnuk** | 43,995 | 44.00 | 18,413 | 18.41 | 58% | 25,582 | 25.58 | **7** | 250 |
| **Kwethluk** | 61,239 | 61.24 | 26,194 | 26.19 | 57% | 35,045 | 35.05 | **7** | 250 |
| **Nightmute** | 17,054 | 17.05 | 7,009 | 7.01 | 59% | 10,045 | 10.05 | **7** | 250 |
| West Totals/Ave | 122,288 | 122.29 | 51,616 | 51.62 | 58% | 70,672 | 71 | 7 | 250 |

| VILLAGES | Annual Savings (kWh) (By Grant =Total) | Electricity Cost per kWh (w/out PCE) (By Grant =Ave) | Annual Village-wide savings (dollars) (By Grant =Total) | KW Generated W/ Diesel Per Gallon(kWh/gal) (By Grant =Ave) | Annual Avoided Fuel Oil (gallons) (By Grant =Total) | Diesel Cost per gallon (By Grant =Ave) | Annual Avoided Fuel Costs (dollars) (By Grant =Total) | Total Project Costs: All grant delivery, labor, materials, shipping and, disposal costs | Simple Payback (yrs) | # of Rural Entities Worked With | # of Buildings Worked In | # of Teacher Housing Units Worked In | Est. # of Maint. Staff Worked With |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Kipnuk** | 44,769 | $0.6527 | $29,220 | 11.35 | 3,944 | $4.74 | $18,696 | $46,000 | 1.57 | 3 | 17 | 6 | 5 |
| **Kwethluk** | 61,329 | $0.5200 | $31,891 | 10.82 | 5,668 | $2.69 | $15,247 | $46,500 | 1.46 | 8 | 21 | 8 | 10 |
| **Nightmute** | 17,579 | $0.5309 | $9,333 | 13.01 | 1,351 | $2.60 | $3,513 | $20,000 | 2.14 | 5 | 12 | 4 | 16 |
| West Totals/Ave | 123,676 | $0.5679 | $70,444 | 11.73 | 10,964 | $3.34 | $37,456 | $112,500 | 1.60 | 16 | 50 | 18 | 31 |

## Lighting Strategy and Savings Estimates

During initial site visits we completed lighting assessments including quantity, locations, and wattage of existing fixtures. From initial assessments and site visits we designed lighting plans and applied various lamp and ballast combinations along with de-lamping strategies to achieve a balance of optimal energy efficiency and ample light levels. From initial assessments and our lighting retrofit plans we determined pre and post energy use by building, village entity, village-wide and region-wide. With a known energy use, we estimated energy and cost savings based on a predicted building and lighting use pattern. Since this information is variable and would require separate grant funds to determine individual building use for these projects, we are reporting our saving estimates based on 250 days / year use and a 3-tier range of 4, 7, and 10 hours/day. (See savings ranges in tables below).

For the purposes of these final reports we focus on a mean lighting use of 7 hours/day. This mid-range use time is selected to average the use pattern of all buildings in our projects. Individual buildings and individual room spaces have a wide range of use patterns. We are confident the actual savings and payback resulting from these projects will fall somewhere within our range of 4 to 10 hours a day. To ground truth our 7-hour/day average run time we sampled run time on lighting with building owners and occupants. These estimates varied largely even for the same building, but local run time estimates generally came in close (on one side or the other) to our 7-hour/day average. For the purposes of these reports we used full electricity rates including fuel surcharges and PCE amounts paid by the State of Alaska. Rates are full electrical rates published in the Alaska Energy Authority FY 2009 (July 2008 – June 2009) PCE Statistical Report. We also used the average bulk fuel price data from the AEA FY09 PCE report.

### The Oil Price Factor

With most village power generated through burning diesel fuel, the global price of oil has a profound effect on rural Alaska electricity costs. The VEUEEM grant projects covered in these final reports occurred just after the highest global oil price spike in history.
As a result, many villages had to endure the highest fuel and electric costs in their history. In the summer of 2008 the global price of oil spiked at over $150/barrel during the time window when most village entities had to order their bulk fuel for the winter of ’08-‘09. This resulted in extremely high local village fuel costs. With most village power generated through burning diesel fuel, the oil price spike caused a corresponding spike in rural electricity costs through large increases in fuel surcharges. These extreme costs of fuel and electricity in most of rural Alaska lasted through the winter of ’08 –’09, well past when the price of gas and oil related commodities dropped in the rest of road-connected America.

With the price of oil gradually decreasing from the oil price spike in late 2008, and maintaining somewhat lower through the spring and into the summer of 2009, rural utilities were able to purchase their bulk fuel at lower prices compared with 2008. With this, rural costs of electricity for many villages dropped off and stabilized at somewhat lower levels. For comparison, the West village average electricity cost for Phase 1, ’05-’06 was .48/ kWh. For Phase 2, ’07-’08, during the oil price spike, the average electricity cost was $ .66 / kWh. For Phase 3, over lapping early 2008 through January of 2010, the average cost of electricity for the current 3 villages in the West region was $ .57/ kWh.

In this discussion, it should be noted that long-term savings and payback patterns from VEUEEM lighting and other energy efficiency measures will correspond directly with fluctuations in the price of oil, with more rapid payback corresponding with higher oil prices.
Also of note on this topic, the price of village electricity and fuel are not the only elements affected by the global price of oil. The price of many materials and supplies associated with these projects rose considerably with the price of oil. Nearly all grant expenses in purchasing, shipping and travel increased in cost – thereby raising the cost of lighting measures and decreasing the number of measures beyond lighting that could be accomplished within grant budgets when compared to Phase I work completed in 2006.

## More on Savings Estimates

When considering savings estimates, it should be noted that for all practical purposes the only thing we can determine accurately is pre and post energy use. When it comes to savings, there are other questions that arise including: The volatile, global price of oil, and who actually sees the savings? If the energy use is reduced in a village, the required operating costs of a village utility must still be met. Utility rates will continue to increase to meet operating costs. Where savings occur, some will be to the State of Alaska in reduced PCE payments, and some will be to the electricity rate-payer. There is also the question of load verses capacity of a given generation system. In some cases where a generation system's capacity is over-extended, dropping the electrical load will be favorable for that utility as they may be spared the costs of generator replacement or overhaul. In other cases, if a system is somewhat oversized for the load already, an additional drop in electrical use may not be favorable to the utility or school. The optimal operating cycle of a given generator will consume a set amount of fuel over time. Reduction in electrical load may not translate directly to how much fuel is burned in a given generator.

Although these factors should be understood, the pressures of high fuel costs, coupled with facts of life in rural Alaska, necessitate the pursuit of energy efficiency programs wherever possible. Also, the trend of improved diesel generation technology, and the ability to tailor power generation levels to match load cycles, means that projects dedicated to overall load reduction are critical. This trend is another practical reason to pursue energy efficiency as an important principle.

We at ABSN continue to be pleased with the results of our work in association with these projects and are happy to be contributing toward energy efficiency cost savings for rural Alaska.

## Savings and Payback Projections '08 – '10

| Community | Annual Electrical Savings Projections | Total Project Costs | Simple Payback (yrs) |
|---|---|---|---|
| Kipnuk | $ 29,220 | $ 46,000 | 1.57 |
| Kwethluk | $ 31,891 | $ 46,500 | 1.46 |
| Nightmute | $ 9,333 | $ 20,000 | 2.14 |
| West Sub Totals | $ 70,444 | $ 112,500 | 1.60 |

**Based on hours of operation: 7 hrs/day for 250 days/year**

| Community | Annual Electrical Savings Projections | Total Project Costs | Simple Payback (yrs) |
|---|---|---|---|
| Kipnuk | $ 13,039 | $ 46,000 | 3.53 |
| Kwethluk | $ 15,420 | $ 46,500 | 3.02 |
| Nightmute | $ 5,064 | $ 20,000 | 3.95 |
| West Sub Totals | $ 33,523 | $ 112,500 | 3.36 |

**Based on hours of operation: 4 hrs/day for 250 days/year**

| Community | Annual Electrical Savings Projections | Total Project Costs | Simple Payback (yrs) |
|---|---|---|---|
| Kipnuk | $ 32,598 | $ 46,000 | 1.41 |
| Kwethluk | $ 38,550 | $ 46,500 | 1.21 |
| Nightmute | $ 12,659 | $ 20,000 | 1.58 |
| West Sub Totals | $ 83,807 | $ 112,500 | 1.34 |

**Based on hours of operation: 10 hrs/day for 250 days/year**

## Notes on Budget and Grant Spending

Our objective is to spend grant funds proportionately with scope of work, between villages to the greatest extent possible. To simplify accounting and purchasing large lighting orders are evenly split among villages and among VEUEEM grants. In financial reporting, grant expenditures are noted by village, and by the following budget categories: Field Management, Project Management, Travel Expenses, Materials, and Village Labor.

The total grant amount of $112,500 is divided by the 3 villages in proportion to the amount of lighting scope of work in each village. Weatherization measures in Nightmute are selected based on cost-benefit of the least project expense verses the most favorable savings and payback. Additionally projects are selected for measures beyond lighting according to local participation and initiative on the part of village entities to accomplish and enable projects through matching funds for labor or materials.

## Disposing and Recycling Old Lamps and Ballasts

ABSN's goal is to ensure that all old and unused lamps and ballasts are shipped out of the villages to Anchorage and points in the lower-48 for proper disposal and recycling. In cases where the existing 34-watt T-12 lamps were fairly new, village building owners sometimes prefer to keep the materials and pass them along for continued use. In most cases, lamps are at or near the end of their useful lifespan and are no longer putting out optimum light. All fluorescent lamps contain mercury and as such should not be disposed of in landfills. . As part of '05 – '06 projects, ABSN developed a system of packing and shipping used lamps and old magnetic ballasts from the villages to Total Reclaim Inc. of Anchorage - the largest recycler of fluorescent lamps in the state. From Anchorage the lamps and ballasts travel by container ship to lower 48 recycling facilities. The mercury from lamps is reclaimed, and the ballasts are recycled for their materials.

For shipping used lamps and ballasts from most villages to regional hubs we arranged free back-haul service - generously provided by Ryan Air, formerly: Alaska Transportation Service (ATS). From the hub communities back to Anchorage, Northern Air Cargo provides backhaul at slightly reduced rates as a grant to this program. Used lamps and non-PCB ballasts travel as general freight in properly sealed containers. Used lamps are categorized as non-hazardous universal waste.

Village maintenance staff packing used lamps for recycling

A village shipment of used lamps and ballasts

Bringing used lamps to the air strip

Total Reclaim Inc. Estimates over all of the regions for the VEUEM grant projects from 2006 to 2010 We have Recycled:

| | Lamps | | Ballasts | |
|---|---|---|---|---|
| Year | Amounts | Weights in Lbs | Amounts | Weights in Lbs |
| 2006 | 2,351 | 1,461 | 1,694 | 5,083 |
| 2007 | 2,232 | 1,348 | 1,215 | 3,644 |
| 2008 | 1,593 | 962 | 1,688 | 5,065 |
| 2009 | 6,030 | 3,642 | 5,341 | 16,024 |
| **2010** | 6,280 | 3,793 | 2,056 | 6,169 |
| **Totals** | **18,486** | **11,206** | **11,994** | **35,985** |

8ft, T-12 lamps prepared for recycling.

8ft lamp recycling container

8ft lamps prepared for shipping.

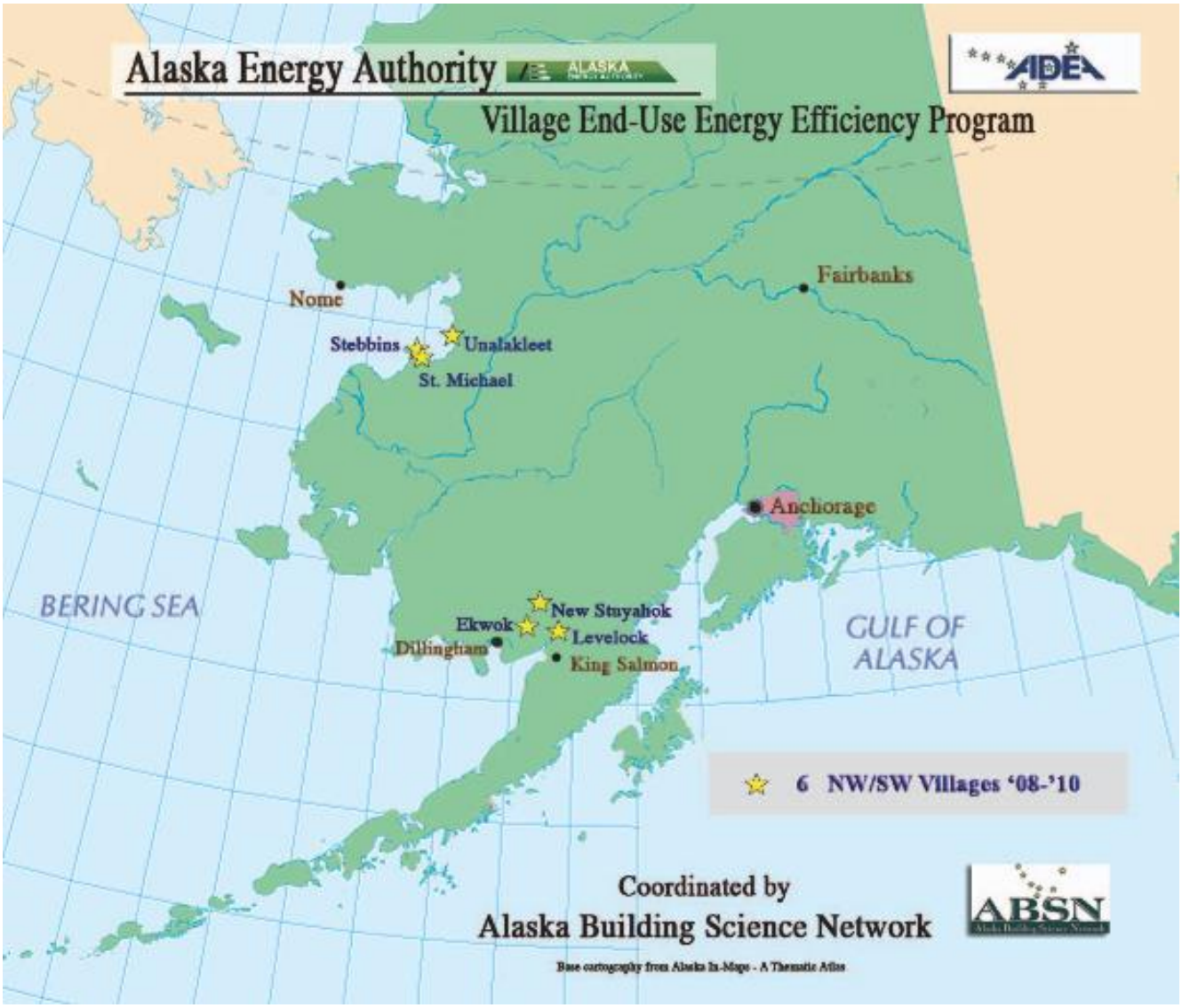
## PCB Ballast Disposal

Ballasts manufactured during or before 1979 are considered to contain PCBs, and are classified hazardous waste. In villages where PCB ballasts are found, they must be dealt with under OSHA, EPA, and DOT regulations for proper removal, transportation and disposal. In the Northwest - Southwest region, we disposed of over 147 pounds of PCB ballasts in Kipnuk, Kwethluk and Nightmute in order to complete lighting retrofits in all community buildings. As part of '05 – '06 projects, project manager Geoff Butler developed a PCB ballast removal and disposal method for village maintenance staff within EPA and DOT compliance and approved by the Alaska State OSHA office. In cases where PCB ballasts were found, proper removal procedures were facilitated by ABSN. Village building owners and their maintenance staff take responsibility for proper removal - as the generator of the hazardous waste.

| Village | Pounds of PCBS |
|---|---|
| Kipnuk | 20 |
| Kwethluk | 67 |
| Nightmute | 60 |
| TOTAL | 147 |

Village maintenance staff double checking ballasts for PCBs

DOT approved shipping manifests and haz-mat container of PCB ballasts ready for shipment




**The following 3 village reports detail lighting and additional measures undertaken in each of our 2008 – 2010 West region villages:**

# ELECTRONIC APPENDICES

## Village End Use Energy Efficiency Measures Program ’08 – ‘10
## West Region Final Reports

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**Electronic appendixes associated with these projects are provided as part of our final reports including:**

- Cover page and Final Report Executive Summary, file name:
  (**ExecSummary_Cover_West_FinalReport_08-10.doc**)

- Regional final reporting summary data, charts and calculations spreadsheets:
  (**West_SummaryReportChartData_FinalReport_08-10.doc**)

- Final reports for each village in a folder titled:
  (**West_FinalReportsVEUEEM_08-10**)

- Pre-Post retrofit spreadsheets for each village, in a folder titled:
  (**West_FinalTalleySheets_08-10**)

- Contact information for all village contacts, file name:
  (**West_Contacts _VEUEEM_08-10.xls**)

- **VEUEEM ’08 –’10 ACCESS Database**